PROBABILITY OF IMPACT WORKSHOP

National Wind Technology Center
November 13, 2007

MEETING BACKGROUND

The National Wind Coordinating Collaborative (NWCC) developed the Probability of Impact workshop to discuss the ability of current methods to accurately assess the probability of impact to wildlife from the development of a proposed wind energy site. The purpose of the meeting was to review methods used to determine impacts and assess the strengths and weaknesses of each. .

MEETING SUMMARY

The accuracy of pre-construction predictions of impact has been debated for years. The Probability of Impact workshop intended to lay common groundwork by identifying mutual terminology and priority issues – allowing participants to begin to determine which impact prediction methods most closely assess actual impacts experienced once wind facilities are operational

The workshop considered four categories of methods typically used in pre-construction studies to assess probability of impact:

- *Potential Impact Index (PII) Score* –This protocol was initially proposed in the *draft* U.S. Fish & Wildlife Service (USFWS) Voluntary Guidelines as a framework for initial investigations of a potential site. Under the PII scoring process, a developer chooses a "reference site," the site expected to have the highest negative impact in the area where building is anticipated. Additional sites are compared to the reference sites using three checklists – physical attributes, species occurrence and status, and ecological attractiveness to wildlife.
- *Reconnaissance Level Site Assessment* – After performing background research on existing projects, habitat, and use in the area, a biologist visits the proposed site to evaluate topography, presence of vegetation and wildlife, and identify any special features. A short report is then prepared identifying "red flag issues" and recommending if and what further studies are needed.
- *Quantitative Data Collection* –This approach involves multiple site visits and provides empirical and statistical data on the population size and diversity of species using the area. Using this data and information on fatalities at wind facilities in similar areas, a biologist will create models of impact and risk.
- *Ecological (or "formal") Risk Assessment* – This approach identifies potential "stressors" and devises a strategy for determining the likelihood that negative impacts will occur as a result of wildlife exposure to each stressor. ERA follows a three step process: 1) Problem Formulation, where a conceptual model is developed; 2) Analysis, during which data is collected and inputted into the conceptual model; and 3) Risk Characterization, during which findings and implications are summarized.

Potential Impact Index (PII) Scores:

Methodology (Al Manville, USFWS)[1]

Developed by a team of industry, state agency, academic, and USFWS members in Montana, the Potential Impact Index (PII) score was developed to ranked proposed development sites**.** A first

[1] http://www.nationalwind.org/pdf/Wind-NWCCProbabilityImpactPIIScoring11-07Manville.pdf

step involves the designation of a "reference site" within the Wind Resource Area under consideration. The "reference site" represents what could be the worst likely site to develop a wind facility, based on the greatest apparent, known, and suspected risk and impact to resident and migratory wildlife, plants, other trust resources, and/or their habitats. Development of such a site could have the greatest negative impact on wildlife and/or habitat. The reference site is determined through review of existing data and literature to have the "highest regional ecological value where hypothetic wind development would result in the maximum negative impact on wildlife." The information on risk and potential impact can be obtained from a variety of sources. These include GIS overlays, landscape and site-specific gap analyses, National Wetlands Inventory data, soil survey data on vegetative associations, habitat fragmentation evaluations, State Heritage Program datasets, habitat suitability indices, species "lists requests" (both State and Federal), Breeding Bird Survey and Birds of Conservation Concern datasets, and from other scientifically valid information sources. Once a "reference site" is selected, preferably within the general geographic area of the proposed wind resource area being considered for development, the site should be scored based on the 3 separate checklists listed below. Next, the site(s) being proposed for development is selected, and scored using the same process just completed for the "reference site." The three checklists below are tailored to include terrain features, species presence, and habitats dictated by local conditions:

- Physical Attributes Checklist – assesses site characteristics, e.g. overall "footprint" of wind facility, its specific topography, migratory corridor potential (for both birds and bats), historic breeding sites, site size, and wind direction
- Species Occurrence and Status Checklist – determines the presence of, e.g. State and Federal threatened and endangered species, "candidate" species, species of conservation concern, critical habitat, State protected lands, proximity to park and refuge lands, and important recreational species
- Ecological Attractiveness Checklist – evaluates the presence of "ecological magnets" that may attract wildlife to the site, e.g. noted significant ecological events, migration routes, important vegetative habitats and associations, important habitats (i.e, for feeding, breeding, foraging, roosting, and maternity), and sites of special concