Table F-10
Golden Eagle REA Mitigation: Extrapolation of the Relative Productivity of Electric Pole Retrofitting in 2011 Over the 30 Years Associated with the Average Life Cycle of Wind Energy Projects

Year	PV Bird-Years/pole
2011	0.210
2012	0.204
2013	0.198
2014	0.192
2015	0.186
2016	0.181
2017	0.175
2018	0.170
2019	0.165
2020	0.160
2021	0.155
2022	0.151
2023	0.146
2024	0.142
2025	0.137
2026	0.133
2027	0.129
2028	0.125
2029	0.122
2030	0.118
2031	0.114
2032	0.111
2033	0.108
2034	0.104
2035	0.101
2036	0.098
2037	0.095
2038	0.092
2039	0.090
2040	0.087
Total PV Bird-Years	4.202

Table F-11
Golden Eagle REA Scaling: Mitigation Owed for a 5-Year Permitted Take of 25 Golden Eagles (5 Eagles Annually)
(REA Step 16)

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

APPENDIX G

COMPENSATORY MITIGATION CASE STUDY[7]: POWER POLE RETROFITTING TO COMPENSATE FOR TAKE OF GOLDEN EAGLES

To offset projected and permitted take, retrofitting of non- Avian Power Line Interaction Committee (APLIC) compliant power poles has been selected by the Service as the initial focus of compensatory mitigation projects. Raptor electrocution is a known source of eagle mortality in the United States (Franson *et al.* 1995, Millsap *et al.* 2004, APLIC 2006, Lehman *et al.* 2007, Lehman *et al.* 2010). In particular, Golden Eagles are electrocuted more than any other raptor in North America; Lehman *et al.* (2007) noted Golden Eagles accounted for 50 – 93% of all reported mortalities of raptor electrocutions. Eagles often come into contact with non-APLIC compliant electric transmission poles. These poles are often responsible for the high incidence of eagle mortality, especially in open habitat devoid of natural perches.

Specific utility poles and line spans in need of retrofit due to known mortalities of eagles and other large raptors will be reviewed by the Service and selected for retrofit based on criteria specified below. Those 'problem' power poles and line spans will be referred to the utility companies to be replaced or retrofitted to make them safer for eagles.

The Service will concentrate compensatory mitigation on utility lines meeting the following categories:

1. Known eagle and raptor mortalities from specific power poles and/or span of line.
2. Located where topographic features suggest power poles and/or span of line is the sole perch, elevated above surrounding terrain, and/or provides a broad field of view.
3. Power pole and/or span of line is located 1) near and eagle territory or migration route, or 2) has a high incidence of eagles in the area documented through Breeding Bird Surveys, Christmas Bird Counts, or other annual standardized surveys.
4. Power pole and/or span of line has not received retrofit action since its initial construction.
5. Can be retrofitted within 1 year of permit issuance.
6. Power poles occur in same Bird Conservation Region as take is occurring.
7. Has already been identified as a priority replacement in an existing Avian Protection Plan.

Lehman *et al.* (2007:159) reviewed raptor electrocution literature and found that few research projects could "*demonstrate the reliability of standardized retrofitting procedures.*" Because of the lack of effective monitoring of attempts to reduce power-line mortalities through retrofitting procedures, the Service will emphasize that standardized, unbiased effectiveness monitoring techniques will be used by project proponents and utility companies involved in the compensatory mitigation process as a standard practice. Specific monitoring methods and study

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[7] This REA for this case study used parameter estimates specific to golden eagles in the western United States and applies only to take associated with wind facilities and compensatory mitigation in the form of non-APLIC compliant power pole retrofits.

design will be pre-approved by the Service prior to final contracting for any and all monitoring activities. In all phases of this process, the Service's Office of Law Enforcement will be directly involved.

As stated in the Compensatory Mitigation section, a project proponent will have three options for providing compensatory mitigation:

> *Directly contract and fund a Service-approved compensatory mitigation project* - If a project proponent elects to directly contract for the mitigation project, the number of power poles retrofitted must be equivalent to or exceed the REA-generated estimate. The project proponent will have the burden of contracting either with the utility company owning the power poles or a third party to have the power poles retrofitted to protect eagles. Within one year of permit issuance, the project proponent will be responsible for providing the Service with evidence that the mitigation project was completed in the form of 1) documentation showing that the project proponent was financially responsible for the purchase of retrofitting equipment, 2) digital photographs of each power pole retrofitted, and 3) a Geographic Information System (GIS) shapefile containing the locations of all power poles retrofitted. The utility company will be responsible for effectiveness monitoring and maintenance of the retrofits.
>
> *Contribute funds to the National Fish and Wildlife Foundation's Bald and Golden Eagle Protection Act account (NFWF BGEPA)* - If a project proponent elects to contribute to the Service's NFWF NBGEPA account, the monetary contribution will be equivalent to the cost associated with retrofitting the number of power poles generated as compensation from the REA. The Service will use an estimate of $1,000 per pole for determining the monetary contribution based on current estimates ranging from $400 to >$2,000 per pole. These funds will be used to contract directly with a utility company or third party to have power poles retrofitted or otherwise removed to protect eagles. The utility company will be responsible for effectiveness monitoring and maintenance of the retrofits.
>
> *Identify and contribute funds to a third-party mitigation account approved by the Service* - If a project proponent elects to contribute to a third party account, the monetary contribution will be equivalent to the cost associated with retrofitting the number of power poles generated as compensation from the REA. The Service will use an estimate of $1,000 per pole for determining the monetary contribution based on current estimates ranging from $400 to >$2,000 per pole. These funds will be used to contract directly with a utility company or third party to have power poles retrofitted or otherwise removed to protect eagles. Within one year of permit issuance, the contractor will be responsible for providing the Service with evidence that the mitigation project was completed in the form of (1) documentation showing that the contractor was financially responsible for the purchase of retrofitting equipment, (2) digital photographs of each power pole retrofitted, and (3) a Geographic Information System (GIS) shapefile containing the locations of all power poles retrofitted. The utility company will be responsible for effectiveness monitoring and maintenance of the retrofits.

Any fiduciary delivery method should consider the costs of compensating for permitted take via the power pole retrofitting requirement, as well as contributing additional funds to cover the account's overhead charges. For example, the NFWF has minimal overhead charges; other mitigation accounts charges vary. If the NFWF BGEPA account is charged 5% overhead, then the project proponent must cover that overhead charge in addition to the compensatory mitigation charge.

In all three options above, the utility company receiving funds from either the project proponent or a mitigation account will be responsible for monitoring the effectiveness of power pole retrofits and the post-construction maintenance. The costs associated with these activities are not included as compensatory mitigation for permitted take, and therefore, are the responsibility of the utility company. Immediately following the completion of retrofits, monitoring will begin and include: 1) an initial survey to remove all carcasses from within a 10-meter radius centered on the base of each power pole; 2) monthly surveys for no less than 24 months to identify any post retrofit mortalities; 3) all mortalities and associated information should be reported to the Service using the Bird Injury and Mortality Reporting System (BIMRS) within 48 hours; and 4) submittal of monitoring reports to the local Service Ecological Services Field Office annually.

This initial effectiveness monitoring would insure that the method selected to retrofit power poles was immediately effective in stopping raptor mortality caused by the individual pole, or string of utility structures. In addition to this effectiveness monitoring, the utility company would also be responsible for monitoring and maintaining the retrofitted poles over their lifespan; for example, insuring that the retrofit maintains its effectiveness over a period of at least 25 years. This may include replacing any damaged or degraded plastic sleeves used to eliminate or reduce electrocution risk on one or multiple power poles. For a utility company that receives mitigation funds, we encourage development of an APP if they currently do not have one in place.

Monitoring reports should include the following minimal information for any detected mortalities:

1. Date.
2. Species (eagle carcasses must be submitted to the National Eagle Repository).
3. Age and sex.
4. Band number and notation if wearing a radio transmitter or auxiliary marker.
5. Observer name.
6. Decimal-degree latitude longitude or UTM coordinates of the pole and carcass.
7. Condition of the carcass (entire, partial, scavenged).
8. Power pole identification number.
9. High resolution photo of carcass.
10. Distance of the carcass from the pole.
11. Azimuth of the carcass from the pole.
12. Type of power pole.
13. High resolution photo of pole (to include the electrical structure).

As an example of how this process will work regarding contributions to the NFWF BGEPA account (or similar account), we provide the following example derived from the REA for the annual take of five Golden Eagles:

> For this example, we assume an annual take of five Golden Eagles over a five year renewable permit, starting in 2011. This power pole retrofit would occur in calendar year 2011, thus avoiding the potential loss of Golden Eagles from electrocution. Proper operation and maintenance 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. The REA has estimated 116 power poles will need to be retrofitted to compensate for the estimated take of 25 eagles. 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. If the project proponent chooses to contribute to an account, the cost will be $116,000 ($1,000 per pole X 116 poles) plus any administrative account overhead charges. At the 5 year renewal period for the life of the project, the Service will generate a new REA estimate for compensatory mitigation based on revised take estimates and any new cost estimates.

APPENDIX H

STAGE 5 – POST-CONSTRUCTION MONITORING RECOMMENDED METHODS AND METRICS

1. Fatality Monitoring

Fatality monitoring must be conducted at all wind facilities to meet regulatory permit requirements and should include a rigorous monitoring design that is able to accurately detect mortality events that result from all aspects of the facility operation (e.g., turbine collision, electrocution, collision with utility lines, etc). Fatality monitoring for eagles can be combined with monitoring mortality of other wildlife (and herein we borrow heavily from the *U.S. Fish and Wildlife Service Draft Wind Energy Guidelines*) so long as sampling intensity takes into account the relative infrequency of eagle mortality events. Fatality-monitoring efforts involve searching for eagle carcasses beneath turbines and other facilities to estimate the number of fatalities. The primary objectives of these efforts are to: (1) estimate eagle fatality rates for comparison with the model-based predictions prior to construction, and (2) to determine whether individual turbines or strings of turbines are responsible for the majority of eagle fatalities, and if so, the factors associated with those turbines that might account for the fatalities and which might be addressed via Advanced Conservation Practices (ACPs). This information is also relevant for evaluating micro-siting options when planning a future facility or expansion of the existing facility.

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

Some general guidance is given below with regard to the following design issues relative to protocols for fatality monitoring:

1. Duration and frequency of carcass searches.
2. Number of turbines to monitor.
3. Delineation of carcass search plots, transects, and habitat mapping.
4. General search protocol guidance.
5. Field bias and error assessment.
6. Estimators of fatality.

More-detailed descriptions and methods of fatality-search protocols for wildlife in general can be found on the Service Wind website at (http://www.fws.gov/habitatconservation/windpower/wind_turbine_advisory_committee.html).

a. Duration and Frequency of Carcass Searches

As noted previously, fatality monitoring will be required for a minimum of three years at all permitted facilities, likely followed by at least two additional years (or potentiallymore if permits are renewed), perhaps at lower intensity, to assess effectiveness of ACPs. This requirement is consistent with the permit condition stating that periodic monitoring may be required for as long as the data is needed to assess eagle impacts for ongoing activities that continue to cause take (50 CFR 22.26(c)(2)). The carcass-searching protocol should be adequate to estimate the density of eagle carcasses at an appropriate level of precision to make general conclusions about the project.

Carcass searches should occur in all seasons when eagle use of the project area is expected. The sampling protocol should take into possible temporal stratification to account for seasonal pulses in eagle occurrence. The search interval is the interval between carcass searches at individual turbines, and this interval may be lengthened or shortened depending on the carcass removal and decomposition rates and results of field bias and error trials. For large birds like eagles where carcass removal rates are typically low, a longer interval between searches may be sufficient. We recommend using a pilot study to determine an appropriate sampling frequency needed to estimate the density of eagle carcasses with a coefficient of variation (CV) of about 0.2.

b. Number of Turbines to Monitor

We recommend that a sufficient number of turbines be selected via a systematic sample with a random start point. A power analysis could be a useful tool to help decide the appropriate number of turbines to sample to achieve the desired CV in the fatality estimate. Sampling plans can be varied (e.g., rotating panels [McDonald 2003, Fuller 1999, Breidt and Fuller 1999, and Urquhart et al. 1998]) to increase efficiency as long as a probability sampling approach is used. If the project contains fewer than 10 turbines, it is recommended that all turbines in the area of interest be searched unless otherwise agreed to by the permitting or wildlife resource agencies. When selecting turbines, it is recommended that a systematic sample with a random start be used when selecting search transects to ensure interspersion among turbines. Stratification among different habitat types also is recommended to account for differences in fatality rates among different habitats (e.g., grass versus cropland or forest); a sufficient number of turbines should be sampled in each strata.

c. Delineation of Carcass Search Transects and Habitat Mapping

We recommend using a transect-based distance sampling framework for estimating fatalities (Buckland *et al.* 2001, 2004; Laing *et al.* 2003; Rivera-Milán *et al.* 2004). Three studies in Wisconsinshowed that bird carcasses could be found at least100 meters from the turbines (BHE Environmental, Inc. 2010; Drake *et al.* 2010; Gruver *et al.* 2009). We recommend using this distance as a general guide for placing transects relative to turbines, but final decisions regarding search transect placement should be made in discussions with the Service, state wildlife agency, local permitting agency, and/or tribes. Transect placement also needs to take into account distance-sampling assumptions that will need to be met in order to draw proper inferences from the data, including the assumption that transect distribution is independent of eagle carcass distribution (e.g., the perpendicular distance between any carcass and the transect centerline is independent of where the observer is along the centerline). Transects may need to be stratified according to vegetation or ground-cover class where delectability differs markedly between classes. If transects are so stratified, detection and removal biases need to be estimated for each class.

Fatality estimates in the form of carcass density estimates should be made for each class and summed for the total area sampled. Global positioning systems (GPS) are useful for accurately mapping the actual total area searched and area searched in each habitat visibility class, which can be used to adjust fatality estimates.

d. General Search Protocol Guidance

Personnel trained in proper search techniques should look for wildlife carcasses along transects or subplots within each plot and record and collect appropriate data (e.g., exact perpendicular distance from the transect center-line, GPS coordinates, and ancillary data outlined below).

Some locations and circumstances may best be searched using alternative methods such as human and dog teams (Arnett 2006). The olfactory capabilities of dogs could greatly improve the efficiency of carcass searches, particularly in dense vegetation (Homan *et al*. 2001) but using dogs also presents unique challenges that should be considered on a case by case basis. Other experimental mortality detection approaches (e.g., the use of bird-strike indicator sensors, such as microphones, accelerometers or fiber optic sensors, video cameras, or radar to identify circumstances of bird fatalities) are encouraged, but should be considered supplemental to transect surveys until their accuracy and utility has been confirmed by the project proponent and the Service. Where special techniques are employed to increase fatality detections, metadata associated with searches needs to clearly indicate when these tools were employed and when they were not so analyses can be appropriately partitioned.

Data that should be recorded for each search include:

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

When a dead eagle is found, we recommend that the searcher place a flag near the carcass and continue the search. After searching the entire plot, the searcher should return to each carcass and record the following information on a fatality data sheet:

1. Date.
2. Species.
3. Age and sex (following criteria in Pyle 2008) when possible.
4. Band number and notation if wearing a radio-transmitter or auxiliary marker.
5. Observer name.
6. Turbine or pole number or other identifying character.
7. Distance of the carcass from the turbine or pole.
8. Azimuth of the carcass from the turbine or pole.
9. Decimal-degree latitude longitude or UTM coordinates of the turbine or pole and carcass.
10. Habitat surrounding the carcass.
11. Condition of the carcass (entire, partial, scavenged).
12. Description of the mortality (e.g., effect, wing shear, etc.).
13. Estimated time of death (e.g., ≤1 day, 2 days, etc.), and how estimated.
14. A digital photograph of the carcass should be taken.
15. Information on carcass disposition.

In some cases, eagle take permits may specify other biological materials or data that should be collected from eagle carcasses (e.g., feathers, tissue samples). Rubber gloves should be used to handle all carcasses to eliminate possible disease transmission and to reduce possible human-scent bias for carcasses later used in scavenger removal trials. All eagle fatalities (not just those found on post-construction surveys) and associated information should also be immediately reported to the OLE if the project proponent does not have a permit and to the Service's migratory bird permit issuing office if they have an eagle take permit. Mortality should also be reported to the Bird Injury and Mortality Reporting System (BIMRS) within 48 hours of discovery of a carcass. Examples of survey and fatality data sheets proposed for use should be included as attachments to the project proponent's ECP.

e. Field Bias and Error Assessment

Carcass searches underestimate actual mortalities at wind turbines. With appropriate sampling, however, carcass counts can be adjusted to account for biases in detection. Important sources of bias and error include: (1) low or highly variable fatality rates; (2) carcass removal by scavengers; (3) differences in searcher efficiency; (4) failure to account for the influence of site (e.g., vegetative) conditions in relation to carcass removal and searcher efficiency; and (5) fatalities or injured birds that may land or move outside search plots.

In situations like (1) above, when fatalities occur sporadically or in pulses, sampling error may be high. To account for this, we recommend that a sample of turbines be searched much more often than the overall sampling frame. To address bias categories 2-4 above, we recommend that all fatality monitoring efforts conduct carcass removal and searcher-efficiency trials using accepted methods (Kunz *et al.* 2007, Arnett *et al.* 2007, NRC 2007, Huso 2010; also see the

Service Wind website at:
http://www.fws.gov/habitatconservation/windpower/wind_turbine_advisory_committee.html).
Bias trials should be conducted throughout the entire monitoring period and searchers should be unaware of which turbines are to be used or the number of carcasses placed beneath those turbines during trials. There is no suitable method for addressing bias category 5 at present, although we anticipate that with increased post-construction monitoring, this factor will become better understood.

We recommend the following basic approach in designing bias and removal trials. Prior to a trial's inception, a list of random turbine numbers and random azimuths and distances (in meters) from turbines should be generated to guide placement of each carcass used in bias trials. Date of placement, species, turbine number, distance and direction from turbine, and visibility class surrounding the carcass should be recorded for each carcass. Before placement, each carcass should be uniquely marked in a manner that does not cause additional attraction, and its location should be recorded. There is no agreed upon sample size for bias trials, though some state guidelines recommend from 50 to 200 carcasses.

f. Disturbance Monitoring

Project proponents will also be required to monitor many of the eagle nesting territories and communal roost sites identified in the Stage 2 assessments for at least three years after project construction as stated in the permit regulations at 50 CFR 22.26(c)(2). The objective of such monitoring will be to determine if changes in (1) territory or roost occupancy rates, (2) nest success rates, or (3) productivity occur after project construction. Changes will be determined based on comparisons with mean values for each parameter from the Stage 2 assessment.

Eagle nesting territories most likely to be affected by disturbance from a wind facility are those that have use areas within or adjacent to the project boundary. In the absence of radio- or satellite-telemetry data to delineate the precise use areas of proximate nesting eagle pairs, the Service will accept an assumption that all pairs within the mean project-area inter-nest distance (as determined from the Stage 2 assessment) of the project boundary are territories that may be at risk of disturbance (e.g., if the mean distance between simultaneously occupied eagle territories in the Stage 2 assessment is five miles, we would expect disturbance to most likely affect eagles within 5 miles of the project boundary; Figures H-1 though H-4).

Where nesting habitat is patchy or eagle nesting density is low such that nearest neighbors are outside the survey area, we recommend either: (1) using a nearest-neighbor distance at the upper end of what has been recorded for the species in the literature as the project-area inter-nest distance (6.2 miles for Golden Eagles in western North America [Millsap 1981, Kochert *et al.* 2002], and 1.2 miles for bald eagles, from a study in Alaska [Sherrod et al.1976, Buehler 2000]); (2) extending the survey area outward to include nearest-neighbors (which, in this case, lie outside the project-area nesting-population boundary) for the purposes of estimating this value; or (3) undertaking detailed observational or radio- or satellite-telemetry studies of the adult eagles using the isolated nest site(s) to determine the home-range size. Regardless which approach is used, territories that meet this distance criterion should be re-sampled annually for at least three years post-construction following identical survey and reporting procedures as were used in the Stage 2 assessment.

If differences in territory occupancy, nest success, or productivity (taking into account statistical power limitations on detecting significant differences based on sample sizes) are observed, project proponents and the Service will consider possible ACPs that might reduce or eliminate disturbance, and if none are available, project proponents may be required to provide compensatory mitigation to offset the observed effective increase in mortality to the extent necessary to meet the statutory requirement to preserve eagles. For example, if the three-year average for productivity of proximate eagle territories in the Step 2 assessment was 0.8 young per territory over five territories, and during the post-construction monitoring the average was 0.2 young over the same five territories, the effective annual mortality rate from disturbance is 3 eagles per year.)

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

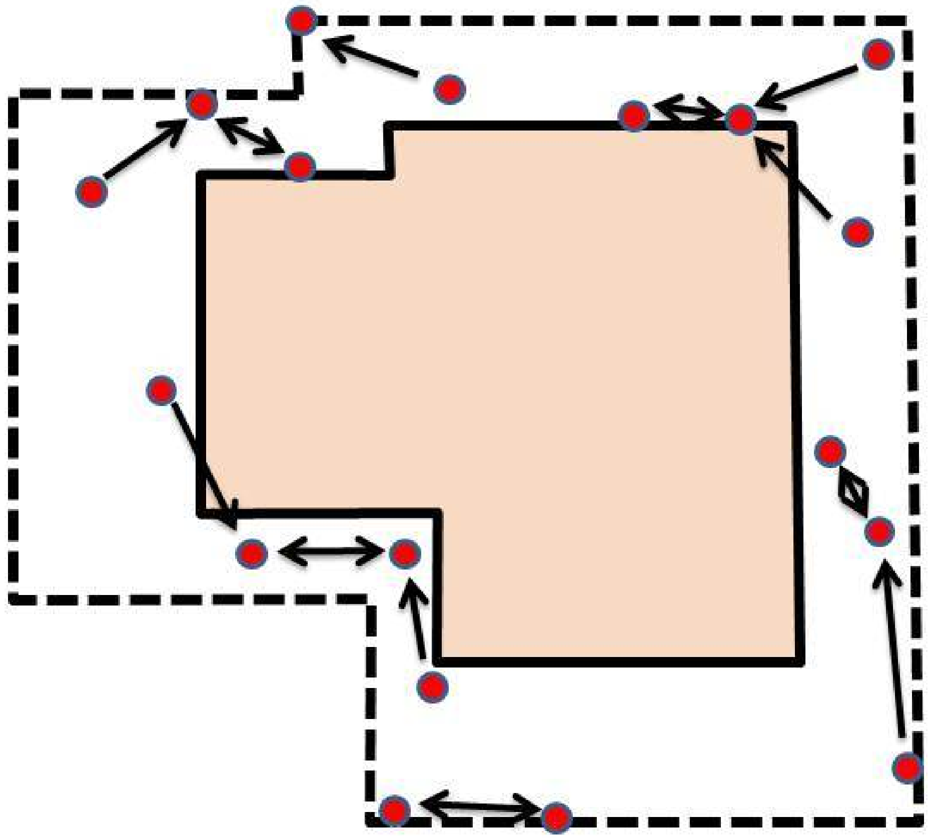

Figure H-1. Map showing hypothetical wind-facility project footprint (area inside the solid-black line, shaded peach), and the recommended project-area for eagle-use area surveys in Stage 2 (inside the dotted line). Red dots denote occupied eagle nests. Arrows represent distance measurements that would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

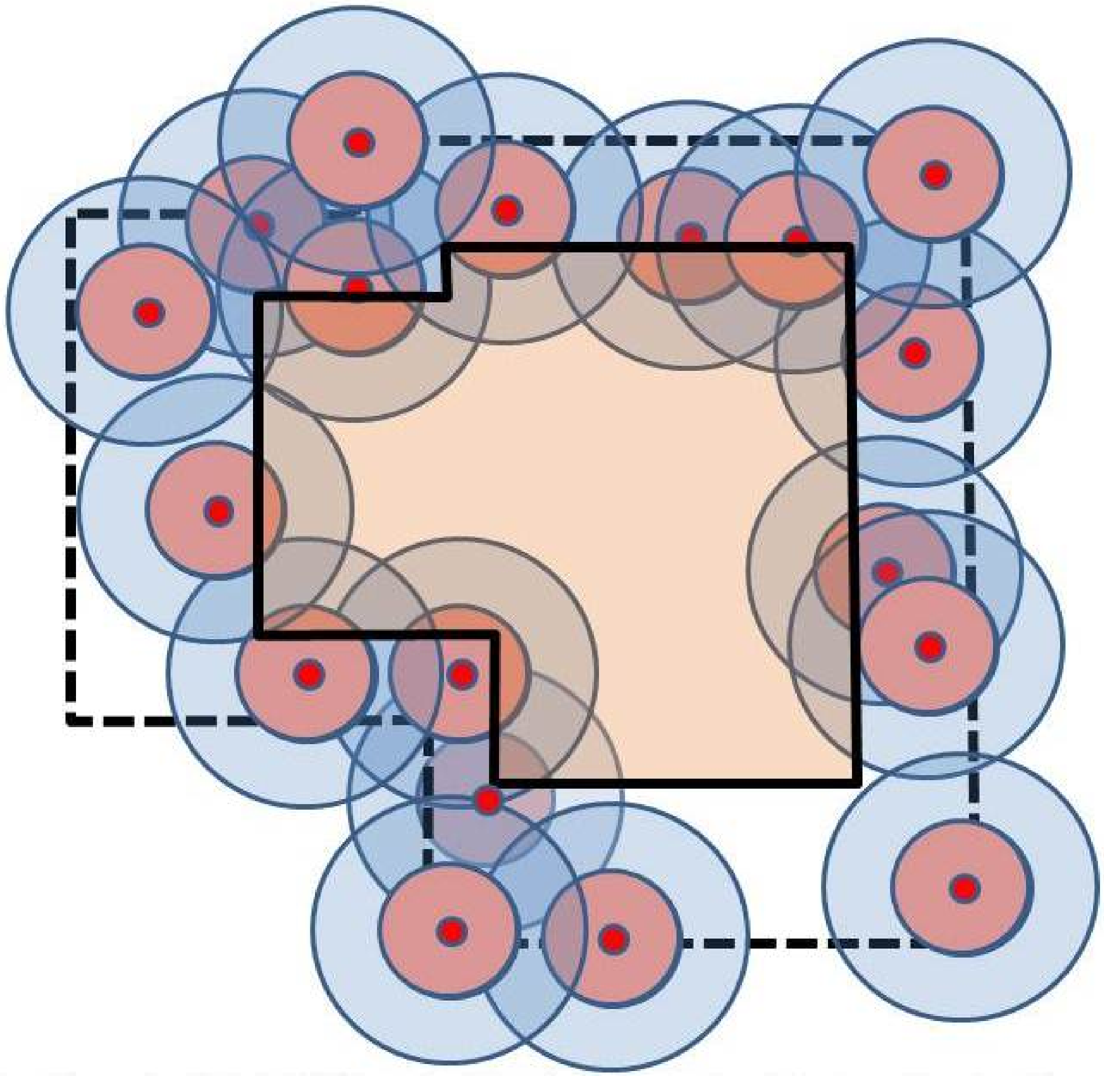

Figure H-2. Map of the same hypothetical wind-facility project as in Fig. H-1. Circles around occupied nests are at the radius of the mean project-area inter-nest distance (blue rings), and ½ the mean project-area inter-nest distance (pink rings), both calculated from the distance measurements collected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

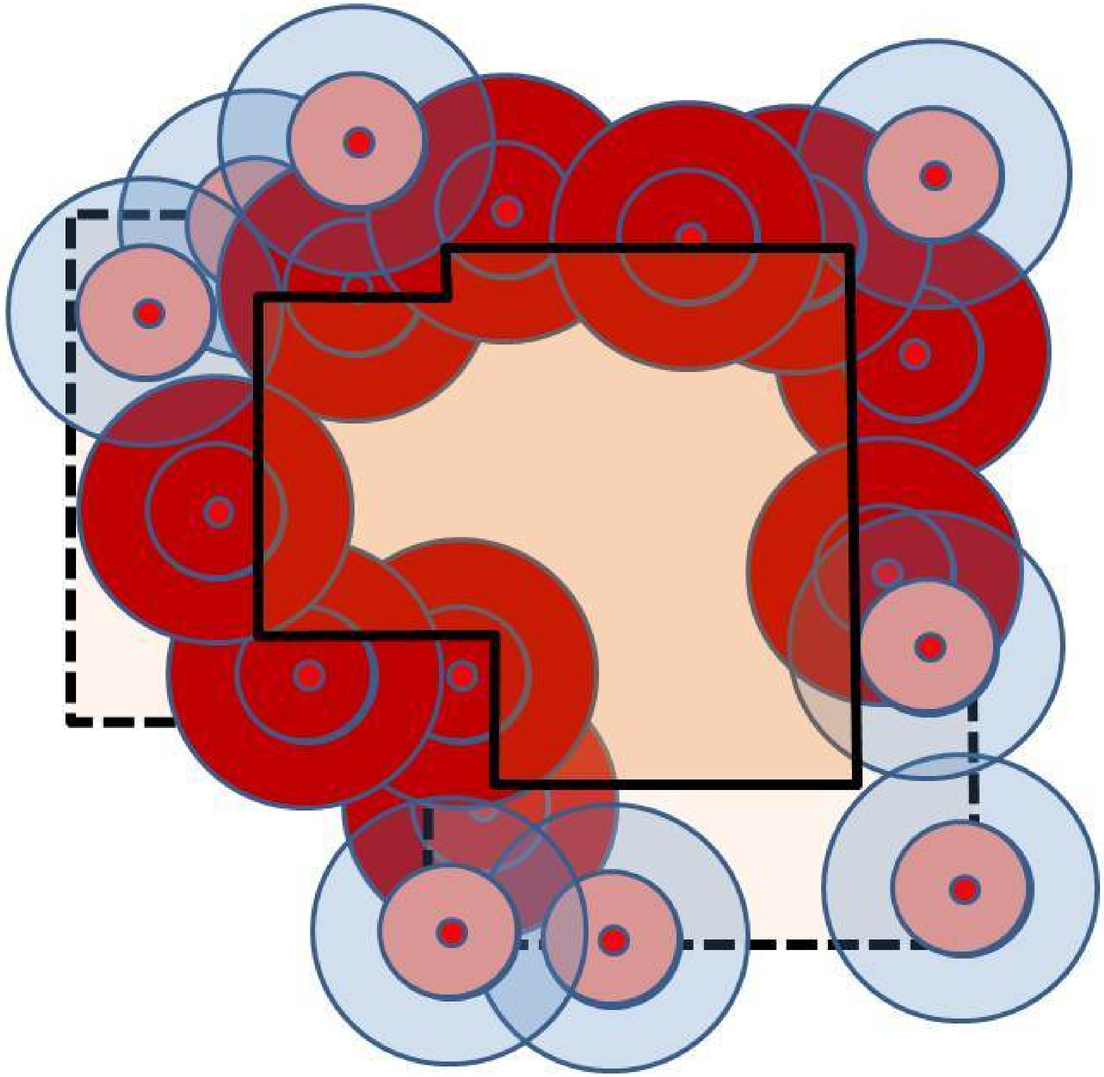

Figure H-3. Map of the same hypothetical wind-facility project area as in Figures H-1 and H-2, after applying site categorization criteria from the Guidelines. The site currently is in category 1 because the footprint includes important eagle-use areas, specifically the area within ½ the project-area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

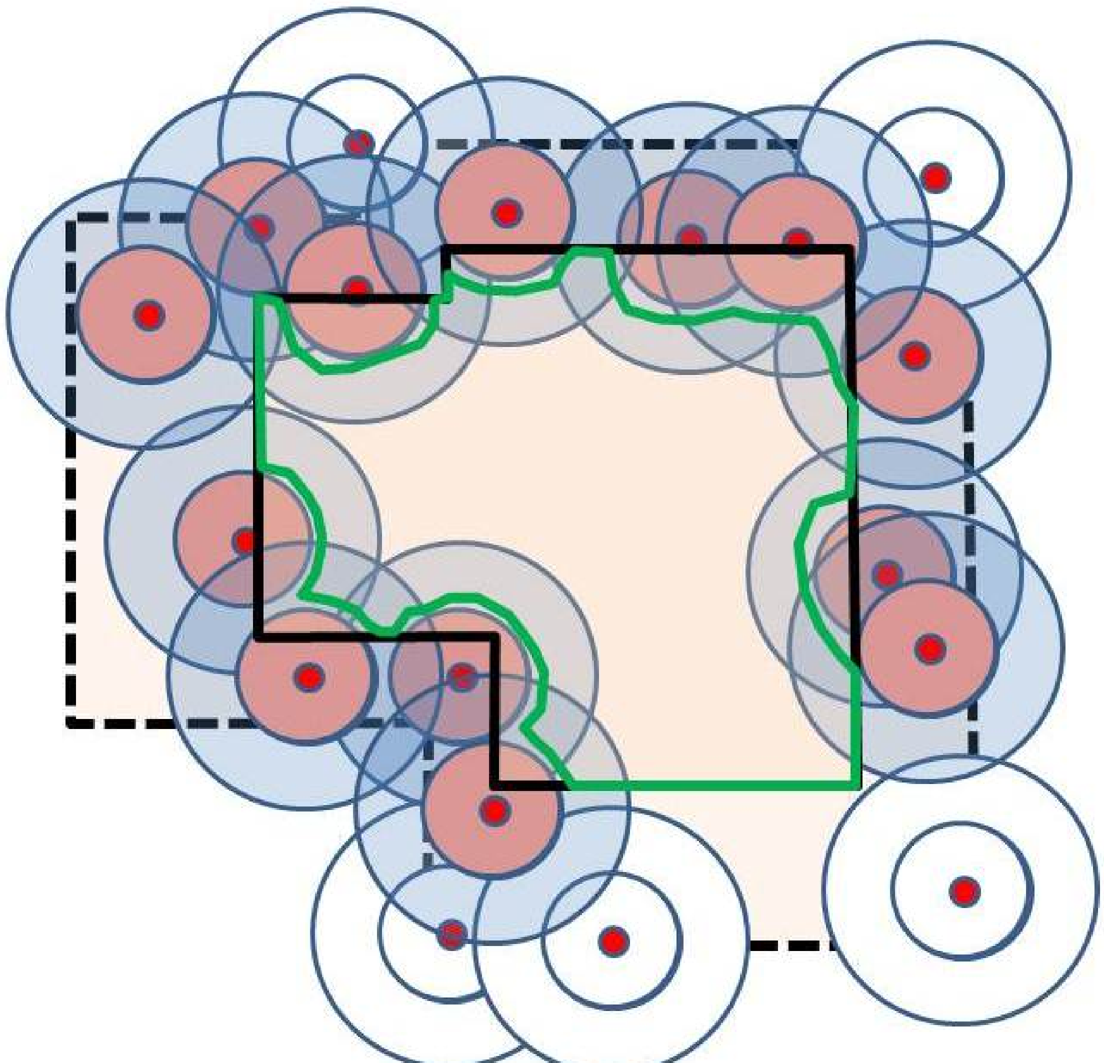

Figure H-4. The same hypothetical wind-facility project as in Figures H-1 – H-3, but re-designed such that the green line now includes the project footprint. The re-design results in the site now being placed in category 2. If the project moves forward and the project proponent receives a programmatic eagle take permit, those territories that are shaded should be monitored for disturbance effects following Stage 5 recommendations because they are at or within one project-area inter-nest distance of the project footprint.

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Rowan Gould, Director U.S. Fish and Wildlife Service

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Paul R. Schmidt, Assistant Director Migratory Bird Program, U.S. Fish and Wildlife Service

REGULATING AVIAN IMPACTS UNDER THE MIGRATORY BIRD TREATY ACT AND OTHER LAWS: THE WIND INDUSTRY COLLIDES WITH ONE OF ITS OWN, THE ENVIRONMENTAL PROTECTION MOVEMENT

John Arnold McKinsey[*]

I. INTRODUCTION

In the renewable energy sector, wind-based energy development continues to expand. Federal and state-based programs encourage the development of renewable energy, and wind appears to be taking the lead. Conferences focused in wind energy abound, many at capacity. Many utilities and traditional energy

* John Arnold McKinsey is an attorney at the law firm of Stoel Rives LLP where he practices siting and development law for the energy industry. A former nuclear power plant operator on submarines in the U.S. Navy, he obtained his B.A. from California State University, Sacramento and his J.D. from University of California, Davis.

companies are aggressively entering this sector. Amidst this booming era for wind energy, however, some problems have been gradually developing. Most are the types of problems any industry expansion must endure, such as equipment reliability problems with new, significantly larger scale, wind turbines.[1] Larger wind turbines mean more visibility, which, predictably, increases the likelihood of visual and aesthetic impact issues.[2] Transmission-related constraints have also arisen as wind energy deals with one significant disadvantage compared to fossil fuels: its immobility. Transmission must come to wind facilities, not vice-versa.[3]

One particularly interesting problem emerging in the wind industry, however, involves a long-time friend of the industry and a long-known issue. Wind energy, like most forms of renewable energy, has long been promoted as being environmentally friendly. To some extent, that is one reason for the push toward renewable energy—the reduced environmental footprint of renewable energy.[4] Thus, many protectors of the environment, long concerned over the effects of excess combustion of fossil fuels in generating electricity, promoted, if not championed, renewable energy in general and, in particular, wind energy. Wind energy is valued in part for its "green" character. It has no direct emissions of air contaminants or green house gasses, and involves almost no recognizable environmental harm in its installation and operation. That is, except for birds.

Avian impacts, originally mostly ignored by many in the development of wind energy, have become a significantly more visible issue for many wind projects.[5] In part, this is due to wind energy's success. As wind energy's role in the United States electricity industry has grown, so too has notice of avian impacts. Birds and bats,[6] of course, collide with wind turbine blades as they

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1. During the first major development of wind energy following the energy crises of the 1970's, many designs of gearboxes in the wind turbines that stepped up the slow rotation of the blades to the higher speeds needed for the electricity generator prematurely failed. To some extent, the development of wind turbines was a large field test for the designs. To a lesser degree, the same field test is occurring again with new gearboxes that are larger in scale and size.

2. Witness the controversy raised over the Cape Wind Project off the coast of Massachusetts, where opponents have brought national attention to the visual/aesthetics issues surrounding modern, large wind turbines.

3. In this sense, wind and geothermal energy share the same burden, as both are geographically dependent. Solar, on the other hand, has significantly more flexibility, in terms of being able to be sited near major transmission corridors.

4. Because of their higher supposed environmental impacts, some forms of renewable energy are not as universally embraced, namely bio-mass combustion, hydro-electric, and geothermal power. Wind, solar, and some proposed forms of ocean, wave, current, or tidal energy systems are more universally accepted as "renewable" energy.

5. That is not to say that avian impacts are a new issue to the wind energy industry. The issue has been around for decades. Avian impacts are simply getting harder to resolve and beginning to hinder wind energy development.

6. Bats are not members of the avian class, but rather flying mammals; more specifically order Chiroptera of the class Mammalia. Bird are members of the sister class Aves. Both classes are members of phylum Chordata (vertebrates) of the Animalia kingdom. Bats are treated similar to birds for wind energy purposes because the nature of the impact upon them is the same. As noted later, bats present different issues in terms of assessing impacts because they are nocturnal. In many cases, bats present difficult problems for wind energy projects.

rotate in the sky.[7] Such impacts, often referred to as "avian mortality," would normally be evaluated and managed like many other undesired environmental side-effects. Avian impacts present an awkward issue for the environmental protectors that promoted wind energy. The historical origins of the wind energy industry, combined with several complicating federal laws—the Migratory Bird Treaty Act (MBTA)[8] in particular—have created a growing issue with no resolution in sight. How well the wind industry deals with avian impacts may determine the ability of the industry to continue its amazing success.

This article explores the complexity, and perhaps irony, of the avian impacts issue facing the wind industry. Section II provides background on the history and make up of the wind energy industry and its regulation. Section III explains the laws protecting avian wildlife, particularly the MBTA. The application and enforceability of the MBTA is explained in light of several recent cases that may lead to increased enforcement of the act against some wind projects. Section IV explores the confrontation between wind energy, with its avian impacts, on the one hand and the wildlife protection laws, with their green values and supporters, on the other hand. Section V evaluates the proposed root of the problem, conflicting values, and considers what policy and actions should be taken to resolve the conflict. The article concludes with a call for action by both the legislature and the agencies tasked with enforcement to create a cohesive and updated balance of law and policy that will allow the United States to further tap into its important and vast wind energy resource.

II. BACKGROUND

Wind energy has long been harnessed for its energy content. In terms of electricity production, the energy policies of the late 1970's and early 1980's sparked the first major explosion or growth of wind-based production of electricity. That period of growth lulled in the 1990's, but a new era of growth in the wind energy industry has begun. The current era of growth is fueled in part by improvements in the competitiveness of the underlying technology and in part by governmental policy, incentives, and laws supportive of renewable energy in general and wind energy in particular. The Energy Policy Act of 2005 (EPAct 2005)[9] is one example of recently enacted law and policy that has helped fuel the latest growth in wind energy.

EPAct 2005 promotes renewable energy by providing numerous incentives and assistance to the development of renewable forms of energy. Many states have also taken action to require or encourage the development of renewable energy. A key state-based program has been the Renewable Portfolio Standard (RPS) which requires energy utilities to procure certain percentages of their

7. A seemingly curious debate has long been whether the bird strikes the blade or the blade strikes the bird. The outcome of that debate, however, has serious ramifications for liability and is thus much more than a curious question.

8. 16 U.S.C. §§ 703-11 (2000).

9. Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594.

energy from renewable sources.[10] In general, renewable energy is in favor. The term "renewable energy," however, is not without debate as to its meaning.

Generally, renewable energy can be thought of as a source of electricity, heat, or combustible fuel that is consumed at a sustainable pace such that the earth's natural processes replenish those sources at a rate equal to or greater than the depletion.[11] Wind, solar, and geothermal energy are all generally considered types of renewable electricity sources. Of these sources of renewable electricity, harnessing wind energy appears to have the greatest potential for short term development when competitiveness and size of the resource are considered.[12] In 2005, developers installed 2,431 megawatts of wind energy capacity in the United States.[13] Wind energy generation capacity in the United States has grown from essentially zero in 1980 to more than 9,976 MW in 2006.[14]

Wind energy's success in responding to the call for more renewable energy is largely driven by improvements in efficiency, which in turn, are largely driven by a significant increase in the scale of wind projects. Whereas in the 1980's, typical wind projects might have used fifty small turbines and produced five megawatts,[15] today's wind projects might use fifty large wind turbines to produce 100 megawatts.[16] Thus, wind energy facilities have reached the "utility" scale where they are comparable in capacity to a thermal power plant combusting fossil fuels. At the same time, wind energy pricing has come down to close-to comparable levels as well. Wind energy facilities can produce electricity at prices reaching perhaps as low as five cents per kilowatt-hour, compared to three cents per kilowatt-hour for a combustion gas turbine power plant.[17] Since there are significant regions in the United States with untapped wind generation potential, the incentives for and encouragement of renewable energy have led many companies and individuals into a wind land rush. Traditional energy companies, such as Florida Power and Light and AES have joined the ranks of companies devoted to renewable or wind energy, such as Horizon Wind Energy or enXco. Electrical cooperatives, investor owned utilities, and municipal utilities are also increasingly making efforts to develop wind energy.

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10. Adoption of requirements for energy utilities to procure certain percentages of their energy from renewable sources is common. Renewable Portfolio Standards (RPS) programs are the most common.

11. To some, renewable energy is equated with "soft path" energy, a concept that originated with Amory Lovins in the 1970's. Soft path technologies are those that minimize total social cost, those that are the most resource efficient. For many today, renewable energy is equated with "green energy", energy that is less harmful to humans or the natural environment.

12. American Wind Energy Ass'n, *Wind Energy Fact Sheets*, AWEA, Jan. 1, 2007, *available at* http://www.awea.org/pubs/factsheets.html [hereinafter AWEA *Fact Sheets*].

13. *See* American Wind Energy Ass'n, 3 NORTH AMERICAN WINDPOWER 3, at 6 (2006).

14. AWEA *Fact Sheets*, *supra* note 12.

15. The first generation wind turbines available in the early 1980's had up to 25 kilowatts of capacity and reached over 100 feet high. A 100 kilowatt turbine quickly became a common size.

16. Common wind turbines today are available in 1.0, 1.5, 2.0, and 2.5 megawatt sizes. They stand more than 300 above the ground.

17. Wind energy cost varies with the wind energy content of each site whereas fossil fuel powered energy cost varies with fuel costs. Both vary significantly based on location and time.

III. FEDERAL AND STATE LAWS PROTECTING WILDLIFE

The most problematic wildlife protection law for the wind industry is the MBTA. Other laws, however, are actually more aggressively enforced and applied to wind energy projects. Those other federal laws have viable compliance mechanisms in place that allow the wind industry to attempt to manage the development process while dealing with the law. In some cases, however, even compliance mechanisms fail to resolve impact issues. Similarly, state laws often have regulatory mechanisms allowing projects to deal with impacts they may cause. As applied to wind projects, however, the MBTA, lacks compliance mechanisms, making the MBTA much like a sword of Damocles that could come swooping down at any time. As wind energy grows and moves into ever more regions and habitats, and as wind energy projects grow in scale, even routine wildlife protection laws have become more difficult to navigate.

A. Endangered Species Act

The Endangered Species Act (ESA)[18] is perhaps the most recognized federal wildlife law.[19] For avian issues, the ESA is enforced by the United States Fish and Wildlife Services (USFWS).[20] The ESA prohibits the unauthorized take of a listed species.[21] Take is broadly defined to include not only injury or death to a bird, but also can include destruction of an essential habitat.[22] Where a project can anticipate the taking of species, an incidental take permit can be obtained allowing the take to occur as authorized.[23] The USFWS can be required to consult regarding a project's compliance with the ESA where a project requires other federal agency approvals.[24] For projects lacking federal involvement, project owners can request USFWS consultation. Violations of the ESA can lead to criminal prison sentences and penalties. Civil penalties can be as much as $25,000 per violation where as criminal penalties can reach $50,000 and up to one year in prison per violation.[25]

Several bats are listed as endangered or threatened species under the ESA.[26] As discussed further below, bat kills can present a significant problem for wind projects operating in an environment containing bats listed under the ESA.[27]

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18. 16 U.S.C. §§ 1531-43 (2000).

19. For an overview of the ESA, *see generally* THE STANFORD ENVIRONMENTAL LAW SOCIETY, The Endangered Species Act (2001).

20. The USFWS is a division of the Department of the Interior. The ESA assigns the Secretary of the Interior to enforce the ESA. *See also*, 16 U.S.C. § 1533(a) (2000).

21. 16 U.S.C. § 1531 (2000).

22. *Id*. at § 1532.

23. 16 U.S.C. § 1539 (2000).

24. Referred to as a "Section 7 consultation."

25. 16 U.S.C. § 1540 (2000).

26. Six bats found in the continental United States are listed as endangered: the lesser long nosed bat, the Mexican long nosed bat, the gray bat, the Indiana bat, the Ozark big-eared bat, and the Virginia big-eared bat.

27. Besides ESA-listed bats, non-listed bats, if killed in sufficient numbers can also invoke regulatory scrutiny under the general environmental harm prevention statutes, both state and federal. *See infra*, discussion of National Environmental Policy Act, Section IV.D.

The ESA allows private citizen suits alleging violations of the ESA. The potential for citizen suits is often the reason why a wind project might seek USFWS consultation and seek an incidental take permit. Some wind developers choose consultation as a matter of policy and as a protective measure. Wind projects can result in an ESA-take when built in or near essential habitat that will be harmed by construction activities. Wind projects can also cause ESA-take operationally, if a listed species of bird is killed during operation. This latter ESA-take must be predicted based on the presence of endangered species and the probability of those species impacting the turbine tower or blades. An incidental take permit would resolve these potential ESA-takes and is the primary reason why it is sought.

Where take is possible, private individuals and organizations can seek an Incidental Take Permit. This is accomplished by submitting a proposed Habitat Conservation Plan to the USFWS along with an application for an Incidental Take Permit. The process can be as short as three months from application and as long as several years, depending on the complexity of the impacts involved and the availability of resources within the local USFWS office.[28] Generally, the Habitat Conservation Plan must minimize impacts and taking of species and provide mitigation for expected take.[29]

Incidental take permits, however, are not without their own uncertainty. A project owner must initiate the incidental take permit process without certainty as to what the USFWS will require in the form of operational constraints or mitigation costs.[30] The process itself can take several years. For the Incidental Take Permit to be effective, it must accurately predict impacts. Assisting in this regard, the USFWS enacted an assurances rule called the "no surprises rule," which provides assurances that holders of Incidental Take Permits will not have ESA enforcement actions brought against them as long as the species taken was included in the Habitat Conservation Plan, and the requirements of the plan and permit are being followed.[31]

B. Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (BGEPA)[32] provides specific protections to Bald and Golden eagles. Like the ESA, the BGEPA is enforced by the USFWS. The BGEPA declares that no person shall take a Bald or Golden eagle and defines take to include the acts of "pursu[ing], shoot[ing], shoot[ing] at, poison[ing], wound[ing], kill[ing], captur[ing], trapp[ing], collect[ing], molest[ing], or disturb[ing]."[33] The meaning of the word "disturbing" in the

28. Notice of Availability of Final Handbook for Habitat Conservation Planning and Incidental Take Permitting Process, 61 Fed. Reg. 63,857 (Dec. 2, 1996).

29. *See generally* United States Fish And Wildlife Service, Habitat Conservation Plans: Section 10 of the Endangered Species Act (Dec. 2006), http://www.fws.gov/Endangered/hcp/HCP_Incidental_Take.pdf.

30. Most areas have "thumb rules" that specialists in that area can provide in advance to developers. Unfortunately, most thumb rules relate to habitat damage, which is not the issue with operational harm such as with avian wind turbine impacts. Still, these thumb rules can translate over if the covered ground surface area is added up and used to compute equivalent acreage requiring offsets.

31. 7 C.F.R. § 222 (1998).

32. Bald and Golden Eagle Protection Act, 16 U.S.C. §§ 668-68d (2000).

33. *Id.* at § 668c.

BGEPA is currently being reviewed by the USFWS for possible regulation clarification or change.[34] The BGEPA differs from the ESA in the fact that its "take" definition does not include damage to habitat. The BGEPA provides for civil penalties regardless of intent, but applies criminal penalties only for "knowingly" causing the death of an eagle or acting with "wanton disregard" of the consequences.[35] The BGEPA provides both criminal and civil penalties.

The BGEPA allows only certain take permits for the express take of eagles and does not contain an incidental take permit program as the ESA does.[36] Thus, as with the ESA, there are means of complying with the law for land use or development projects that risk harm to Bald and Golden eagles.

C. Migratory Bird Treaty Act

The MBTA is, in many ways, a bird of a different feather from the ESA and the BGEPA. It is a much older law, having been enacted in 1918, well before the advent of the environmental protection movement of the sixties and seventies. The MBTA uses very broad language in its prohibition: "[I]t shall be unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill . . . any migratory bird . . . ."[37] The scope of prohibited conduct has been addressed numerous times. Scienter is not required,[38] and the use of the word "any" several times in that prohibition has been interpreted several times to mean that conduct not expressly cited can be included as prohibited conduct.[39] The USFWS is responsible for enforcing the MBTA.

Unlike the ESA, the MBTA has no incidental take permit or its equivalent. Instead, there are only some very specific take permits allowed for specific purposes, such as falconry and scientific collecting.[40] The MBTA itself authorizes take permits for numerous intentional acts including hunting, and there is actually a set of regulations specifically for the hunting of migratory birds.[41] The MBTA reaches a tremendous number of species of birds, currently more than 800.[42] The unauthorized killing of any one of those species constitutes a violation of the MBTA.

The MBTA provides criminal penalties for its violations. Unknowing violations of the MBTA can receive fines up to $15,000 per violation and prison terms up to six months. Knowing violations are felonies and receive fines of $250,000 to $500,000 per violation and up to two years in prison.[43] Several cases have allowed strict liability for the take of migratory birds, even where the

34. Protection of Bald Eagles; Definition of "Disturb", 71 Fed. Reg. 74,483 (Dec. 12, 2006) (to be codified at 50 C.F.R. pt. 22).

35. Bald and Golden Eagle Protection Act § 668(a).

36. *Id.*

37. Bald and Golden Eagle Protection Act, 16 U.S.C. § 703 (2000).

38. *See generally* United States v. FMC Corp., 572 F.2d 902 (2d Cir. 1978); United States v. Catlett, 747 F.2d 1102, 1104 (6th Cir. 1984).

39. *See generally* United States v. Corbin Farm Serv., 444 F. Supp. 510 (E.D. Cal. 1978).

40. 50 CFR § 10.13 (2005).

41. Migratory Bird Treaty Act, 16 U.S.C. § 705 (2000); 50 C.F.R. § 20 (2006).

42. 50 CFR § 10.13 (2005).

43. Migratory Bird Treaty Act § 707. It is clearly possible that wind turbine avian kills could be considered "knowing violations."

take appears incidental to other conduct. Two cases, *United States v. Corbin Farm Services*,[44] and *United States v. FMC Corporation*,[45] involved criminal sentences for pesticide use that resulted in the killing of migratory birds. In a recent case, *United States v. Moon Lake Electrical Association*,[46] that reaches the electrical power industry, an electrical utility that refused to install bird guards for power lines was found criminally liable for the unintended killing of migratory birds from electrocution.

More realistically, for wind turbine operators, it is fair to expect a punishment commensurate with the crime. Thus, where a wind energy facility has evaluated and taken measures to reduce avian collisions, and where a wind energy facility has engaged federal and state wildlife authorities such as the USFWS, enforcement of the MBTA should be expected to result in lesser or minimal punishments. This might be little consolation to the individual manager or executive facing criminal charges for MBTA violations.

The MBTA is mostly accommodated in the United States by being ignored, or more euphemistically, by "selective enforcement." The doctrine of selective enforcement as a means to comply with the MBTA was expressly stated in a USFWS memorandum.[47] Because the MBTA contains no private right of action, individuals and non-governmental organizations dedicated to the protection of wildlife cannot use the MBTA directly. This lack of a private right of action is what gives the selective enforcement rule its value: if the USFWS does not enforce then there will be no enforcement of the MBTA, since no other agency can enforce it.

Because the MBTA's scope is so expansive, its authority reaches probably every wind energy project. The wind energy industry is not alone. The MBTA's protected birds are killed through collisions with cars and buildings. Electrocution of the MBTA's protected birds has long been a problem in the electric utility industry when birds perch in location that provides a path to ground for power. High voltage power lines can electrocute without a grounding path. As discussed further below, the history of MBTA enforcement against the utility industry and the industry's efforts to establish methods of reducing avian impacts provide insight into the potential problems that the MBTA may present the wind energy industry and also into possible solutions. Mostly, however, the entire industrial sector, including wind energy, depends upon the USFWS's selective enforcement history and the lack of a private cause of action for protection from MBTA liability.

In recent years, there have been several attempts to enforce the MBTA through the Administrative Procedures Act (APA).[48] The theory underlying these attempts argues that when a federal agency fails to comply with a statute when performing an act subject to the APA, then that failure is a violation of the APA. Thus, when the USFWS takes an action related to a wind project—for

44. United States v. Corbin Farm Serv., 444 F. Supp. 510 (E.D. Cal. 1978).

45. United States v. FMC Corp., 572 F.2d 902 (2nd Cir. 1978).

46. United States v. Moon Lake Elec. Assoc., 45 F. Supp. 2d 1070 (D. Colo. 1999).

47. Memorandum from U.S. Dep't of the Interior, Fish and Wildlife Service on Service Interim Guidance on Avoiding and Mitigating Wildlife Impacts from Wind Turbines (May 13, 2003), http://www.fws.gov/habitatconservation/wind.pdf [hereinafter Fish and Wildlife Service].

48. Administrative Procedures Act, 5 U.S.C. § 500-706 (2000).

example issuing an Incidental Take Permit—then USFWS' failure to enforce the MBTA would be actionable under the APA. The two cases addressing this approach on the merits involved challenges to governmental decisions allowing governmental action, not challenges to actions of private individuals. Even then, the first case failed on appeal,[49] and the second case became moot while on appeal because Congress intervened with regulations granting an incidental take permit for the activity.[50] This latter case foreshadows a primary recommendation of this article—that Congress should intervene in the wind energy avian situation and grant an incidental take permit for wind energy impacts.

D. National Environmental Policy Act

The National Environmental Policy Act (NEPA)[51] requires that federal agencies assess the environmental consequences of proposed governmental actions and alternatives available to avoid those consequences.[52] Federal agencies must also prepare detailed documents that detail the environmental analysis.[53] Many states have adopted laws substantially identical or similar to NEPA.[54] NEPA and the state-equivalent NEPA laws present a slightly different type of a wildlife issue than the wildlife-focused laws. While the ESA, the BGEPA, and the MBTA are focused on specific impacts to specific classes or species of wildlife that can be as few as a single animal being harmed or killed, NEPA and NEPA-equivalent laws look at impacts as a whole. The killing of otherwise unprotected birds could still be a forbidden impact to an ecosystem if 100,000 of those birds were killed. As wind energy projects have grown in scale, so to have the scale of their impacts. Thus, modern wind energy projects are much more likely to trigger NEPA level reviews.

When conducting NEPA-style impact assessments for wind energy avian impacts, guidance is needed regarding the method of assessing impacts. Generally, literature studies followed by on-site field inspections are relied upon to generate data from which an assessment of the potential for birds to strike a wind turbine blade is made. The newness of the scale of the wind industry projects and their turbine size has forced recent development of new ideas and standards for assessing avian impacts. For instance, the USFWS issued "Interim Guidance" on avian impact avoidance in 2003.[55] Not only was this guidance "interim" but it also lacked specificity, prompting many in the wind industry to dismiss its value. Similarly, a joint effort is underway by the Wildlife

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49. Sierra Club v. Martin, 110 F.3d 1551 (11th Cir. 1997).

50. Ctr. for Biological Diversity v. Pirie, 201 F. Supp. 2d 113 (D.C. Cir. 2002), *appeal dismissed sub nom*., Ctr. for Biological Diversity v. England, 02-5163, 2003 U.S. App. Lexis 1110 (D.C. Cir. Jan. 23, 2003).

51. National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321-75 (2000).

52. *Id.* at § 4332; NICHOLAS C. YOST & SONNENSCHEIN NATH ROSENTHAL, THE NEPA DESKBOOK (Envtl. Law Inst. 3rd ed. 2003).

53. National Environmental Policy Act § 4332; 40 C.F.R. §§ 1500-05 (2005).

54. According to the Council on Environmental Quality the following states have NEPA-equivalent laws: California, Connecticut, Georgia, Hawaii, Indiana, Maryland, Massachusetts, Minnesota, North Carolina, South Dakota, Montana, New Jersey, New York, Virgina, Washington, and Wisconsin. State Environmental Planning Information (2006), *available at* http://ceq.eh.doe.gov/nepa/states.html.

55. Fish and Wildlife Service, *supra* note 47.

Workgroup Core Group of the National Wind Coordinating Collaborative (NWCC),[56] a voluntary coalition of government, industry, and representatives, to develop and promote consistent standards relating to the avian impacts. This group, however, is still advancing towards such standards.[57]

Lacking clear standards, each federal agency tasked with implementing NEPA must rely upon dueling experts to determine what an effective methodology for assessing avian impacts is. The same problem applies to states having NEPA-equivalent laws. This ad hoc approach breeds controversy and litigation, and, ultimately, increases uncertainty at the expense of project funding viability. Uncertainty is addressed below.

IV. CONFRONTATION

The laws that regulate impacts to avian wildlife in the United States are colliding with renewable energy policy and promotion in the United States. In particular, wind energy systems and the industry as a whole have grown to a scale that wildlife impact issues, long in background, have come to the forefront. Chief among them are avian impacts. Yet the very problem of avian impacts is complicated, if not created, by other federal and state policies and laws that have not been adjusted to reflect current energy policy favoring renewable energy. In short, to continue to sustain the renewable energy boom led by wind energy, Congress and federal agencies and, in some instances, state government, may need to revise existing wildlife protection law and policy.

A. Wind Industry Role in Renewable Energy

Renewable energy has generally been a component of United States energy policy for several decades. Various investigations, rulemaking, and enticements have been required to encourage the development of renewable energy sources. EPAct 2005 extended the wind energy tax credit and had other supportive provisions for renewable energy and wind energy.[58] RPS laws, implemented in a limited form in EPAct 2005 and in broad form by many states, are also encouraging the development of renewable energy.[59] Under an RPS, the governmental unit requires that a certain percentage of electricity be obtained from renewable sources.[60] While the definitions of renewable sources differ from state to state, wind and solar are consistent components. State RPS programs, however, are burgeoning. Currently, seventeen states have adopted

56. *See* The National Wind Coordinating Collaborative, http://www.nationalwind.org [hereinafter NWCC]. The NWCC is a voluntary organization including representatives of the USFWS, utilities, wind energy companies, scientists, and environmental organizations. *Id.*

57. *See generally* NWCC, *Wind Turbine Interactions With Birds and Bats: A Summary of Research Results and Remaining Questions*, Nov. 2004, http://www.nationalwind.org/publications/wildlife/wildlife_factsheet.pdf.

58. Energy Policy Act of 2005, Pub. L. No. 109-58, § 211, 119 Stat. 594.

59. *Id.* § 203.

60. To some, the RPS in EPAct 2005 is not actually an RPS, but rather a purchasing requirement the federal government has imposed upon itself. Under EPAct 2005, the federal government must purchase 7.5% of its energy from renewable sources by 2013. A federal RPS, to some, would be a federal mandate to utilities to achieve minimum portfolio percentages of renewable energy procurement.

RPS standards including California, Colorado, and New York.[61] Typically, an RPS requires around ten to twenty percent of renewable energy procured by a utility to be certified or approved as renewable by a date within seven to fifteen years.

As the call for increasing the reliance upon renewable energy has been growing, it has mostly been answered by wind energy. In part, this is because wind energy had a head start. It does not require the steam power plant of a geothermal project or bio-mass generating station. Likewise it does not rely upon the very new and technical concept of photo-voltaic cells that convert sunlight to electricity as solar does. It does not even require elaborate efforts to collect and harness natural resources like water, as hydroelectricity does. Instead, it harnesses wind in its natural form and converts it to rotational mechanical energy, which is in turn converted to electricity. The idea of harnessing wind to do mechanical work has of course been around since pre-Don Quixote days.[62] Wind is also pervasive across the face of the earth. For all these reasons, wind turbines have proliferated. As the scale of wind turbine projects have grown, allowing better economies of scale, which in turn has led to lower costs per unit of electrical energy, wind energy has dominated the development of renewable electricity sources.

The modern wind generating facility is tremendous in scale. One megawatt to two megawatt turbines are common. The blade tip can reach more than 400 feet in the air on common large sizes. Turbine blade diameters reach more than 250 feet. These large structures are placed in locations according to precise modeling to determine the ideal configuration of locations for a given parcel or set of parcels of land to maximize total generation potential. Wind energy projects are supported by teams of consultants that model, measure, map, evaluate, advise, and predict. Wind energy, however, remains grounded to several basic tenets. First, the location has to be windy on a relatively regular basis. The United States has been publicly and privately mapped numerous times to show the windiest locations in the country. Second, transmission has to be available or feasible to allow the generated electricity to reach the national grid and, in turn, reach users. Those criteria have historically driven wind project locations.

B. Predicting and Assessing Avian Impacts

It is intuitive that flying birds or bats could, and probably will, collide with rotating wind turbine blades. Avian collisions with both moving objects, such as vehicles, and stationary objects, such as buildings, have long been witnessed by humans and generally accepted as a toll the human environment takes on

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61. American Wind Energy Assoc., *State-Level Renewable Energy Portfolio Standards (RPS) Fact Sheet* (Jan. 30, 2005), http://www.awea.org/legislative/pdf/RPS_Fact_Sheet.pdf.

62. Annoying to most wind energy industry members, many journalists cannot resist the temptation to talk of "tilting at windmills" when writing of wind energy news, referring of course to the fictional character, Don Quixote and his mad quest to joust windmills in Miguel de Cervantes Saavedra's DON QUIXOTE DE LA MANCHA. Most annoying about the reference to windmills is that wind-generated electricity does not use a "windmill" but instead a "wind turbine generator" or often just "wind turbine."

wildlife.[63] What is not as well understood is how many birds or bats collide with wind turbines. Even less understood is how many birds or bats *will* collide with a *future* wind project that exists only on paper. Avian impacts, moreover, have not traditionally been a criteria used for site selection. Instead, avian collision issues are mostly dealt with in the permitting phase of a project or perhaps not until actual operation occurs. As the industry has matured, and as the scale of wind projects has grown, environmental laws such as NEPA and NEPA-equivalent laws are increasingly forcing pre-project evaluations of avian and bat impacts and post-project studies of actual impacts. These surveys can also be required to satisfy ESA and BGEPA consultations and incidental take permit process applications.

1. Pre-project Surveys

Pre-project surveys attempt to predict what the impacts *will* be. Thus, pre-project surveys are rooted in prediction science. This science, however, is new and methodologies vary across the country and even within states themselves. The industry and involved agencies are making varied, sometimes conflicting efforts to establish standards for the assessment of avian impacts.

Most commonly, potential avian impact studies include literature research and on-site observations to determine the species and quantities of species that will be present or will pass-through a wind project. Then, an analysis is conducted to determine the specific, probable number of birds that will be injured by the turbine blades. The significance of these injuries is assessed in the context of the applicable laws. For the ESA and BGEPA, each "take" of a protected species requires address. Under the MBTA, in theory, the same should be true for every protected bird, though as discussed, the MBTA largely goes un-enforced in wind projects. Finally, and perhaps most complexly, the effect on bird populations might need to be assessed if a significant quantity of birds will be harmed relative to the population as a whole. This last assessment can involve very subjective and conflicting opinions of ornithologists and other avian experts.

The science and standards of studying avian impacts is evolving. A time tested method is to conduct ground surveys at appropriate times of the year, use the bird counts from those surveys to calculate a theoretical total number of birds, and then apply formulas to predict what percentage of those birds will be killed. The appropriate process for conducting the ground survey is ever changing and is often controversial. For instance, is mere observation enough, or should nets be used to capture ground occupying birds for counting? What time of day should ground surveys be conducted? How many days? What months or seasons should be surveyed? Finally, the biggest question, what about nocturnal birds and, of course, bats?

Nighttime surveys, of course cannot be visual.[64] Auditory surveys are useful for species that make noises, some owls for instance. Otherwise, predicting nighttime bird and bat impacts requires either the use of radar surveys

63. It is worth noting that avian collisions with wind turbines are usually considered to be less than auto and building collisions by an order of magnitude.

64. Though one theoretical method involves shining bright lights briefly to count illuminated birds.

or daytime habitat evaluation. The use of radar is relatively new and at an early stage in its evolution. Birds and bats appear as blips and lines on a radar screen. Each blip and line must be interpreted. Fast moving blips are often bats or small hunting birds. Slow moving ones are often soaring owls. Higher altitude contacts are probably nighttime migrating birds.

2. Operational Studies

Once operational, wind projects are increasingly being required to conduct studies of *actual* impacts. These often require site inspections to count bird carcasses. Bird carcass numbers are manipulated through formulas to assess actual total impacts. Bird carcass counting, while sounding accurate and adequate on paper, is not always supported by interest groups as being accurate or adequate. An injured, mortally or otherwise, but not immediately killed bird or bat might fly some distance before landing. Killed birds and bats might be carried off during the night by predators or scavengers.[65]

Depending on the status of the species killed and the scale of the impacts, operational studies can force projects to obtain additional permits, reduce or stop the operation of some turbines during some periods of the year, or provide off-site mitigation or restoration. Post-operational surveys thus, while allowing certainty after-the-fact to the extent that the study process is generally accepted, creates uncertainty before operations, during permitting and construction. This uncertainty may present problems for project financing. This problem is discussed further below.

An avian impact assessment industry is evolving right along with the wind energy industry. Companies exist that are nearly exclusively studying avian impacts for wind projects. Businesses have started up solely to provide radar survey services for wind projects. Evaluating avian impact risk has become an accepted practice in developing wind energy projects. Such efforts can be very expensive, depending in part on what level of effort is required. In general, avian impact risk evaluation is people-intensive. The various activities all involve individuals watching, catching, and/or counting birds or inspecting the ground for clues as to what birds or bats might utilize the project location. Night time surveys are also costly. Radar surveys alone, must factor in the cost of radar equipment as well as the operator or operators. The biggest problem of all, however, may be that impact standard.

3. Efforts to Standardize Impact Assessment

Standardized avian and bat impact study requirements would be of great value to the wind energy industry. Many efforts have been made or are being made to accomplish that. In 2005, USFWS issued interim guidelines for the wind energy industry.[66] Met with much fanfare, the guidelines were not well received and ultimately were withdrawn. Critics pointed out that the guidelines lacked specificity, the one key component they needed to be effective at

65. Unconfirmed stories circulate of vulture deaths caused by the scavenger bird's efforts to reach killed birds lying on the ground beneath wind turbines.

66. Fish and Wildlife Service, *supra* note 47.

standardizing the prediction and assessment of avian impacts.[67] USFWS probably struggled with the core problem of standardization efforts: not all locations and projects have the same species or the same survey needs. A survey methodology needed at one site might be superfluous at another. Likewise, fall surveys needed at one site might be pointless at another.

Another problem inherent in the USFWS effort lies in the multiple jurisdictional nature of many wind projects. Many wind projects do not involve federal land, making the USFWS and the laws it enforces only part of the regulation of avian impacts at best, and minor involved laws at worst. For many wind projects, state laws also loom large. Thus, a coordinated national effort would be advantageous. Such an effort might lie in the NWCC's efforts to provide sound practices for developing wind resources in the United States.[68]

While standardized assessment methodology might resolve the issues over predicting or measuring avian and bat impacts caused by wind projects, they will not eliminate the other core issue: establishing what impacts will be allowable under what circumstances. This latter problem is creating barriers and uncertainty of its own. A collaboration of utility industry and conservation representatives recently released updates for power line electrocution avoidance. The Avian Power Line Interaction Committee (APLIC) released its 2006 Suggested Practices Manual in November of 2006, which provides comprehensive guidelines for the siting, design, construction, and operation of power lines to reduce avian electrocution.[69] This APLIC effort highlights the concern the electrical industry has over avian impacts and also the industry's need to turn to private cooperative efforts to reduce both avian impacts and liability. Similarly, the wind energy industry is also striving to reduce avian impacts.

C. *Mitigating and Reducing Avian and Bat Impacts with Wind Turbines*

As wind energy projects began emerging in the late 1970's and early 1980's, it quickly became obvious that avian impacts might require extensive efforts to reduce them by design or practice. What has followed has been a long quest to test various ideas that held promise towards reducing avian impacts. Generally speaking, the methods can be divided into four categories: deterrence through equipment design, project location, and operation, and offsetting mitigation. The science and practice of reducing impacts has found various practices that have reduced avian impacts, but there is growing indications that further progress may be long in coming as few new progressive ideas are emerging.

Early on it was clear that the design of wind turbines and their towers could be improved. One simple solution was to reduce equipment that offered perching opportunities for hunting birds such as hawks and eagles. Single pole towers quickly became preferred over multi-leg lattice towers. Today, as wind

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67. A common criticism was that the guidelines suggested parameters, or a range of parameters, without specifying when a particular parameter should apply and when it should not.

68. NWCC, *supra* note 56.

69. AVIAN POWER LINE INTERACTION COMM., SUGGESTED PRACTICES FOR AVIAN PROTECTION ON POWER LINES: THE STATE OF THE ART IN 2006, *available at* http://www.aplic.org.

turbines have grown in size, single pole towers are the norm. But this may not be for avian impact reduction reasons. In fact, one study evaluating the benefits of eliminating lattice style wind turbine support structures found little or no benefit.[70] Other design ideas have been implemented or are being tested. For instance, experiments have been done and are being done to test various painting schemes on turbine blades, with the idea of making turbine blades more visible and noticeable to birds.[71] There is a theory that newer and larger wind turbines, with their slower more visible motions, might reduce collisions. Still more studies and ideas have involved using radar to steer off birds or placing lights at selected locations to avoid impacts.[72] Bats present a curious problem in regard to deterrence ideas. With their radar, one would presume that bats would be easily able to avoid impacts, yet the high bat-kill rates at some project's plants belie this assumption.[73]

Another approach to avian impact reduction involves location and operation of wind turbines. As the industry has matured, the initial project location decision is increasingly involving evaluation of the potential for avian impacts. Thus, the ultimate way to avoid avian and bat impacts, not building the project, is becoming increasingly viable. High value wind resource areas, however, attract developers so this strategy may only work to deter more risk adverse developers from the major wind resource areas.

D. Wind Energy Confrontations

Some interest groups have risen to challenge established and proposed wind projects in recent years. To date, there have not been any successful defeats or court-ordered shutdowns of wind projects, but the potential for such outcomes appears increasingly possible as opponents gain sophistication and wind projects grow in scale and number. Three example wind project confrontations provide a good overview of the varying types of issues, interests, and laws that are being increasingly fought over.

1. Altamont Pass

A legacy wind resource area, the story of the Altamont Pass, east of the San Francisco Bay area, provides an excellent overview of past and present avian impact issues. Altamont Pass was developed in the early 1980's during the first wind energy boom. These early turbines, often called "first generation" wind turbines, were small in stature and varied tremendously in their design. The blades on most designs were propeller style and spun quickly, often seen as a blur. Altamont Pass, it turned out, while an excellent wind resource area, was also a challenging location to avoid avian impacts. Worse, this area of rolling hills was a primary hunting ground for large birds of prey, raptors. The end

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70. *See* CAL. ENERGY COMM'N., A ROADMAP FOR PIER RESEARCH ON AVIAN COLLISIONS WITH WIND TURBINES IN CALIFORNIA (2002), *available at* http://www.energy.ca.gov/reports [hereinafter Cal. Energy Comm'n].

71. *Id.*

72. Cal. Energy Comm'n., *supra* note 70.

73. Bats continue to puzzle researchers. Some projects have a very large bat kill whereas others have minimal bat kill.

result was numerous dead raptors. Actual numbers have never been agreed upon by the various sides in the Altamont Pass confrontations, but a significant number of study efforts have taken place. Estimates often claim that more than 1000 eagles, hawks, and owls are killed each year.[74]

Several legal efforts have been made to stop the operation of the wind turbines in the Altamont Pass or force lengthy detailed environmental studies. Though no lawsuits have prevailed, the responsible permitting agency, the County of Alameda, has ordered an extensive study of avian impacts for the region as part of the gradual retrofitting of the region to new, larger wind turbines. The main challenge to the wind projects there has involved the compliance with the California Environmental Quality Act (CEQA),[75] the NEPA-equivalent law in California. The current operators,[76] meanwhile have been undertaking efforts to assess and reduce, avoid, or mitigate impacts.[77] The transition from the first generation small wind turbines to large, modern generation turbines has also provided an opportunity to compare the generations of wind turbines to determine if modern wind turbines have a lesser impact on a power produced or acreage affected basis.

If Altamont Pass were to be considered for wind development today, the permitting process would certainly be a different story. Whereas in the 1980's, project location selection focused on the wind resource primarily, while today developers must look carefully at the environmental issues a wind resource area presents. Initial studies would readily reveal the high frequency of raptor hunting and that would, in turn, caution development before the scope and cost of liability and remediation could be assessed.

2. Flint Hills

Flint Hills[78] is a tallgrass prairie area in Kansas. Like many of the windy prairie areas of the Midwest it offers sustained high winds that have attracted wind development during the current boom. In some ways, the Flint Hills habitat presents issues similar to those of Altamont Pass. The Flint Hills confrontation, however, differs primarily by its involvement with the MBTA and also by the fact that it is entirely a new project with no history of first generation wind turbine use such as with Altamont Pass

Whereas in Altamont Pass, it was the ESA and NEPA-equivalent CEQA statute that was applied, the challenge in Flint Hills involved an attempt to assert that the project in question would violate the MBTA because it would kill

74. Many opponents came to call the wind turbines in Altamont Pass "bird blenders" a term that has hung on the wind industry like an albatross tied around its neck.

75. CAL. PUB. RES. CODE §§ 21000-177 (West 2005).

76. Originally the wind turbines were owned by many small operators. Gradually these smaller operators were bought out resulting in several wind energy companies owning the vast bulk of the turbines, led by Florida Power and Light which operates more than 2000 of the approximately 5000 wind turbines in the region.

77. *See also* Dale Strickland & Wallace Erickson, Study Plan For Testing Effectiveness of Management Measures for Avian Fatality Risk Reduction at Altamont Pass Wind Resource Area (Nov. 2004) (last visited Jan. 20, 2006), http://www.nationalwind.org/events/wildlife/2004-2/presentations/Strickland_Altamont.pdf.

78. The author's law firm represented the defendants in the Flint Hills cases. This article reflects views solely of the author and not any of the defendants.

migratory birds protected under the Act.[79] The values driving the challenge were mostly the same. Plaintiffs feared the killing of owls, hawks, and eagles along with general damage to the tallgrass prairie habitat by virtue of the project and its impacts on raptors.

The plaintiffs failed. The Tenth Circuit affirmed the District Court's holding that the court lacked jurisdiction under the MBTA for lack of a private cause of action. Going unspoken, in the dismissal of the case, was the answer to the question whether the project would violate the MBTA. In fact, given the broad scope of the MBTA and lack of any permit or exemption allowing take, many felt that it was clear that the project, like nearly all, if not every wind project, would have take of birds protected by the MBTA. Thus, the protection afforded Flint Hills was the same protection relied upon by all wind projects as to the MBTA: lack of a private right of action and the tolerance of the USFWS of the take occurring at wind facilities. Stated another way, wind facility operators avoided the sword of the MBTA at the good grace of the USFWS.

3. Pine Tree

The Pine Tree[80] confrontation illustrates the very complex issue involved when the concerned avian mortality involves an abundant population that is alleged to be threatened with some significant level or injury. The Pine Tree Wind Energy Project is proposed in a rocky canyon area of Southern California receiving little annual rainfall. Thus, its habitat differs significantly from those habitats sustaining large year round bird populations. In Pine Tree, the issue was the impacts to migrating songbirds that might have potentially used the project area for rest and foraging in the spring or fall. Two chapters of the Audubon Society challenged the adequacy of the CEQA Environmental Impact Report[81] as to its assessment of songbird impacts. Specifically, the Audubon chapters claimed that little or no adequate on-site observations or surveys were completed. They thus argued that Songbird impacts had not been properly assessed. The challenge in the Superior Court of California failed and the Audubon chapters appealed. The appeal was pending at the time this article was written.

Pine Tree, while sharing the same underlying statute as Altamont Pass, namely CEQA, involved the fundamental issue of what the legal standard is or should be applied to assess avian impacts to a large population of birds that might migrate through an area. It reflects the current questions of how many years of on-survey data is necessary and how many different months or seasons must be involved in those years. Actual on-site survey methodologies were also questioned. Were mere observations sufficient, or are capture-and-count methods such as mist-netting necessary? Finally, time-of-day or better stated, time-of-night, issues presented themselves. Are nighttime surveys needed? If so, how must they be conducted? Is the use of radar necessary for nighttime

79. Flint Hills Tallgrass Prairie Heritage Foundation v. Scottish Power, 147 Fed. App'x 785 (2005).

80. The author represented the developer of the project in the Pine Tree case in the subject litigation. This article reflects views solely of the author and not those of any party to the litigation.

81. An Environmental Impact Report under CEQA is the functional equivalent of an Environmental Impact Statement under NEPA.

surveys? All these questions remain lurking in the background of most wind projects today. Currently, there is no consensus or legal standard on these issues.

Altamont Pass, Flint Hills, and Pine Tree collectively illustrate the myriad of controversial avian issues and laws facing wind projects today. One notable and consistent feature of these three example confrontations is the mostly local character of the opposition. Most national environmental protection organizations are supportive of wind energy, and many have made such policy declarations. These three projects demonstrate, however, that such mainstream, national leadership has not been able to deter local groups, concerned over local impacts from opposing local projects. In Pine Tree, it was two local Audubon chapters opposing the project, not the national Audubon organization. In Flint Hills, it was a local environmental organization dedicated to protecting the local prairie habitat. The environmental opposition to wind has much more of a NIMBY-ist character than a national environmental organization character. The local character of opposition both helps and hurts. While local opposition can often lack expertise and resources, local opposition can be harder to predict and deal with.

While all three of these projects have not been prevented from continuing towards or sustaining operation, the uncertainty these issues create certainly threatened and perhaps continue to threaten these projects as well as many others.

F. The Development Problem: Uncertainty

The development of a modern wind project costs tens of millions, and often hundreds of millions of dollars.[82] Thus, the source of funds and the willingness of banks or holders of capital to support a project are critical factors in the success of a modern wind project. Traditionally, lenders balance risk with rate of return. For large electrical generating projects, the limits on rate of return, driven by a mostly regulated or competitive market, require limited risk before funding will be released to allow construction. Thus, there is low tolerance for uncertainty in wind energy projects.

Unfortunately, there are multiple sources of uncertainty in wind energy projects. Wind energy faces its own inherent uncertainty as to how much energy will actually be produced.[83] Uncertainty of the ability of the project to obtain permits can, and often does, prevent funding. Uncertainty on costs can be a problem.

The uncertainty brought on by unknown avian impacts, unknown possible consequences to the ability of the project to operate, and unknown mitigation costs can reach all these categories of uncertainty in a wind energy project and can be an unbearable burden on project financing. Avian impacts thus present several distinct challenges to wind energy developers, all related to assessing and

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82. A current rough pricing, based on public data, puts wind projects in the area of $1.5 million per megawatt. Robert Thresher, *Wind Power Today*, EJOURNAL USA, June 2005, *available at* http://usinfo.state.gov/journals/itgic/0605/ijge/thresher.htm.

83. Wind strength varies with time, and projections of the future wind energy production are modeled guesses founded upon wind data from the recent past. Thus nearly all wind projects present production risk.

managing avian and bat impacts: for instance pre-project permitting uncertainty and post-operation risk of reduced operation, shutdown, or fines for avian impacts.

The uncertainty brought on by reliance on selective enforcement of the MBTA is perhaps the most difficult risk to precisely assess. For the time being, resolution of MBTA issues is a fine balancing act, capable of being upset by perhaps just one catastrophic case where a wind energy facility is forced to grapple with take under the MBTA.[84] One can look towards a sister industry, the general electrical utility industry and its history of impact issue and enforcement regarding power line interaction, for an example of the vulnerability of an industry to MBTA attacks.

The lack of clear standards in the assessment of avian impacts not only has created some of the wind energy opposition or concern but is also a source of uncertainty. Unclear standards for assessing impacts make it more questionable that a project will receive a permit and also raise questions regarding how well that permit will sustain a legal challenge. That uncertainty must also be overcome. Fortunately, the passage of time frequently alleviates these sources of uncertainty. Once a statute of limitations on a legal challenge has passed, uncertainty regarding the legitimacy of the studies and impact assessment can become moot. Delays, however, can be devastating to projects. Other permits might expire while the lead permit is undergoing legal challenge. Funding can be made available for only a period of time. Further, some permits have no statute of limitations, leaving the uncertainty in place for all time.[85]

The uncertainty created by the MBTA and the lack of standards in the assessment of avian and bat impacts are problems that require redress if the United States is going to rely on wind energy to meet renewable energy goals. While efforts are underway to perhaps partly resolve the impact assessment problems, the MBTA, ESA, BGEPA, and NEPA still can present problems to a project as to how to resolve its impacts even when known. The MBTA's lack of a compliance mechanism further exacerbates these problems. At the core of these problems, is a fundamental shortcoming in the current energy policy: while EPAct 2005 promotes renewable energy and thus ostensibly raises its value, older laws, with now outdated value systems, have been left as barriers to renewable energy.

V. THE POLICY VALUE GAME: HOW MUCH ENERGY IS A BIRD WORTH?

Allowing effective development of the wind energy resources of the United States will require revising or supplementing now antiquated environmental laws that were not revised to reflect current energy policy. EPAct 2005 promotes renewable energy development as sound policy for the United States in the 21st Century. The question remains, however, whether that policy has been fully implemented at all the required levels and in all the needed locations.

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84. As explained above, MBTA compliance for probably all wind energy projects is accomplished through selective enforcement, or more accurately, by the USFWS not enforcing MBTA.

85. *See, e.g.*, Endangered Species Act of 1973, 16 U.S.C. § 1531 (for example, private right of action for violations).

A. Policy Questions

As the United States shifts its energy policy towards renewable energy, reliance upon the vast wind resources of the country is weakened by lack of supporting environmental protection policy. It will not suffice to merely declare renewable energy as being valued and provide incentives for wind energy. The wind energy industry would argue that the United States must also clear the barriers it has presented to energy infrastructure development in the past where those barriers are out of balance with the harm protected against. The wind energy industry would emphasize that a bird killed for a megawatt-hour of renewable, non-foreign wind energy is much more acceptable than a bird killed for a unit of foreign-purchased[86] or non-renewable energy. EPAct 2005 certainly expresses a policy that values new, renewable energy more than fossil-fueled energy.

Detractors to those arguments would hold that renewable energy is only better to the extent that it is compared on an equal playing field. They would argue that a bird is a bird, and a megawatt-hour a megawatt-hour, regardless of whether the energy fit a convenient, popular definition of being "renewable." They would argue that all environmental values should stand for themselves and treat all others, including various sources of energy, equally.

In essence then, the policy question is one of how much energy a bird is worth, and whether it is worth more renewable energy than non-renewable energy. Certainly, all species are not equal in the eyes of environmental law. But the ESA and BGEPA, two laws that treat threatened birds differently than other birds, both have compliance mechanisms. It is the archaic, ancient MBTA that lacks compliance tools. It is the same MBTA that is being resolved by not being enforced. It is the same MBTA that protects a very broad scope of birds. Thus, the true policy problem facing the wind industry is one of a new value clashing with an old value. The MBTA is increasingly coming into focus as a problem for the wind energy industry. It was not a particular problem for other types of electricity generation and thus has not historically stood in the way of energy infrastructure development.

Resolution to this conflict is perhaps stymied by the failure of an important ally to renewable energy, the environmental protection collective, to consider softening any environmental law. The fear is, of course, that allowing any modification might open the floodgates and allow tremendous trimming of environmental protection that would reach beyond renewable energy. Consider the common lobbying on each side of the ESA. Farmers and industry press for changes to the ESA while non-governmental environmental protection organizations maintain a staunch fight against such relaxation. Wind energy thus is hurt by the very relationship it has relied upon to advance in United States energy policy. Organizations that historically fight development of energy

86. The foreign versus non-foreign comparison, though frequently made regarding renewable electricity, is not as sound as when comparing renewable transportation fuels with foreign oil. While significant quantities of transportation fuel come from foreign sources, electricity mainly comes from domestic sources of coal, water, nuclear fuel, and from mostly continental sources of natural gas. It is still legitimate to promote renewable electricity as being non-foreign because it is non-foreign and because it could reduce demands on natural gas and coal, allowing those fuels to increasingly provide thermal heating and, in some cases, transportation fuel.

industry facilities need to understand how they can help and how they can hurt the development of wind energy. To the extent that they too still hold onto older policy values with regard to avian impacts, environmental organizations also need to refresh their policy think.

B. Call for Action

Congress, in advancing an incomplete policy, has to bear the primary responsibility to correct the problem. Logically, Congress should either withdraw its support of renewable energy values or complete its promotion and clear the left over environmental policy of the MBTA. There are several specific actions mostly involving Congress or the USFWS that would significantly reduce the undue hurdles the wind industry must currently clear.

1. Statutory Redefinition of MBTA Take

The simplest and quickest single action Congress could take would be to redefine illegal take under the MBTA to be a killing resulting from an act intended to kill the bird, such as shooting a gun.[87] This would relieve not only wind turbine operators, but also building owners, vehicle drivers, and even household cats, all of whom kill migratory birds on a regular basis.[88] The earlier explained take definition in the MBTA[89] could be changed by the insertion of the phrase "excepting therein incidental harm or death to birds occurring from birds striking structures, including rotating or stationary wind energy turbine blades, reasonably designed to minimize such collisions" as shown below:

> [I]t shall be unlawful at any time, by any means or in any manner, excepting therein incidental harm or death to birds occurring from birds striking structures, including rotating or stationary wind energy turbine blades reasonably designed to minimize such collisions, to pursue, hunt, take, capture, kill . . . any migratory bird . . . .

2. Statutory MBTA Take Permit

An alternative solution involving the MBTA would be for Congress to statutorily authorize a take permit under the MBTA for wind energy facilities. Given the broad willingness of the USFWS to let the MBTA go un-enforced in the face of rapidly rising wind energy development, the USFWS should prove more than willing to support such a take permit for wind energy needs. Creation of a take permit under the MBTA may not require Congressional action. Section 704 of the MBTA authorizes the Secretary of the Interior to allow "taking" of migratory birds.[90] By Congress establishing a statutory take permit, however, there would be no ambiguity about it legitimacy. Congress can probably accomplish this much faster than the regulatory process can be completed.

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87. Recall the discussion above, regarding the question of whether the blade kills the bird or the bird kills itself by striking the blade.

88. Buildings, cars, and domestic cats are commonly believed to be the greatest killers of birds migratory and non-migratory alike.

89. 16 U.S.C. § 703 (2000).

90. *Id.* at § 704 provides: **"[**T]he Secretary of the Interior is authorized and directed, from time to time . . . to determine when, to what extent, if at all, and by what means . . . to allow hunting, *taking*, capture, killing . . . of any such bird . . . and to adopt suitable regulations permitting and governing the same . . . ." (emphasis added).

3. Development of Avian and Bat Impact Assessment Standards

Consistent standards for the assessment of the probable or actual avian impacts of a wind energy project are needed. Because federal law (the MBTA, ESA, BGEPA, and NEPA) create avian impact issues for all wind energy projects, a federal standard that reaches across all of those laws is necessary for it to have value. This logically suggests that the USFWS should accomplish this, or be involved since it enforces, or is key in the application of all of those laws.

The standards need to provide a clear and specific minimum methodology necessary for satisfactorily estimating avian impacts from wind energy. Congress could greatly aid the creation of an avian impact assessment standard by ordering the USFWS to develop a single standard, set of guidelines, or a safe harbor that covers the MBTA, the ESA, the BGEPA, and the USFWS's role in implementation of the NEPA.

A safe harbor or assessment standard should include design and location criteria, acceptable avian impact assessment methodologies, and an impact threshold standard below which a wind project would be deemed compliant with the MBTA. It would need to address the question of the duration and frequency needed for pre-operation studies and present that in the context of varying site conditions.

Alternatively, consultation with the USFWS for ESA, and possibly BGEPA, issues could be deemed a safe harbor for the MBTA. Lacking Congressional mandates, or perhaps in concert with them, cooperative efforts including those of the NWCC should also focus on production of a clear assessment standard. Because the USFWS participates in the NWCC, the effect of such standards would go towards reducing the threat and uncertainty created under the current regime. It would also aid in the quest to standardize assessment methodologies across the states. It would not be as valuable, however, as a USFWS enacted assessment standard for the federal wildlife and environmental laws.

VI. CONCLUSION

The success and growth of wind energy in the United States is leading it into conflict with laws and values in several disciplines. Recent cases show that organized opposition groups have formed and, for various reasons, are fighting against wind energy projects. Besides aesthetic values, a chief issue is avian impacts. Even without successful opposition, the ancient MBTA leaves nearly every wind energy project in a world of uncertainty that could threaten to further challenge the wind energy industry. With the passage of EPAct 2005, the United States has further declared its promotion of the value of renewable energy. That would suggest that it is time to clear the land of laws and regulations founded on old, out-of-date policy that conflict with renewable energy. Congress should act to provide an MBTA exemption for properly designed and permitted wind energy projects. Further, the federal government should help establish clear standards for the assessment of avian impacts that states can or will want to adopt as well. That, coupled with environmental laws reflecting renewable energy values, should allow the wind industry to better move towards utilizing the vast resource of wind energy in the United States.

MODIFIED PROPOSED TEXT AMENDMENTS
MARIN COUNTY DEVELOPMENT CODE (TITLE 22)

SHOWING TRACK CHANGES FROM THE
PLANNING COMMISSION HEARING OF NOVEMBER 23, 2009

22.32.180 – Wind Energy Conversion Systems (WECS)

This Section establishes permit requirements for planned district and non-planned district zones and standards for the development and operation of Wind Energy Conversion Systems (WECS) in compliance with Marin County policies and State and Federal laws and allows and encourages the safe, effective, and efficient use of WECS in order to reduce consumption of utility supplied electricity.

A. **Permit requirements.** Wind Energy Conversion Systems (WECS) are allowed in all zoning districts, except the RF (Floating Home Marina) zoning district, subject to the following permit requirements.

   1. **Planned Districts.** Large WECS located in planned district zones shall require the approval of a Master Plan, Precise Development Plan, and Use Permit subject to the development standards outlined in Subsection 22.32.180.B unless the Master Plan and Precise Development Plan requirements are waived in compliance with Section 22.44.040 (Waiver of Master Plan/Precise Development Plan Review) and a Use Permit and Design Review are instead required. Small WECS located in planned district zones shall require Design Review approval, subject to the development standards in Subsection 22.32.180.Bunless exempt in accordance with the development standards in Table 3-8.

   2. **Other zoning districts.** Large WECS located in zoning districts other than a planned district shall require Use Permit and Design Review approval, subject to the development standards outlined in Subsection 22.32.180.B. Small WECS shall require Design Review approval, subject to the development standards outlined in Subsection 22.32.180.B unless exempt in accordance with the development standards in Table 3-8.

   3. **Time limits.** The approval for a Large WECS shall be granted for a term of no less than 10 years unless it has been inoperative or abandoned for a one-year period. The approval for a Small WECS shall be for an indefinite period unless it has been inoperative or abandoned for a one-year period.

B. **Development standards.**

   1. **Small WECS.**

      a. All small WECS shall be subject to the development standards in Table 3-8.

      b. All Small WECS shall avoid significant impacts to birds and bats as verified by a Bird and Bat Study, using the "California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development", (California Energy Commission and California Department of Fish and Game,) prepared by a qualified consultant approved by the Marin County Environmental Coordinator.

c. Small-Ministerial WECS shall not result in noise levels that exceed 55 dbA at the property line in residential zoning districts or 60 dbA at the property line of all other zoning districts, except during short-term events such as utility outages and severe wind storms, as verified by specifications provided by the manufacturer.

d. Exceptions to the standards in Table 3-8 for Small-Ministerial WECS shall be considered through the Design Review process pursuant to Chapter 22.42 (Design Review). Exceptions to the standards in Table 3-8 for Small-Discretionary WECS shall be considered through the Use Permit process pursuant to Chapter 22.48 (Use Permits).

e. All Small-Discretionary WECS shall comply with the development standards contained in Sections 22.32.180.C through 22.32.180.H.

TABLE 3-8
SMALL WECS DEVELOPMENT STANDARDS

	Small Discretionary			Small Discretionary		
	Roof-Mounted	Non-Grid -Tied Agricultural Uses	Freestanding	Freestanding		
Min. Parcel Size (acres)	N/A	>10	N/A	N/A	N/A	N/A
Max. Total Height	10 feet (Above Roof Line)	≤100 feet	≤ 40 feet	>40 - ≤ 100 feet	>100 - ≤ 150 feet	>150 - ≤ 200 feet
Max. Rotor Blade Radius/ Max. Rotor Diameter	7.5 feet/ 5 feet	0.5 x tower height	0.5 x tower height 5 feet	0.5 x tower height	0.5 x tower height	0.5 x tower height
Min. Setback from property line	0.5 x tower height	0.5 x tower height	0.5 x total height	1 x total height	1.5 x total height	2 x total height
Max. Units/Parcel	1	1	1	2	2	2
Min.Unit Separation	N/A	N/A	N/A	1 x tower height	1 x tower height	1 x tower height
Min. Setback from Habitable Structures	N/A	1 x total height	1 x total height	1 x total height	1 x total height	1 x total height

2. Large WECS.

a. Large WECS are allowed only in agricultural zoning districts (A3-A60, ARP, APZ) with a minimum lot size of 20 acres.

b. The minimum setback from property lines shall be a minimum of two times the total height. The minimum setback from habitable structures shall be two times the total height.

c. Large WECS are subject to submittal of a comprehensive environmental assessment prepared by a qualified consultant approved by the Marin County Environmental Coordinator in consultation with the County to determine the development capability and physical and policy constraints of the property The environmental assessment shall include a Bird and Bat Study, using the "California Guidelines for Reducing Impacts to

Birds and Bats from Wind Energy Development", (California Energy Commission and California Department of Fish and Game). Based upon the findings, conclusions and recommendations of the environmental assessment, specific regulations for siting and design on the site can be identified.

d. Exceptions to the standards in Table 3-9 for Large WECS shall be considered through the Use Permit process pursuant to Chapter 22.48 (Use Permits).

e. Large WECS shall comply with the development standards contained in Sections 22.32.180.C through 22.32.180.H.

f. The maximum number of Large WECS that is allowed per parcel shall be established through the permit process.

C. Public notice. Where required, a Notice of the required application(s) shall be provided in compliance with Section 22.118.020 (Notice of Hearing).

Notice of a discretionary permit application for any WECS within five miles of Federal, State, and regional park property shall be provided to the superintendent of the appropriate park.

D. Site and design requirements:

1. General standards. No WECS or supporting infrastructure shall be allowed:

a. Within five times the height or 300 feet, whichever is greater, of a known nest or roost of a listed State or Federal threatened or endangered species or California Department of Fish and Game designated bird or bat 'species of special concern' (unless siting of the WECS preceded nest or roost establishment) based on information in the California Natural Diversity Database, California Partners in Flight Database or a Bird and Bat Study, prepared by a qualified consultant approved by the Marin County Environmental Coordinator.

b. Within five times the height or 300 feet, whichever is greater, of a known or suspected avian migratory concentration point (ridge, valley, peninsula, water body or course, habitat island, concentrated food source) based on a Bird and Bat Study prepared by a qualified consultant approved by the Marin County Environmental Coordinator.

c. Within 1.5 times the height or 100 feet, whichever is greater, of a Stream Conservation Area (SCA), a Wetlands Conservation Area (WCA), a State or Federal listed special status species, a designated archaeological or historical site, or a water course, wetland, pond, lake, bayfront area habitat island, or other significant water body with suitable avian habitat based on a Bird and Bat Study prepared by a qualified consultant approved by the Marin County Environmental Coordinator.

d. Where prohibited by any of the following:

1) The Alquist-Priolo Earthquake Fault Zoning Act.
2) The terms of any conservation easement or Williamson Act contract.
3) The listing of the proposed site in the National Register of Historic Places or the California Register of Historical Resources.

E. **Appearance and visibility:**

In addition to any conditions which may be required by Master Plan/Precise Development Plan or Design Review/Use Permit approvals, all WECS shall comply with the following design standards:

1. All WECS, other than roof-mounted WECS, shall be located downslope a minimum of 300 feet horizontally from a visually prominent ridgeline, unless it can be demonstrated through submittal of a Wind Measurement Study that no other suitable locations are available on the site.

2. WECS shall be designed and located to minimize adverse visual impacts from public viewing places, such as roads, trails, scenic vistas, or parklands.

3. Brand names or advertising associated with any WECS installation shall not be visible from any public access. Only signs warning of the WECS installation are allowed.

4. Colors and surface treatments, materials and finishes of the WECS and supporting structures shall minimize visual disruption. Exterior materials, surfaces, and finishes shall be non-reflective to reduce visual impacts.

5. Exterior lighting on any WECS or associated structure shall not be allowed except that which is specifically required in accordance with Federal Aviation Association (FAA) regulations.

6. Large WECS shall be located in a manner which minimizes their visibility from any existing Federal wilderness area.

7. All new electrical wires and transmission lines associated with WECS shall be placed underground except for connection points to a public utility company infrastructure. This standard may be modified by the Director if the project area is determined to be unsuitable for undergrounding of infrastructure due to reasons of excessive grading, biological impacts, or similar factors.

8. Construction of on-site access routes, staging areas, excavation, and grading shall be minimized. Excluding the access roadway, areas disturbed due to construction shall be re-graded and re-vegetated to as natural a condition as feasibly possible after completion of installation.

9. All permanent WECS related equipment shall be weather-proof and tamper-proof.

10. If a climbing apparatus is present on a WECS tower, access control to the tower shall be provided by one of the following means:

    a. Tower-climbing apparatus located no closer than 12 feet from the ground;

    b. A locked anti-climb device installed on the tower; or

c. A locked, protective fence at least six feet in height that encloses the tower.

11. All WECS shall be equipped with manual and automatic over-speed controls. The conformance of rotor and over-speed control design and fabrication with good engineering practices shall be certified by the manufacturer.

12. Latticed towers shall be designed to prevent birds from perching or nesting on the tower and to not exceed the wind loading forces the tower was designed to withstand. Measures to prevent the nesting and perching of birds on external tower climbing devices and other possible perching and nesting areas shall also be implemented.

13. aThe use of guy wires shall be avoided whenever feasible. If guy wires are necessary, they shall be marked with bird deterrent devices as recommended by USFWS or CDFG.

F. **Noise.** The noise level of the WECS shall not exceed 55 dbA at the property line in residential zoning districts or 60 dbA at the property line of all other zoning districts, except during short-term events such as utility outages and severe wind storms, as verified by specifications provided by the manufacturer.

G. **Application submittal requirements.** Except for Small-Ministerial WECS, all WECS permit applications shall include, but may not be limited to, the following information:

1. A plot plan of the proposed development drawn to scale showing:

   a. Acreage and boundaries of the property;

   b. Location of all existing structures, their use and dimensions within five times the height of the proposed WECS;

   c. Location within a distance of five times the total height of the proposed WECS of all wetlands, ponds, lakes, water bodies, watercourses, listed State or Federal special status species habitats, habitat islands, and designated archaeological or historical sites. ;

   d. Location of all proposed WECS and associated structures, and their designated use, dimensions, and setback distances;

   e. Location of all areas to be disturbed by the construction of the proposed WECS project including access routes, trenches, grading and staging areas; and

   f. The height of all trees taller than 15 feet within five times the height of the proposed WECS.

2. Elevations of the components of the proposed WECS.

3. A description of the measures taken to minimize adverse noise, transmission interference, and visual and safety impacts to adjacent land uses including, but not limited to, over-speed protection devices and methods to prevent public access to the structure.

4. A post-installation erosion control, revegetation, and landscaping plan.

5. Standard drawings and an engineering analysis of the system's tower, showing compliance with the Uniform Building Code (UBC), the International Building Code (IBC) or the California Building Code and certification by a professional mechanical, structural, or civil engineer licensed by this state. However, a wet stamp shall not be required, provided that the application demonstrates that the system is designed to meet the UBC or IBC requirements for wind exposure D, the UBC or IBC requirements for Seismic Zone 4, and the requirements for a soil strength of not more than 1,000 pounds per square foot, or other relevant conditions normally required by a local agency.

6. A line drawing of the electrical components of the system in sufficient detail to allow for a determination that the manner of installation conforms to the National Electric Code.

7. Written evidence that the electric utility service provider that serves the proposed site has been informed of the owner's intent to install an interconnected customer-owned electricity generator, unless the owner does not plan, and so states so in the application, to connect the system to the electricity grid.

8. Wind Measurement Study. A wind resource assessment study, prepared by a qualified consultant approved by the Marin County Environmental Coordinator, may be required to be submitted. The study shall be performed for a minimum five-month prime wind period from May to September at the proposed site prior to the acceptance of an application. The study may require the installation of a meteorological tower, erected primarily to measure wind speed and directions plus other data relevant to appropriate siting. The study shall include any potential impacts on existing WECS within a minimum of two miles of the proposed WECS site.

9. Biological Study. All WECS projects before issuance of County building or planning permit approvals shall require the submittal of a biological study, consisting of a Bird and Bat Study using the "California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development", (California Energy Commission and California Department of Fish and Game), prepared by a qualified consultant approved by the Marin County Environmental Coordinator. The Bird and Bat Study shall identify any listed State or Federal threatened or endangered species or California Department of Fish and Game designated bird or bat 'species of special concern' found to nest or roost in the area of the proposed WECS site. The study shall identify periods of migration and roosting and assess pre-construction site conditions and proposed tree removal of potential roosting sites and, if necessary, provide mitigation measures.

-10. Visual Simulations. Visual simulations taken from a minimum of four off-site views shall be submitted showing the site location with the proposed WECS installed on the proposed site.

-11 Project-Specific Acoustical Analysis. A project-specific acoustical analysis may be required that would simulate the proposed WECS installation to assure acceptable noise levels and, if necessary, provide measures to comply with applicable County noise standards.

H. Post approval.

1. A post-construction avian and bat monitoring program may be required of the owner during periods of nesting and roosting. The application of this requirement shall be in accordance with criteria established by a governmental agency, such as the U. S. Fish and Wildlife Service (USFWS) or the California Department of Fish and Game (CDFG), or the PRBO Conservation Science (PRBO). The required monitoring program shall be conducted by a professional biologist or an ornithologist approved by the Marin County Environmental Coordinator. Monitoring protocol shall be utilized as set forth in the "California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development", (California Energy Commission and California Department of Fish and Game). Operation of a WEC determined to be detrimental to avian and bat wildlife may be required to cease operation for a specific period of time or may be required to be decommissioned.

2. Before issuance of a building permit, the owner/operator of any WEC shall enter into a "WECS Decommission and Reclamation Plan Agreement" with the County, outlining the anticipated means and cost of removing the WECS at the end of its serviceable life or upon becoming a discontinued use. The owner/operator shall post suitable financial security as determined by the County in order to guarantee removal of any WECS that is non-operational or abandoned. The plan must include in reasonable detail how the WECS will be dismantled and removed. The WECS must be dismantled and removed from the premises if it has been inoperative or abandoned for a one-year period. Decommissioning shall include removal of all equipment, and may require removal of all foundations and other features such as fencing and access roads to the satisfaction of the Director. The owner/operator, at his/her expense shall complete the removal within 90 days following the one-year period of non-operation, useful life, or abandonment, unless an extension for cause is granted by the Director or a plan is submitted outlining the steps and schedule for returning the WECS to service to the satisfaction of the Director. The "WECS Decommission and Reclamation Plan Agreement" shall be recorded by the Community Development Agency against the title of the property.

3. Any encumbrances placed on a parcel or parcels due to the installation of a WECS system shall remain in effect for as long as the WECS is on the site, and these encumbrances shall hold equal weight and be cumulative with respect to other limitations on the development of the parcel or parcels. Such encumbrances may not be the basis for granting variances or any other exception to the Marin County Development Code or Marin Countywide Plan regardless of any other additional development constraints imposed on the parcel or parcels. It is the owner's due diligence responsibility to ensure the siting of the WECS will not impose future development restrictions that are unacceptable to the owner.

4. Construction monitoring of individual projects may be required to include, but not be limited to, surveys and/or inspections as needed, to ensure on-site compliance with all permit requirements, until implementation of requirements is complete.

5. Upon the completion of construction and before final inspection, solid and hazardous wastes, including, but not necessarily limited to, packaging materials, debris, oils and lubricants, shall be removed promptly from the site and disposed of in accordance with all applicable County, State and Federal regulations. No hazardous materials shall be stored on the WECS site.

22.130.030 – Definitions of Specialized Terms and Phrases.

W. Definitions, "W."

Wind Energy Conversion System (WECS) (land use). This land use is defined as any machine that converts the kinetic energy in the wind into a usable form of mechanical or electrical energy. The WECS consists of all parts of the system, including the tower, wind turbine, generator, rotor, blades, supports, and transmission equipment. Additional WECS definitions include:

Small Wind Energy Conversion System. Small WECS are comprised of Small-Ministerial and Small-Discretionary WECS systems, as defined below.

Small-Ministerial Wind Energy Conversion System. This land use is defined as: (1) any small free-standing WECS up to 40 feet in total height above grade; (2) a roofmounted WECS utilizing a horizontal-axis wind turbine (HAWT) or a vertical-axis wind turbine (VAWT) and not exceeding 10 feet in height above the roof line of the structure; or (3) a non-grid-tied WECS used solely to pump water for agricultural uses and not exceeding 100 feet in height.

Small-Discretionary Wind Energy Conversion System. This land use is defined as any WECS project up to 200 feet in total height above grade.

Large Wind Energy Conversion System. This land use is defined as any WECS project greater than 200 feet in total height above grade..

Guy Wires. Wires used to secure wind turbines or towers that are not self-supporting.

Rotor Blade. The part of a wind turbine that interacts with wind to produce energy. It consists of the turbine's blades and the hub to which the blades attach.

Tower. The tower is the support structure, including guyed monopole and lattice types, upon which a wind turbine or other mechanical device is mounted as part of a wind energy system.

Tower Height (WECS). The tower height is the height from natural grade of the upper-most fixed portion of the tower excluding the length of any vertical axial-rotating turbine blade.

Total Height. The total WECS height is the height from natural grade of the fixed portion of the tower and includes the highest vertical length of any extensions such as the rotor blades of the wind turbine.

Wind Turbine. A wind turbine is a rotating machine which converts the kinetic energy in wind into mechanical energy, which is then converted to electricity.

Wind Turbine Generator. A wind turbine generator converts mechanical energy into electrical energy by means of attaching a generator to a rotating part of a wind turbine.

22.20.060 – Height Measurement and Height Limit Exceptions.

E. Exceptions to height limits:

4. **Spires, towers, water tanks, etc.** Chimneys, cupolas, flag poles, gables, monuments, spires, towers (e.g., transmission, utility, etc.), water tanks, similar structures and necessary mechanical appurtenances may be allowed to exceed the height limit established for the applicable zoning district, subject to the following standards.

   a. The structure shall not cover more than fifteen percent of the lot area at any level.

   b. The area of the base of the structure shall not exceed thousand six hundred square feet.

   c. No gable, spire, tower or similar structure shall be used for sleeping or eating quarters or for any commercial purpose other than that which is incidental to the allowed uses of the primary structure.

   d. No structure shall exceed a maximum height of one hundred fifty feet above grade, except for parcels in the A2 or IP zoning districts.

LAND USE (1)	PERMIT REQUIREMENT BY DISTRICT				See Standards in Section:
	R2 Residential Two Family	RMP Residential Multiple Planned	RX Residential Mobile Home Park	RF Floating Home Marina	
AGRICULTURAL, RESOURCE AND OPEN SPACE USES					
Agricultural accessory structures	P	MP(4)	--	--	22.32.030
Commercial gardening	P	MP(4)	--	--	
Dairy operations	--	MU(4)	--	--	22.32.030
Fish hatcheries and game reserves	--	MU(4)	--	--	
Livestock operations, grazing	--	MU(4,5)	--	--	22.32.030
Livestock operations, large animals	--	MU(4,5)	--	--	22.32.030
Livestock operations, sales/feed lots, stockyards	--	MU(4,5)	--	--	22.32.030
Livestock operations, small animals	(5)	MP(5)	--	--	22.32.030
Mariculture/aquaculture	--	MU(4)	--	--	
Nature preserves	--	MU	--	--	
Plant nurseries, with on-site sales	U	MU	--	--	
Plant nurseries, without on-site sales	P	MP	--	--	
Small WECS	P	MP	MP	--	22.32.180
Large WECS	U	MU	MU	--	22.32.180

Indirect Effects of Development on the Flat-tailed Horned Lizard

Final Report Submitted to Arizona Game and Fish Department, Yuma

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Prepared by

Kevin V. Young and April T. Young

ABSTRACT

We assessed indirect effects of human activity on adjacent populations of flat-tailed horned lizards by sampling plots at increasing distances from agricultural or urban development that abutted undeveloped flat-tailed horned lizard habitat. Surveys consisted of one-hour presence-absence searches on one-hectare plots centered at 50, 250, 450, and 650 meters from disturbance. Detection rates were low, and horned lizard scats were used to indicate presence when lizards were not found. The data were analyzed using logistic regression analysis. Distance to disturbance was found to be a highly significant factor in whether or not flat-tailed horned lizards were present. Probability of presence increased significantly with increasing distance from disturbance, indicating a negative indirect effect to at least 450 m away from agricultural or urban areas. We suspect the impact is mainly due to increased predator density near human activity. Harvester ants, the main prey of flat-tailed horned lizards, were not diminished near agriculture. We did not evaluate presence of invasive species but discuss this as another risk associated with human development.

ACKNOWLEDGEMENTS

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INTRODUCTION

Habitat loss through human activities is considered the leading agent of species declines, followed by threats from non-native species (Czech and Krausman 1997, Wilcove *et al.* 1998). Habitat destruction comes from a variety of human activities, with agricultural and urban development topping the list (Wilcove *et al.* 1998). While it is understood that either activity makes former habitat completely unusable for the flat-tailed horned lizard (FTHL), *Phrynosoma mcallii*, the extent to which negative indirect effects impact adjoining populations has not been established (FTHL ICC 2003).

The FTHL has the most limited range of any of the 14 species of horned lizards (Sherbrooke 2003). It is found only in the extreme southwestern corner of Arizona, the southeastern corner of California, and adjoining portions of Sonora and Baja California, Mexico (Stebbins 2003, FTHL ICC 2003). While a variety of human activities have modified or destroyed habitat throughout the Sonoran Desert (Lovich and Bainbridge 1999), agricultural and urban development have been the primary causes of habitat loss within the range of the FTHL. As of 1997 approximately 24,000 acres of FTHL habitat had been converted to agricultural and urban use in Arizona and 877,000 acres in California (Hodges 1997). While it has been suspected that the impact to FTHL populations is greater than the total acreage directly converted to human use (FTHL ICC 2003), no data to measure indirect effects have previously been available.

In May 2004 we conducted a series of time and area-constrained presence-absence searches for FTHL near Yuma, Arizona. We surveyed plots beginning at places of human activity (agricultural or urban development) and extending into adjacent undeveloped desert land, with a goal of assessing whether or not human activities have a measurable indirect effect on FTHL populations.

METHODS

We surveyed 4 plots along a 650 m transect at each of 27 sites, selected randomly from a pool of all possible sites (provided by Fred Wong, Bureau of Land Management, Yuma) that met the following criteria: 1) a sharp edge between agricultural or urban development and undeveloped desert, 2) development was at least one year old, 3) no major road within 200 m, 4) no additional disturbances or other transects within 500 m, and 5) no protruding or recessed edges of the disturbance within 200 m on either side of the transect. We avoided areas close to heavily-traveled roads in order to limit our study to the effects of agricultural and urban development, but a few sites close to roads were included to increase sample size. We conducted some additional surveys away from disturbance to test the methodology, but did not include these in analyses (Fig. 1).

At each of the 27 sites we placed four one-hectare plots in a line going perpendicular to the edge of human activity, for a total of 108 total sample plots. The center of the first plot was placed 50 m from the disturbance (so that one edge of the plot touched the human disturbance), and other plots were placed 250 m, 450 m, and 650 m away from the edge of disturbance.

Each plot was surveyed by a single person. Two observers worked together at a site to survey all 4 plots between sunrise and 9:30 AM. In the case of evening surveys we sampled two plots one evening and the remaining plots the following evening. To survey a plot an observer navigated to the coordinates of the plot center using a handheld GPS unit and flagged the center point with a pin flag. The approximate edges of the plot were delineated by pacing from the center point, and searches were constrained to within these boundaries for one hour. We randomly chose which plots to survey first, with the constraint that a near plot (50 m or 250 m) and a far plot (450 m or 650 m) were always surveyed simultaneously.

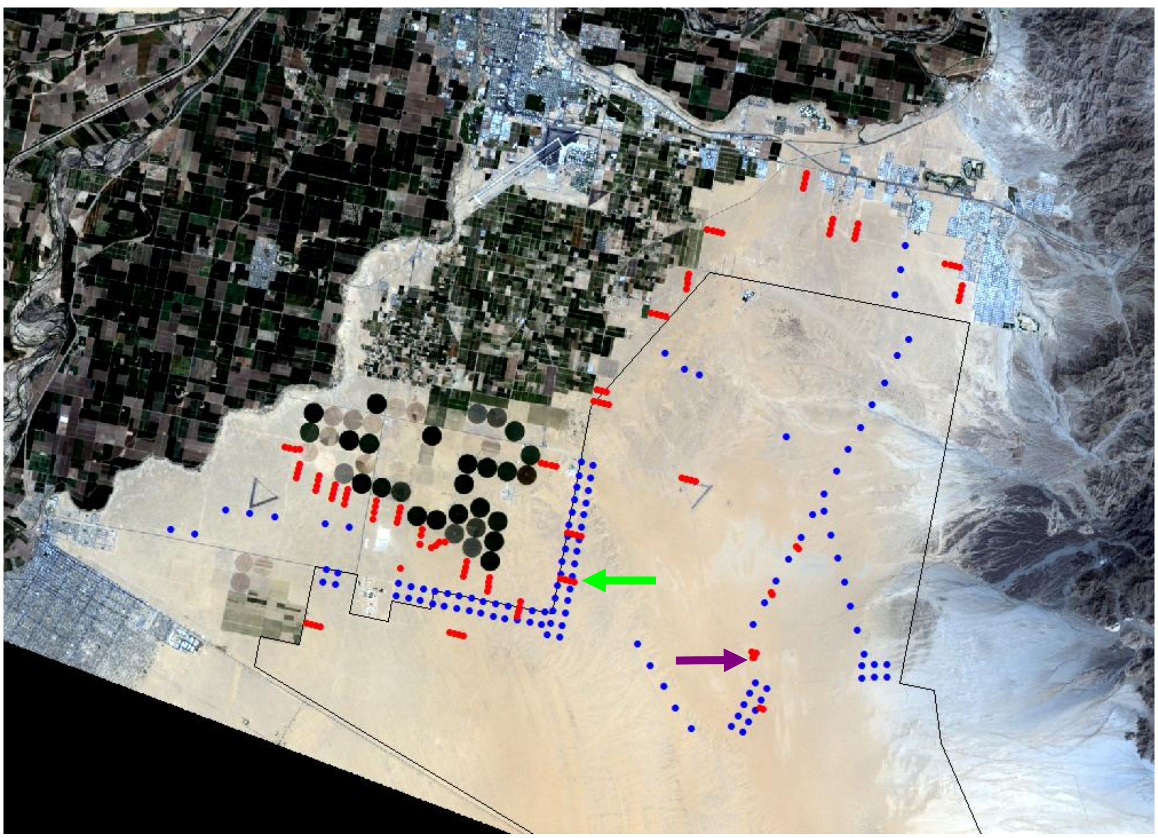
Data that were collected include date, time, location in UTMs, type of disturbance (agricultural, urban, or both), tracking conditions, percentages of different substrate components (fine sand, coarse sand, gravel, rock), number of scat, tracks, and FTHLs found, roundtail ground squirrel (*Spermophilus tereticaudus*) density (high, medium, or low based on tracks, burrows, and vocalizations), number of black harvester ant mounds (*Messor pergandei*) observed, and a density estimate of FTHLs. In short the methodology was similar to the presence-absence surveys conducted in 2003 by Young *et al.* (2004) except that we surveyed each plot for a full hour regardless of whether or not a FTHL was caught because we wanted to estimate FTHL density instead of just determining presence or absence. Factors that we considered for the density estimate included number of FTHLs found, number of tracks, number of scat, distribution of tracks and scat throughout the plot, freshness of tracks and scat, tracking conditions, and overall habitat quality. Tracking conditions were relatively poor this year due to dense annual vegetation and high rodent activity (in response to winter rainfall), so we had to rely more heavily on indirect measures of FTHL presence.

Primarily because of the difficult tracking conditions, we lacked confidence in the density estimates and chose to not present any summary data on these estimates or use them for estimating effects of disturbance. Since 75% of the estimates were either 0 or 1 anyway it seemed prudent to base analyses simply on presence or absence and do a logistic regression analysis instead of a linear regression. We counted presence for any plot where a FTHL was captured, but also for any plot (outside the range of desert horned lizards) with at least 3 scats found, or at least one definite track plus a scat. If we were near where desert horned lizards were known to occur we only counted FTHL captures as presence. During the 2003 presence-absence surveys we only counted presence when we found a FTHL, thus avoiding any false presences but risking false absences. The change in protocol this year is because our ability to find FTHLs was so much lower than last year (due to tracking conditions). We would have created too many false absences if we had relied solely on captures.

We performed a logistic regression analysis using stepwise selection (SAS 2004). Stepwise selection begins with no independent variables in the model. It adds variables one at a time by comparing the *P*-values for the F statistics of the possible independent variables (the variable with the lowest *P*-value is added first). Unlike forward selection, in stepwise selection a variable that has already been added to the model does not necessarily stay there (if the F statistic changes too much in presence of other variables then it is dropped from the model). The stepwise selection process ends when no variable outside the model has an F statistic that is significant at the specified entry level (we used $P < 0.05$ as the entry criteria). The independent variables that were available for selection by the model were distance from disturbance, northing coordinate, easting coordinate, percentages of fine sand, coarse sand, and gravel, tracking rating, type of disturbance, observer, and probability of presence values (from the model of predicted distribution that was created with 2003 presence/absence survey data) (Young *et al*. 2004).

After running the logistic regression model we plotted predicted presence at each sampling distance and compared mean values of these predictions with t-tests. We ran a separate logistic regression analysis that forced type of disturbance (agricultural, urban, or both) to stay in the model to evaluate differences between disturbance types. Data for ground squirrel density and density of active black harvester ant mounds were summarized but not statistically analyzed.

Figure 1. Sample plots for 2004 indicated by red dots. Blue dots indicate 2003 presence-absence samples used to create a model of predicted distribution. Some samples (such as indicated by the green arrow) are adjacent to disturbance that is new since the time of this satellite image in the year 2000. Other samples (such as indicated by the purple arrow) are not adjacent to disturbance and were not included in any analyses. A black line shows the boundaries of the Yuma Desert Management Area



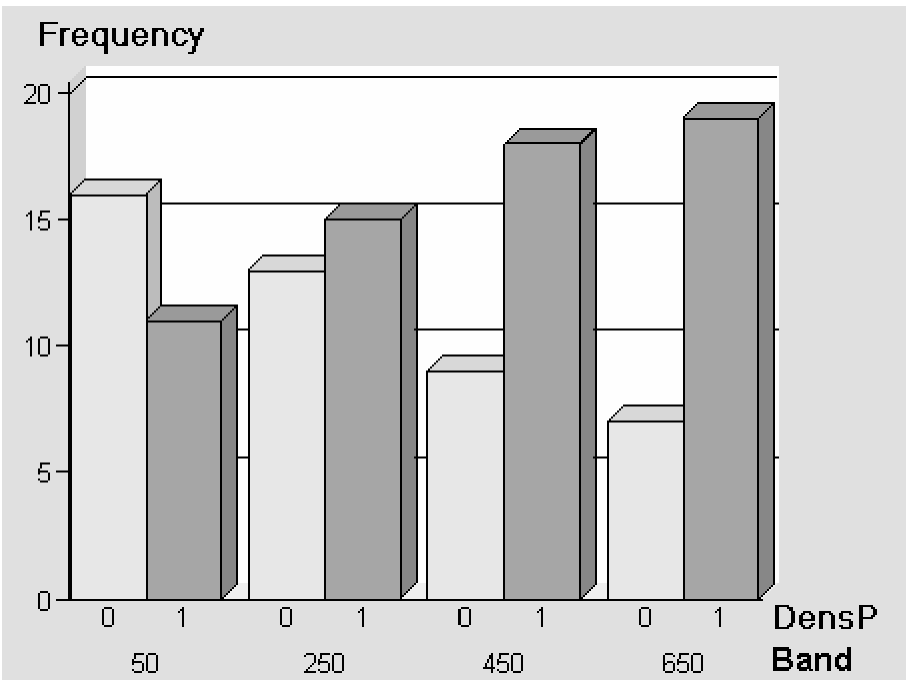
RESULTS

We surveyed 27 sites, with 4 plots per site, for a total of 108 plots sampled as 27 replicates per distance treatment. Of the 27 different sites that interfaced between human disturbance and desert, 18 were adjacent to agriculture, 5 next to urban development, and 4 were a mixture of agricultural and urban impacts. FTHL presence was counted at 1 or more plots at 22 of the 27 sites, while 5 sites had absence at all 4 plots. Presence was confirmed by capture of at least one

FTHL at only 27 of the 108 plots (25%), but we noted presence based on tracks, scat, habitat suitability, and captures at 63 plots (58%). Scat was the most common indicator of presence, with an average of 4 scats found per plot (35 maximum), compared to an average of 0.66 tracks (5 maximum) and 0.23 FTHLs (3 maximum) found per plot.

A bar graph showing how many plots had presence or absence at each of the distances from disturbance (50 m, 250 m, 450 m, and 650 m) shows a clear increase in frequency of FTHL presence with increasing distance from agricultural or urban development (Figure 2).

Figure 2. Bar chart of frequency of absence (0) or presence (1) of flat-tailed horned lizards at plots of increasing distances (in meters) from human disturbance.



The step-wise selection criteria only included the 2003 model predictions ($P = 0.0133$) and the distance from disturbance ($P = 0.0148$) as effects in the model. The predictions from the logistic regression analysis were plotted to visualize probability of presence at each of the four distances from disturbance (Figure 3). The mean predicted value at each distance was statistically different from the values at all other distances ($P < 0.05$).

When type of disturbance was forced into the logistic regression analysis along with the 2003 model predictions and distance from disturbance, type of disturbance did not have any measurable effect on probability of FTHL presence ($P = 0.4363$).

Ground squirrel densities were considered high at eight of the nearest plots, but at only one plot at each of the other distances (Table 1). Number of active black harvester mounds was higher at the two nearest plots than the two farthest plots (Table 1). Because ground squirrel data were subjective and ant data were not collected systematically, we did not statistically test for differences between distances for these variables.

Figure 3. A box plot indicating a positive relationship between the probability of occurrence of flat-tailed horned lizards and distance (in meters) from human disturbance. Predicted probability of occurrence at each sample plot was output from the logistic regression analysis that used output from a predictive model of distribution and distance from disturbance as predictive variables. The box encloses the middle 50% of the predicted values for each distance, the horizontal line within the box represents the median value, and the line extending beyond the box represents the range of values.

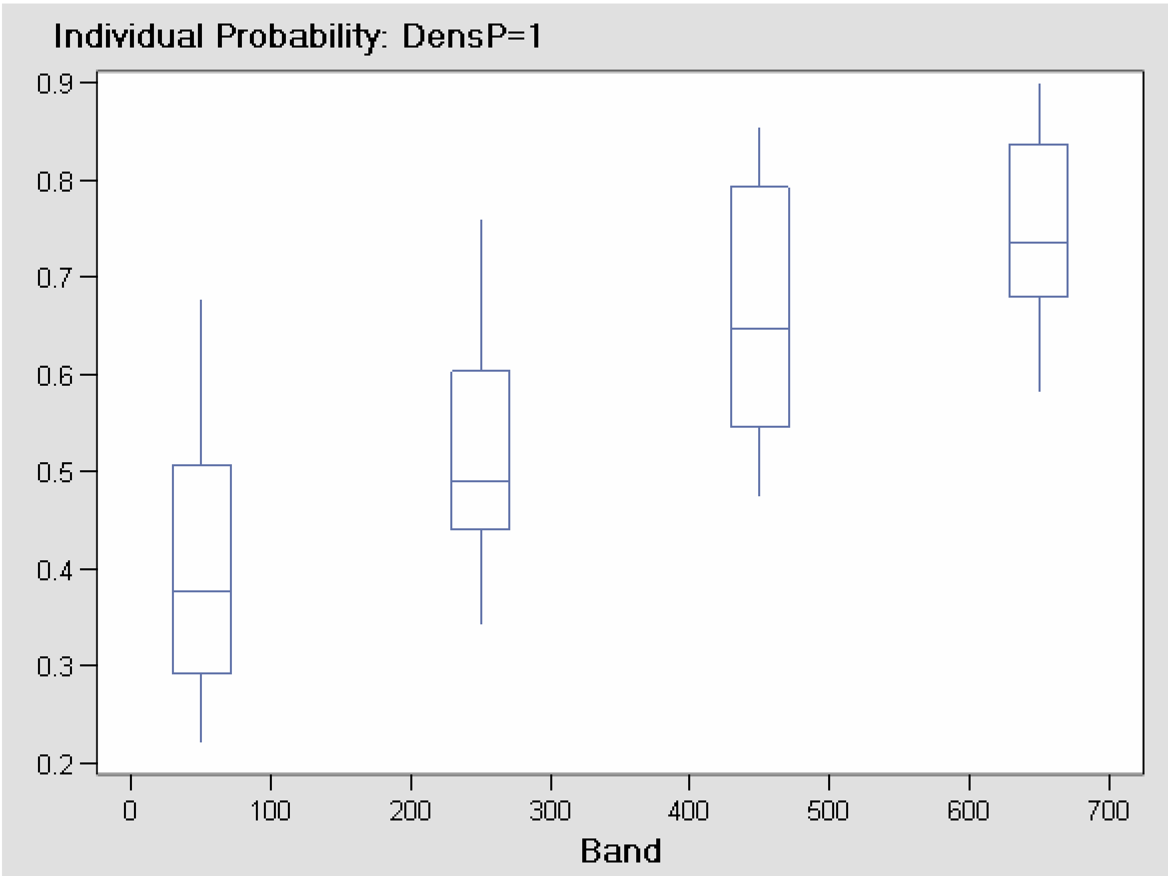


Table 1. Comparison of ground squirrel (*Spermophilus tereticaudus*) density categories and mean number of black harvester ant mounds (*Messor pergandei*) at increasing distances from human activity.

		Distance From Disturbance			
		50 m	**250 m**	**450 m**	**650 m**
Number of plots with different ground squirrel densities	Low	12	16	17	16
	Med	4	7	5	3
	High	8	1	1	1
Mean *Messor* mounds per plot		10.3	12.9	7.8	7.3

DISCUSSION

The data are very clear in any form—there is a negative effect on FTHLs that extends beyond the margins of human activity. While the main predictor of presence in the logistic regression model was the 2003 model of predicted distribution (which is a reflection of habitat suitability), the only other significant predictor of FTHL presence was distance from disturbance. There is a clear negative impact on FTHL presence to at least 450 m away from disturbance. We did not sample far enough away from disturbance to verify that we had reached the edge of the disturbance effect since predicted density did not reach an asymptote. However, our subjective opinion is that the rates of presence at the most distant plots were similar to those at areas far removed from disturbance. A measurable edge effect of 450 m is similar to other studies where it was found that most edge effects typically extend a few hundred meters into natural areas (Murcia 1995, Laurance 2000). We found no difference between agricultural and urban development, but it should be noted that our sample size from urban development was low (not surprising since agriculture commonly adjoins undisturbed habitat but urban areas generally do not).

We have documented that development along an edge of a management area impacts adjacent habitat, thus diminishing the overall reserve size. For example, a 40-acre field (1/4 mile square) that borders FTHL habitat on one edge (1/4 mile = 402 m) negatively impacts at least 45 acres of undisturbed FTHL habitat (402 m * 450 m = 180,900 m^2 = 18.1 ha = 44.7 acres). Management agencies need to consider that they will experience FTHL losses <u>within</u> their management areas on at least 180 acres per mile of edge that borders agricultural or urban development. Impacts from human activities are a leading cause of mortality within protected areas (Woodroffe and Ginsberg 1998). A visual estimate of the perimeter of the Yuma Desert Management Area shows at least 20 miles that border land that has been or may be converted to agricultural or urban development, for a potential indirect negative impact on FTHL populations on 3,600 acres of protected land. Because the habitat is still intact FTHL will continue to move into these areas, creating a population sink that will have a negative impact on the overall population on an ongoing basis. Such sinks would have the greatest impact on population dynamics in small habitat fragments with a high perimeter:area ratio and on species that range widely (Woodroffe and Ginsberg 1998). Fortunately, the Yuma Desert Management Area and other FTHL Management Areas are quite large relative to the movements of the FTHL, thus reducing the risk of extinction from edge effects within these reserves.

With the FTHL Management Areas already established, one additional way to conserve FTHL populations would be to minimize edge effects on border areas (Woodroffe and Ginsberg 1998). This can be difficult, but in the case of the proposed Area Service Highway, the planned horned lizard-proof fence along the border of the Management Area should mitigate much of the impact. FTHL habitat occurs on both sides of the proposed highway along some stretches, but the fence will only be on the side that borders the Management Area. The success of minimizing impacts of the road could be studied by comparing plots on either side of the road at increasing distances from it. This would indicate both the effect of a road in FTHL habitat and also the effectiveness of horned lizard-proof fencing.

Artificially increased predator densities may be an important contributor to the negative correlation between FTHL presence and proximity to human development. As stated in the Rangewide Management Strategy (FTHL ICC 2003), “Predators, such as common ravens, American kestrels, and domestic dogs and cats, also increase in urban areas, resulting in increased predation rates on FTHLs in adjacent wildlands (Bolster and Nicol 1989; Cameron Barrows, CNLM, pers. comm.).” Although we cannot attribute the reduced presence of FTHLs near development to specific causes with certainty, the density of a major FTHL predator, the roundtail ground squirrel, was highest in the plots closest to human activity. Young and Young (2000) found that the roundtail ground squirrel killed a higher proportion of FTHLs carrying transmitters in the Yuma Desert Management Area than all other predators combined. Shrikes are almost certainly more common around agricultural fields, but we made no attempts to measure their density.

While we think increased predator density is the most likely cause for the observed decline in FTHLs near development, invasive species may also contribute. Biological invasions can spread far into a reserve, thus decreasing its effective area (Suarez and Case 2002). We did not evaluate presence or density of alien species, but they are known to be problems for other horned lizards. Argentine ants (*Linepithema humile*) invade coastal horned lizard (*Phrynosoma coronatum*) habitat much more readily in disturbed areas or adjacent to development (Suarez *et al.* 1998). These ants displace native ants and are not, themselves, eaten by horned lizards (Suarez *et al.* 2000). This “bottom-up” effect is different than the “top-down” effect of increased predator abundance, but can be just as threatening to a rare species, particularly when that species is a dietary specialist (Suarez and Case 2002). Fire ants (*Solenopsis invicta*), which have had adverse effects on the Texas horned lizard (*P. cornutum*), were found in Yuma on one occasion but have apparently been eradicated (L. Piest pers. comm.). We did not look for fire ants at the sites we sampled. We did count active mounds of *Messor pergandei*, which is a native harvester ant and an important food source of FTHLs (Young and Young 2000). Since we found more of these harvester ants closer to development, we suspect that fire ants had not invaded any of the areas that we sampled. We know invasive plants occur over wide areas of the Yuma Desert MA and suspect that they are more common closer to development. Invasive plants may negatively affect FTHLs but the actual impacts are unknown (FTHL ICC 2003) and we did not attempt to measure their presence or density in this study. Another factor that may cause decline in prey abundance is pesticide drift. Although harvester ants were more abundant closer to fields, we do not know which, if any, of these fields had been sprayed with pesticides applied by plane. Either there was no pesticide drift, or if there was there was no measurable negative impact on black harvester ants.

Presence-absence data yields less information than actual counts, but due to low detection rates this year we were limited to using only presence-absence data in the analyses. Because we did not resample sites and create a history of detection/non-detection for each site, it was not possible for us to estimate detection rates or true occupancy rates (MacKenzie *et al.* 2002). These estimates would be helpful for establishing differences in detection rates in different years, and we recommend including site resampling in future designs. If enough sites are resampled enough times, it is even possible to deduce abundance estimates from presence-absence samples (Royle and Nichols 2003). Since FTHL are easy to capture if detected, mark-recapture data can be collected during repeated site visits, which will yield better abundance estimates when combined with presence-absence data than the presence-absence data alone (Royle, pers. comm. 2005). If samples are repeated across years it is also possible to estimate extinction and recolonization rates (MacKenzie *et al.* 2003), which would be particularly valuable in areas where new disturbance occurs.

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APPENDIX

A CD containing the following has been deposited at AZGFD and BLM offices in Yuma

- Capture data (Excel file)
- Survey data (Excel file)
- Digital photos of captures
- Digital photos of habitat

Young Environmental Consulting
527 N. 400 E.
Logan, UT 84321
Ph. 435-755-8339
Fax: 435-797-3943
Email: keviny@ext.usu.edu

Title:

Boundary processes between a desert sand dune community and an encroaching suburban landscape

Author:

Barrows, Cameron W., University of California, Riverside
Allen, M F
Rotenberry, J T

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Abstract:

In contrast to the body of work in more mesic habitats, few studies have examined boundary processes between natural and anthropogenic desert landscapes. Our research examined processes occurring at boundaries between a desert sand dune community and an encroaching suburban habitat. We measured responses to an anthropogenic boundary by species from multiple trophic levels, and incorporated measures of habitat suitability, and temporal variation, at multiple spatial scales. At an edge versus core habitat scale the only aeolian sand species that demonstrated an unambiguous negative response to the anthropogenic habitat edges was the flat-tailed homed lizard (Phrynosoma mcallii). Conversely loggerhead shrikes (Lanius ludovicianus) demonstrated a positive response to that edge. At a finer scale, species that exhibited a response to a habitat edge within the first 250 m included the horned lizards along with desert kangaroo rats (Dipodomys deserti). The latter species' response was confined to 25 In from the edge. For the flat-tailed horned lizard, edge effects were measured up to 150 m from the habitat boundary. Three potential causal hypotheses were explored to explain the edge effect on horned lizards: (1) invasions of exotic ant species reducing potential prey for the lizards; (2) road avoidance and road associated mortalities; and (3) predation from a suite of avian predators whose occurrence and abundance may be augmented by resources available in the suburban habitat. We rejected the exotic ant hypothesis due to the absence of exotic ants within the boundary region, and because native ant species (prey for horned lizards) did not show an edge effect. Our data supported the predation and road mortality hypotheses. Mechanisms for regulating population dynamics of desert species are often "bottom-up," stochastic processes driven by precipitation. The juxtaposition of an anthropogenic edge appears to have created a shift to a "top-down," predator-mediated dynamic for these lizards. (c) 2006 Elsevier Ltd. All rights reserved.

Boundary processes between a desert sand dune community and an encroaching suburban landscape

Cameron W. Barrows [a, b, *] and Michael F. Allen [a, c] and John T. Rotenberry [a, c]

[a] Center for Conservation Biology, University of California Riverside, Riverside, CA 92521-0334, USA
[b] Center for Natural Lands Management, 53298 Ave. Montezuma, La Quinta, CA 92253, USA
[c] Department of Biology, University of California, Riverside, CA 92521-0334, USA
cbarrows@cnlm.org

Abstract

In contrast to the body of work in more mesic habitats, few studies have examined boundary processes between natural and anthropogenic desert landscapes. Our research examined processes occurring at boundaries between a desert sand dune community and an encroaching suburban habitat. We measured responses to an anthropogenic boundary by species from multiple trophic levels, and incorporated measures of habitat suitability, temporal variation, and spatial scales. At an edge versus core habitat scale the only aeolian sand species that demonstrated an unambiguous negative response to the anthropogenic habitat edges was the flat-tailed horned lizard (*Phrynosoma mcallii*). Conversely loggerhead shrikes (*Lanius ludovicianus*) demonstrated a positive response to that edge. At a finer scale, species that exhibited a response to a habitat edge within the first 250 m included the horned lizards along with desert kangaroo rats (*Dipodomys deserti*). The latter species' response was confined to 25 m from the edge. For the flat-tailed horned lizard, edge effects were measured up to 150 m from the habitat boundary. Three potential causal hypotheses were explored for explaining the edge effect on horned lizards: 1) potential invasions of exotic ant species reducing potential prey for the lizards; 2) road avoidance and road associated mortalities; and, 3) predation from a suite of avian predators whose occurrence and abundance may be augmented by resources available in the suburban habitat. We rejected exotic ant hypothesis due to the absence of exotic ants within the boundary region, and because native ant species (prey for horned lizards) did not show an edge effect. Our data supported the predation hypothesis and road mortality hypotheses. Mechanisms for regulating population dynamics of desert species are often "bottom-up," stochastic processes driven by precipitation. The juxtaposition of an anthropogenic edge appears to have created a shift to a "top-down," predator mediated dynamic for these lizards.

Keywords: Edge Effect; Anthropogenic boundary processes; Desert aeolian sand community; Flat-tailed horned lizard; Loggerhead shrike: Predation

1. Introduction

Primary mechanisms that distinguish processes at habitat boundaries include: 1) abiotic gradients unique to those boundaries, 2) access to spatially separated resources, and 3) species interactions (Wiens et al. 1985, Murcia 1995, Laurance et al. 2002, Ries et al. 2004). Collectively these mechanisms create a conceptual framework for understanding ecological boundary responses. Additionally, understanding factors that control the occurrence and dynamics of populations in relatively unfragmented habitat patches provide a context from which to evaluate how those drivers are impacted at boundaries. In arid ecosystems highly variable and unpredictable precipitation often regulates biological processes (Noy-Meir, 1973). Support for this axiom can be found across a broad range of taxa and regions (Mayhew 1965, 1966; Pianka 1970; Ballinger 1977; Whitford and Creusere 1977; Seely and Louw 1980; Dunham 1981; Abts 1987; Robinson 1990; Brown and Ernest 2002; Germano and Williams 2005). Population dynamics of desert species are thus often characterized as being regulated from the bottom-up, by resource availability mediated by annual rainfall (Brown and Ernest 2002). In contrast, Faeth et al. (2005) described a shift in the processes controlling population dynamics in a suburban desert environment. There irrigated landscapes regulated productivity and resulted in a predation controlled, top-down community. These different population regulating processes meet at the boundary between natural desert and anthropogenic habitats. The extent to which processes generated by anthropogenic habitats encroach on the natural desert and impact components of that community is the subject of this paper.

In contrast to the body of work in more mesic habitats, few studies have examined boundary processes between natural and anthropogenic desert landscapes (e.g., Germaine et al. 1998, Germaine and Wakeling 2001, Boal et al. 2003, Gutzwiller and Barrow 2003). Here we examined processes and species occurring at boundaries between an aeolian sand landscape and encroaching suburban and abandoned agricultural field habitats. Distinguishing between variance in abundance imposed by the heterogeneity of the available habitats and what if any effects the proximity of an edge has on the distribution of native species is critical in determining the ecological importance of those edges (Bolger et al. 1997, Fagan et al. 2003). We incorporated measures of habitat suitability, temporal variation, and spatial scales to identify whether components of an aeolian sand community have altered their distributions in response to the presence of anthropogenic habitat edges.

Much of the previous research on edges has focused on temperate and tropical habitats (Janzen 1983, Wilcove 1985, Laurance 1991, Murcia 1995, Laurance et al. 2002, Watson et al. 2004) where boundary-mediated ecological flow processes extend from 10-400 m into interior habitats (i.e., Kapos 1989, Camargo and Kapos 1995, Laurance et al. 2001). Fewer studies have investigated edge effects in semi-arid environments, with much of that work focusing on coastal sage scrub in southern California (Bolger et al. 1991, Bolger et al. 1997, Kristan et al. 2003). In this habitat, moisture gradients at suburban-natural community boundaries have limited the invasion of non-native ants to 100 m or more into the natural communities from mesic refuges in the suburban landscape, with a corresponding negative cascade affecting overall native species richness (Suarez et al. 1998). Increased predation is another factor identified at sage scrub boundaries (Bolger et al. 1991, Bolger et al. 1997, Crooks and Soulé 1999, Suarez et al. 2000, Suarez and Case 2002, Unfried 2003). Collectively these findings define the range of anthropogenic boundary impacts described to date. Our objective was to determine whether any of these impacts also influence the distribution and abundance of species in desert habitats.

2. Methods

2.1 Study Area

Aeolian sand habitats were studied within the Thousand Palms Preserve (33^{o} 47' N, 116^{o} 20' W*)* in the Coachella Valley near Palm Desert, Riverside County, California. The Preserve includes approximately 1,300 ha of contiguous sand dunes and hummocks.

The Coachella Valley is an extremely arid shrub desert with a mean annual rainfall of 79 to 125 mm (most recent 60 year means, Western Regional Climate Center, Palm Springs and Indio reporting stations). The lowest rainfall year occurred in 2002, with just 4 to 7 mm recorded across the valley floor. Temperatures range from a low approaching 0 ^{o}C in the winter to highs exceeding 45 ^{o}C commonly recorded during July and August.

Study plots were designed to enable analyses at both a coarse scale (edge versus interior plots) and at a finer scale along the habitat edges (within plot distance from the habitat edge). Additionally, study plots were established to identify effects from two separate edge types. Fourteen study plots were established within the Preserve: three were located along a 2.4 km boundary with a suburban golf course community, six were located along a 3.2 km boundary with an abandoned agricultural area and sparse rural housing (Figure 1), and five control plots were centrally located in "core" habitat, greater than 500 m from roads. There was a four-lane paved road separating the Preserve from the suburban habitat and a two-lane paved road separating the Preserve from an area of abandoned agriculture. All study plots were located in a stratified random manner. Plots were stratified so as to include both active sand dune and sand hummock habitat in a proportion corresponding to the aerial extent of those different habitat types. Edge plots were established adjacent to paved roads, but randomly located along the roadway.

Each of the 14 study plots consisted a cluster of 5-8, 10 m x 100 m belt transects. Edge plots included seven transects, with the first centered on a barbed wire boundary fence and running parallel to the fence and adjacent paved road. A second transect was established parallel to the first, but was 25 m interior from the edge. Additional parallel transects were placed at 50, 100, 150, 200, and 250 m from the edge. Core plots consisted of similar clusters of belt transects with the same dimensions as the edge sites. Core plots were >500 m from any roadway, residence, or habitat discontinuity and included five to eight parallel belt transects separated by 50-150 m. Each transect was marked with a short wooden stake at the beginning, middle, and end so that their position with respect to the boundaries of the belt transect could be readily determined. Each study plot covered approximately 2.5 ha. Surveys were repeated six times at each plot between June and July each year from 2002 through 2004. Data collected in 2002 focused on flat-tailed horned lizards, *Phrynosoma mcallii*. Data collected in 2003 and 2004 included all species encountered.

2.2 Survey Protocol

The fine aeolian sand of the Thousand Palms Preserve presented an opportunity unique to sand dunes to quantify the occurrence and abundance of all terrestrial species occurring along transects with more or less equal detectability. Each vertebrate species could be identified to species and age class by their diagnostic tracks left in the sand. Ground-based species left easily identifiable tracks, and so their ability to avoid detection by differences in activity times, cryptic coloration, or stealthy behavior was nullified. Because late afternoon and evening breezes would wipe the sand clean the next day's accumulation of tracks could not be confused with those from the previous day. On those days when the wind did not blow, tracks from the current day could be distinguished from those from previous days by whether or not the tracks of nocturnal arthropods crossed over the vertebrate's track. Lizard track identification criteria were developed by spending several weeks prior to surveys, following tracks until animals were located and the species and age class was confirmed. Tracks from other diurnal vertebrates were confirmed as they were encountered during pre-survey field work. Nocturnal or otherwise cryptic species' tracks were confirmed by comparisons with foot sizes and configurations from museum specimens

Surveys would begin after the sand surface temperature had risen sufficiently so that diurnal reptiles were observed to be active, usually $\geq 35^{o}$ C. Surveys continued until late morning when the high angle of the sun reduced the observer's ability to distinguish and identify tracks. One or two observers working in tandem completed a survey on a given study plot in 30-45 minutes, recording all fresh tracks observed within the 10 m wide belt of each 100 m transect. Tracks were followed off transect if it was necessary to confirm a species' identification and to insure that the same individual was not crossing the same transect repeatedly, thus avoiding an inflated count of the individuals active on that transect. Data for separate transects were considered independent for most species. In addition to tracks, we recorded any sightings of animals along transects and recorded any bird vocalizations heard during a survey. Wide ranging predators such as coyotes (*Canis latrans*), greater roadrunners (*Geococcyx californianus*), American kestrels (*Falco sparverius*), and loggerhead shrikes (*Lanius ludovicianus*), had ranges much larger than the transect dimensions, and so were recorded as present on a study plot, rather than on individual transects.

Harvester Ants (*Pogonomyrmex* sp.) were sampled using dry pitfall traps in April of each year. Previous arthropod sampling efforts (Barrows, unpublished data) have indicated that in most years ant numbers reached peak numbers in April. This was also the period when lizards eating ants would be consuming the resources necessary for egg production in the coming months. Three pitfall traps was placed on each transect; one at both ends and another at the transect middle. The traps were collected within 24 hrs of being set out to avoid any mortality of vertebrates that happened into the traps. Ant data were presented as the total count per transect.

2.3 Habitat Measures

Vegetation density and plant species composition were measured on each transect each year. All perennial shrubs were counted within the 10 m x 100 m belt transects. Annual plants were counted and cover estimated in a 1 m^2 sampling frame placed at 12 locations along the midline of the belt transect.

Sand compaction has been described as a key habitat variable for Coachella Valley fringe-toed lizards, *Uma inornata*, (Barrows 1997), and may be important for other psamnophilic species. Sand compaction was measured at 25 points, approximately four m apart, along the midline of each belt transect using a hand-held penetrometer with an adapter foot for loose soils (Ben Meadows Company, Janesville, WI, USA).

2.4 Data Analysis

A one-way analysis of variance (ANOVA) was employed to conduct coarser scale analyses, examining edge versus core differences, and to include wider ranging bird species. Here edge plots adjacent to the preserve edge (including transects ranging from 0

– 250 m from that edge) were compared with core plots (> 500 m from the preserve edge). A two-way ANOVA was conducted to partition finer scale variance in species abundance between the treatment (distance from the preserve edge) and variance associated with habitat heterogeneity between each of the edge plots.

For the nine edge plots, those species that showed statistically significant variation with respect to distance to edge (0-250 m) were then subjected to a linear regression to determine whether environmental variation coincident with the edge distance could explain that observed variance. All variables were tested for normality and transformed with natural logs when necessary. Dependent variables were means of the six surveys on each transect per year for each species. Independent variables included measures of sand compaction (kg / cm$^{2)}$ for each year, shrub density (shrubs / m^2), and linear distance from the Preserve edge. Total observations equaled 63 (seven transects / plot over nine plots), and just since one or two variables were included in the regression analyses, model over fitting was avoided. Linear regression analyses were performed using SYSTAT 10.0 (SYSTAT, Wilkinson, 1990). A threshold of α= 0.05 for statistical significance was used throughout this paper.

3. Results

Of the nine species tested with ANOVAs at the edge versus core scale, only the flat-tailed horned lizard and the loggerhead shrike showed a statistically significant effect, although their responses were opposite (Table 1). Shrikes were more common along the edge whereas the horned lizards were more abundant in the core. At the finer scale, for those nine plots situated along the Preserve boundary, distance from the

Preserve edge was found to be a significant source of variance for the flat-tailed horned lizard, and the Desert kangaroo rat, *Dipodomys deserti* (Table 2).

These statistical results are corroborated by the patterns of temporal and spatial species' abundance for the seven sand dune occurring species included in our analysis (Figs. 2a-2g). There were no consistent responses to proximity of the habitat boundary for Coachella Valley round-tailed ground squirrels (*Spermophilus tereticaudus chlorus*), sidewinders (*Crotalus cerastes*), western shovel-nosed snakes (*Chionactis occipitalis*), and harvester ants (*Pogonomyrmex* spp., including *P. californicus* and *P. magnacanthus*). The abundance of both fringe-toed lizards and desert kangaroo rats appeared to be reduced along the immediate habitat edge in both 2003 and 2004, but not at distances $\geq$ 25 m from that boundary in either year. In contrast, flat-tailed horned lizards' abundance was reduced at distances from the habitat edge of 150 m in 2002, and 100 m in 2003 and 2004.

For the nine edge plots, Pearson's correlations were calculated for distance from the habitat edge and sand compaction and shrub density. Edge distance was not correlated with sand compaction (r = -0.001 to -0.135, all P = .0335 to 0.995), and was only moderately negatively correlated with shrub density (r = - 0.235, P = 0..043). However, sand was consistently more compacted along the immediate Preserve boundary than it was 25 m interior of that boundary (paired t-test, p = 0.048).

Regression models were run for the two species for which the within-plot ANOVAs indicated significant edge correlations (Table 3). Shrub density did not explain a significant amount of the variance in abundance for either species, and so was not included in the models. For each species, a single variate model using distance as the independent variable yielded statistically significant linear relationships. However, only the horned lizard's edge distance model yielded a R^2 above 0.100. A single variate model using sand compaction as the independent variable also yielded a significant relationship for the horned lizard.

Boundaries between the natural desert and anthropogenic landscapes evaluated here were of two types. One was adjacent to a suburban golf course community, but separated by a well used four-lane road with curbs. The other boundary was adjacent to abandoned agricultural fields with tree rows surrounding each parcel, and was separated by a low use, two-lane road without curbs. The abundance of flat-tailed horned lizards, round-tailed ground squirrels, desert kangaroo rats and harvester ants differed between habitats adjacent to the two boundary types (Table 2). For species other than horned lizards, abundances within boundary types were statistically invariant on transects within plots; no difference in their response to the edge was detected. For the horned lizards there were differences in abundance with respect to the Preserve edge. No horned lizards were located closer than 100 m from the boundary adjacent to the suburban landscape; here lizard abundance didn't reach an apparent asymptote until 200 m from the preserve edge (Fig. 3). Some horned lizards were located right to the edge of the boundary along the abandoned agricultural fields. Abundance appeared asymptotic 100 m from the preserve edge

4. Discussion

We identified negative responses to anthropogenic boundaries for flat-tailed horned lizards, and desert kangaroo rats. Data for the horned lizards were the most consistent from the standpoint of different scales (edge versus core plots and within-plot edge distances) and linear regression results. For the kangaroo rat, edge effects were apparent only at the finer scale, within-plot analyses and relatively weak regression results. This pattern may be explained by environmental variation associated with Preserve habitat boundary. Historic road grading created low berms along the road-Preserve boundaries. Rare flood events create pooled standing water and silt deposition along those berms, resulting in significantly more compacted sediments within 10-20 m of that boundary. The edge effect for desert kangaroo rats appeared to be confined to < 25 m from the Preserve boundary, coincident with the effects of roadside berms.

Flat-tailed horned lizards typically occupy sand compaction conditions found throughout the nine edge plots., Edge effects for this species were measured up to 150 m from the habitat boundary, well beyond the impact of the roadside berms. This lizard's range has been reduced and fragmented in recent years (Turner and Medica 1982) and this preserve may represent the only remaining habitat for flat-tails in the northern one-third of their original distribution. Deciphering causal factors for the flat-tail's absence along the preserve boundary may provide important directions for future management and preserve design strategies. Three non-exclusive hypotheses were evaluated to explain this edge effect.

1) <u>Road Mortality – Road Avoidance Hypothesis</u> - Like many reptiles, flat-tailed horned lizards will use the margins of paved roads, most likely for thermoregulation (Norris 1949, Turner and Medica 1982). Impacts of roads on wildlife populations include direct mortality and road avoidance (Forman and Alexander 1998). If there is a road impact here we would expect the response from the lizards to be stronger adjacent to

larger, busier roadways. In fact, we found consistent differences in lizard-edge relationships between edges adjacent to a busy four-lane road and a less used two-lane road. While edge effects were apparent along each road type, lizards adjacent to the four-lane road demonstrated a more pronounced and abrupt edge effect than those along the two-lane road, and so the data are consistent with a road effect hypothesis. No statistical difference in shrike abundance was found between plots along the two-land and four-lane roads, eliminating shrike predation as a confounding variable. The lack of a edge effect in any of the three nocturnal species included in our analysis may be in part a reflection of reduced vehicle traffic during the night.

2) Invasive Alien Ant Hypothesis - Flat-tailed horned lizards' prey is almost exclusively harvester ants (Pianka and Parker 1975, Turner and Medica 1982). The reduction in harvester ants from 2003 to 2004 in the aeolian sand habitat, which coincided with a similar reduction in flat-tails, supports a hypothesis that the population dynamics of these two taxa are linked.

Suarez and Case (2002) and Fisher et al. (2002) have identified the invasion of non-native Argentine ants (*Linepithema humile*) as a leading factor in the disappearance of coast horned lizards (*P. coronatum*) from fragmented habitats in coastal southern California. Suarez et al. (1998) described Argentine ants being able to invade up to 100 m into semi-arid natural habitats, greatly reducing native ant populations within that same 100 m belt. Coast horned lizards that were limited to Argentine ants for prey had negative or zero growth rates, and so could not maintain populations unless native ant populations were present (Suarez et al. 2000, Suarez and Case 2002).

Argentine ants were known to occur in adjacent suburban golf course communities. Similarly, introduced fire ants (Solenopsis invicta) have also been identified in the Coachella Valley and elsewhere are associated with roads, suburban development and edges (Forys et al. 2002), No non-native ant species were collected within any plots on the Thousand Palms Preserve.. The extreme aridity of this habitat may be a barrier to invasion of ant species otherwise problematic to more mesic habitats. These data, and the lack of any edge effect apparent in the native harvester ants, indicate that alien ant invasions are not a cause for the observed edge effect in the horned lizard population

3) Enhanced Predation Hypothesis - Increased predation along habitat edges is often identified as a causal factor for reducing nesting success for birds along forest edges (Andrén et al. 1985, Wilcove 1985, Angelstam 1986, Andrén and Angelstam 1988, Burkey 1993, Estrada et al. 2002, Maina and Jackson 2003, Aquilani and Brewer 2004). If increased levels of predation along the habitat margins are responsible for reduced flat-tail numbers there, then increased numbers of predators should be evident.

Comparing edge versus core plots, counts of loggerhead shrikes were consistently higher on edge of the aeolian sand habitat. The higher numbers of shrikes at edge plots versus core locations in our study area was consistent with an enhanced predator hypothesis. However, if predation rates are an important causal factor, then why were other species not similarly impacted? Of the six vertebrate species measured, three are primarily nocturnal and so would not be subjected to predation pressure from the diurnal shrikes; however Daley et al. (2000) did record shrike predation on four kangaroo rats. Of the diurnal potential prey species, the ground squirrel's large size puts them outside of the prey range of shrikes. The two lizards are within the shrikes' prey size, and flat-tailed horned lizards are regularly preyed on by shrikes (Young et al. 2004). Whereas both lizards are cryptically colored, flat-tailed horned lizards are slower moving and often respond to threats by remaining motionless (Norris 1949). Fringe-toed lizards respond to threats by running extremely fast or diving into the loose sand (Stebbins 1944).

Although predators were not quantified in 2002, flat-tailed horned lizards were commonly observed being preyed upon by American kestrels during site visits that year. Carcasses of marked horned lizards that had disappeared from study plots were located 0.7 km away in a palm tree planted on the edge of a golf course and frequented by kestrels. In 2003 and 2004 when predator occurrence was quantified, there were few observations of kestrels, but shrike observations were common. While kestrels and shrikes are native to the deserts of southern California, their abundance in the sand dune habitats of the Coachella Valley is likely enhanced by suburban development. In a pre-development landscape there were no trees growing in or around the Coachella Valley sand dunes. American kestrels are obligate hole or ledge nesters. Whereas there were once no nest sites for kestrels within 10 km of the dunes, today palm trees and other exotic vegetation planted in the neighboring suburban developments provide abundant nest sites on ledges formed by the large leaf petioles and in the thick “skirts” of dead palm leaves. While shrikes nest in native desert shrubs, trees in suburban areas as well as tree windbreaks planted at the margins agricultural fields provide more sheltered nest sites. Power poles bordering the preserve provide elevated perch sites for both the kestrels and shrikes to see prey and then launch their hunting sorties. Flat-tailed horned lizards may be subjected to levels of predation along edges that they would not likely have experienced in a pre-development landscape.

By collecting data on multiple species from multiple trophic levels we have rejected the alien ant hypothesis and found support for both the predation and road affect hypotheses. Dynamics of the flat-tailed horned lizard population occupying a 100-200 m boundary region of the available habitat appears to have shifted from a bottom-up process where the lizard numbers are regulated by native ant abundance, to a top-down process where the lizards are limited by predation, and possibly road mortality. This shift in regulatory processes may contribute to a habitat "sink" (Pulliam 1988) along the preserve boundary. For 2003 and 2004 combined, the horned lizards' mean reproductive success ranged from 0 – 0.2 hatchlings/adult at distances from 0 to 150 m from the habitat edge; at 200 m from the edge and in core plots, mean reproductive success averaged 0.8 hatchlings/adult (Barrows, unpubl. data). Without immigration from the preserve core, flat-tailed horned lizards may not be able to sustain populations in the boundary region.

These results demonstrate the utility of community based research designed to evaluate hypotheses regarding processes that regulate the abundance of species (Barrows et al. 2005). Rather than having broad impacts from indeterminate causes, boundary effects here were found to have a narrow scope and likely causes were identified. These findings can allow managers to focus adaptive management strategies aimed at reducing the boundary effect for flat-tailed horned lizards and so improve the viability of this remnant population. In the face of increasing suburban expansion into natural desert communities in the southwestern U. S. and elsewhere in arid regions of the world, managers otherwise face decisions with little or no baseline from which to predict species responses.

Acknowledgements

Funding was provided by the Coachella Valley Association of Governments, the County of Riverside, and the California Department of Fish and Game. We particularly thank James Sullivan, Kim Nicol and Eric Loft. Donna Thomas, Marisa Sripracha, Thomas Prentice, Brandon Mutrux, Darrell Hutchinson, Kathleen Fleming, and Monica Swartz provided essential support in collecting and summarizing data. Invaluable editorial suggestions were provided by Katherine Barrows. Research on flat-tailed horned lizards was conducted under California Department of Fish and Game Scientific Collecting Permit 801015-01.

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Table 1. Analysis of variance (ANOVA) of the abundance of nine species at the larger, edge versus core, scale. The error term represents variation among plots. P-values ≤ 0.05 indicate a statistically significant amount of the variance in the distribution of that species is explained by that treatment (edge effect).

Species	Source of variation	SS	df	MS	F	P-value
Coachella Valley fringe-toed lizard	Edge effect	1.404	1	1.404	0.871	0.361
	Error	33.850	21	1.612		
Flat-tailed horned lizard	Edge effect	1.294	1	1.294	8.464	0.007
	Error	3.975	26	0.153		
Sidewinder	Edge effect	0.008	1	0.008	0.564	0.465
	Error	0.208	14	0.015		
Shovel-nosed snake	Edge effect	0.032	1	0.032	0.211	0.650
	Error	3.344	22	0.152		
Round-tailed ground squirrel	Edge effect	0.302	1	0.302	3.941	0.063
	Error	1.379	18	0.077		
Desert kangaroo rat	Edge effect	0.078	1	0.078	0.125	0.727
	Error	11.781	19	0.620		
Harvester ants	Edge effect	13.209	1	13.209	0.551	0.467
	Error	455.486	19	23.973		
Greater roadrunner	Edge effect	0.009	1	0.009	0.096	0.760
	Error	2.169	22	0.099		
Loggerhead shrike	Edge effect	1.131	1	1.131	18.871	0.0002
	Error	1.558	26	0.060		

Table 2. Two-way ANOVAs were employed to determine sources of variance at a smaller, within edge plot, scale. Here variance is partitioned between edge effects and between plots occurring along two boundary types. Coachella Valley fringe-toed lizards did not occur along the boundary that included the four-lane road, so only a one-way ANOVA was calculated for edge effect. P-values ≤ 0.05 indicate a statistically significant amount of the variance in the distribution of that species is explained by that treatment (edge effect or boundary type).

SPECIES	*SOURCE OF VARIATION*	*SS*	*df*	*MS*	*F*	*P-value*
Coachella Valley fringe-toed lizard						
	Edge Effect	11.569	6	1.928	1.629	0.150
	Within Group (Error)	91.107	77	1.183		
Flat-tailed horned lizard						
	Edge Effect	1.549	6	0.258	9.545	0.007
	Boundary Type	0.319	1	0.319	11.810	0.014
	Error	0.162	6	0.027		
Sidewinder						
	Edge Effect	0.008	6	0.001	0.585	0.735
	Boundary Type	< 0.0001	1	< 0.0001	0.010	0.923
	Error	0.014	6	0.002		
Shovel-nosed snake						
	Edge Effect	0.109	6	0.018	2.073	0.198
	Boundary Type	0.005	1	0.004	0.550	0.486
	Error	0.053	6	0.009		
Round-tailed ground squirrel						
	Edge Effect	0.075	6	0.013	1.345	0.364
	Boundary Type	0.197	1	0.197	21.085	0.004
	Error	0.056	6	0.009		
Desert kangaroo rat						
	Edge Effect	2.683	6	0.447	15.529	0.002
	Boundary Type	3.323	1	3.323	115.400	< 0.0001
	Error	0.173	6	0.029		
Harvester ants						
	Edge Effect	8.789	6	1.465	1.890	0.229
	Boundary Type	13.114	1	13.114	16.921	0.006
	Error	4.650	6	0.775		

Table 3. Results of linear regressions, with species abundance as the dependent variable and two habitat metrics as independent variables, included here as two separate one-variable models and together as a two-variable multiple regression model. Regression coefficients, R^2, and p-values are included.

Species		Edge distance	Sand compaction	Edge distance and sand compactio
Flat-tailed horned lizard				
	p	< 0.0001	< 0.0001	< 0.0001
	R^2	0.345	0.127	0.406
	Regression Coefficient	0.003	-0.241	.003/-0.16
Desert kangaroo rat				
	p	0.04	0.952	0.108
	R^2	0.038	< 0.0001	0.04
	Regression Coefficient	0.003	-0.669	0.001/-0.643

Figure Captions

Figure 1. Satellite image depicting distribution of plots, extent of aeolian sand habitat, juxtaposition of suburban golf course development and abandoned agricultural fields, and roads

Figure 2a-2h. Mean counts and one standard error (indicated by the error bar) of species occurring on sand dunes and sand hummocks in the Coachella Valley at various distances from an anthropogenic habitat edge. Data for each year are the combined means for the plots on which the species occurred, with six repetitions per transect per plot. Data collected at >500 m represent the combined core plots.

Figure 3. Mean counts and one standard error (indicated by the error bar) of flat-tailed horned lizards at distances from two boundary types. Solid black bars represent data summarized from three plots adjacent to a four-lane road, with curbs, bounded by a suburban golf course community. Diagonally lined bars represent data summarized from five plots adjacent to a two-lane curbless road, bounded by abandoned agricultural fields and tree-row windbreaks. Both summaries include data combined from 2002 and 2003. Data for each year are the combined means for the plots on which the species occurred, with six repetitions per transect per plot.

Figure 1.

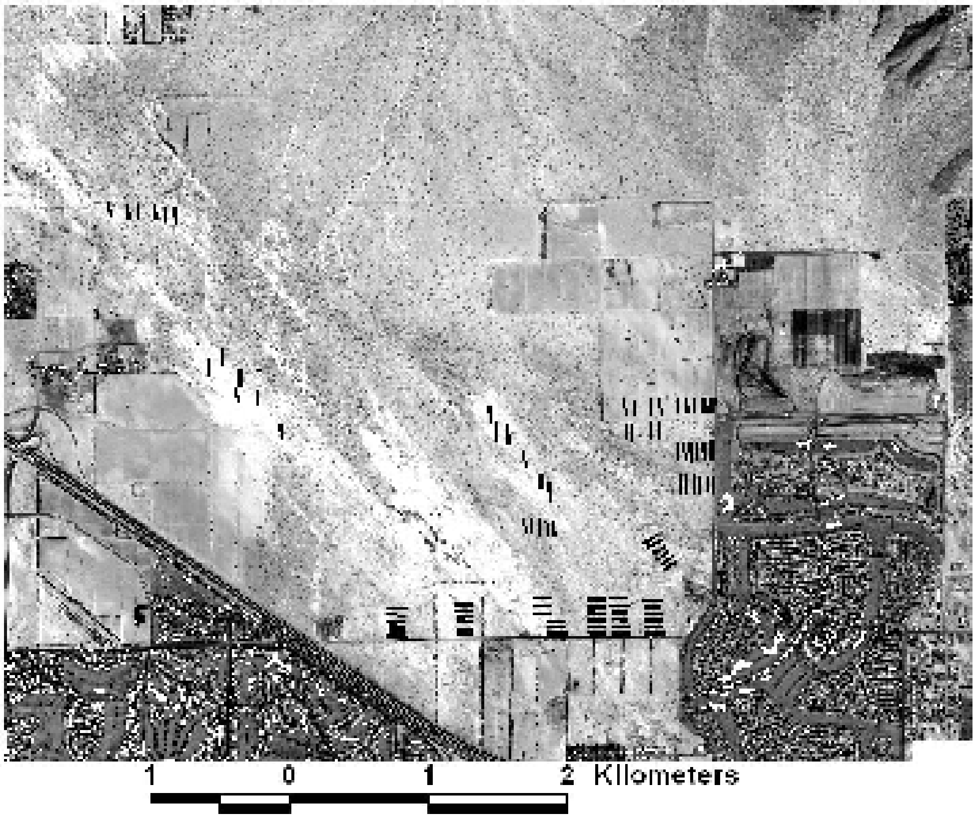


Figure 2a.

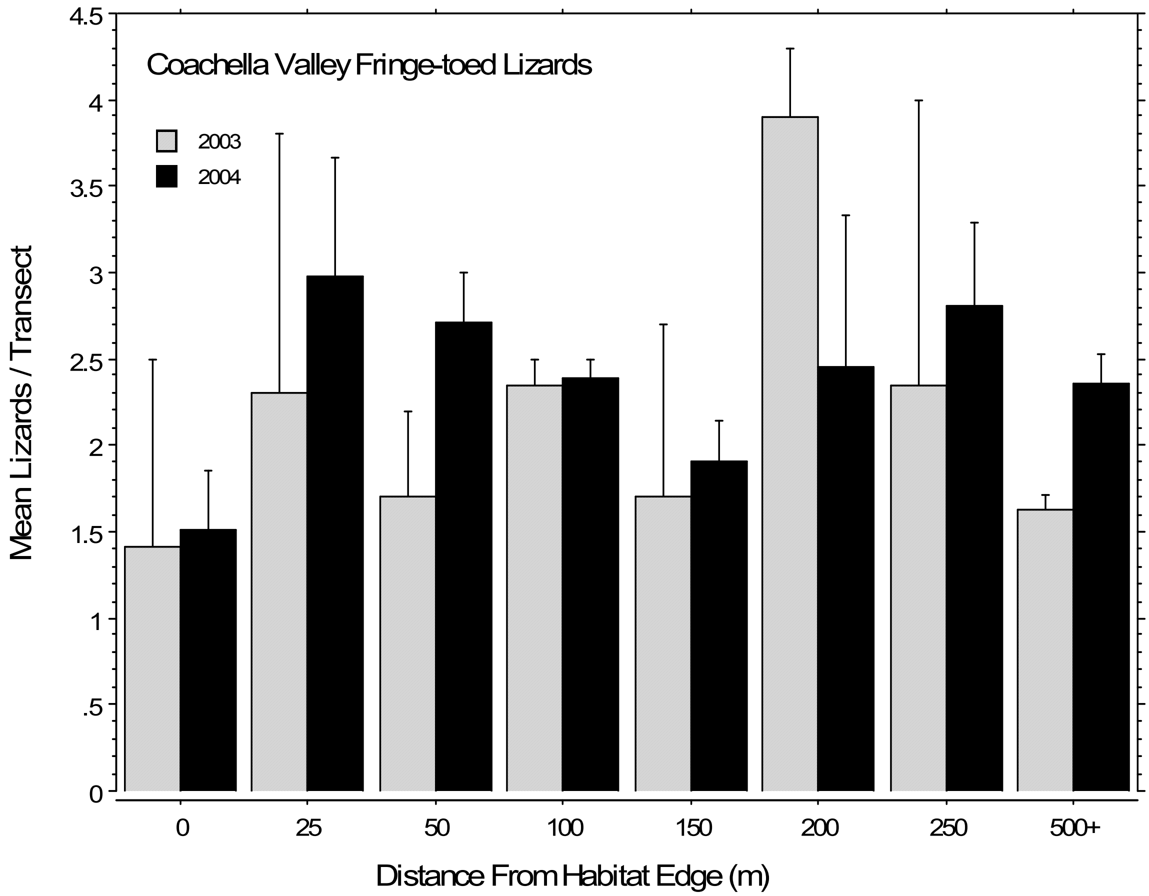


Figure 2b.

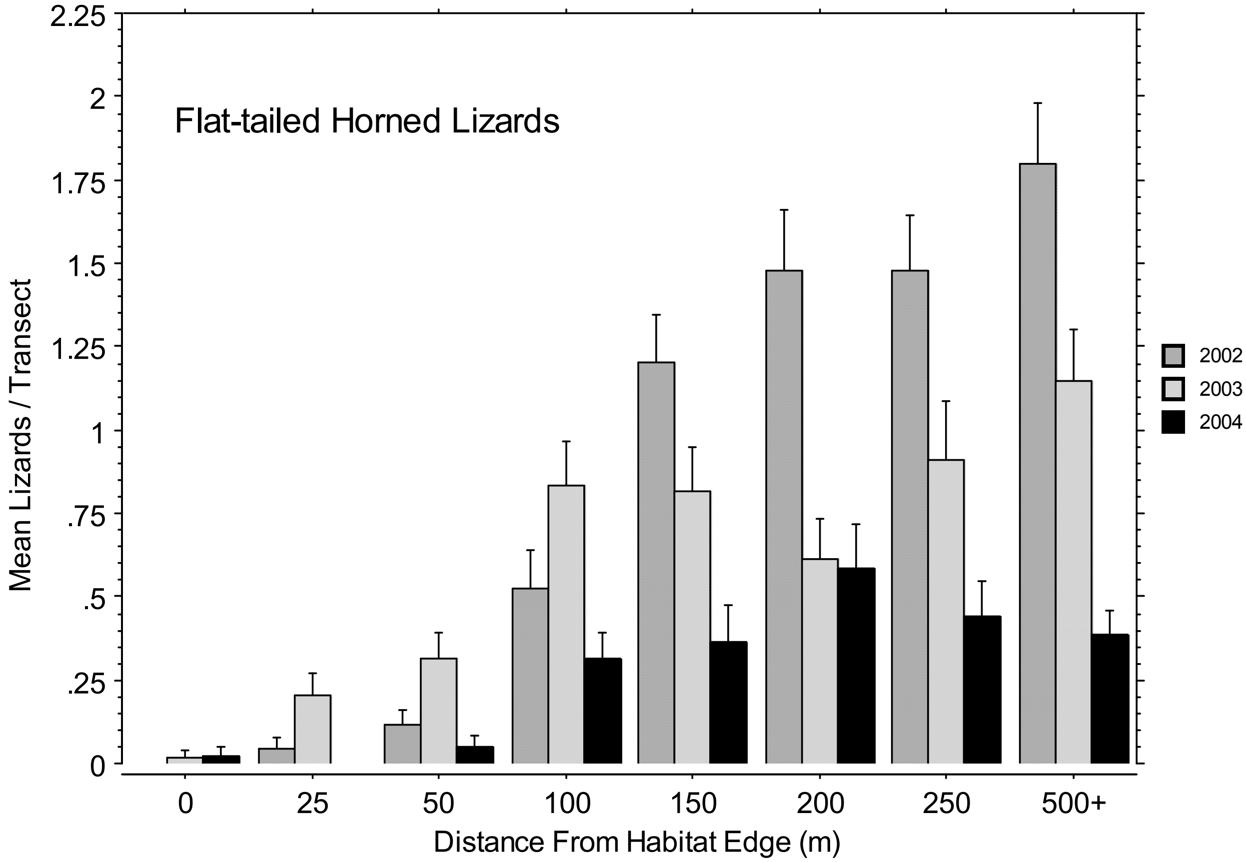

Flat-tailed Horned Lizards
Mean Lizards / Transect
Distance From Habitat Edge (m)
2.25
2
1.75
1.5
1.25
1
.75
.5
.25
0
0
25
50
100
150
200
250
500+
2002
2003
2004

Figure 2c.

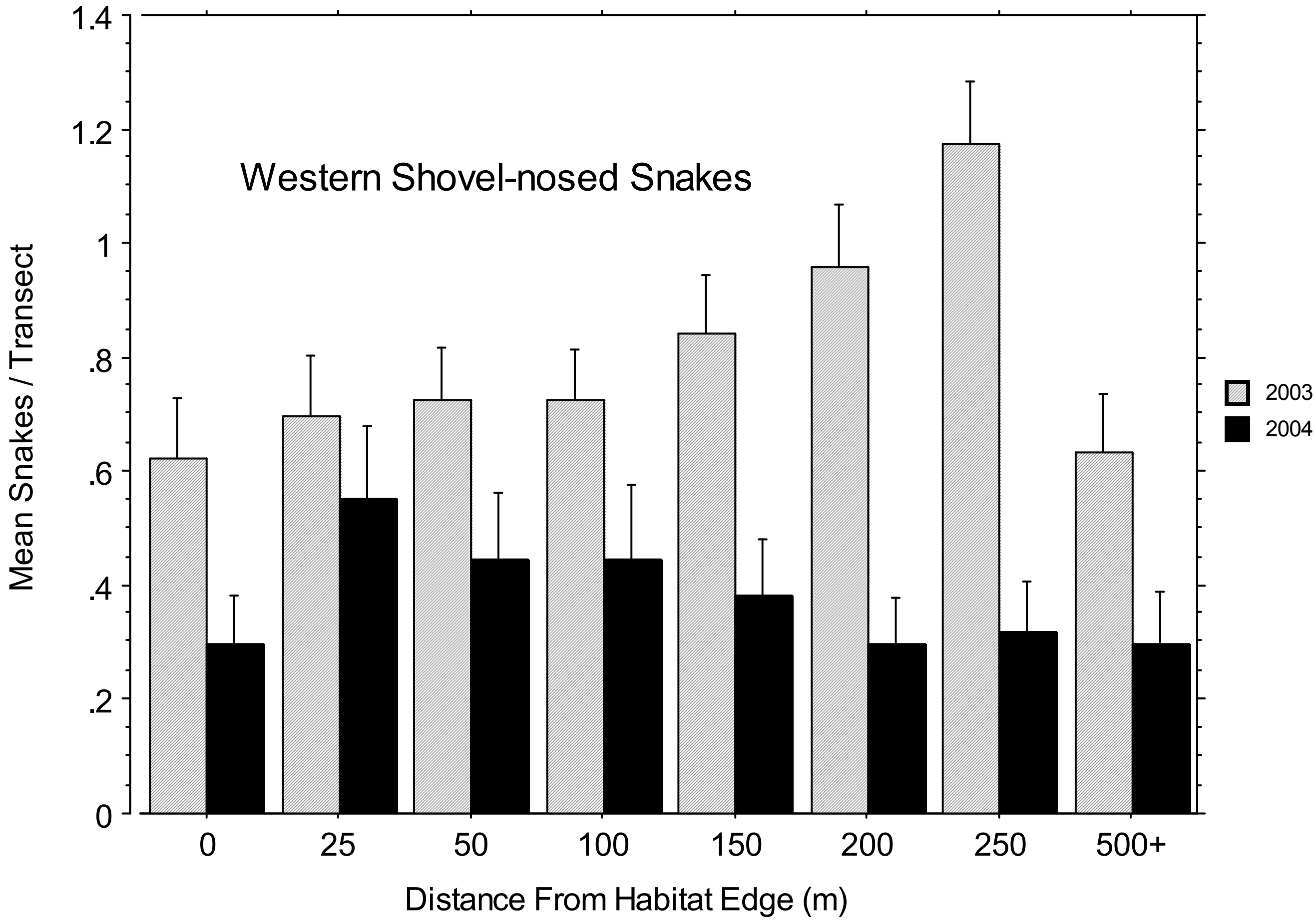

Western Shovel-nosed Snakes
Mean Snakes / Transect
Distance From Habitat Edge (m)
0
.2
.4
.6
.8
1
1.2
1.4
0
25
50
100
150
200
250
500+
2003
2004

Figure 2d.

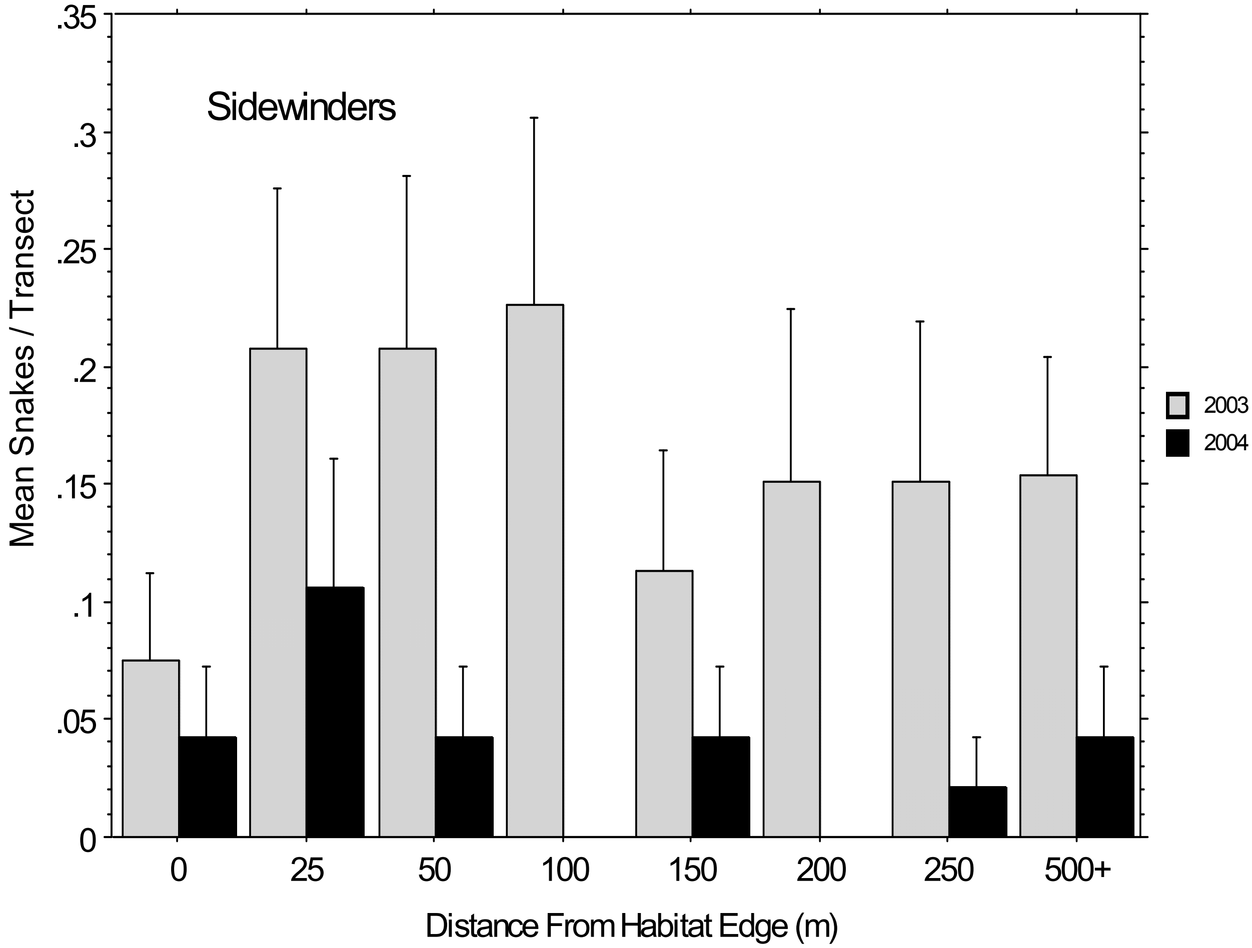


Figure 2e.

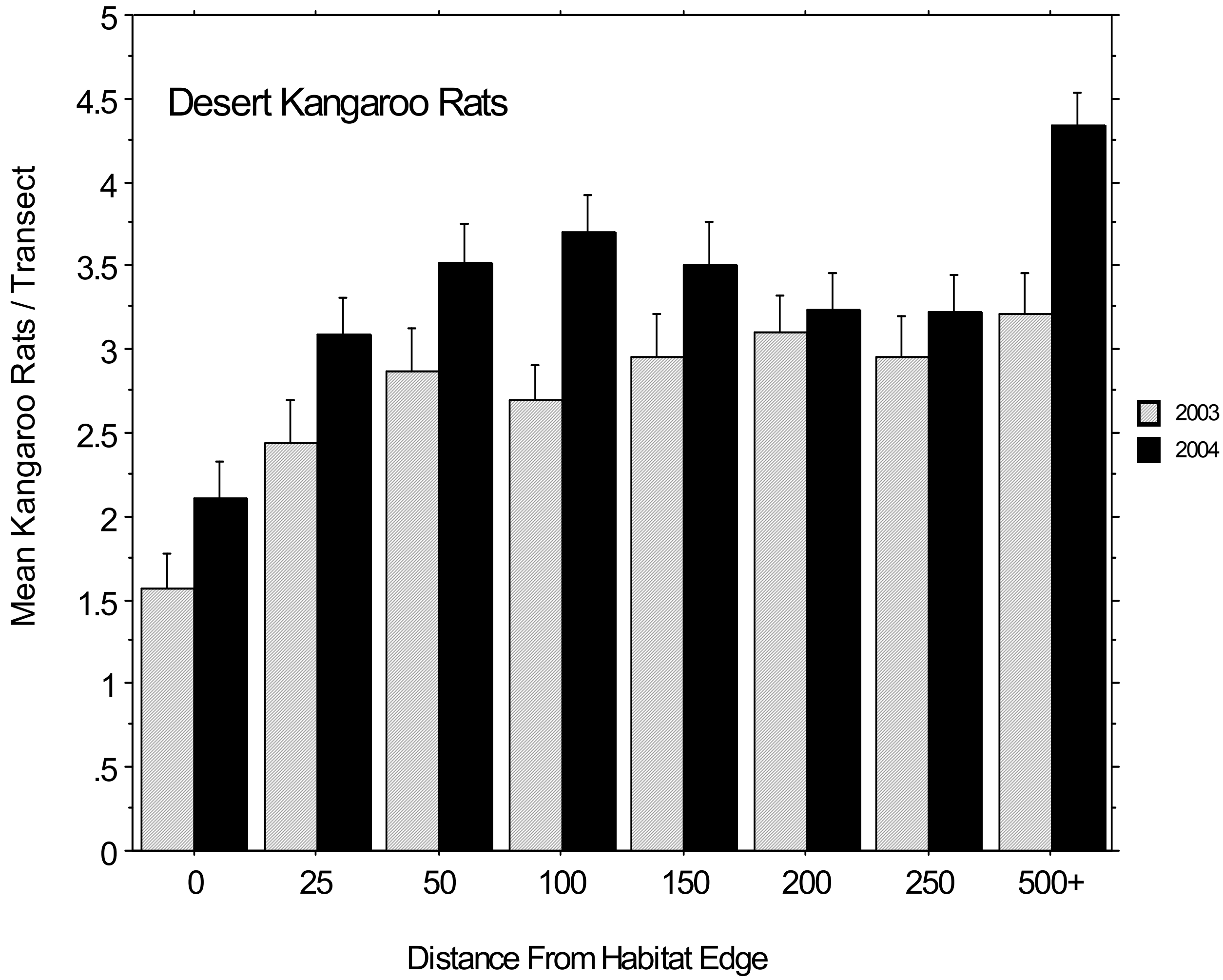

Desert Kangaroo Rats
Mean Kangaroo Rats / Transect
0
.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
25
50
100
150
200
250
500+
Distance From Habitat Edge
2003
2004

Figure 2f.

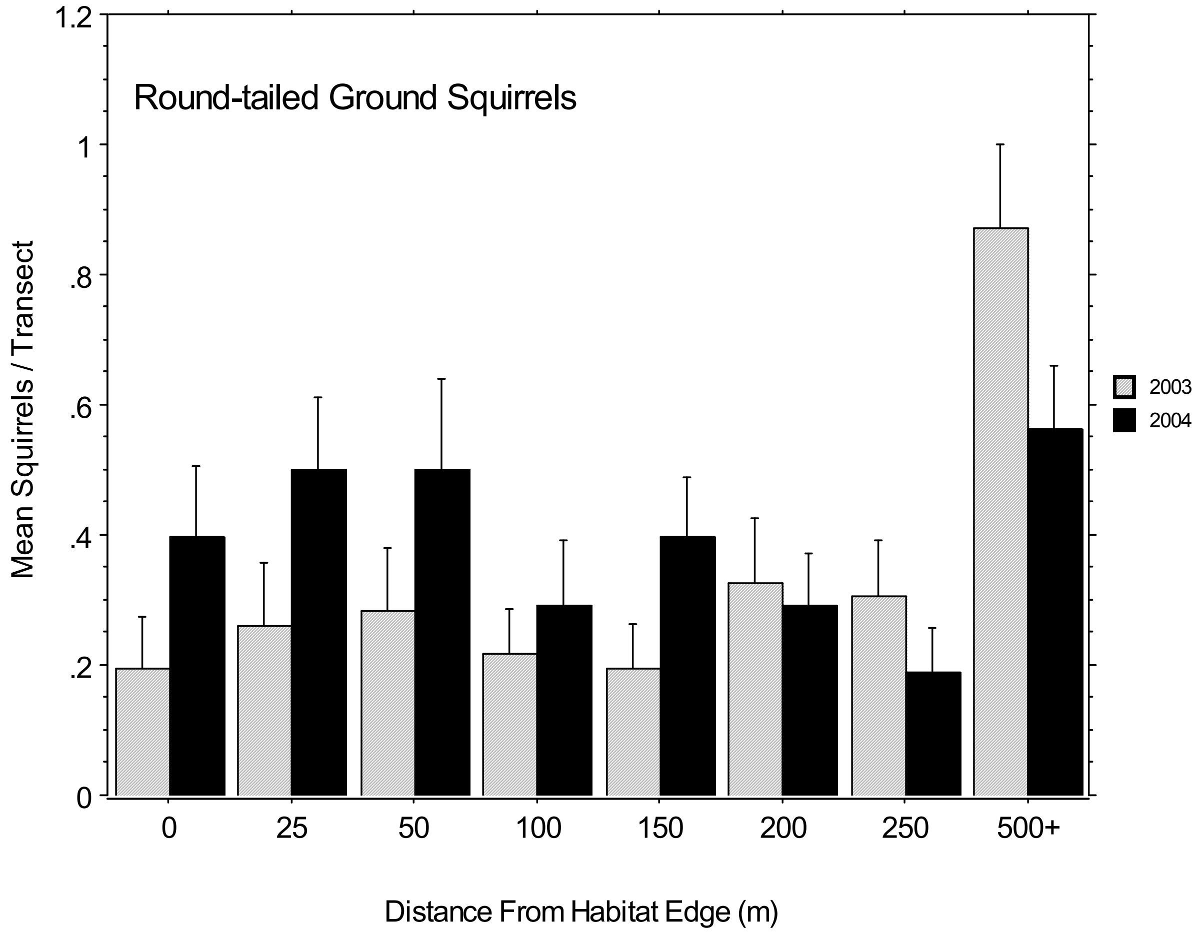

1.2
1
.8
.6
.4
.2
0
Round-tailed Ground Squirrels
Mean Squirrels / Transect
0
25
50
100
150
200
250
500+
Distance From Habitat Edge (m)
2003
2004

Figure 2g.

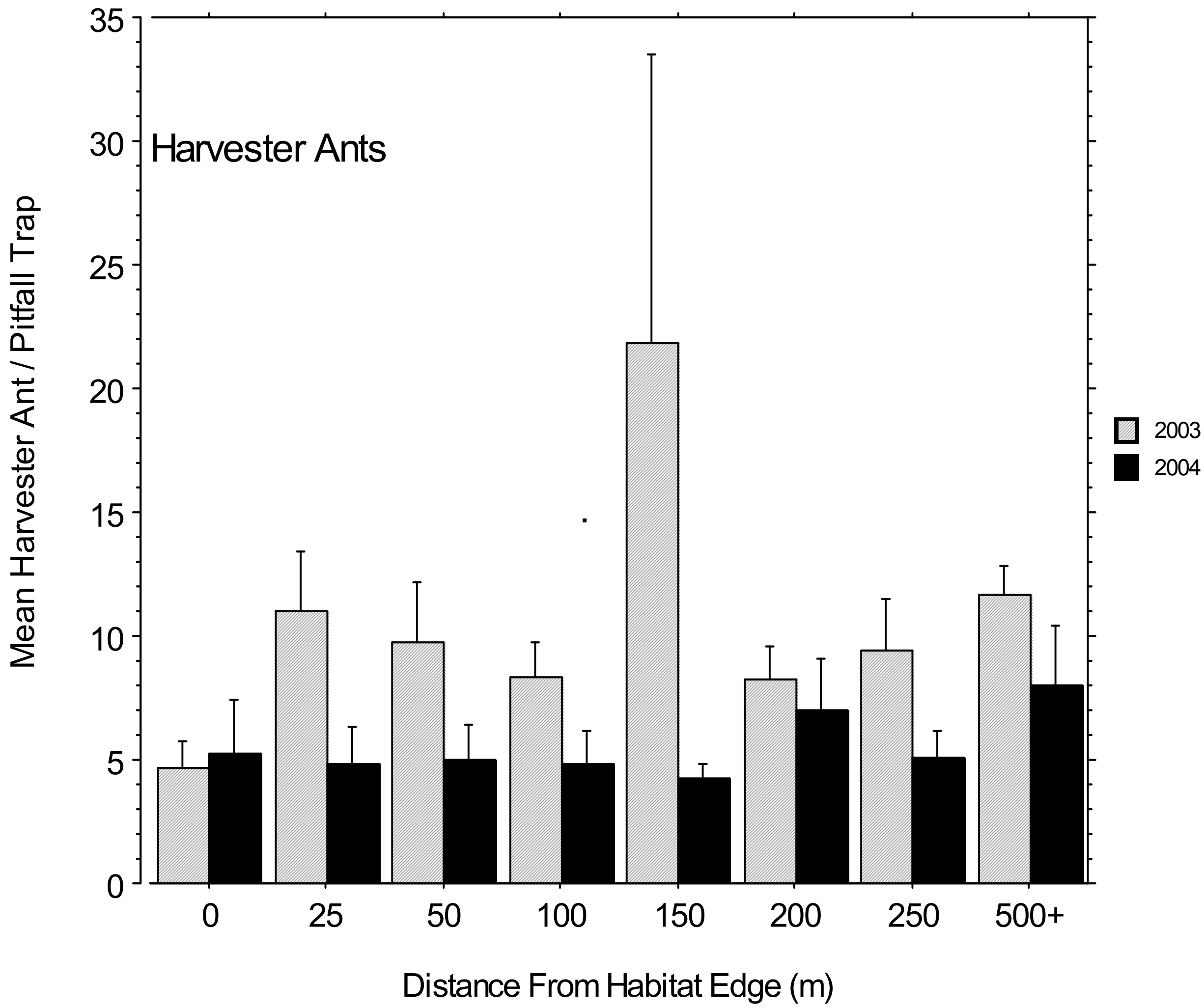
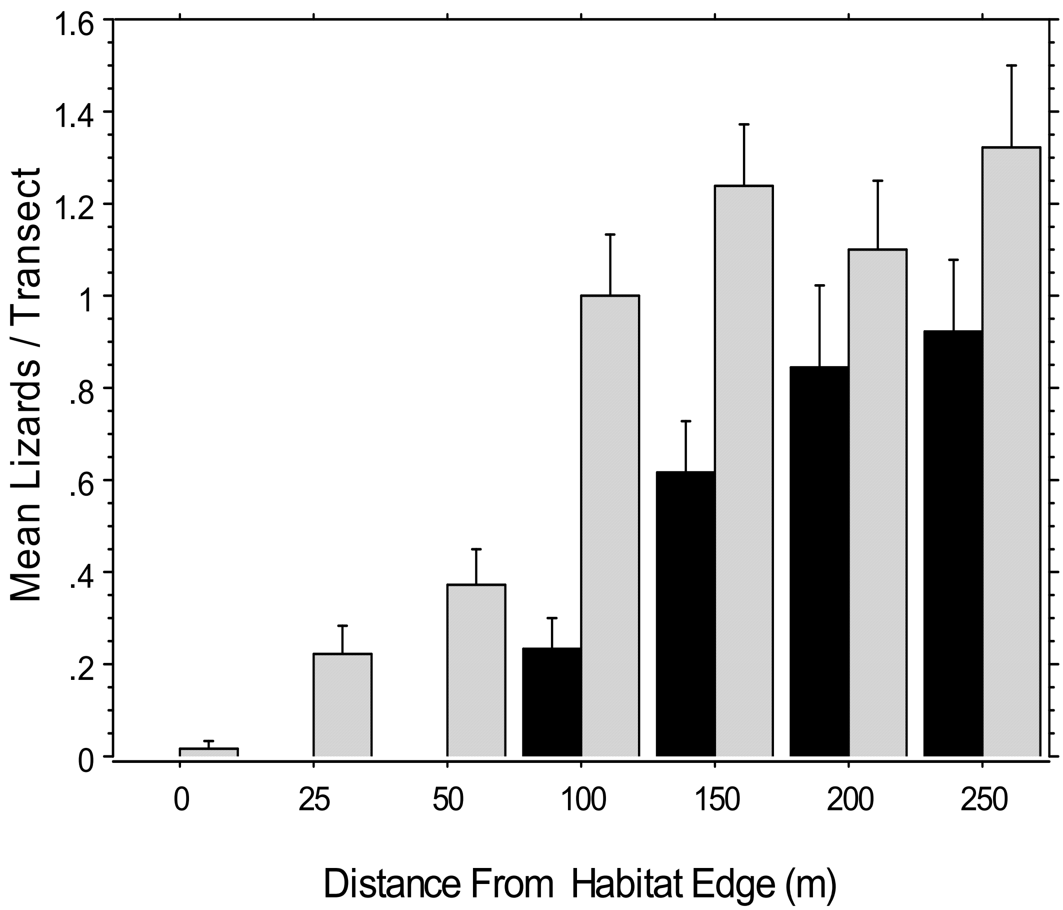

Harvester Ants
Mean Harvester Ant / Pitfall Trap
35
30
25
20
15
10
5
0
0
25
50
100
150
200
250
500+
Distance From Habitat Edge (m)
2003
2004

Figure 3.


1.6
1.4
1.2
1
.8
.6
.4
.2
0
Mean Lizards / Transect
0
25
50
100
150
200
250
Distance From Habitat Edge (m)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240

IN REPLY REFER TO:

MAY 13 2003

FWS/DFPA/BFA

Memorandum

To: Regional Directors, Regions 1-7

From: Deputy Director

Subject: Service Interim Guidance on Avoiding and Minimizing Wildlife Impacts from Wind Turbines

Wind-generated electrical energy is renewable, produces no emissions, and is considered to be generally environmentally friendly technology. Development of wind energy is strongly endorsed by the Secretary of the Interior, as expressed in the Secretary's Renewable Energy on Public Lands Initiative (May 2002). However, wind energy facilities can adversely impact wildlife, especially birds and bats, and their habitats. As more facilities with larger turbines are built, the cumulative effects of this rapidly growing industry may initiate or contribute to the decline of some wildlife populations. The potential harm to these populations from an additional source of mortality makes careful evaluation of proposed facilities essential. Due to local differences in wildlife concentration and movement patterns, habitats, area topography, facility design, and weather, each proposed development site is unique and requires detailed, individual evaluation.

Service personnel may become involved in the review of potential wind energy developments on public lands through National Environmental Policy Act review (sections 1501.6, *opportunity as a cooperating agency,* and section 1503.4, *duty to comment on federally-licensed activities for agencies with jurisdiction by law*, i.e., the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act); or because of special expertise. The National Wildlife Refuge System Improvement Act requires that any activity on Refuge lands be determined to be compatible with the Refuge system mission and Refuge purpose(s). In addition, the Service is required by the Endangered Species Act to assist other Federal agencies in ensuring that any action they authorize, implement, or fund will not jeopardize the continued existence of any federally endangered or threatened species. Service biologists have also received requests from industry for consultation on wildlife impacts of proposed wind energy developments on private lands.

The following guidance was prepared by the Service's Wind Turbine Siting Working Group. It is intended to assist Service staff in providing technical assistance to the wind energy industry to avoid or minimize impacts to wildlife and their habitats through: (1) proper evaluation of potential wind energy development sites; (2) proper location and design of turbines and associated structures within sites selected for development; and (3) pre- and post-construction research and monitoring to identify and/or assess impacts to wildlife. This guidance is intended for terrestrial applications only; guidelines for wind energy developments in marine environments and the Great Lakes will be provided at a future date. The interim guidelines are based on current science and will be updated as new information becomes available. They will be evaluated over a two-year period, and then modified as necessary based on their performance in the field and on the latest scientific and technical discoveries developed in coordination with industry, states, academic researchers, and other Federal agencies. A Notice of Availability and request for comments will be published in the Federal Register simultaneously with the release of this guidance to Service personnel. We encourage industry use of this guidance and solicit their feedback on its efficacy.

These guidelines are not intended nor shall they be construed to limit or preclude the Service from exercising its authority under any law, statute, or regulation, and to take enforcement action against any individual, company, industry or agency or to relieve any individual, company, industry, or agency of its obligations to comply with any applicable Federal, State, or local laws, statutes, or regulations.

Implementation of Service recommendations provided in accordance with these guidelines by the wind energy industry is voluntary. Field offices have discretion in the use of these guidelines on a case-by-case basis, and may also have additional recommendations to add which are specific to their geographic area.

The Migratory Bird Treaty Act (16 U.S.C. 703-712) prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. While the Act has no provision for allowing an unauthorized take, it must be recognized that some birds may be killed at structures such as wind turbines even if all reasonable measures to avoid it are implemented. The Service's Office of Law Enforcement carries out its mission to protect migratory birds not only through investigations and enforcement, but also through fostering relationships with individuals and industries that proactively seek to eliminate their impacts on migratory birds. While it is not possible under the Act to absolve individuals, companies, or agencies from liability if they follow these recommended guidelines, the Office of Law Enforcement and Department of Justice have used enforcement and prosecutorial discretion in the past regarding individuals, companies, or agencies who have made good faith efforts to avoid the take of migratory birds.

Please ensure that all field personnel involved in review of wind energy development proposals receive copies of this memorandum. Questions regarding this issue should be directed to Dr. Benjamin N. Tuggle, Chief, Division of Federal Program Activities, at (703) 358-2161, or Brian Millsap, Chief, Division of Migratory Bird Management, at (703) 358-1714.

Attachment

<u>INTERIM GUIDELINES TO AVOID AND MINIMIZE WILDLIFE IMPACTS FROM WIND TURBINES</u>

Introduction

Wind-generated electrical energy is renewable, produces no emissions, and is generally considered to be an environmentally friendly technology. Development of wind energy is strongly endorsed by the Secretary of the Interior, as expressed in the Secretary's Renewable Energy on Public Lands Initiative (May 2002). However, wind energy facilities can adversely impact wildlife, especially birds (e.g., Orloff and Flannery 1992, Leddy et al. 1999, Woodward et al. 2001, Braun et al. 2002, Hunt 2002) and bats (Keeley et al. 2001, Johnson et al. 2002, Johnson et al. 2003). As more facilities with larger turbines are built, the cumulative effects of this rapidly growing industry may initiate or contribute to the decline of some wildlife populations (Manes et al. 2002, Johnson et al. 2002, Manville 2003). The potential harm to these populations from an additional source of mortality or adverse habitat impacts makes careful evaluation of proposed facilities essential. Due to local differences in wildlife concentration and movement patterns, habitats, area topography, facility design, and weather, each proposed development site is unique and requires detailed, individual evaluation.

The following guidance was prepared by the U.S. Fish and Wildlife Service (Service). Like the Service's voluntary guidance addressing the siting, construction, operation, and decommissioning of communication towers (http://migratorybirds.fws.gov/issues/towers/comtow.html) and the voluntary guidance developed in cooperation with the electric utility industry to minimize bird strikes and electrocutions (APLIC 1994, APLIC 1996), this guidance is intended to assist the wind energy industry in avoiding or minimizing impacts to wildlife and their habitats. This is accomplished through: (1) proper evaluation of potential Wind Resource Areas (WRAs), (2) proper location and design of turbines and associated structures within WRAs selected for development, and (3) pre- and post-construction research and monitoring to identify and/or assess impacts to wildlife. These guidelines are based on current science and will be updated as new information becomes available. They are voluntary, and interim in nature. They will be evaluated over a two-year period, and then modified as necessary based on their performance in the field, on comments from the public, and on the latest scientific and technical discoveries developed in coordination with industry, states, academic researchers, and other Federal agencies. After this period, the Service plans to develop a complete operations manual for evaluation, site selection, design, construction, operation, and monitoring of wind energy facilities in both terrestrial and aquatic environments.

Data on wildlife use and mortality collected at one wind energy facility are not necessarily applicable to others; each site poses its own set of possibilities for negative effects on wildlife. In addition, the wind industry is rapidly expanding into habitats and regions that have not been well studied. The Service therefore suggests a precautionary approach to site selection and development, and will employ this approach in making recommendations and assessing impacts of wind energy developments. We encourage the wind energy industry to follow these guidelines and, in cooperation with the Service, to conduct scientific research to provide additional information on the impacts of wind energy development on wildlife. We further encourage the industry to look for opportunities to promote bird and other wildlife conservation when planning wind energy facilities (e.g., voluntary habitat acquisition or conservation easements).

The Service is guided by the Fish and Wildlife Service Mitigation Policy (<u>Federal Register</u> 46 (15), January 1981) in evaluating modifications to or loss of habitat caused by development. This policy follows the sequence of steps recommended in the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (NEPA) in seeking to avoid, minimize, or compensate for negative impacts. Mitigation can involve (1) avoiding the impact of an activity by taking no action; (2) minimizing impacts by limiting the degree of activity; (3) rectifying an impact by repairing, rehabilitating, or restoring an affected environment; (4) reducing or eliminating an impact by conducting activities that preserve and maintain the resources; or (5) compensating for an impact by replacing or providing substitute resources or environments. Any mitigation recommended by the Service for wind energy development would be voluntary on the part of the developer unless made a condition of a Federal license or permit. Mitigation does not apply to "take" of species under the Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, or Endangered Species Act. The goal of the Service under these laws is the elimination of loss of migratory birds and endangered and threatened species due to wind energy development. The Service will actively expand partnerships with regional, national, and international organizations, States, tribes, industry, and environmental groups to meet this goal.

Projects with Federal involvement may require additional analysis under the National Environmental Policy Act (http://www.fws.gov/r9esnepa), Endangered Species Act (http://endangered.fws.gov), or National Wildlife Refuge System Administration Act (http://www.fws.gov/policyMakers/mandates/index.html#adminact). This includes projects on federally-owned lands (e.g., National Wildlife Refuges, National Forests), lands where a Federal permit is required for development (e.g., BLM-administered lands), or lands where Federal funds were used for purchase or improvement (some State Wildlife Management Areas).

These guidelines are not intended nor shall they be construed to limit or preclude the Service from exercising its authority under any law, statute, or regulation, and to take enforcement action against any individual, company, or agency, or to relieve any individual, company, or agency of its obligations to comply with any applicable Federal, State, or local laws, statutes, or regulations.

The guidelines contain a site evaluation process with checklists for pre-development evaluations of potential terrestrial wind energy development sites (Appendix 1). Use of this process allows comparison of one site with another with respect to the impacts that would occur to wildlife if the area were developed. The evaluation area for a potential development site should include the "footprint" encompassing all of the turbines and associated structures planned for that proposed facility, and the adjacent wildlife habitats which may be affected by the proximity of the structures, but excluding transmission lines extending outside the footprint. All potential development sites within a geographic area should be evaluated before a site is selected for development.

Pre-development evaluations should be conducted by a team that includes Federal and/or State agency wildlife professionals with no vested interest (e.g., monetary or personal business gain) in the sites selected. Teams may also include academic and industry wildlife professionals as available. Any site evaluations conducted by teams that do not include Federal and/or State agency wildlife professionals will not be considered valid evaluations by the Service.

The pre-development evaluation may also identify additional studies needed prior to and after development. Post-construction monitoring to identify any wildlife impacts is recommended at all developed sites. Pre- and post-development studies and monitoring may be conducted by any qualified wildlife biologist without regard to his/her affiliation or interest in the site.

Additional information relevant to these guidelines is appended as follows:

Appendix 2 – Definitions Related to Wind Energy Development and Evaluation
Appendix 3 – Wildlife Laws Relevant to Wind Power Development Projects
Appendix 4 - Research Needs on the Impacts of Wind Power Development on Wildlife
Appendix 5 – Procedures for Endangered Species Evaluations and Consultations
Appendix 6 – Guidelines for Considering Wind Turbine Siting on Easement Lands Administered as Part of the National Wildlife Refuge System in Region 6 (CO, KS, MT, NE, ND, SD, UT, WY)
Appendix 7 – Known and Suspected Impacts of Wind Turbines on Wildlife
Appendix 8 – Literature Cited

Site Evaluation

The site evaluation protocol presented in Appendix 1 was developed by a team of Federal, State, university, and wind energy industry biologists to rank potential terrestrial wind energy development sites by their potential impacts on wildlife. There are two steps to follow:

1. Identify and evaluate reference sites, preferably within the general geographic area of the proposed facility. Reference sites are high-quality wildlife areas where wind development would result in the maximum negative impact on wildlife (i.e., sites selected to have the highest possible rank using the protocol). Reference sites are used to determine the comparative risks of developing other potential sites.

2. Evaluate potential development sites to determine risk to wildlife and rank sites against each other using the highest-ranking reference site as a standard. Although high-ranking sites are generally less desirable for wind energy development, a high rank does not necessarily preclude development of a site, nor does a low rank automatically eliminate the need to conduct pre-development assessments of wildlife resources or post-development assessments of impacts.

Studies to Assess and Monitor Wildlife Impacts

While ranking potential development sites, the site evaluation team referenced above may identify pre-development studies that are needed to better assess potential negative impacts to wildlife. Ranking may also suggest the extent and duration of study required. Developers are encouraged to conduct any studies suggested by the team in coordination with Service and other agency wildlife biologists.

Post-development mortality studies should be a part of any site development plan in order to determine if or to what extent mortality occurs. As with pre-development studies, ranking may suggest the extent and duration of study needed. Studies should be designed in coordination with Federal and other agency biologists.

Site Development Recommendations

The following recommendations apply to locating turbines and associated structures within WRAs selected for development of wind energy facilities:

1. Avoid placing turbines in documented locations of any species of wildlife, fish, or plant protected under the Federal Endangered Species Act.

2. Avoid locating turbines in known local bird migration pathways or in areas where birds are highly concentrated, unless mortality risk is low (e.g., birds present rarely enter the rotor-swept area). Examples of high concentration areas for birds are wetlands, State or Federal refuges, private duck clubs, staging areas, rookeries, leks, roosts, riparian areas along streams, and landfills. Avoid known daily movement flyways (e.g., between roosting and feeding areas) and areas with a high incidence of fog, mist, low cloud ceilings, and low visibility.

3. Avoid placing turbines near known bat hibernation, breeding, and maternity/nursery colonies, in migration corridors, or in flight paths between colonies and feeding areas.

4. Configure turbine locations to avoid areas or features of the landscape known to attract raptors (hawks, falcons, eagles, owls). For example, Golden Eagles, hawks, and falcons use cliff/rim edges extensively; setbacks from these edges may reduce mortality. Other examples include not locating turbines in a dip or pass in a ridge, or in or near prairie dog colonies.

5. Configure turbine arrays to avoid potential avian mortality where feasible. For example, group turbines rather than spreading them widely, and orient rows of turbines parallel to known bird movements, thereby decreasing the potential for bird strikes. Implement appropriate storm water management practices that do not create attractions for birds, and maintain contiguous habitat for area-sensitive species (e.g., Sage Grouse).

6. Avoid fragmenting large, contiguous tracts of wildlife habitat. Where practical, place turbines on lands already altered or cultivated, and away from areas of intact and healthy native habitats. If not practical, select fragmented or degraded habitats over relatively intact areas.

7. Avoid placing turbines in habitat known to be occupied by prairie grouse or other species that exhibit extreme avoidance of vertical features and/or structural habitat fragmentation. In known prairie grouse habitat, avoid placing turbines within 5 miles of known leks (communal pair formation grounds).

8. Minimize roads, fences, and other infrastructure. All infrastructure should be capable of withstanding periodic burning of vegetation, as natural fires or controlled burns are necessary for maintaining most prairie habitats.

9. Develop a habitat restoration plan for the proposed site that avoids or minimizes negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species. For example, avoid attracting high densities of prey animals (rodents, rabbits, etc.) used by raptors.

10. Reduce availability of carrion by practicing responsible animal husbandry (removing carcasses, fencing out cattle, etc.) to avoid attracting Golden Eagles and other raptors.

Turbine Design and Operation Recommendations

1. Use tubular supports with pointed tops rather than lattice supports to minimize bird perching and nesting opportunities. Avoid placing external ladders and platforms on tubular towers to minimize perching and nesting. Avoid use of guy wires for turbine or meteorological tower supports. All existing guy wires should be marked with recommended bird deterrent devices (Avian Power Line Interaction Committee 1994).

2. If taller turbines (top of the rotor-swept area is >199 feet above ground level) require lights for aviation safety, the minimum amount of pilot warning and obstruction avoidance lighting specified by the Federal Aviation Administration (FAA) should be used (FAA 2000). Unless otherwise requested by the FAA, only white strobe lights should be used at night, and these should be the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes) allowable by the FAA. Solid red or pulsating red incandescent lights should not be used, as they appear to attract night-migrating birds at a much higher rate than white strobe lights.

3. Where the height of the rotor-swept area produces a high risk for wildlife, adjust tower height where feasible to reduce the risk of strikes.

4. Where feasible, place electric power lines underground or on the surface as insulated, shielded wire to avoid electrocution of birds. Use recommendations of the Avian Power Line Interaction Committee (1994, 1996) for any required above-ground lines, transformers, or conductors.

5. High seasonal concentrations of birds may cause problems in some areas. If, however, power generation is critical in these areas, an average of three years monitoring data (e.g., acoustic, radar, infrared, or observational) should be collected and used to determine peak use dates for specific sites. Where feasible, turbines should be shut down during periods when birds are highly concentrated at those sites.

6. When upgrading or retrofitting turbines, follow the above guidelines as closely as possible. If studies indicate high mortality at specific older turbines, retrofitting or relocating is highly recommended.

Appendix 1

PROTOCOL TO RANK POTENTIAL TERRESTRIAL WIND ENERGY DEVELOPMENT SITES BY IMPACTS ON WILDLIFE

This protocol was developed by a team of Federal, State, university, and industry biologists to rank potential wind development sites in Montana by their potential for impacts on wildlife (USFWS 2002). It has been modified to apply nationwide. The protocol allows the user to evaluate potential development sites and rank them against a reference site. Objectives are to: (1) assist developers in deciding whether to proceed with development; (2) provide a procedure to determine pre-construction study needs to verify use of potential sites by wildlife; and (3) provide recommendations for monitoring potential sites post-construction to identify, quantify, or verify actual impacts (or lack thereof).

Although this protocol focuses on impacts to wildlife, potential impacts to fish, other aquatic life, and plants should be considered as well. Surveys for rare, threatened, or endangered plants known or suspected to occur in the geographic area should be conducted at all proposed terrestrial development sites having suitable habitat.

This protocol is intended to provide a conceptual framework for initial steps in investigating a site. It is not intended to be all-inclusive relative to objectives, methods, and analysis nor to serve as the definitive reference or directive for any step in wind power related investigations. The Physical Attributes, Species Occurrence and Status, and Ecological Attractiveness groupings in this protocol should serve as a model framework; the terrain features, species, and conditions used in these groupings will be dictated by local conditions and should be developed by wildlife biologists familiar with the region in which this protocol is being used.

Potential Impact Index (PII)

The Potential Impact Index represents a "first cut" analysis of the suitability of a site proposed for development. It does so by estimating use of the site by selected wildlife species as an indicator of potential impact. Emphasis of the PII is on initial site evaluation and is intended to provide more objectivity than simple reconnaissance surveys.

There are two steps to follow in ranking sites by their potential impact on wildlife:

1. Identify and evaluate reference sites within the general geographic area of Wind Resource Areas (WRA's) being considered for development of a facility. Reference sites are areas where wind development would result in the maximum negative impact on wildlife, resulting in a high PII score. Reference sites are used to determine the comparative risks of developing other potential sites.

2. Evaluate potential development sites to determine risk to wildlife, and rank sites against each other using the highest-ranking reference site as a standard. While high-ranking sites are generally less desirable for wind development, a high rank does not necessarily preclude development of a site, not does a low rank automatically eliminate the need to conduct pre-development assessments of wildlife use and impact potential.

The following assumptions are implicit in the PII process:

1. All WRA sites, regardless of turbine design, configuration, placement, or operation present some hazard and risk to wildlife from both an individual and population perspective.

2. Certain sites present less hazard and risk to wildlife than others.

3. No adequate and defensible information exists regarding the appropriateness of the proposed WRA site being evaluated relative to impacts to wildlife.

4. Evaluations will be conducted by qualified biologists without competitive interest in site selection, including those from State and Federal agencies who are familiar with local and regional wildlife.

The PII is designed primarily to evaluate potential impacts on aerial wildlife from collision with turbines and infrastructure. The PII is derived from the results of three checklists (forms are attached). These checklists should be developed and applied as follows:

A. The PHYSICAL ATTRIBUTE checklist considers topographic, meteorological, and site characteristics that may influence bird and bat occurrence and movements.

B. The SPECIES OCCURRENCE AND STATUS checklist includes: Birds of Conservation Concern at the Bird Conservation Region level (http://migratorybirds.fws.gov/reports/reports.html); all federally-listed Endangered, Threatened, and Candidate Species (http://endangered.fws.gov); bird species of high recreational or other value (e.g., waterfowl, prairie grouse); State Endangered, Threatened, and Species of Management Concern; and any additional species of concern listed by State Natural Heritage Programs.

C. The ECOLOGICAL ATTRACTIVENESS checklist evaluates the presence and influence of ecological magnets and other conditions that would draw birds or bats to the site or vicinity.

Each checklist has boxes to be checked for a particular attribute or species found at an evaluation site. The number of boxes in each checklist will vary from region to region due to variations in the number of physical attributes and species of concern in that region. Keep in mind that all boxes in a checklist are very unlikely to be checked at a single evaluation site, because all species and ecological physical conditions potentially occurring in the region would not exist at one site.

Each checklist should be assigned a divisor, which is developed by dividing the number of boxes in a checklist by the total number of boxes in all three checklists. This expands the spread of index values and more dramatically displays the magnitude of differences among sites. For example, if the PHYSICAL ATTRIBUTE checklist has 36 boxes and the total number of boxes in all three checklists is 144, divide 36 by 144 = 0.25, the divisor.

You can change the number of boxes in any of the checklists to fit your geographic area, habitat type, or other selected region (e.g., a state or portion of a state). Remember to recalculate the divisor if you change the number of boxes.

Boxes in a checklist are checked if the condition or species is known or strongly suspected to occur. Criteria for checklist conditions marked with an asterisk (*) are explained on the following page. Conditions that are self-explanatory are not included. Conditions are not weighted. Boxes are checked in the SPECIES OCCURRENCE AND STATUS checklist if presence of the species is unconfirmed but strongly suspected (i.e., WRA is within the range and habitat of the species). This permits more liberal assignment of potential impact, reduces the probability of missing impacts on specific species due to lack of empirical data, and focuses future study and monitoring effort. Totals for each checklist are simple column sums. The PII is calculated from the checklist totals. A completed example from Montana is provided at the end of this Appendix.

Determining Checklist Scores

Checklist scores are determined as follows:

1. Place a check in each box for which an attribute, species, or condition is present or strongly suspected.

2. After completing the three checklists for each site, add the total number of checks in a checklist for an ending sum (each box checked equals one).

Determining PII Score

The Potential Impact Index score is determined as follows:

1. Place the sums from each of the three checklists in the POTENTIAL IMPACT INDEX table sum boxes (Σ column) in the appropriate category.

2. Divide each checklist sum by the previously calculated divisor to adjust the sum for disproportionate numbers of conditions in each checklist, and place this adjusted sum in the Σ/p boxes for each checklist.

3. Add the adjusted checklist sums (Σ/p column) to produce the PII score.

Include any questions, statements, comments, or concerns regarding any checklist cell or category on the SITE SPECIFIC COMMENTS sheet. These comments are critical to determining pre-construction study needs. They will also help identify and refine questions and objectives to be addressed by follow-up study and monitoring. The nature of suspected Significant Ecological Events should be noted on the SITE SPECIFIC COMMENTS sheet.

Ranking PII Scores

PII of each site evaluated is assigned a ranking based on its proportional relationship to the reference site that has the maximum PII score, as shown in Figure 2 in the Montana example. Ranking categories (High, Low, etc.) in the example are arbitrarily set at intervals of 20 percent of maximum.

Rankings are intended as a guide to developers. They are designed to serve as indicators of relative risk to wildlife and thus provide an estimator of the level of impact that may be expected should a site be developed. A high rank does not preclude development, nor does a low rank automatically eliminate the need to conduct pre-development assessments of impacts on wildlife. More intensive pre-construction studies may be needed for both scenarios if development of the site is pursued. Rankings may also suggest the extent of additional study needed.

In the case of federally listed threatened, endangered, or candidate species of wildlife, fish, or plants, consultation with the Fish and Wildlife Service under the Endangered Species Act is required, and may preclude development of a site regardless of its PII score. See Appendix 5 for procedures for obtaining lists of these species that may be present, and for consulting with the Fish and Wildlife Service if species or their habitats are found.

Determining Pre-construction Study Needs

The goals of pre-construction studies are to estimate impacts of proposed wind power development on wildlife by addressing areas of concern identified during the PII process. Objectives, intensity, duration, and methods of pre-construction studies are likely to be site specific, but may be independent of ranking. Regardless of ranking, studies should be designed to address (1) verification of use of WRAs by all species recorded in the “SPECIES OCCURRENCE AND STATUS” checklist, (2) verification of natural conditions (e.g., under “Significant Ecological Events”, the magnitude, timing, and location of suspected bird/bat migration), or (3) questions noted in the SITE SPECIFIC COMMENTS sheet for that site. The SITE SPECIFIC COMMENTS sheet may also indicate conditions that need not be investigated. As a result, a site with a low rank may require radar surveillance (e.g., important songbird migration site) while a site with a high rank may require only a single season visual survey (e.g., site potentially contains autumn Whooping Crane habitat). The process should involve a feedback mechanism within an adaptive management strategy (Figure 1). Timely review of study results will determine if data are

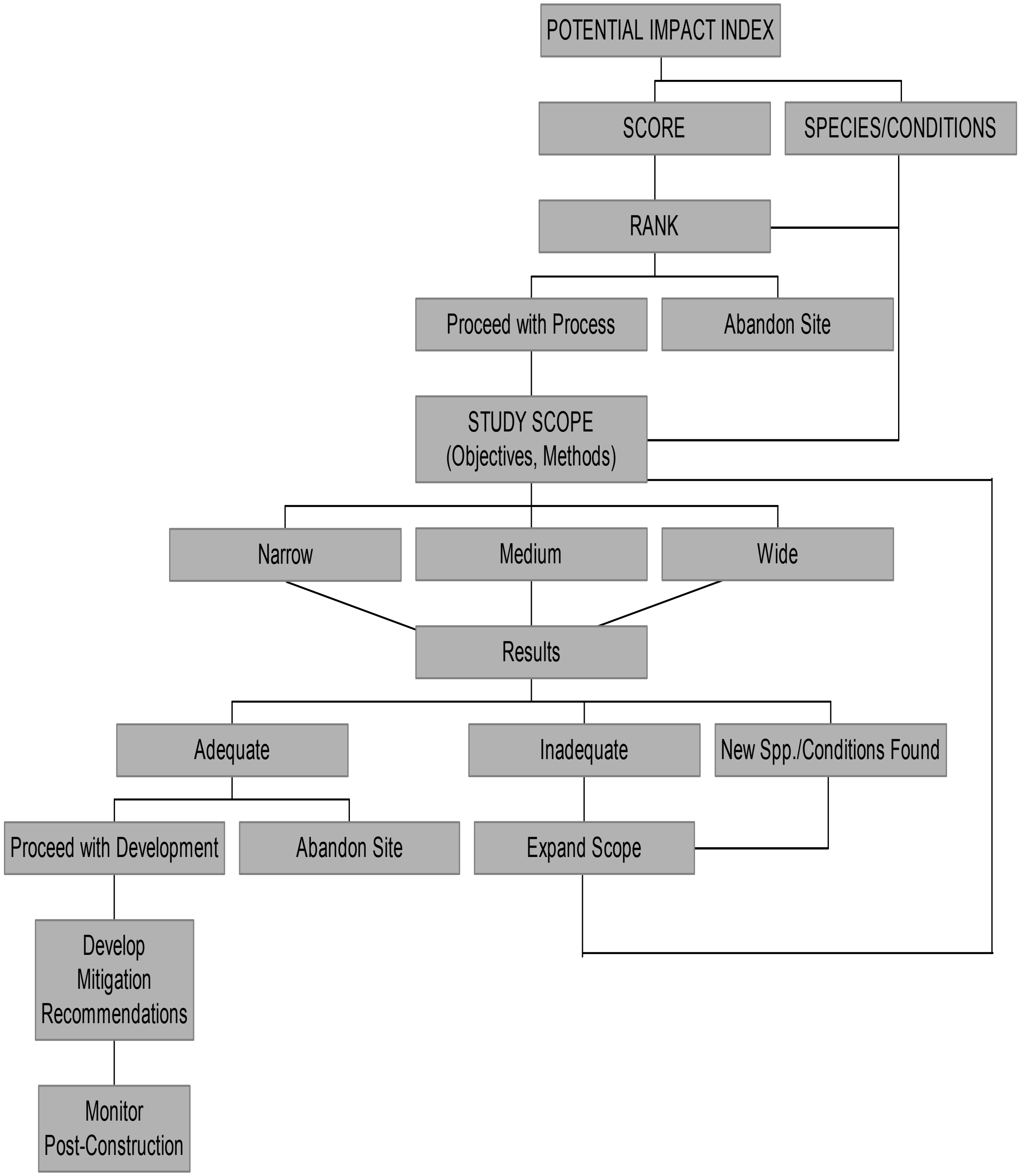


Figure 1. A suggested decision tree for assessing potential development sites. Begin by developing a PII score.

adequate, if conclusions are defensible (Anderson et al. 1999), and if additional investigational effort is required (e.g., if Black-footed Ferrets are found on Mountain Plover searches). Projects with Federal involvement may require additional analysis under the National Environmental Policy Act (http://www.fws.gov/r9esnepa), Endangered Species Act (http://endangered.fws.gov), or National Wildlife Refuge System Administration Act (http://www.fws.gov/policyMakers/mandates/index.html#adminact). Also, the mere existence of a pre-construction study, whether in progress or completed, does not imply Federal sanction for development of a site.

Post-construction Studies

The Service recommends that all sites be monitored for impacts on wildlife after construction is completed. Some sites may be so obviously benign that little more than simple reconnaissance study may be needed and any impact will be revealed during post-construction monitoring. Otherwise, pre-construction studies should be designed to explicitly consider post-construction monitoring that permits statistically valid evaluation of actual impacts. Accordingly, studies should be conducted as much as possible within a Before-After-Control-Impact (BACI) study design (Green 1979). Such design requires investigation of at least two sites (Impact [proposed site] and Control) simultaneously, both pre-construction (Before) and post-construction (After). Because true "Control" sites are seldom available, other sites may be substituted, including reference sites used in developing the PII ranking. In the case of radar surveillance studies, sites within the proposed WRA boundaries may be acceptable (e.g., Harmata et al. 1998). Structuring pre-construction studies within a hypotheses-testing framework will help identify appropriate metrics, focus effort, and permit comparisons with post-construction conditions or other WRAs.

Where feasible, post-construction studies should also be utilized to test measures that may eliminate or reduce impacts on wildlife. See Appendix 4, Research Needs on the Impacts of Wind Power Development on Wildlife.

Metrics and Methods

Metrics and methods are specific tools used to assess wildlife populations and their status (e.g., point counts, line transects, nest success studies, radar surveys, mortality rates, and risk). They can provide important information about birds, bats, and other wildlife at proposed development sites. Metrics and methods may be selected to collect seasonal, group, guild, or habitat specific information, based on data and comments in the SPECIES OCCURRENCE AND STATUS checklist and SITE SPECIFIC COMMENTS sheet. For example, a proposed WRA may be in a narrow north-south oriented valley of relatively monotypic habitat. These conditions suggest a heavy seasonal avian migration corridor but little avian breeding habitat. Accordingly, study emphasis should be on defining use and mortality of migratory birds during autumn or spring or both, with little effort directed at defining use and mortality of breeding birds. Conversely, a potential WRA on a flat plain in diverse habitat would indicate the exact opposite in study emphasis.

While metrics represent specific measurements, concepts, and relationships, methods refer to observational or manipulative study techniques that may be used to verify the location of birds and other wildlife, estimate their numbers, and document their use and behavior (Anderson et al. 1999). Table 1 depicts some commonly used metrics and methods for wildlife studies.

Table 1. Examples of metrics and methods associated with evaluating use and mortality of wildlife at proposed Wind Resource Areas in Montana.

Data Need	Metric	Methods
Use Profile	Individuals/Count	Point Counts (birds) Winter Raptor Surveys Lek Counts (grouse) Migration Counts Ungulate Surveys Spotlight Surveys

	Species/Count	Species/guild/group List Point Counts (birds) Raptor Nesting Surveys Raptor Migration Counts Winter Raptor Surveys Acoustic Surveillance (bats) Pellet Counts Bait Stations Track Boards
	Use per unit of time (e.g., hour, season)	Radar Migration Counts Raptors/watch Area Searches
	Individuals/capture effort	Various techniques for capture
	Productivity	Nests/area Raptor Nesting Surveys Nest Success Ungulate Surveys
	Events/height category (Altitude Profile)	Radar
	Events/distance category (Spatial Profile)	Radar
Mortality	Dead/injured individuals/unit	Transects Spot Searches Carcass Removal Study Observer Detection Efficiency Study

Studies should also strive to generate information to mitigate impacts by properly locating, configuring, or operating turbines (Johnson et al. 2000). Every effort should be made to choose metrics and methods that allow comparisons of pre-construction studies with post-construction studies, other WRAs, and other regions.

Interpreting Metrics

It may be difficult to establish empirically exactly what constitutes high use (i.e., potentially high impact). When looking at the distribution and movements, and local, regional, or range-wide population estimates for particular species, the relative proportions of species, groups, or guilds of wildlife using proposed WRAs may indicate degrees of risk. If baseline population data are unknown, consult with a qualified biologist who can recommend a specific metric.

It is likely that little or no evidence of mortality will be found during pre-construction study. If, however, post-construction mortality is found, and statistical evaluation is not possible, that mortality should be assessed in regard to the species status (e.g., ESA-listed species or Birds of Conservation Concern) or the effect of the loss of individuals of that species on a local, regional, or continental population.

Determining Post-construction Monitoring Needs

Post-construction monitoring is important to the Service, industry, and public because of the limited information available on impacts of wind turbines and WRAs on wildlife. Therefore, post-construction monitoring should be designed to detect major impacts. The intended time frame for post-construction monitoring is not expected to exceed three years, however. Major impacts may be considered as statistically significant decreases in use by species of concern, or limited to statistically significant increases in mortality rates of any wildlife. Monitoring effort may be intensive or cursory, depending on results of pre-construction use and mortality studies. Simple, infrequent mortality surveys on impact and control plots may be all that is needed at WRAs where recorded pre-construction use by wildlife is low. Documented high use of a proposed WRA may require monitoring methods identical to those employed in pre-construction studies. Anderson et al. (1999) provide specific, detailed direction in post-construction study design and monitoring. Manville (2002) developed a monitoring protocol for use by the U.S. Forest Service at three National Forests in Arizona to monitor the impact of cellular telecommunications towers on migratory birds that could be modified for use at land-based wind turbines.

POTENTIAL IMPACT INDEX CHECKLIST FORMS AND INSTRUCTIONS

PHYSICAL ATTRIBUTE CHECKLIST

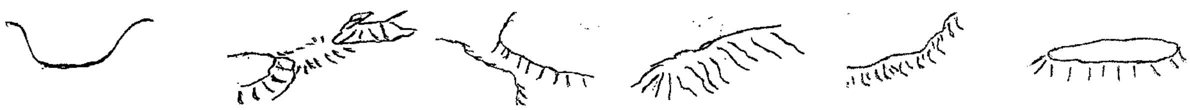
Physical Attribute				Site			
Topography	Mountain Aspect, if mountainous*	Side	W				
			E				
			N				
			S				
		Top					
		Foothill	W				
			E				
			N				
			S				
Wind* Direction	S						
	N						
	E						
	W						
	Updrafts*						
Migratory* Corridor Potential	Latitudinal (N ↔ S)						
	Longitudinal (E ↔ W)						
	Wide Approaches (>30 km)*						
	Funnel Effect	Horizontal					
		Vertical					
Site Size (acres) & Configuration*	<640						
	>640 <1000						
	>1000 <1500						
	Turbine Rows not Parallel to						
Infrastructure To Build	Transmission						
	Roads						
	Buildings*						
			Maintenance				
			Daily Activity				
	Substation						
Increased Activity*							
			Totals				

∗ Criteria on following page

PHYSICAL ATTRIBUTE CRITERIA - categories, max Σ = , (p =).

Topography - Terrain characteristic within the ecological influence of the proposed wind development site, generally, but not restricted to ± 5 mi. Some examples are:

Valley Pass Gap Ridgetop Bluff Butte



Mountain Aspect - Aspect of topography for site of proposed development. Multiple categories may be checked.

Wind Direction - Compass direction *from* which prevailing winds approach. Multiple categories may be checked.

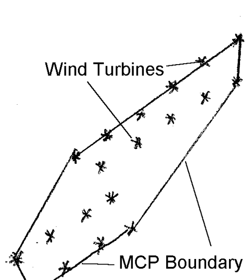
Updrafts - Do updrafts/upslope winds prevail?

Migratory Corridor Potential - Subjective estimate of area to be a potential avian/bat migratory corridor based strictly on topographical characteristics. Multiple categories may be checked.

Wide (>20 mi) - Terrain characteristics of approaches to site from each migratory direction, i.e., a large plain, river corridor, long valley. The larger the area that migrant birds/bats are drawn from, the more may be at risk

Funnel Effect - Is the site in or near an area where migrant birds/bats may be funneled (concentrated) into a smaller area, either altitudinally, laterally, or both?

Site Size & Configuration – Size is estimated as if a minimum convex polygon (MCP) were drawn around peripheral turbines.



Successive boxes are checked to convey relationship of larger size = increased impact to birds/bats, *e.g.*, a 700 acre site will have 2 categories checked while a 1,200 acre site will have all 3 categories checked.

Configuration of turbine rows is usually perpendicular to prevailing wind direction. Rows aligned perpendicular or oblique to route of migration intuitively presents more risk to birds than rows aligned parallel to movement.

Buildings – Building are categorized by relative size and visitation frequency, *i.e.,* structures that are visited daily are usually larger and present more impact than those that are not. If a “Daily Activity” building is required, all Building categories are checked. If a maintenance structure is required, Substation is also checked.

Increased Activity - Will any type of human activity increase? Sites in urban-suburban or otherwise developed areas (oil, gas, mines) will have less impact on wildlife than those in remote or undeveloped areas.

Avian Species of Concern Checklist
(Complete prior to SPECIES OCCURRENCE & STATUS Checklist)

Birds (n =)	Site											
Occurrence	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ
Subtotals												
Total												

Avian Species of Concern Checklist (species, max Σ =)

Column totals of this list are added to appropriate cells in the SPECIES OCCURRENCE & STATUS checklist. Consult Birds of Conservation Concern (http://migratorybirds.fws.gov/reports/reports.html) and Threatened/Endangered Species list (http://endangered.fws.gov), and list other species of high value or management concern such as migratory waterfowl and prairie grouse. Appropriate avian field guides and species accounts should be consulted for confirmation of species distribution and habitat associations. State Natural Heritage Programs may also provide species accounts that include additional information useful in completing checklists.

In addition to species lists (rows), season of occurrence is also indicated (columns). “B” indicates breeding or summer occurrence and “M/W” indicates presence during migration or as wintering species. If occurrence within or in the vicinity of a proposed site is confirmed or suspected, an “X” is entered.

Bat Species Of Concern Checklist
(Complete prior to SPECIES OCCURRENCE & STATUS Checklist)

	Site											
Bats (n =)												
Occurrence	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ
Subtotals												
Total												

Bat Species Of Concern Checklist (species, max Σ =   ).

Column totals of this list are added to appropriate cells in the SPECIES OCCURRENCE & STATUS checklist. Appropriate bat field guides and references (Barbour and Davis 1969) should be consulted for confirmation of species distribution and habitat associations. State Natural Heritage Programs may also provide species accounts that include additional information useful in completing checklists.

In addition to species lists (rows), season of occurrence is also indicated (columns). “B” indicates breeding or summer occurrence and “M/W” indicates presence during migration or as wintering species. If occurrence within or in the vicinity of a proposed site is confirmed or suspected, an “X” is entered.

SPECIES OCCURRENCE & STATUS CHECKLIST

		Site											
Species													
	Occurrence	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ
Threatened & Endangered (includes wildlife, fish, and plants)													
Candidate*													
Special Concern*	Birds (max Σ=)												
	Bats (max Σ=)												
Subtotals													
Total													

* Criteria on following page

SPECIES OCCURRENCE & STATUS Checklist (categories, max Σ = , (p =).

Checklist totals for each column in "Avian Species of Concern List" and "Bat Species of Concern List" are inserted in this checklist.

Threatened & Endangered Species - Species on the Federal List of Endangered and Threatened Species (http://endangered.fws.gov).

Candidate Species - Species being investigated for inclusion in the Federal List of Endangered and Threatened Species (http://endangered.fws.gov).

Species of Special Concern - Species listed in Birds of Conservation Concern; by Natural Heritage Programs that are known or suspected to be rare, endemic, disjunct, threatened or endangered; and species of high value such as migratory or other game birds.

Golden Eagles may be included in this checklist because of special protective status afforded under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d). Other species (e.g., Sage Grouse) may be included because of recent concern over population declines range wide. Bats (other than bat Species of Special Concern) should be included due to generally unknown impacts of wind farms on individuals and populations.

ECOLOGICAL ATTRACTIVENESS CHECKLIST

Site

Ecological Attractor						
Migration Route*		Local				
	Continental*	N				
		S				
		E				
		W				
Ecological Magnets*		Lotic System				
		Lentic System				
		Wetlands				
		Native Grassland				
		Forest				
		Food Concentrated				
		Energetic Foraging				
	Vegetation/ Habitat	Unique				
		Diverse				
Significant Ecological Event*						
Site of Special Conservation Status*						
		Total				

* Criteria on following page

ECOLOGICAL ATTRACTIVENESS CRITERIA - categories, max Σ = , (p =).

Migration Route - Indicates predominate direction of movement of seasonal migrations. Multiple categories may be checked.

Local - Some avian populations move only altitudinally & direction may be East-West (Sage Grouse, owls, Bald Eagles).

Continental - Some migratory corridors experience mass movements in only one season/direction annually (e.g., Bridger Mountains autumn eagle migration).

Ecological Magnets - Special, unique, unusual, or super ordinary habitats or conditions within the vicinity of the site that may attract wildlife. Lotic systems include small perennial or seasonal creeks to major rivers. Lentic systems include stock ponds to lakes to marine environments. Multiple categories may be checked.

Vegetation/Habitat - Unique or exceptionally diverse vegetation or habitat in the vicinity may indicate exceptional diversity and abundance of avian species or bats.

Significant Ecological Event - Special, unique, unusual, or super ordinary events that occur or are suspected to occur in the vicinity of the site, e.g., up to one third of the Continental population of Trumpeter Swans visit Ennis Lake, < 2.5 miles from a proposed Wind Resource Area; the Continental migration of shorebirds passes over (many stop) at Benton Lake National Wildlife Refuge) and up to 2,000 Golden Eagles pass over the Bridger Mountains in autumn. If unknown but suspected a "?" is entered. Specifics regarding the cell are then addressed in the appropriate box of the SITE SPECIFIC COMMENTS sheet to focus follow-up investigation and assist in definition of study objectives.

Site of Special Conservation Status - Any existing or proposed covenants, conservation easements, or other land development limitations intended to conserve, protect, or enhance wildlife or habitat. This criterion is weighted (2 entered if true) because of previous financial or other investment in ecological values. Specifics regarding the easement are then addressed in the appropriate box of the SITE SPECIFIC COMMENTS sheet to focus follow-up attention.

POTENTIAL IMPACT INDEX

	Site							
Checklist (p)[1]	Σ	Σ/p	Σ	Σ/p	Σ	Σ/p	Σ	Σ/p
Physical ( )								
Species Occurrence & Status ( )								
Ecological ( )								
Totals								

[1]Proportion of total checklist categories.

Determining PII Score

A. Place the sums from each of the three checklists in the POTENTIAL IMPACT INDEX table sum boxes (Σ column) in the appropriate category.

B. Divide each checklist sum by the previously calculated divisor to adjust the sum for disproportionate numbers of conditions in each checklist, and place this adjusted sum in the Σ/p boxes for each checklist.

C. Add the Σ/p boxes for the three checklists to obtain a total score.

SITE SPECIFIC COMMENTS

Checklist	**Site**			
Physical				
Species Occurrence				
Ecological				

EXAMPLE SITE ASSESSMENT AND
CALCULATION OF POTENTIAL IMPACT INDEX (PII)
FROM MONTANA

POTENTIAL IMPACT INDEX CHECKLISTS

Calculating Divisors

A. Each checklist should be assigned a divisor, which is developed by dividing the number of boxes in a checklist by the total number of boxes in all three checklists. In this example, the total number of boxes in all three checklists is 143.

B. Physical Attribute checklist: 36 boxes ÷ 143 = 0.25; Species Occurrence and Status checklist: 91 boxes ÷ 143 = 0.63; Ecological Attractiveness checklist: 16 boxes ÷ 143 = 0.11.

Determining Checklist Scores

A. Place a check in each box for which an attribute, species, or condition is present or strongly suspected.

B. After completing the three checklists for each site, add the total number of checks in a checklist for an ending sum (each box checked equals 1).

PHYSICAL ATTRIBUTE CHECKLIST

Physical Attribute				Site			
				Snowy Mtn.Range			
Topography	Mountain Aspect	Side	W	X			
			E				
			N				
			S				
		Top					
		Foothill	W	X			
			E				
			N				
			S				
	Valley			X			
	Pass						
	Gap						
	Ridge			X			
	Bluff						
	Butte						
Wind Direction	S						
	N			X			
	E						
	W						
	Updrafts			X			
Migratory Corridor Potential	Latitudinal (N ↔ S)						
	Longitudinal (E ↔ W)			X			
	Wide Approaches (>30 km)						
	Funnel Effect	Horizontal		X			
		Vertical					
Site Size (acres) & Configuration	<640			X			
	>640 <1000			X			
	>1000 <1500			X			
	Turbine Rows not Parallel to						
Infrastructure To Build	Transmission			X			
	Roads			X			
	Buildings			X			
			Maintenance	X			
			Daily Activity	X			
	Substation			X			
Increased Activity				X			
			Totals	18			

Avian Species of Concern Checklist
(Complete prior to SPECIES OCCURRENCE & STATUS Checklist)

	Site											
Birds (n = 12)	Snowy Mtn. R.											
Occurrence	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ
Nelson’s Sharptailed Sparrow	X	X	2									
LeConte’s Sparrow	X	X	2									
Baird’s Sparrow	X	X	2									
Dickcissel	X		1									
Cassion’s Kingbird	X		1									
Blackbacked Woodpecker	X		1									
Yellow-billed Cuckoo	X		1									
Peregrine Falcon	X		1									
Northern Goshawk		X	1									
Ferruginous Hawk		X	1									
Clark’s Grebe	X		1									
Common Loon	X		1									
Subtotals	10	5	15									
Total			15									

Bat Species Of Concern Checklist
(Complete prior to SPECIES OCCURRENCE & STATUS Checklist)

Bats (n = 2)	Site: Snowy Mtn. Range											
Occurrence	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ
Fringed Myotis	X		1									
Spotted Bat	X		1									
Subtotals	2		2									
Total			2									

SPECIES OCCURRENCE & STATUS CHECKLIST

	Species	Site											
		Snow Mtn. R.											
	Occurrence	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ	B	M/W	Σ
Threatened & Endangered	Bald Eagle		X	1									
Candidate	Columbian Sharp-tailed Grouse	X	X	2									
Special Concern	Birds (max Σ=)			15									
	Bats (max Σ=)			2									
	Subtotals			20									
	Total			20									

ECOLOGICAL ATTRACTIVENESS CHECKLIST

Site

Ecological Attractor			Snowy Mtn. Range			
Migration Route	Local					
	Continental	N	X			
		S	X			
		E				
		W				
Ecological Magnets	Lotic System					
	Lentic System					
	Wetlands		X			
	Native Grassland		X			
	Forest		X			
	Food Concentrated					
	Energetic Foraging		X			
	Vegetation/ Habitat	Unique				
		Diverse	X			
Significant Ecological Event						
Site of Special Conservation Status						
		Total	7			

POTENTIAL IMPACT INDEX

Checklist (p)[1]	Site							
	Σ	Σ/p	Σ	Σ/p	Σ	Σ/p	Σ	Σ/p
Physical (0.25) 15÷.25=60	15	60						
Species Occurrence & Status (0.63) 20÷.63=32	20	32						
Ecological (0.11) 7÷.11=64	7	64						
Totals	42	**156**						

[1]Proportion of total checklist categories.

Score is 156, compared to the highest reference site score of 244 (Figure 2).

Determining PII Score

A. Place the sums from each of the three checklists in the POTENTIAL IMPACT INDEX table sum boxes (Σ column) in the appropriate category.

B. Divide each checklist sum by the previously calculated divisor to adjust the sum for disproportionate numbers of conditions in each checklist, and place this adjusted sum in the Σ/p boxes for each checklist.

C. Add the Σ/p boxes for the three checklists to obtain a total score.

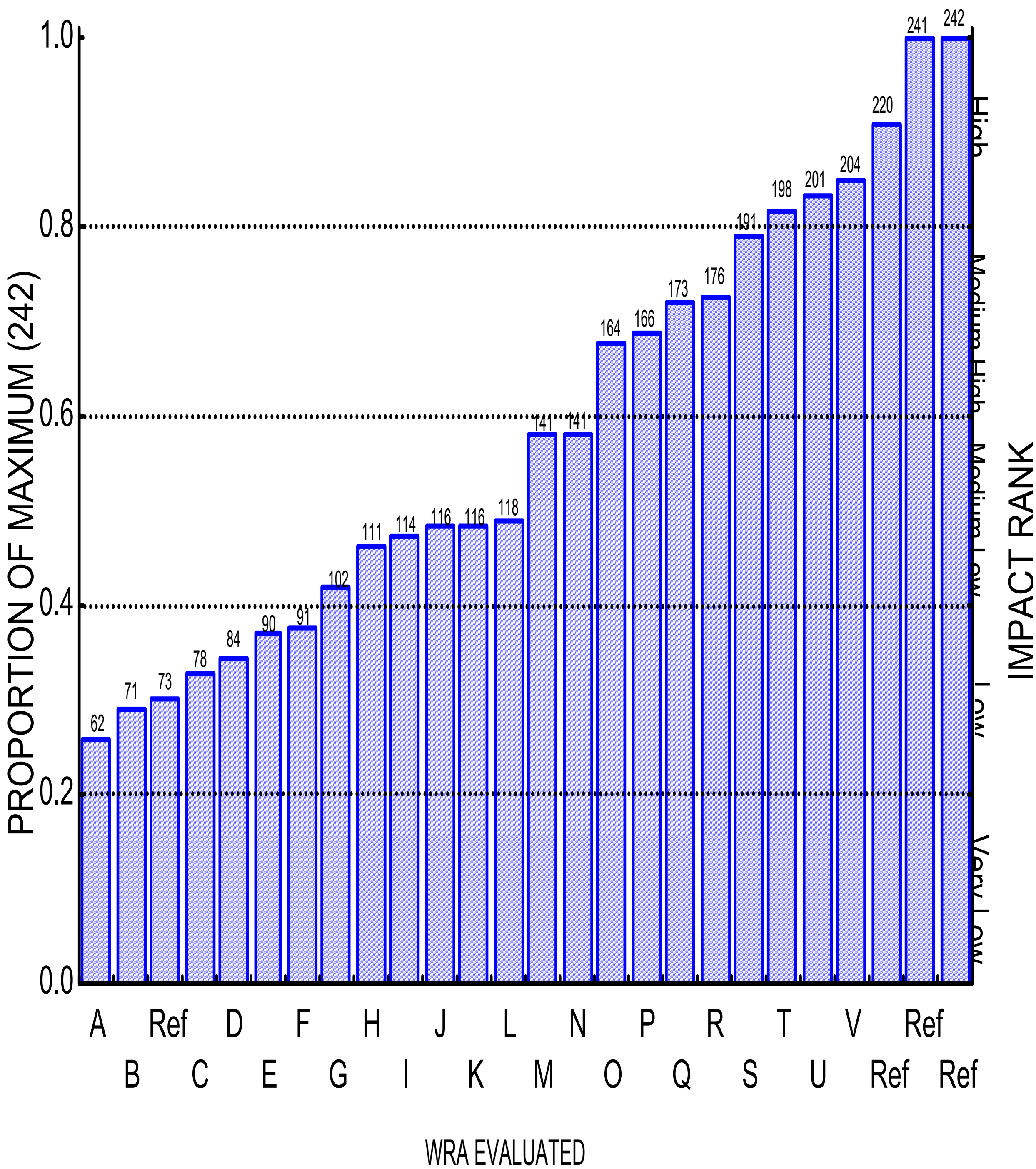


Figure 2. Impact ranks of proposed Wind Resource Areas in Montana. The number above each bar is the PII score. Rank is a function of the proportional relationship of proposed development sites to the maximum score of 4 Reference Sites evaluated.

Appendix 2

DEFINITIONS RELATED TO WIND ENERGY DEVELOPMENT AND EVALUATION

AGL: height above ground level in feet.

Breco Bird Scaring Buoy: a device developed to disperse seabirds at oil spills, which emits some 30 different sounds (including alert calls) up to 130 dB, generally effective in scaring birds at distances up to 200 yards, but may deter birds to 0.5 mile radius. The floating device can be used daytime or night, in fog, wind or storms.

Deterrent Devices: specific equipment, devices, or techniques which are intended to be seen or heard to alert and deter birds from contacting turbine towers, rotors, guy wires, or related equipment. These include diverters installed on turbine or meteorological tower guy wires, dark (e.g., black) paint on single turbine blades or portions of a blade, or noise-making devices that alert (e.g., infrasound) or frighten (e.g., Breco Buoys) birds.

Fish and Wildlife: any member of the animal kingdom, including any bird (including any migratory, non-migratory, or endangered bird for which protection is afforded), mammal, fish, amphibian, reptile, mollusk, crustacean, arthropod, or other invertebrate. Unless otherwise indicated, the Fish and Wildlife Service is particularly concerned about the impacts of wind turbines on birds and bats.

Flyway: a concentrated, predictable flight path of migratory bird species (e.g., particularly water birds such as ducks, geese, large waders, and shorebirds, but also raptors, and sometimes songbirds) from their breeding ground to wintering area. Except along coast lines, the flyway concept may not generally apply to songbirds because they tend to migrate in broad fronts rather than down specific flyways. The term "corridors" has sometimes been used. These frontal movements of songbirds can change within and between seasons and years – as can, for example, movements of waterfowl – making specific designations more difficult. The concept applies both biologically and administratively. For administrative purposes, for example, there are four waterfowl flyways (Atlantic, Pacific, Central, and Pacific and three shorebird flyways (East, Central, and Pacific). "Daily flyways" may also exist between roosting, breeding, and feeding areas.

Lek: A traditional site used year after year by males of certain species of birds (in North America, Greater and Lesser Prairie-chickens, Sage and Sharp-tailed grouse, and Buff-breasted Sandpiper), within which the males display communally to compete for female mates. Dominant males secure the majority of all the matings. Pair bonds are not formed; females leave to nest and raise the young, and males do not take part in parental care.

Passerines: a scientific term for the order of songbirds, many of which winter in tropical areas.

Precautionary Approach: a conservative, scientific approach to conserving and managing habitats and species. Absent definitive data, the approach suggests taking the best steps available to initiate appropriate conservation actions. Those actions should then be refined through the use of principles of adaptive management and sound science. The absence of complete or definitive scientific information should not be used as a reason for postponing or failing to take measures to conserve target species, associated or dependent species, or non-target species and their environments. Specifically, developers should apply a precautionary approach widely to conservation and management of birds, bats, other fauna, flora, and affected habitats. This will protect the resources and preserve Wind Resource Areas by taking account of the best scientific evidence available.

Reference Site: an area of high wildlife value which is used to evaluate the suitability of other areas for wind energy development. Reference sites are selected by biologists familiar with the wildlife in the geographic area and habitat types where wind energy development is contemplated, and evaluated using the Ranking Protocol in Appendix 1. The reference site having the highest score, i.e., the area where wind energy development would have the greatest negative impact on wildlife, is used as the standard against which potential wind energy development sites are ranked.

Riparian Area: The vegetation, habitats, or ecosystems that are associated with streams, rivers, or lakes, or are dependent upon the existence of perennial, intermittent, or ephemeral surface or subsurface water drainage. Relative to other habitats, riparian habitats have a disproportionately high wildlife value in the drier western states due to the presence of surface water and/or lush vegetation that is typically surrounded by harsher, arid or semi-arid environments.

Rookery: the breeding place of a colony of gregarious birds (e.g., herons) or mammals (e.g., bats).

Rotor-swept Area: generally the vertical airspace within which the turbine blades (usually 3) rotate on a pivot point or drive train rotor. The Area will vary in location depending on the direction of the prevailing wind. While "slower" turbines may operate at speeds less than 30 revolutions per minute (RPMs), turbine speeds at the blade tips can still exceed 220 miles per hour in stiff winds. Recent studies indicate that birds appear unable to recognize blade presence at rotor tips during high blade speed, referred to as the "smear effect."

Staging Area: a traditional site where migratory birds of one or more species congregate in spring and fall for varying periods of time to forage and build up fat reserves prior to launching migratory flights. The term may be used on both the breeding and wintering grounds, as well as at intermediate stopover sites used at any point along the migration route.

Turbine Position within a Row/String: the specific position of a turbine within a string or row of turbines. It may be designated as an end-row, mid-row, or lone row turbine (one not located within a row).

Wind Resource Area: the geographic area or footprint within which wind turbines are located and operated, such as the Altamont Pass, California, WRA, or where location and operation of turbines are anticipated. The term may be used to describe an existing facility, or a general area in which development of a facility is proposed. Existing facilities are known variously as "wind farms," "wind parks," or "energy parks." WRAs are selected based primarily on the reliability and availability of sufficient wind. These areas are designated by the *United States Wind Resource Map*, published by the National Renewable Energy Laboratory, Department of Energy (http://rredc.nrel.gov). The *Map* delineates wind power classifications from "marginal" to "superb" based on a Weibull wind speed index.

Appendix 3

WILDLIFE LAWS RELEVANT TO WIND POWER DEVELOPMENT PROJECTS

The Migratory Bird Treaty Act (16 U.S.C. 703-712; MBTA), which is administered by the Fish and Wildlife Service (FWS), is the cornerstone of migratory bird conservation and protection in the United States. The MBTA implements four treaties that provide for international protection of migratory birds. It is a strict liability statute wherein proof of intent is not an element of a taking violation. Wording is clear in that most actions that result in a "taking" or possession (permanent or temporary) of a protected species can be a violation. Specifically, the MBTA states:

"Unless and except as permitted by regulations … it shall be unlawful at any time, by any means, or in any manner to pursue, hunt, take, capture, kill … possess, offer for sale, sell … purchase … ship, export, import … transport or cause to be transported … any migratory bird, any part, nest, or eggs of any such bird … (The Act) prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior." The word "take" is defined as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect."

A 1972 amendment to the MBTA resulted in inclusion of Bald Eagles and other birds of prey in the definition of a migratory bird. The MBTA provides criminal penalties for persons who, by any means or in any manner, pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported, deliver for transportation, transport or cause to be transported, carry or cause to be carried, or receive for shipment, transportation, carriage, or export, any migratory bird (including Bald Eagles) as well as possessing Bald Eagles, their parts, nests, or eggs without a permit. A violation of the MBTA by an individual can result in a fine of up to $15,000, and/or imprisonment for up to 6 months, for a misdemeanor, and up to $250,000 and/or imprisonment for up to 2 years for a felony. Fines are doubled for organizations. Penalties increase greatly for offenses involving commercialization and/or the sale of migratory birds and/or their parts. Under authority of the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d; BGEPA), Bald and Golden Eagles are afforded additional legal protection. Penalties for violations of the BGEPA are up to $250,000 and/or 2 years imprisonment for a felony, with fines doubled for an organization.

While these Acts have no provision for allowing unauthorized take, the FWS realizes that some birds may be killed even if all reasonable measures to avoid the take are implemented. The FWS Office of Law Enforcement carries out its mission to protect migratory birds not only through investigations and enforcement, but also through fostering relationships with individuals, companies, and industries who seek to eliminate their impacts on migratory birds. Unless the activity is authorized, it is not possible to absolve individuals, companies, or agencies from liability even if they implement avian mortality avoidance or similar conservation measures. However, the Office of Law Enforcement focuses on those individuals, companies, or agencies that take migratory birds with disregard for their actions and the law, especially when conservation measures have been developed but are not properly implemented.

The Endangered Species Act (16 U.S.C. 1531-1544; ESA) was passed by Congress in 1973 in recognition that many of our Nation's native plants and animals were in danger of becoming extinct. The purposes of the Act are to protect these endangered and threatened species and to provide a means to conserve their ecosystems. To this end, Federal agencies are directed to utilize their authorities to conserve listed species, as well as "Candidate" species which may be listed in the near future, and make sure that their actions do not jeopardize the continued existence of these species. The law is administered by the Interior Department's FWS and the Commerce Department's National Marine Fisheries Service (NMFS). The FWS has primary responsibility for terrestrial and freshwater organisms, while the NMFS has responsibility for marine species such as whales and salmon. These two agencies work with other agencies to plan or modify Federal projects so that they will have minimal impact on listed species and their habitats. Protection of species is also achieved through partnerships with the States, with Federal financial assistance and a system of incentives available to encourage State participation. The FWS also works with private landowners, providing financial and technical assistance for management actions on their lands to benefit both listed and non-listed species.

Section 9 of the ESA makes it unlawful for a person to "take" a listed species. Take means ". . . to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." The Secretary of the Interior, through regulations, defined the term "harm" as "an act which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." However, permits for "incidental take" can be obtained from the FWS for take which would occur as a result of an otherwise legal activity, such as construction of wind turbines, and which would not jeopardize the species.

Section 10 of the ESA allows for the development of "Habitat Conservation Plans" for endangered species on private lands. This provision is designed to assist private landowners in incorporating conservation measures for listed species with their land and/or water development plans. Private landowners who develop and implement an approved habitat conservation plan can receive an incidental take permit that allows their development to go forward.

The National Environmental Policy Act of 1969 (42 U.S.C. 4371 et seq.; NEPA) requires that Federal agencies prepare an environmental impact statement (EIS) for Federal actions significantly affecting the quality of the human environment. "Federal Actions" are those actions in which a Federal agency is conducting the activity, providing funding for the activity, or licensing or permitting the activity. An EIS must describe the proposed action, present detailed analyses of the impacts of the proposed action and alternatives to that action, and include public involvement in the decision making process on how to proceed to accomplish the purpose of the action. The purpose of NEPA is to allow better environmental decisions to be made. The Council on Environmental Quality, established by NEPA, has promulgated regulations in 40 CFR 1500-1508 that include provisions for 1) preparing EISs and Environmental Assessments, 2) considering categorical exclusions from NEPA documentation requirements for certain agency actions, and 3) developing cooperating agency agreements between Federal agencies.

Other Federal agencies may be required by NEPA to review and comment on proposed activities as a cooperating agency with the action agency under Section 1501.6, or because of a duty to comment on federally-licensed activities for which the agency has jurisdiction by law (Section 1503.4). For the FWS, this would be the MBTA and BGEPA. Other agencies may also be called on for review and comment because of special expertise.

The National Wildlife Refuge System Administration Act (16 U.S.C. 668dd), as amended, serves as the "organic act" for the National Wildlife Refuge System. It consolidates the various categories of lands administered by the Secretary of the Interior (Secretary) through the FWS into a single National Wildlife Refuge System. The Act establishes a unifying mission for the Refuge System, a process for determining compatible uses of refuges, and a requirement for preparing comprehensive conservation plans. The Act states first and foremost that the mission of the National Wildlife Refuge System will be focused singularly on wildlife conservation.

The Act identifies six priority wildlife-dependent recreation uses; clarifies the Secretary's authority to accept donations of money for land acquisition; and places restrictions on the transfer, exchange, or other disposal of lands within the Refuge System. Most importantly, the Act reinforces and expands the "compatibility standard" of the Refuge Recreation Act, authorizing the Secretary, under such regulations as he may prescribe, to "permit the use of any area within the System for any purpose, including but not limited to hunting, fishing, public recreation and accommodations, and access whenever he determines that such uses are compatible with the major purposes for which such areas were established." This section applies to any proposed development of wind energy on Refuge System lands; such development must be compatible with the major purpose for which that Refuge was established.

The National Historic Preservation Act of 1966 (16 U.S.C. 470-470b, 470c-470n) approved October 15, 1966 and repeatedly amended, provides for preservation of significant historical features (buildings, objects, and sites) through a grant-in-aid program to the States. It established a National Register of Historic Places and a program of matching grants under the existing National Trust for Historic Preservation (16 U.S.C. 468-468d). The Act also requires Federal agencies to take into account the effects of their actions on items or sites listed or eligible for listing in the National Register. Thus, the Act functions similarly to NEPA, requiring a determination of the presence of any such items or sites, and an evaluation of the effects of proposed developments (such as wind energy facilities) on them, if the facility would be built, funded, licensed or permitted by a Federal agency. This includes State lands purchased or improved with Federal Aid in Wildlife Restoration funds.

Appendix 4

RESEARCH NEEDS ON THE IMPACTS OF WIND POWER DEVELOPMENT ON WILDLIFE

Representatives of the Fish and Wildlife Service's Wind Turbine Siting Working Group have suggested the following research needs:

- Effects of inclement weather in attracting birds and bats to lighted turbines, e.g., drawing birds and bats to within rotor-swept area of turbines, particularly for passerines during spring and fall migrations.

- Localized effects of turbines on wildlife: habitat fragmentation and loss; effects of noise on both aquatic and terrestrial wildlife; habituation.

- Effects of wind turbine string configuration on mortality, e.g., end of row turbine effect, turbines in dips or passes or draws, setbacks from rim/cliff edges.

- Effectiveness of deterrents: alternating colors on blades (particularly, effect of black/white and UV gel coats on the smear effect); lights (e.g., color, duration, and intensity of pilot warning lights; lasers); infrasound (Breco Buoys, other noisemakers such as predator and distress calls if not irritating to humans, other wildlife, or domestic animals); visual markers on guy wires.

- Utility of acoustic, infrared, and radar technologies to detect bird species presence, abundance, location height, and movement.

- Accuracy of mortality counts: estimate of the number of carcasses (especially of passerines) lost because they have been fragmented and lost to collision momentum and the wind; size and shape of dead bird search areas; possibility of recording collisions acoustically or with radar or infrared monitoring.

- Annual variability (temporal and spatial) in migratory pathways; what is the utility of Geographic Information System to assess migratory pathways and stopovers, particularly for passerines and bats.

- Effectiveness of seasonal wind turbine shutdowns at preventing mortalities, including the feasibility of using "self-erecting" turbines that are easily erected and dismantled without cranes, and taking them down during critical periods such as migrations.

- Impacts of larger turbines versus smaller models.

- Changes in predator-prey relationships due to placing potential perching sites in prairie habitats.

Appendix 5

PROCEDURES FOR ENDANGERED SPECIES EVALUATIONS AND CONSULTATIONS

The Endangered Species Act (ESA) directs all Federal agencies to participate in endangered species conservation. Specifically, section 7(a)(1) of the ESA charges Federal agencies to aid in the conservation of listed species. Section 7 (a)(2) requires Federal agencies to consult with the Fish and Wildlife Service (FWS) to ensure that actions that they fund, authorize, permit, or otherwise carry out will not jeopardize the continued existence of any listed species or adversely modify designated critical habitats. The FWS has developed a handbook describing the consultation process in detail. It is available on the FWS web site at http://endangered.fws.gov/consultations. Consultation may be informal or formal, depending upon the presence of listed species and the potential for the proposed project to affect them.

Before initiating an action, the Federal action agency (the agency authorizing a specific action) or its non-Federal permit applicant, must ask the FWS to provide a list of threatened, endangered, proposed, and candidate species and designated critical habitats that may be present in the project area. This initiates the informal consultation process. If the FWS answers that no species or critical habitats are present, then the Federal action agency or permit applicant has no further ESA obligation under section 7(a)(2), and consultation is concluded. If listed species or critical habitats are present, then the action agency or applicant must determine whether the project may affect those species (known as a *may affect* determination), and informal consultation continues. If the action agency or applicant determines, and the FWS agrees, that the project does not adversely affect any listed species, then the consultation is concluded and the decision is put in writing.

If the action agency or applicant determines that a project *may adversely affect* a listed species or designated critical habitat, the action agency/applicant prepares a *Biological Assessment* and requests formal consultation. There is a designated period of time in which to consult (90 days), and beyond that, another set period of time for the FWS to prepare a *biological opinion* (45 days). An analysis of whether or not the proposed action would be likely to jeopardize the species or adversely modify its critical habitat is determined in the biological opinion. If a *jeopardy* or *adverse modification* determination is made, the biological opinion must identify any reasonable and prudent alternatives that could allow the project to move forward.

The biological opinion will contain an “incidental take statement.” “Take” is defined as harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting or attempting to engage in any such conduct. “Harm” is further defined to include significant habitat modification or degradation that results in death or injury to a listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. “Incidental take” is defined as take that is incidental to, and not the purpose of, an otherwise lawful activity. If the FWS issues a *jeopardy* opinion, the incidental take statement will simply state that no take is authorized. If the FWS issues a nonjeopardy opinion, the FWS will anticipate the take that may result from the proposed project and describe that take in the incidental take statement. The statement will contain clear terms and conditions designed to reduce the impact of the anticipated take to the species; these terms are non-discretionary on the action agency or applicant.

When non-Federal activities will result in take of threatened or endangered species, an *incidental take permit* is required under section 10 of the ESA. A habitat conservation plan or “HCP” must accompany an application for an incidental take permit. The habitat conservation plan associated with the permit is to ensure that there are adequate conservation measures to avoid jeopardy to the species.

Examples:

1. **No Effect** – The appropriate conclusion when the action agency or applicant determines that its proposed action will not affect a listed species or designated critical habitat.

   Example: A permit applicant contacts the FWS to request information on listed species. The FWS provides a species list containing 3 plants, 1 fish, and 1 butterfly. The proposed project would be constructed at an upland site on clay soils. The 3 plants are found only on sandy soils. The butterfly’s habitat is one of the plants on sandy soil. The nearest sandy soils are 10 miles from the proposed project. The fish is in a stream 5 miles from the proposed project. Conclusion: No effects from the project, either direct or indirect. Justification: No construction is proposed in listed species habitat or in an area that may affect listed species. In addition, the project proponent has charted a route for heavy equipment moving onto the construction site that avoids listed species habitat.

2. **May Affect, but Not Likely to Adversely Affect** – The appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not (a) be able to meaningfully measure, detect, or evaluate insignificant effects, or (b) expect discountable effects to occur.

   Example: The applicant contacts the FWS to request information on listed species. The FWS provides a species list containing 2 birds and 1 fish. The proposed project would be constructed at an upland site, 200 yards from the stream (fish habitat) and adjoining riparian vegetation (bird habitat). The migratory birds use the riparian vegetation to nest between April 15 and August 15. The uplands are highly erodible soils. The project proponent agrees not to construct during the nesting season. He flags the riparian vegetation to indicate an avoidance zone and installs silt fencing between the riparian vegetation and the construction site. He states that he will plant the disturbed soils surrounding the project with native vegetation after construction. He also agrees to monitor the vegetation planted for 3 years to assure that it establishes sufficiently to prevent any additional erosion in the project area caused by construction. Conclusion: Although the project proponent is working in very close proximity to listed species habitat, the action is not likely to adversely affect listed species. Justification: The proponent has incorporated sufficient avoidance and other mitigation measures into the project that any effects to listed species would be discountable. The project proponent prepares a Biological Assessment that includes a complete description of the project, all proposed avoidance and other mitigation measures, and the resulting effects of the project on the listed species. The Biological Assessment is sent to the FWS to request concurrence that the project is not likely to adversely affect listed species.

3. **May Affect, and Likely to Adversely Affect** – The appropriate finding in a Biological Assessment (or conclusion during informal consultation) if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not discountable, insignificant, or beneficial. In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species. If incidental take is anticipated to occur as a result of the proposed action, an "is likely to adversely affect" determination should be made. This determination requires the initiation of formal section 7 consultation.

   Example: The applicant contacts the FWS to request information on listed species. The FWS provides a species list containing 10 birds. The proposed project would be constructed at an upland site within a significant migratory bird corridor that is utilized by the 10 listed birds. Construction will permanently alter the character of the corridor and will likely cause take of listed birds every year during the migration periods. Conclusion: Formal consultation will be required. The project proponent prepares a Biological Assessment to submit to the action agency to accompany their request to initiate formal consultation. Justification: The project is likely to cause take of listed birds every year during their migration periods.

Appendix 6

GUIDELINES FOR CONSIDERING WIND TURBINE SITING ON EASEMENT LANDS ADMINISTERED AS PART OF THE NATIONAL WILDLIFE REFUGE SYSTEM IN REGION 6

Grassland easements are acquired to protect native and planted grasslands essential for grassland dependent migratory birds and other wildlife. Healthy grasslands provide both nesting and migration habitat necessary to maintain these important populations. Wind energy could severely impact this important program if not developed carefully with as little impact to migratory birds and their habitat as possible.

The following guidelines are to be used when making compatibility determinations for the siting of wind turbines and associated facilities on lands encumbered by U.S. Fish and Wildlife Service (Service) grassland easements and USDA conservation easements administered by the Service in Region 6, particularly in North Dakota, South Dakota, and Montana. These guidelines are intended to provide guidance for considering compatibility determinations during the period while the Service and the wind power industry monitor potential impacts to migratory birds as a result of turbine construction, maintenance, and operation. The following guidelines will be incorporated into rights-of-way permits issued for the construction of turbines, access roads, and other associated activities necessary to make the turbines operational. The intention of these guidelines is to minimize impacts to migratory birds and protect the habitat covered by the easement. The guidelines pertain only to permits issued for the alteration or destruction of grassland habitat as a result of turbine and other associated construction on lands encumbered by Service easements.

Refuge Managers and Wetland District Managers shall use these guidelines for site-by-site consideration of compatibility determinations for individual right-of-way requests for wind turbines on easement lands. These guidelines may be incorporated as needed as right-of-way or permit stipulations.

These guidelines may be revised and modified as a result of the findings of research and monitoring conducted in the future. Wind turbine rights-of-way applications will be reviewed according to these guidelines in conjunction with the Service's compatibility policy and in accordance with 50 CFR 29.21 and the Service Realty Manual. Future right-of-way applications will be reviewed using the guidelines in effect at the time of application. The Service will not make changes to previously issued rights-of-way or easement permits issued under these guidelines.

1) The Service may permit up to one turbine per 160 acres on an individual easement tract. No more than one turbine may be allowed on an individual easement tract of less than 160 acres. Current biological information (Attachment 2) indicates that this density of turbines would not have any significant impact to grassland habitat and its value to migratory birds or other wildlife. This is the upper limit for the density of turbines on easements. However, consideration may be given to clump or consolidate towers within an easement tract(s) to minimize the disturbance to the remaining habitat, i.e., two turbines may be clumped on a tract of 320 acres. Information available at this time indicates that turbine densities at this level will not materially interfere with or detract from the purposes of the easement (Attachment 2). Wind power industry turbine spacing recommendations are 2,000 feet between wind turbines and 2,000 feet from an occupied building. This constraint may limit the ability to clump turbines.

2) Turbines shall not be constructed in wetlands, including lakes, ponds, marshes, sloughs, swales, swamps, or potholes. Similarly, turbine locations should avoid obvious "duck passes" between large (20 acres or greater), semi-permanent (type 4, or cattail/bulrush) wetlands or sloughs. In addition, known migratory bird corridors or flight paths and environmentally sensitive areas such as colonial bird nesting areas or upland game bird leks, should be avoided.

3) Siting recommendations made by the Service for turbines and access roads and turbine lighting recommendations shall be consistent with all general siting and mitigating measures for tower and transmission line construction (Director's September 14, 2000 memorandum, attachment 3, APLIC 1996, and APLIC 1994).

4) Priority should be given to siting turbines on tame, planted, or seeded grasslands in preference to unbroken native prairie when such options are available on a given easement tract.

5) Spoil material from the excavated turbine pad shall not be deposited in wetlands and must be stored or deposited off easement lands using established roads to transport the material off site.

6) Turbines shall be sited as close to existing roads or the edge of the grassland tract as practical. Disturbance of grassland to construct and maintain a wind turbine shall be done in such a manner as to minimize the destruction or alteration of the habitat. Use of existing roads as a means of accessing a turbine within protected habitats is strongly encouraged. Conservation measures shall be used to avoid the impacts of erosion and sedimentation in order to protect grasslands and wetlands during the construction of the access road. Buried transmission lines, electric lines, and other cables shall be co-located on the access road when practical. Turbine construction should be encouraged to occur outside the breeding season for migratory birds when practical.

7) Regardless of a Service permit the developer is responsible for adhering to all local, state, and federal regulations in siting turbine location and construction. In the event that location and construction criteria conflict between the various levels of government, the criteria providing the maximum protection to the habitat shall be the criteria used during turbine location and construction.

8) In the event that a turbine is no longer utilized for power generation and has been abandoned for that purpose, the turbine owner shall remove the turbine at his/her own expense from the easement tract. The turbine site and associated facilities shall be reclaimed by the turbine owner by planting these areas to a grass mixture consistent with the surrounding grassland or such mixture as is mutually agreed upon by the Service and the turbine owner.

9) The turbine owner must update bird strike avoidance equipment on turbines and implement techniques that reduce the disturbance to nesting birds at turbine sites as future research and evaluation by the Service and the industry indicate.

These guidelines provide flexibility for the Service Refuge Manager in evaluating compatibility determinations and to negotiate with the energy company and the easement landowner to allow wind turbine development consistent with the purposes of the conservation easements. Where development is found to be compatible with easement purposes the guidelines will be used to negotiate siting, lighting, and other restrictions to grant rights-of-way and easement permits for wind turbines.

References:

Avian Power Line Interaction Committee (APLIC). 1994. Mitigating bird collisions with power lines: The state of the art in 1994.

Avian Power Line Interaction Committee (APLIC). 1996. Suggested practices for raptor protection on power lines: the state of the art in 1996.

Attachment 2

Potential Effect of Wind Turbine Presence on Numbers of Breeding Grassland Birds and Nesting Ducks on Grassland Easement Properties in North and South Dakota.

Ron Reynolds, Project Leader, Habitat And Population Evaluation Team, Bismarck, North Dakota.
Neal Niemuth, Biologist, Habitat And Population Evaluation Team, Bismarck, North Dakota

Recently, companies that develop wind-powered electricity generation have begun operations in areas of South Dakota and North Dakota where the U.S. Fish and Wildlife Service has purchased or intends to purchase conservation easements on grasslands. Questions have been raised within the FWS as to whether the placement of wind towers on easement tracts would violate terms of the easement contract, and whether the Service would consider purchasing easements on lands after towers are in place. Before allowing turbines on easement lands, the Service must address the issue of whether placement of wind turbines on grassland easements is compatible with the goals and purpose of refuge lands as defined by the Refuge Improvement Act, which states that, "A Compatible use means . . . any other use of a National Wildlife Refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purposes(s) of the National Wildlife Refuge." If birds avoid the area surrounding wind turbines because of noise, disruption of habitat, or disturbance, the biological value of an easement may be compromised. At this time, we do not know if wind turbines are compatible with the purpose of grassland easements, because we do not know if turbines reduce the attractiveness of a site to birds or if turbines affect avian reproductive success. The issue is complicated partly because, if, the FWS restricts certain alternative uses on easements, this may reduce the willingness of landowners to offer to sell easements to the FWS in the future. For example, some landowners believe the potential income derived from wind generators will exceed the income from selling grass easements to the FWS or other conservation organizations. In this respect, the future success of the easement program could be compromised if these restrictions are unnecessary.

Little is known about bird avoidance of grasslands near wind turbines, as previous avian research at wind towers has focused primarily on bird strikes. In one study that did consider avoidance, density of grassland birds was reduced in the immediate vicinity of wind turbines at Buffalo Ridge, Minnesota, (Leddy et al. 1999), although at larger scales no differences were detected (Johnson et al. 2000). However, in the Buffalo Ridge study, wind turbines were placed primarily in Conservation Reserve Program fields with few wetlands and much higher densities of breeding birds than are typically found in native prairie where grassland easements are targeted in the Dakotas, and therefore results from Leddy et al. (1999) may not be applicable here. In the absence of specific data on the effect of wind turbines on birds in North and South Dakota, we used two approaches to assess the potential impact; 1) existing data (Igl and Johnson 1997, D. H. Johnson, unpublished data) was used to estimate the potential impact of wind turbine placement on grassland bird use in quarter-section (160 acre) parcels, and 2) a Mallard productivity model (Cowardin et al. 1988) was used to predict changes in nesting and recruitment rate of ducks on grassland areas with wind turbines in place.

Grassland birds. For the first assessment, abundance of grassland birds, standardized to 160 acres of grassland habitat, was estimated from data gathered on 128 quarter sections in North Dakota during summers of 1992 and 1993 (Igl and Johnson 1997, D. H. Johnson, unpublished data). We estimated the potential impact of wind turbines at two scales representing a five-acre and two-acre loss of habitat for each wind tower, with one wind tower per quarter section. We estimated the two-acre potential area of impact as approximately 4 times the area of road and tower pad (Appendix 1); the five-acre area of impact was estimated using the 80-m reported zone of reduced bird density surrounding towers at Buffalo Ridge (Leddy et al. 1999, Appendix 1). For purposes of our analysis, we assumed that no grassland birds would be present in the area immediately surrounding the tower, which is a worst-case scenario, because (Leddy et al. 1999) showed that birds are present immediately adjacent to turbines, but at reduced densities. Thus, our methods guaranteed we would predict a reduction in birds using easements, however, our intent was to put this change into perspective relative to bird use on the entire easement. Given the high variance associated with the grassland bird data we used, it would be impossible to detect a statistically significant decrease in grassland bird numbers, because the lower 95% confidence limit for population estimates was less than zero for each species (D. H. Johnson, unpublished data). Therefore, we estimated the impact of tower presence by calculating the density of each grassland bird species per 160-acre tract, and then calculating the mean reduction in the number of pairs if 2 acre and 5 acre areas of habitat were considered as unused (Table 1).

Expected reductions were estimated at approximately 1% and 3% of the number of individuals present for each species. As expected, greatest reductions in number of pairs occurred with common species such as the chestnut-collared longspur and horned lark; where, at the 5 acres level, a reduction of less than 1 pair per 160-acre tract would be expected. For all species combined, we estimated the expected maximum reduction would be about 2 pairs per 160 acre area, or about 3 percent of the total population. As mentioned previously, based on variation observed in the existing data set, these levels of change would not be statistically significant. Additionally, because we would expect some bird use of the area near the tower, the actual change would likely be less than the numbers presented in table 1.

Table 1. Mean number of breeding pairs of grassland birds found per 160 acres of grassland and expected reduction in pairs with loss of 5 acres and 2 acres of habitat. Data based on surveys of 128 160-acre parcels in North Dakota during summers of 1992 and 1993 (Igl and Johnson 1997, D. H. Johnson, unpublished data).

	Mean Number (pairs)		Mean Reduction (pairs)	
Species	1992	1993	5 acre	2 acre
Baird's Sparrow	1.424	2.464	0.06075	0.0243
Bobolink	0.336	0.784	0.0175	0.007

Brewer's Sparrow	0	0	0	0
Brown-headed Cowbird	2.88	3.632	0.10175	0.0407
Chestnut-collared Longspur	15.584	19.696	0.55125	0.2205
Clay-colored Sparrow	2.08	1.92	0.0625	0.025
Common Yellowthroat	0.144	0.112	0.004	0.0016
Dickcissel	0.304	0.32	0.00975	0.0039
Ferruginous Hawk	0.032	0.24	0.00425	0.0017
Field Sparrow	0.24	0	0.00375	0.0015
Grasshopper Sparrow	6.368	8.928	0.239	0.0956
Gray Catbird	0	0	0	0
Gray Partridge	0.16	0.128	0.0045	0.0018
Horned Lark	6.88	12.544	0.3035	0.1214
Killdeer	0.544	0.848	0.02175	0.0087
Lark Bunting	8.416	4.16	0.1965	0.0786
Lark Sparrow	0.448	0.128	0.009	0.0036
Le Conte's Sparrow	0	0.192	0.003	0.0012
Northern Harrier	0.304	0.512	0.01275	0.0051
Red-winged Blackbird	1.616	1.248	0.04475	0.0179
Ring-necked Pheasant	0.16	0.368	0.00825	0.0033
Savannah Sparrow	1.184	2.144	0.052	0.0208
Sedge Wren	0.16	0	0.0025	0.001
Sharp-tailed Grouse	0.432	0.464	0.014	0.0056
Sharp-tailed Sparrow	0.032	0	0.0005	0.0002
Short-eared Owl	0.032	0.032	0.001	0.0004
Sprague's Pipit	0.256	0.576	0.013	0.0052
Swainson's Hawk	0.032	0.16	0.003	0.0012
Upland Sandpiper	1.52	1.552	0.048	0.0192
Vesper Sparrow	1.312	0.976	0.03575	0.0143
Western Meadowlark	7.088	11.184	0.2855	0.1142
SUM	**59.97**	**75.31**	**2.11**	**0.85**

Ducks. To assess the impact of wind turbines on ducks, we used the Mallard Productivity Model (Cowardin et al. 1988). The Mallard Model is particularly useful for this exercise because it allowed us to predict any "net" change in nest site selection and recruitment that might occur as a result of simulating the reduction of grasslands available to nesting hens due to the placement of wind turbines. For example, if grassland availability is reduced as a result of disturbance, displaced hens may select other habitat types (e.g., cropland, hayland etc.) in the area for nesting, or they may elect to nest elsewhere in the grasslands protected by easement. If other habitats are selected, this could result in reduced recruitment because, most other habitats are characterized by lower nest success compared to grass habitats. However, if these hens select nest sites in the remaining grasslands outside the influence of the wind turbines, nest success will not change materially and recruitment rate will be the same with-or-without turbines. For this exercise, we selected six study areas from Four Square Mile plots used for breeding population and production surveys (Cowardin et al. 1995) in the Kulm Wetland Management District in North Dakota. Plots were selected that had ≥160 acres of grassland in one unit, and were accessible to ≥60 breeding duck pairs (≥12 mallard pairs) based on the "thunderstorm map" (HAPET 2000) for North Dakota. These criteria are consistent with those used by FWS Realty Office, Bismarck, ND for focusing grassland easements, and the Kulm WMD is representative of areas where the grassland easement program is being targeted. For the purpose of our assessment, all grasslands on study plots selected were treated as protected by easement. This was done to obtain sample acreage similar to easement acreage being purchased. We ran the model on plots with-and-without wind turbines in place and compared the response by mallard hens. The area of influence for turbines was set at 5 acres and was converted to barren habitat which simulated eliminating all nesting activity in that area. To reduce variability, and thus increase the precision of our estimates we conducted eight model runs (1000 hens each) and then scaled the average results to the estimated mallard population on each study plot.

Neither nests initiated or recruitment rates differed significantly between treatment and control model runs (Table 2). The variation shown in nests initiated and recruitment rate between treatment and control runs is due to variation inherent in the biological system being examined. The model predicts that hens displaced by the presence of wind turbines will select nesting sites in the remaining available grass habitat and that recruitment rates will not be influenced.

Summary. Using data collected in North Dakota and South Dakota for grassland birds and ducks, we were able to estimate the magnitude of change that would likely be observed if similar data were collected on grassland easement properties. For some species of grassland birds that have restricted distributions the changes predicted could be underestimated on some sites, but it is unlikely these would be of a different order of magnitude. For ducks, the changes predicted account for differences in geographic distribution. Based on our assessment, the expected impact of wind turbines on grassland nesting species would be negligible with the density of one turbine per 160 acre area.

Table 2. Mallard nests initiated and recruitment rate estimates on six study plots with-and-without wind turbines, based on Mallard Model predictions. ( ) standard errors.

		Without Wind Turbines				With Wind Turbines			
Study plot	Pop. Estimate	Grass Acres	Init. Nests	Recr. Rate	SE	No. Turbines	Init.Nests	Recr. Rate	SE
153	55	761	21	0.67	(.0115)	2	21	0.64	(.0090)
178	60	205	14	0.53	(.0094)	1	13	0.52	(.0064)
329	45	1496	59	0.57	(.0055)	3	59	0.59	(.0124)
330	35	1810	51	0.55	(.0163)	8	52	0.55	(.0118)
331	26	1310	18	0.62	(.0104)	2	18	0.59	(.0120)
332	70	1312	58	0.58	(.0166	2	60	0.58	(.0072)

LITERATURE CITED

Cowardin, L. M., D. H. Johnson, T. L. Shaffer, and D. L. Sparling. 1988. Applications of a simulation model to decisions in mallard management. U. S. Fish and Wildlife Service Technical Report 17.
Cowardin, L. M., T. L. Shaffer, and P.M. Arnold. 1995. Evaluation of Duck habitat and estimation of duck population sizes with a remote-sensing-based system. Biological Science Report 2.
Igl, L. D., and D. H. Johnson. 1997. Changes in breeding bird populations in North Dakota: 1967 to 1992-1993. Auk 114:74-92.
Johnson, G. D., W. P. Erickson, M. D. Strickland, M. F. Shepherd, and D. A. Shepherd. 2000. Avian monitoring studies at the Buffalo Ridge, Minnesota Wind Resource Area: results of a 4-year study. Western Ecosystems Technology, Inc. Cheyenne, Wyoming. 262pp.
Leddy, K. L., K. F. Higgins, and D. E. Naugle. 1999. Effects of wind turbines on upland nesting birds in Conservation Reserve Program grasslands. Wilson Bulletin 111:100-104.

APPENDIX 1. Calculations of potential area of impact for wind towers on grassland easements in North Dakota and South Dakota.

Two-acre impact:

40 foot by 40 foot pad for tower		1,600 ft^2
16.5 foot by 1320 foot access road		<u>21,780 ft^2</u>
	total	23,380

Physical disruption of site is approximately 0.54 acre; we multiplied this by four to estimate a zone of potential impact.

Five-acre impact:
80-m zone of reduced density surrounding tower

80 m * 80 m * 3.14	2.0 ha
˜ 2.5 acres per ha	5.0 acres

Attachment 3

Memorandum

To: Regional Directors, Regions 1-7

From: Director

Subject: Service Guidance on the Siting, Construction, Operation and Decommissioning of Communications Towers

Construction of communications towers (including radio, television, cellular, and microwave) in the United States has been growing at an exponential rate, increasing at an estimated 6 percent to 8 percent annually. According to the Federal Communication Commission=s *2000 Antenna Structure Registry*, the number of lighted towers greater than 199 feet above ground level currently number over 45,000 and the total number of towers over 74,000. By 2003, all television stations must be digital, adding potentially 1,000 new towers exceeding 1,000 feet AGL.

The construction of new towers creates a potentially significant impact on migratory birds, especially some 350 species of night-migrating birds. Communications towers are estimated to kill 4-5 million birds per year, which violates the spirit and the intent of the Migratory Bird Treaty Act and the Code of Federal Regulations at Part 50 designed to implement the MBTA. Some of the species affected are also protected under the Endangered Species Act and Bald and Golden Eagle Act.

Service personnel may become involved in the review of proposed tower sitings and/or in the evaluation of tower impacts on migratory birds through National Environmental Policy Act review; specifically, sections 1501.6, opportunity to be a cooperating agency, and 1503.4, duty to comment on federally-licensed activities for agencies with jurisdiction by law, in this case the MBTA, or because of special expertise. Also, the National Wildlife Refuge System Improvement Act requires that any activity on Refuge lands be determined as compatible with the Refuge system mission and the Refuge purpose(s). In addition, the Service is required by the ESA to assist other Federal agencies in ensuring that any action they authorize, implement, or fund will not jeopardize the continued existence of any federally endangered or threatened species.

A Communication Tower Working Group composed of government agencies, industry, academic researchers and NGO=s has been formed to develop and implement a research protocol to determine the best ways to construct and operate towers to prevent bird strikes. Until the research study is completed, or until research efforts uncover significant new mitigation measures, all Service personnel involved in the review of proposed tower sitings and/or the evaluation of the impacts of towers on migratory birds should use the attached interim guidelines when making recommendations to all companies, license applicants, or licensees proposing new tower sitings. These guidelines were developed by Service personnel from research conducted in several eastern, midwestern, and southern States, and have been refined through Regional review. They are based on the best information available at this time, and are the most prudent and effective measures for avoiding bird strikes at towers. We believe that they will provide significant protection for migratory birds pending completion of the Working Group=s recommendations. As new information becomes available, the guidelines will be updated accordingly.

Implementation of these guidelines by the communications industry is voluntary, and our recommendations must be balanced with Federal Aviation Administration requirements and local community concerns where necessary. Field offices have discretion in the use of these guidelines on a case by case basis, and may also have additional recommendations to add which are specific to their geographic area.

Also attached is a Tower Site Evaluation Form which may prove useful in evaluating proposed towers and in streamlining the evaluation process. Copies may be provided to consultants or tower companies who regularly submit requests for consultation, as well as to those who submit individual requests that do not contain sufficient information to allow adequate evaluation. This form is for discretionary use, and may be modified as necessary.

The Migratory Bird Treaty Act (16 U.S.C. 703-712) prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. While the Act has no provision for allowing an unauthorized take, it must be recognized that some birds may be killed at structures such as communications towers even if all reasonable measures to avoid it are implemented. The Service=s Division of Law Enforcement carries out its mission to protect migratory birds not only through investigations and enforcement, but also through fostering relationships with individuals and industries that proactively seek to eliminate their impacts on migratory birds. While it is not possible under the Act to absolve individuals or companies from liability if they follow these recommended guidelines, the Division of Law Enforcement and Department of Justice have used enforcement and prosecutorial discretion in the past regarding individuals or companies who have made good faith efforts to avoid the take of migratory birds.

Please ensure that all field personnel involved in review of FCC licensed communications tower proposals receive copies of this memorandum. Questions regarding this issue should be directed to Dr. Benjamin N. Tuggle, Chief, Division of Habitat Conservation, at (703)358-2161, or

Jon Andrew, Chief, Division of Migratory Bird Management, at (703)358-1714. These guidelines will be incorporated in a Director=s Order and placed in the Fish and Wildlife Service Manual at a future date.

Attachment

cc: 3012-MIB-FWS/Directorate Reading File
3012-MIB-FWS/CCU Files
3245-MIB-FWS/AFHC Reading Files
840-ARLSQ-FWS/AF Files
400-ARLSQ-FWS/DHC Files
400-ARLSQ-FWS/DHC/BFA Files
400-ARLSQ-FWS/DHC/BFA Staff
520-ARLSQ-FWS/LE Files
634-ARLSQ-FWS/MBMO Files (Jon Andrew)

FWS/DHC/BFA/RWillis:bg:08/09/00:(703)358-2183
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Service Interim Guidelines For Recommendations On
Communications Tower Siting, Construction, Operation, and Decommissioning

1. Any company/applicant/licensee proposing to construct a new communications tower should be strongly encouraged to collocate the communications equipment on an existing communication tower or other structure (e.g., billboard, water tower, or building mount). Depending on tower load factors, from 6 to 10 providers may collocate on an existing tower.

2. If collocation is not feasible and a new tower or towers are to be constructed, communications service providers should be strongly encouraged to construct towers no more than 199 feet above ground level, using construction techniques which do not require guy wires (e.g., use a lattice structure, monopole, etc.). Such towers should be unlighted if Federal Aviation Administration regulations permit.

3. If constructing multiple towers, providers should consider the cumulative impacts of all of those towers to migratory birds and threatened and endangered species as well as the impacts of each individual tower.

4. If at all possible, new towers should be sited within existing “antenna farms” (clusters of towers). Towers should not be sited in or near wetlands, other known bird concentration areas (e.g., State or Federal refuges, staging areas, rookeries), in known migratory or daily movement flyways, or in habitat of threatened or endangered species. Towers should not be sited in areas with a high incidence of fog, mist, and low ceilings.

5. If taller (>199 feet AGL) towers requiring lights for aviation safety must be constructed, the minimum amount of pilot warning and obstruction avoidance lighting required by the FAA should be used. Unless otherwise required by the FAA, only white (preferable) or red strobe lights should be used at night, and these should be the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes) allowable by the FAA. The use of solid red or pulsating red warning lights at night should be avoided. Current research indicates that solid or pulsating (beacon) red lights attract night-migrating birds at a much higher rate than white strobe lights. Red strobe lights have not yet been studied.

6. Tower designs using guy wires for support which are proposed to be located in known raptor or waterbird concentration areas or daily movement routes, or in major diurnal migratory bird movement routes or stopover sites, should have daytime visual markers on the wires to prevent collisions by these diurnally moving species. (For guidance on markers, see *Avian Power Line Interaction Committee (APLIC). 1994. Mitigating Bird Collisions with Power Lines: The State of the Art in 1994. Edison Electric Institute, Washington, D.C., 78 pp*, and *Avian Power Line Interaction Committee (APLIC). 1996. Suggested Practices for Raptor Protection on Power Lines. Edison Electric Institute/Raptor Research Foundation, Washington, D.C., 128 pp.* Copies can be obtained via the Internet at http://www.eei.org/resources/pubcat/enviro/, or by calling 1-800/334-5453).

7. Towers and appendant facilities should be sited, designed and constructed so as to avoid or minimize habitat loss within and adjacent to the tower “footprint”@ However, a larger tower footprint is preferable to the use of guy wires in construction. Road access and fencing should be minimized to reduce or prevent habitat fragmentation and disturbance, and to reduce above ground obstacles to birds in flight.

8. If significant numbers of breeding, feeding, or roosting birds are known to habitually use the proposed tower construction area, relocation to an alternate site should be recommended. If this is not an option, seasonal restrictions on construction may be advisable in order to avoid disturbance during periods of high bird activity.

9. In order to reduce the number of towers needed in the future, providers should be encouraged to design new towers structurally and electrically to accommodate the applicant/licensee’s antennas and comparable antennas for at least two additional users (minimum of three users for each tower structure), unless this design would require the addition of lights or guy wires to an otherwise unlighted and/or unguyed tower.

10. Security lighting for on-ground facilities and equipment should be down-shielded to keep light within the boundaries of the site.

11. If a tower is constructed or proposed for construction, Service personnel or researchers from the Communication Tower Working Group should be allowed access to the site to evaluate bird use, conduct dead-bird searches, to place net catchments below the towers but above the ground, and to place radar, Global Positioning

System, infrared, thermal imagery, and acoustical monitoring equipment as necessary to assess and verify bird movements and to gain information on the impacts of various tower sizes, configurations, and lighting systems.

12. Towers no longer in use or determined to be obsolete should be removed within 12 months of cessation of use.

In order to obtain information on the extent to which these guidelines are being implemented, and to identify any recurring problems with their implementation which may necessitate modifications, letters provided in response to requests for evaluation of proposed towers should contain the following request:

> "In order to obtain information on the usefulness of these guidelines in preventing bird strikes, and to identify any recurring problems with their implementation which may necessitate modifications, please advise us of the final location and specifications of the proposed tower, and which of the measures recommended for the protection of migratory birds were implemented. If any of the recommended measures can not be implemented, please explain why they were not feasible."

Appendix 7

KNOWN AND SUSPECTED IMPACTS OF WIND TURBINES ON WILDLIFE

While wind-generated electrical energy is renewable, emission-free, and generally environmentally clean (American Wind Energy Association [AWEA] unpubl. data, <http://www.awea.org>), it does have one significant downside -- rotor blades kill birds, especially raptors (Hunt 2002) and bats. Birds can strike the towers; electrocutions can occur if designs are poor; and wind farms may impact bird movements, breeding, and habitat use.

Wind turbine technology is not new to the United States. In the 1800s, Cape Cod supported over 1,000 working wind turbines (Ferdinand 2002). In the late 1930s, Vermont boasted the world's then-largest turbine, which was likely disabled by high winds due to design flaws. But wind turbine 'farms' and their impacts to birds are a recent phenomenon compared to power lines and communication towers, where mortality has been documented for decades or longer (Boeker and Nickerson 1975, Olendorff et al. 1981, APLIC 1994, APLIC 1996, Harness 1997, Ainley et al. 2001, Manville 2001). The problem in the U.S. surfaced in the late 1980s and early 1990s at the Altamont Pass Wind Resource Area, a facility then containing some 6,500 turbines on 73 mi^2 of gently rolling hills just east of San Francisco Bay, California (Davis 1995). Orloff and Flannery (1992) estimated that several hundred raptors were killed each year due to turbine collisions, guy wire strikes, and electrocutions. The most common fatalities were those of Red-tailed Hawks (*Buteo jamaicensis*), American Kestrels (*Falco sparvarius*) and Golden Eagles (*Aquila chrysaetos*), with fewer mortalities of Turkey Vultures (*Cathartes aura*), Common Ravens (*Corvus corax*), and Barn Owls (*Tyto alba*). The impacts of this wind farm were of most concern to the population of Golden Eagles, which was showing a "disturbing source of mortality" to a disproportionately large segment of the population (Southern Niagara Escarpment [WI] Wind Resource Area unpubl. report). More recent studies indicate that a model previously used to assess Golden Eagle mortality was defective, and that nonbreeding Golden Eagles representing a "floater" population were likely suffering less mortality based on a new model (Hunt 2002). Research continues at this time to further assess the impacts of Altamont turbines on raptors. The Altamont turbines are still estimated to kill 40-60 subadult and adult Golden Eagles each year, as well as several hundred Red-tailed Hawks and American Kestrels – a continuing concern for the FWS. Of the variety of wind turbines at the site, the smaller, faster moving, Kenetech-built, lattice-supported turbines caused most of the mortality. As part of a re-powering effort, these turbines are now being replaced with slower moving, tubular-supported turbines. While Europeans have used tubular towers almost exclusively, the U.S. has almost solely used lattice support, at least until recently (Berg 1996).

Colson (1995) indicated that some 16,000 wind turbines operated in California, making the State the largest concentration of wind energy development in the world. Since 1995, that statistic has changed. While California still boasts the greatest number of turbines in the U.S., many smaller turbines are being replaced by fewer but larger models. Worldwide, an estimated 50,000 turbines are generating power (AWEA unpubl. data; Ferdinand 2002), of which over 15,000 are currently in 29 states in the U.S. Turbine numbers are often difficult to track since statistics are generally presented in megawatts (MW) of electricity produced rather than number of turbines present. The latter statistic is of greater concern to ornithologists. In 1998, for example, Germany was the greatest producer with 2,874 MW of electricity produced by turbines, followed by the U.S. (1,884), and Denmark (1,450); (AWEA unpubl. data). While some project that the number of wind turbines in the U.S. may increase by another 16,000 in the next 10 years, current trends indicate an even greater potential growth. Although the U.S. presently produces less than 1% of its electrical energy from turbines – compared, for example, to Norway's 15% – 2001 was a banner year for U.S. turbine technology, doubling the previous record for installed wind production. Companies installed 1,898 turbines in 26 states, which will produce nearly 1,700 MW, at a cost of $1.7 billion for the new equipment (J. Cadogan, U.S. Department of Energy, 2002, pers. comm.). Over the past decade, wind power has been the fastest growing energy industry in the world. By 2020, the AWEA (unpubl. data) predicts that wind will provide 6% of this nation's electricity, serving as many as 25 million households. Enron Wind Corporation constructed some 1,500 of the 1,898 turbines installed in the U.S. in 2001. Although Enron is now bankrupt, General Electric purchased the company and is now producing wind turbines.

In March 2002, President Bush signed the Job Creation and Worker Assistance Act, extending the production tax credit to the wind industry for another two years. There are presently attempts in Congress to amend the reauthorization of this legislation for five or more years. However, even with a bright future for growth, and with low speed tubular-constructed wind turbine technology now being stressed, larger and slower moving turbines still kill raptors, passerines, waterbirds, other avian species, and bats. Low wind speed turbine technology requires much larger rotors, blade tips often extending more than 420 ft. above ground, and blade tips can reach speeds in excess of 200 mph under windy conditions (J. Cadogan, U.S. Department of Energy, 2002, pers. comm.). When birds approach spinning turbine blades, “motion smear” – the inability of the bird’s retina to process high speed motion stimulation – occurs primarily at the tips of the blades, making the blades deceptively transparent at high velocities. This increases the likelihood that a bird will fly through this arc, be struck by a blade, and be killed (Hodos et al. 2001).

What cumulative impact these larger turbines will have on birds and bats has yet to be determined. Johnson et al. 2002b raised some concerns about the impacts of newer, larger turbines on birds. Their data indicated that higher levels of mortality might be associated with the newer and larger turbines, and they indicated that wind power-related avian mortality would likely contribute to the cumulative impacts on birds. Since little research has been conducted on the impacts of large land-sited and offshore turbines on birds and bats, this newer technology is ripe for research.

Howell and Noone (1992) estimated U.S. avian mortality at 0.0 to 0.117 birds/turbine/yr., while in Europe, Winkelman (1992) estimated mortality at 0.1 to 37 birds/turbine/yr. Erickson et al. (2001) reassessed U.S. turbine impact, based on more than 15,000 turbines (some 11,500 in California), and estimated mortality in the range of 10,000 to 40,000 (mean = 33,000), with an average of 2.19 avian fatalities/turbine/yr. and 0.033 raptor fatalities/turbine/yr. This may be a considerable underestimate. As with other structural impacts, only a systematic turbine review will provide a more reliable estimate of mortality. While some have argued that turbine impacts are small (Berg 1996), especially when compared to those from communication towers and power lines, turbines can pose some unique problems, especially for birds of prey. Mortalities must be reduced, especially as turbine numbers increase. In addition to protections under the MBTA, Bald and Golden Eagles are afforded protections under the ESA for the former and the BGEPA for both raptors. As strict liability statutes, MBTA and BGEPA also provide no provisions for unauthorized “take.” Wind farms can affect local populations of Golden Eagles and other raptors whose breeding and recruitment rates are naturally slow and whose populations tend to have smaller numbers of breeding adults (Davis 1995). Large raptors are also revered by Native Americans as well as by many others within the public. They are symbolic megafauna, and provide greater emotional appeal to many than do smaller avian species. Raptors also have a lower tolerance for additive mortality (Anderson et al. 1997). As with all other human-caused mortality, we have a responsibility to reverse mortality trends.

Until very recently, U.S. wind turbines have mostly been land-based. Perhaps following the European lead of siting wind turbines in estuarine and marine wetlands (van der Winden et al. 1999, van der Winden et al. 2000), and perhaps due to an assessment of a large number of potential offshore turbine locations in the U.S. (based on Weibull analyses of “good, excellent, outstanding, and superb” wind speed potentials [National Renewable Energy Laboratory 1987]), a new trend is evolving in North America. Several proposals for huge offshore sites are being submitted for locations on both Atlantic and Pacific coasts. These, at the very least, should require considerable research and monitoring to assess possible impacts to resident and migrating passerines, waterfowl, shorebirds, and seabirds. One site at Nantucket Shoals, offshore of Nantucket Island near Cape Cod, Massachusetts, is proposed by the Cape Wind Association to contain 170 turbines, many over 420 feet high, within a 25 mi^2 area (AWEA unpubl. data, Ferdinand 2002). What impacts this wind farm would have on wintering sea ducks and migrating terns, especially the Federally endangered Roseate Tern (*Sterna dougallii dougallii*), and on Northern Gannets (*Morus bassanus*), is unknown. The Long Island Power Authority is proposing a site offshore of Long Island, New York’s south shore, covering as much as 314 mi^2. Other sites are being proposed for Portland, Maine, and Lake Erie. The largest proposed wind farm in North America is being planned for a 50 mi^2 area between Queen Charlotte Island, BC, and Alaska. It is being designed to contain 350 turbines, many exceeding 400 feet in height. The potential for significant offshore turbine impacts on waterbirds is great, virtually no research has been conducted in the United States to quell these concerns, and finding carcasses at sea is very challenging.

Europe presently has 10 offshore wind projects in operation, producing over 250 MW of electricity (British Wind Energy unpub. data, www.offshorewindfarms.co.uk). Many other projects are currently under review. To avoid citizen concerns regarding the “not in my backyard” complex, most European turbines are sited offshore or in estuaries, away from immediate human development (Larsen and Madsen 2000). While Europe is well ahead of the United States regarding turbine research, their study results are still generally inconclusive (T. Bowan, FWS, 2003 pers. comm.). Collision mortality, while generally unknown, is believed to be small because birds appear to avoid offshore wind farms. There are exceptions, including for Whooper Swans (*Cygnus Cygnus*; Larsen and Clausen 2002) that are susceptible to turbine strikes in the early mornings and evenings, especially in inclement weather. The collection of carcasses at offshore sites is more challenging than for land-based turbines since nets generally must be used to collect carcasses, tides and weather affect collection, and fog is a frequent problem. While habitat loss is not believed to be a serious concern, its impacts continue to be assessed. Disturbance may be problematic since some species such as Common Eiders avoid wind farms and may not return to a coastal area for several years (Guillemette and Larsen 2002). Disturbance may lead to displacement, and turbines may serve as barriers to seaduck movements. Only a few studies have been conducted in Denmark, the Netherlands, and Sweden, so further research is needed. Studies deal mostly with wintering species (Noer et al. 2000, Percival 2001, Langstron and Pullan 2002, Christensen et al. 2002, and Bruns et al. 2002).

In an attempt to begin addressing the bird mortality issue – and ancillary to this, the issue of ESA-listed bat strikes – the National Wind Coordinating Committee was created in 1994 as part of President Clinton's Global Climate Change Action Plan (Colson 1995). Shortly following the creation of the Committee, the Avian Subcommittee (now called the Wildlife Work Group) was formed, co-founded by the Service. In 1999, the Avian Subcommittee published a *Metrics and Methods* document to study turbine impacts on birds (Anderson et al. 1999). The document provides an excellent resource for conducting research on proposed and existing turbines and wind farms.

Appendix 8

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Land-Based Wind Energy Guidelines

Comment [UF&WS1]: Note to Reviewers:

Substantial differences from the July 12 draft have been highlighted in grey. Editorial changes were not highlighted.

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The U.S. Fish and Wildlife Service (Service) would like to recognize and thank the Wind Turbine Guidelines Federal Advisory Committee for its dedication and preparation of its Wind Turbine Recommendations. The Recommendations have served as the basis from which the Service's team worked to develop the Service's Guidelines for Land-Based Wind Energy Development. The Service also recognizes the tireless efforts of the Regional and Field Office staff that helped to review and update these Guidelines.

U.S. Fish and Wildlife Service

Land-Based Wind Energy Guidelines

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Comment [UF&WS2]: Will be updated in the Final Guidelines.

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Introduction

As the United States moves to expand wind energy production, it also must maintain and protect the Nation's fish, wildlife, and their habitats, which wind energy production can negatively affect. As with all responsible energy development, wind energy projects should adhere to high standards for environmental protection. With proper diligence paid to siting, operations, and management of projects, it is possible to mitigate for adverse effects to fish, wildlife, and their habitats. This is best accomplished when the developer coordinates as early as possible with the Service and other stakeholders. Such coordination allows for the greatest range of development and mitigation options.

In response to increasing wind energy development in the United States, the U.S. Fish and Wildlife Service (Service) released a set of voluntary, interim guidelines for reducing adverse effects to fish and wildlife resources from wind energy projects for public comment in July 2003. After the Service reviewed the public comments, the Secretary of the Interior (Secretary) established a Federal Advisory Committee to provide recommendations to revise the guidelines related to land-based wind energy facilities. In March 2007, the Service announced in the *Federal Register* the establishment of the Wind Turbine Guidelines Advisory Committee (the Committee). The Committee submitted its final Recommended Guidelines (Recommendations) to the Secretary on March 4, 2010. The Service used the Recommendations to develop its draft Land-Based Wind Energy Guidelines.

The Service's Land-based Wind Energy Guidelines are founded upon a "tiered approach" for assessing potential adverse effects to wildlife species of concern and their habitats. The tiered approach is an iterative decision making process for collecting information in increasing detail; quantifying the possible risks of proposed wind energy projects to wildlife species of concern and habitats; and evaluating those risks to make siting, construction, and operation decisions. Subsequent tiers refine and build upon issues raised and efforts undertaken in previous tiers. At each tier, a set of questions is provided to help the developer evaluate the potential risk associated with developing a project at the given location. The tiered approach guides a developer's decision process as to whether or not the selected location is appropriate for wind development. This decision is related to site-specific conditions regarding potential species and habitat effects.

Briefly, the tiers address:

- Tier 1 – Preliminary evaluation or screening of potential sites (landscape-scale screening of possible project sites)

- Tier 2 – Site characterization (broad characterization of one or more potential project sites)

- Tier 3 – Pre-construction monitoring and assessments (site-specific assessments at the proposed project site)

- Tier 4 – Post-construction fatality and habitat studies

- Tier 5 – Post-construction studies to further evaluate direct and indirect effects, and assess how they may be addressed

The Service urges voluntary adherence to the Guidelines (see page 12, *Service Expectations*) and frequent communication with the Service when planning and operating a facility.

The Guidelines are based on best available methods and metrics to help answer the questions posed at each tier. Research on wind energy effects on wildlife species of concern and their habitats is ongoing and new information is made available on a regular basis. Substantial variability can exist among project sites and as such, methods and metrics should be applied with the flexibility to address the varied issues that may occur on a site-by-site basis, while maintaining consistency in the overall tiered process. As research expands and provides new information, these methods and metrics will be updated to reflect current science.

Chapter 1

General Overview

The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people. As part of this, the Service is charged with implementing statutes including the Endangered Species Act, Migratory Bird Treaty Act, and Bald and Golden Eagle Protection Act. These statutes prohibit taking of federally listed species, migratory birds and eagles unless otherwise authorized. These Guidelines are intended to:

(1) Promote compliance with relevant wildlife laws and regulations;

(2) Encourage scientifically rigorous survey, monitoring, assessment, and research designs proportionate to the risk to species of concern;

(3) Produce potentially comparable data across the Nation;

(4) Avoid, minimize, and, if appropriate, compensate for potential adverse effects on species of concern and their habitats; and,

(5) Improve the ability to predict and resolve effects locally, regionally, and nationally.

The Service encourages project proponents to use the process described in these voluntary Land-based Wind Energy Guidelines (Guidelines) to address risks to species of concern. The Service intends that these Guidelines, when used in concert with the appropriate regulatory tools, will be the best practical approach for conservation of species of concern.

Statutory Authorities

These draft Guidelines are not intended nor shall they be construed to limit or preclude the Service from exercising its authority under any law, statute, or regulation, or from conducting enforcement action against any individual, company, or agency. They are not meant to relieve any individual, company, or agency of its obligations to comply with any applicable federal, state, tribal, or local laws, statutes, or regulations.

Ultimately it is the responsibility of those involved with the planning, design, construction, operation, maintenance, and decommissioning of wind projects to conduct relevant fish, wildlife, and habitat evaluation (e.g., siting guidelines, risk assessment, etc.) and determine, which, if any, species may be affected. The results of these analyses will inform all efforts to achieve compliance with the appropriate jurisdictional statutes. Project proponents are responsible for complying with applicable state and local laws.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) is the cornerstone of migratory bird conservation and protection in the United States. The MBTA implements four treaties that provide for international protection of migratory birds. It is a strict liability statute, meaning that proof of intent, knowledge, or negligence is not an element of an MBTA violation. The statute's language is clear that most actions resulting in a "taking" or possession (permanent or temporary) of a protected species, in the absence of regulatory authorization, are a violation of the MBTA.

The MBTA states, "Unless and except as permitted by regulations … it shall be unlawful at any time, by any means, or in any manner to pursue, hunt, take, capture, kill … possess, offer for sale, sell … purchase … ship, export, import … transport or cause to be transported … any migratory bird, any part, nest, or eggs of any such bird …. [The Act] prohibits the taking, killing, possession, transportation, import and export of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior." 16 U.S.C. 703. The word "take" is defined by regulation as "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.

The MBTA provides criminal penalties for persons who commit any of the acts prohibited by the statute in section 703 on any of the species protected by the statute. *See* 16 U.S.C. 707. The Service maintains a list of all species protected by the MBTA at 50 C.F.R. 10.13. This list includes over one thousand species of migratory birds, including eagles and other raptors, waterfowl, shorebirds, seabirds, wading birds, and passerines. The MBTA does not protect introduced species such as the house (English) sparrow, European starling, rock dove (pigeon), Eurasian collared-dove, and non-migratory upland game birds. The Service maintains a list of introduced species not protected by the Act. *See* 70 Fed. Reg. 12,710 (Mar. 15, 2005).

Bald and Golden Eagle Protection Act

Under authority of the Bald and Golden Eagle Protection Act (BGEPA), 16 U.S.C. 668–668d, bald eagles and golden eagles are afforded additional legal protection. BGEPA prohibits the take, sale, purchase, barter, offer of sale, purchase, or barter, transport, export or import, at any time or in any manner , of any bald or golden eagle, alive or dead, or any part, nest, or egg thereof. 16 U.S.C. 668. BGEPA also defines take to include "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb," 16 U.S.C. 668c, and includes criminal and civil penalties for violating the statute. *See* 16 U.S.C. 668. The Service further defined the term "disturb" as agitating or bothering an eagle to a degree that causes, or is likely to cause, injury, or either a decrease in productivity or nest abandonment by substantially interfering with normal breeding, feeding, or sheltering behavior. 50 C.F.R. 22.3. BGEPA authorizes the Service to permit the take of eagles for certain purposes and under certain circumstances, including scientific or exhibition purposes, religious purposes of Indian tribes, and the protection of wildlife, agricultural, or other interests, so long as that take is compatible with the preservation of eagles. 16 U.S.C. 668a.

In 2009, the Service promulgated a final rule on two new permit regulations that, for the first time, specifically authorize the incidental take of eagles and eagle nests in certain situations under BGEPA. *See* 50 C.F.R. 22.26 & 22.27. The permits will authorize limited, non-purposeful (incidental) take of bald and golden eagles; authorizing individuals, companies, government agencies (including tribal governments), and other organizations to disturb or otherwise take eagles in the course of conducting lawful activities such as operating utilities and airports. Most permits issued under the new regulations would authorize disturbance. In limited cases, a permit may authorize the take of eagles that results in death or injury. Removal of active eagle nests would usually be allowed only when it is necessary to protect human safety or the eagles. Removal of inactive nests can be authorized when necessary to ensure public health and safety, when a nest is built on a human-engineered structure rendering it inoperable, and when removal is necessary to protect an interest in a particular locality, but only if the take or mitigation for the take will provide a clear and substantial benefit to eagles.

To facilitate issuance of permits under these new regulations, the Service has drafted Eagle Conservation Plan (ECP) Guidance. The ECP Guidance is intended to be compatible with these Land-Based Wind Energy Guidelines. The Guidelines guide developers through the process of project development and operation. If eagles are identified as a potential risk at a project site, developers are strongly encouraged to refer to the ECP Guidance. The ECP Guidance describes specific actions that are recommended to comply with the regulatory requirements in BGEPA for an eagle take permit as described in 50 CFR 22.26 and 22.27. The ECP Guidance is intended to provide a national framework for assessing and mitigating risk specific to eagles through development of ECPs. The final ECP Guidance will be made available to the public through the Service's website when it is finalized.

Endangered Species Act

The Endangered Species Act (16 U.S.C. 1531–1544; ESA) was enacted by Congress in 1973 in recognition that many of our Nation's native plants and animals were in danger of becoming extinct. The ESA directs the Service to identify and protect these endangered and threatened species and their critical habitat, and to provide a means to conserve their ecosystems. To this end, federal agencies are directed to utilize their authorities to conserve listed species, and ensure that their actions are not likely to jeopardize the continued existence of these species or destroy or adversely modify their critical habitat. Federal agencies are encouraged to do the same with respect to "candidate" species that may be listed in the near future. The law is administered by the Service and the Commerce Department's National Marine Fisheries Service (NMFS).

The Service has primary responsibility for terrestrial and freshwater organisms, while NMFS generally has responsibility for marine species. These two agencies work with other agencies to plan or modify federal projects so that they will have minimal impact on listed species and their habitats. Protection of species is also achieved through partnerships with the states, with federal financial assistance and a system of incentives available to encourage state participation. The Service also works with private landowners, providing financial and technical assistance for management actions on their lands to benefit both listed and non-listed species.

Section 9 of the ESA makes it unlawful for a person to "take" a listed species. Take is defined as "... to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." 16 U.S.C. 1532(19). The terms harass and harm are further defined in our regulations. *See* 50 C.F.R. 17.3. However, the Service may authorize "incidental take" (take that occurs as a result of an otherwise legal activity) in two ways.

Take of federally listed species incidental to a lawful activity may be authorized through formal consultation under section 7(a)(2) of the ESA, whenever a federal agency, federal funding, or a federal permit is involved. Otherwise, a person may seek an incidental take permit under section 10(a)(1)(B) of the ESA upon completion of a satisfactory habitat conservation plan (HCP) for listed species. If threatened or endangered species are identified as a potential risk at a project site, developers are strongly encouraged to discuss with the Service whether an incidental take permit or other form of authorization may be appropriate. For more information regarding formal consultation and HCPs, please see the Endangered Species Consultation Handbook at http://www.fws.gov/endangered/esa-library/index.html#consultations and the Service's HCP website, http://www.fws.gov/endangered/what-we-do/hcp-overview.html.

Service Expectations

Consideration of the Guidelines in MBTA and BGEPA Enforcement

The Service urges voluntary adherence to the guidelines and communication with the Service when planning and operating a facility. These guidelines do not authorize take under MBTA or BGEPA. Violations of those statutes may result in prosecution. The Service will regard voluntary adherence and communication as evidence of due care with respect to avoiding, minimizing, and mitigating significant adverse impacts to species protected under the MBTA and BGEPA, and will take such adherence and communication fully into account when exercising its discretion with respect to any potential referral for prosecution related to the death of or injury to any such species. Each developer and operator will be responsible for maintaining internal records sufficient to demonstrate adherence to the guidelines, and responsiveness to communications from the Service. Examples of these records could include: studies performed in the implementation of the tiered approach; an internal or external review or audit process; an

Avian and Bat Protection Plan; or a wildlife management plan. ~~The Service retains its existing authority to inspect and assess the sufficiency of those records.~~

With regard to eagles, application of these considerations will not apply when take of eagles is anticipated. If Tiers 1, 2, and/or 3 identify a potential to take eagles, developers should consider also developing an ECP and, if necessary, apply for a take permit. If taking of eagles is not anticipated, adherence to the Guidelines would give rise to assurances regarding enforcement discretion if an unexpected taking occurs.

If a developer and operator are not the same entity, the Service expects the operator to maintain sufficient records to demonstrate adherence to the Guidelines.

Voluntary Adherence and Communication

For projects commencing after the effective date of the guidelines, "voluntary adherence and communication" means that the developer has applied the guidelines, including the tiered approach, through site selection, design, construction, operation and post-operation phases of the project, and has communicated with the Service and considered its advice. Table 1, Communications Protocol, provides guidance to the Service and developers in this regard. 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. Although the guidelines leave decisions up to the developer, the Service retains authority to evaluate whether developer efforts to avoid and mitigate impacts are sufficient, and to refer for prosecution any take of migratory birds that it believes to be reasonably related to lack of responsiveness to Service communications or insufficient compliance with the guidelines.

Table 1. Suggested Communications Protocol

This table provides examples of potential communication opportunities between a wind energy project developer and the Service. Not all projects will require all steps indicated below.

1

TIER	Project developer/operator Role	Service Role
Tier 1: Preliminary site evaluation	• Landscape level assessment of habitat for species of concern • Request data sources for existing information and literature	• Provide lists of data sources and references, if requested
Tier 2: Site characterization	• Assess potential presence of species of concern, including species of habitat fragmentation concern, likely to be on site • Assess potential presence of plant communities present on site that may provide habitat for species of concern • Assess potential presence of critical congregation areas for species of concern • One or more reconnaissance level site visit by biologist • Communicate results of site visits and other assessments with the Service • Provide general information about the size and location of the project to the Service	• Provide species lists, for species of concern, including species of habitat fragmentation concern, for general area, if available • Respond to information provided about findings of biologist from site visit • Identify initial concerns about site(s) based on available information
Tier 3: Field studies and impact prediction	• Discuss extent and design of field studies to conduct with the Service • Conduct biological studies • Communicate results of studies to Service field office • Evaluate risk to species of concern from project construction and operation • Identify ways to mitigate potential direct and indirect impacts of building and operating the project	• Respond to requests to discuss field studies • Advise project proponent about studies to conduct and methods for conducting them • Communicate with project proponent(s) about results of field studies and risk assessments • Communicate with project proponents(s) ways to mitigate potential impacts of building and operating the project
Tier 4: Post construction studies to estimate impacts	• Discuss extent and design of post-construction studies to conduct with the Service • Conduct post-construction studies to assess fatalities and habitat-related impacts • Communicate results of studies to Service field office • If necessary, discuss potential adaptive management and mitigation strategies with Service • Maintain appropriate records of data collected from studies	• Advise project operator on study design, including duration of studies to collect adequate information • Communicate with project operator about results of studies • Advise project operator of potential adaptive management/mitigation strategies, when appropriate
Tier 5: Other post-construction studies and research	• Communicate with the Service about the need for and design of other studies and research to conduct with the Service, when appropriate, particularly when impacts	• Advise project proponents as to need for Tier 5 studies to address specific topics based on information collected in Tiers 3 and 4

	exceed predicted levels • Communicate with the Service about ways to evaluate cumulative impacts on species of concern, particularly species of habitat fragmentation concern • Conduct appropriate studies as needed • Communicate results of studies with the Service • Identify potential adaptive management and mitigation strategies to reduce impacts and discuss them with the Service	• Advise project proponents of methods and metrics to use in Tier 5 studies • Communicate with project operator and consultants about results of Tier 5 studies • Advise project operator of potential adaptive management/mitigation strategies, when appropriate, based on Tier 5 studies

Implementation of the Guidelines

The Service recognizes that hundreds of wind energy projects exist and are being planned. The Service recommends that wind project developers and operators contact local Service offices to work with them regarding how to apply this tiered approach to operating projects and projects in various stages of planning. Tiers 1 through 5 should be applied at the appropriate tier based on the stage of development or construction of the project. The Service is aware that it will take time to train Service and other personnel, including wind project developers and their biologists, in the implementation of the Guidelines. However, the Guidelines will be implemented upon final publication. The Service will make every effort to begin training staff, users, and other interested parties as soon as possible, with a goal of beginning training no later than six months after publication of the final Guidelines.

The Service encourages use of the guidelines and adoption of the tiered approach by future projects, and, where feasible, existing projects. Accordingly, all projects that commence after the effective date should apply the tiered approach to all phases of the project. However, projects that are already under development or are in operation are not expected to start over or return to the beginning of a specific tier. Instead, these projects should implement those portions of the guidelines relevant to the continuing phases of the project. Projects that are operational prior to the effective date, should follow Tier 4, and, if applicable, Tier 5.

Scope and Project Scale of the Guidelines

The Guidelines are designed for "utility- scale" land-based wind energy projects to reduce potential impacts to species of concern, regardless of whether they are proposed for private or public lands. While these Guidelines are designed for utility- scale wind projects, the general principles may also apply to distributed and community-scale wind energy projects. Developers should contact the Service to determine applicability of the Guidelines to their particular project. Offshore wind energy projects may involve another suite of effects and analyses not addressed here.

The Service considers a "project" to include all phases of wind energy development, including, but not limited to, prospecting, site assessment, construction, operation, and decommissioning, as well as all associated infrastructure and interconnecting electrical lines. A "project site" is the land and airspace where development occurs or is proposed to occur, including the turbine pads, roads, power distribution and transmission lines on or immediately adjacent to the site; buildings and related infrastructure, ditches, grades, culverts; and any changes or modifications made to the original site before development occurs. Project evaluations should consider all potential effects to species of concern, which includes species (1) protected by the MBTA, BGEPA, and ESA, designated by law, regulation or other formal process for protection and/or management by the relevant agency or other authority, or that have been shown to be significantly adversely affected by wind energy development, and 2) determined to be possibly affected by the project. These draft Guidelines are not designed to address power transmission beyond the point of interconnection to the transmission system.

The tiered approach is designed to lead to the appropriate amount of evaluation in proportion to the anticipated level of risk that a project may pose to wildlife and their habitats. Study plans and the duration and intensity of study efforts should be tailored specifically to the unique characteristics of each site and the corresponding potential for significant adverse impacts on wildlife and their habitats as determined through the tiered approach. In particular, the risk of adverse impacts to wildlife and their habitats tends to be a function of site location, not necessarily the size of the project. A small project may pose greater risk to wildlife than a larger site in a less sensitive location, which may necessitate more pre- and post-construction studies than the larger site. This is why the tiered approach begins with an examination of the potential location of the project, not the size of the project. In all cases, study plans and selection of appropriate study methods and techniques may be tailored to the relative scale, location and potential for significant adverse impacts of the proposed site.

Service Review Period

The Service is committed to providing timely responses. 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. The request should be in writing to the field office and copied to the Regional Office with information about the proposed project, location(s) under consideration, and point of contact. The request should contain a description of the information needed from the Service. The Service will provide a response, even if it is to notify a developer of additional review time, within the 60 day review period. 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. It is particularly important, that if data from Tier 1-3 studies predict that the project is likely to produce significant adverse impacts on wildlife, the developer inform the Service of the actions it intends to implement to avoid or minimize those impacts. If the Service cannot respond within 60 days, this does not relieve developers from their MBTA, BGEPA, and ESA responsibilities.

The tiered approach allows a developer in certain limited circumstances to move directly from Tier 2 to construction (e.g., adequate survey data for the site exists). The developer should notify the Service of this decision and to give the Service 60 calendar days to comment on the proposed project prior to initiating construction activities.

Introduction to the Decision Framework Using a Tiered Approach

The tiered approach provides a decision framework for collecting information in increasing detail to evaluate risk and make siting and operational decisions. It provides the opportunity for evaluation and decision-making at each tier, enabling a developer to abandon or proceed with project development, or to collect additional information if necessary. This approach does not require that every tier, or every element within each tier, be implemented for every project. Instead, it allows efficient use of developer and wildlife agency resources with increasing levels of effort until sufficient information and the desired precision is acquired for the risk assessment.

Application of the Tiered Approach and Possible Outcomes

Figure 1 ("General Framework for Minimizing Impacts of Wind Development on Wildlife in the Context of the Siting and Development of Wind Energy Projects") illustrates the tiered approach, which consists of up to five iterative stages, or tiers:

Tier 1 – Preliminary evaluation or screening of potential sites

Tier 2 – Site characterization

Tier 3 – Field studies to document site wildlife conditions and predict project impacts

Tier 4 – Post-construction studies to estimate impacts[1]

Tier 5 – Other post-construction studies

At each tier, potential issues associated with developing or operating a project are identified and questions formulated to guide the decision process. Chapters Two through Six outline the questions to be posed at each tier, and describes recommended methods and metrics for gathering the data needed to answer those questions.

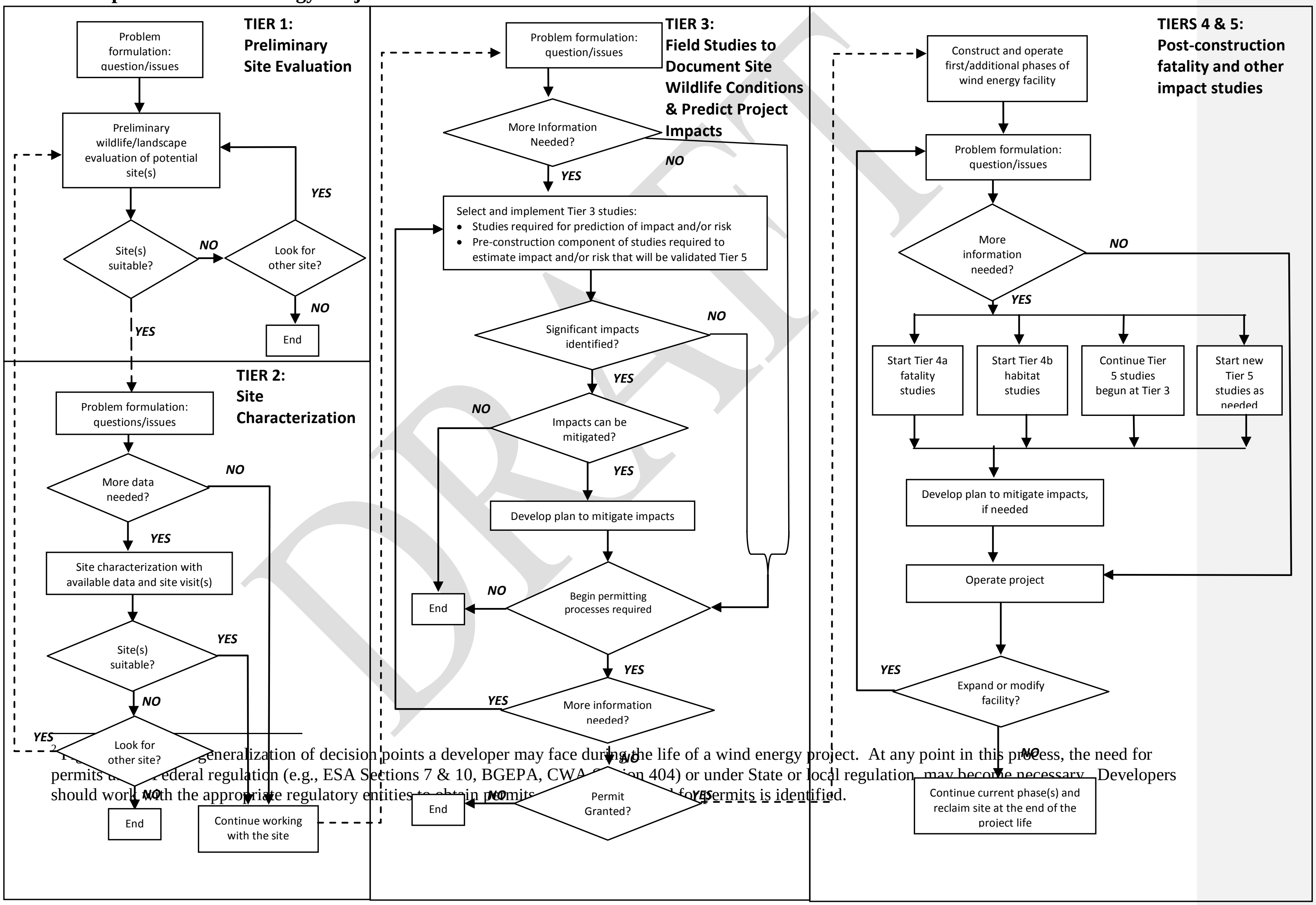
If sufficient data are available at a particular tier, the following outcomes are possible based on analysis of the information gathered:

1. The project site is abandoned because of the level of risk to species of concern.
2. The project proceeds to the next tier in the development process without additional data collection.
3. An action or combination of actions, such as project modification, mitigation, or specific post-construction monitoring, is indicated.

If data are deemed insufficient at a tier, more intensive study is conducted in the subsequent tier until sufficient data are available to make a decision to abandon the project, modify the project, or proceed with the project.

[1] The Service anticipates these studies will include fatality monitoring as well as studies to evaluate habitat impacts.

Figure 1. General Framework for Minimizing Impacts of Wind Development on Wildlife in the Context of the Siting and Development of Wind Energy Projects [2]



[2] [illegible] generalization of decision points a developer may face during the life of a wind energy project. At any point in this process, the need for permits under Federal regulation (e.g., ESA Sections 7 & 10, BGEPA, CWA Section 404) or under State or local regulation, may become necessary. Developers should work with the appropriate regulatory entities to obtain permits [illegible] for permits is identified.

Application of the Tiered Approach and Risk Assessment

Risk is the likelihood that adverse impacts will occur to individuals or populations of species of concern as a result of wind energy development and operation. Estimates of fatality risk can be used in a relative sense, allowing comparisons among projects, alternative development designs, and in the evaluation of potential risk to populations. Because there are relatively few methods available for direct estimation of risk, a weight-of-evidence approach is often used (Anderson et al. 1999). Until such time that reliable risk predictive models are developed, estimates of risk would typically be qualitative, but would be based upon quantitative site information.

Risk can also be defined in the context of populations, but the calculation is more complicated as it could involve estimating the reduction in population viability as indicated by demographic metrics such as growth rate, size of the population, or survivorship, either for local populations, metapopulations, or entire species. For most populations, risk cannot easily be reduced to a strict metric, especially in the absence of population viability models for most species. Consequently, estimating the quantitative risk to populations is usually beyond the scope of project studies due to the difficulties in evaluating these metrics, and therefore risk assessment will be qualitative. Risk to habitat is a component of the evaluation of population risk. In this context, the estimated loss of habitat is evaluated in terms of the potential for population level effects (e.g., reduced survival or reproduction).

The assessment of risk should synthesize sufficient data collected at a project to estimate exposure and predict impact for individuals and their habitats for the species of concern, with what is known about the population status of these species, and in communication with the relevant wildlife agency and industry wildlife experts. Predicted risk of these impacts could provide useful information for determining appropriate mitigation measures if determined to be necessary. In practice in the tiered approach, risk assessments conducted in Tiers 1 and 2 require less information to reach a risk-based decision than those conducted at higher tiers.

Cumulative Impacts of Project Development

Cumulative impacts are the comprehensive effect on the environment that results from the incremental impact of a project when added to other past, present, and reasonably foreseeable future actions. Consideration of cumulative impacts should be incorporated into the wind energy planning process as early as possible to improve decisions. To achieve that goal, it is important that agencies and organizations take the following actions to improve cumulative impacts analysis: review the range of development-related significant adverse impacts, determine which species of concern or their habitats within the landscape are most at risk of significant adverse impacts from wind development in conjunction with other reasonably foreseeable significant adverse impacts, and make that data available for regional or landscape level analysis. The magnitude and extent of the impact on a resource depend on whether the cumulative impacts exceed the capacity for resource sustainability and productivity.

Federal agencies are required to include a cumulative impacts analysis in their NEPA review, including any energy projects that require a federal permit or have any other federal nexus. The federal action agency coordinates with the developer to obtain the necessary information for the NEPA review and cumulative impacts analysis. To avoid project delays, federal and state agencies are encouraged to use existing wildlife data for the cumulative impacts analysis until improved data are available.

Where there is no federal nexus, individual developers are not expected to conduct their own cumulative impacts analysis. However, a cumulative impacts analysis would help developers and other stakeholders better understand the significance of potential impacts on wildlife and habitats. Developers are encouraged to coordinate with federal and state agencies early in the project planning process to access any existing information on the cumulative impacts of individual projects on species and habitats at risk, and to incorporate it into project development and any necessary wildlife studies.

Applicability of Adaptive Management

Adaptive management is an iterative learning process producing improved understanding and improved management over time (Williams et al 2007). The Department of the Interior determined that its resource agencies, and the natural resources they oversee, could benefit from adaptive management. Use of adaptive management in the DOI is guided by the DOI Policy on Adaptive Management. DOI adopted the National Research Council's 2004 definition of adaptive management, which states:

> Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.

This definition gives special emphasis to uncertainty about management effects, iterative learning to reduce uncertainty, and improved management as a result of learning.

When using adaptive management, project proponents will generally select several alternative management approaches to design, implement, and test. The alternatives are generally incorporated into sound experimental designs. Monitoring and evaluation of each alternative helps in deciding which alternative is more effective in meeting objectives, and informs adjustments to the next round of management decisions.

Adaptive 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 AM, when warranted. In the pre-construction environment, analysis and interpretation of information gathered at a particular tier influence the decision to proceed further with the project or the project assessment. If the project is constructed, information gathered in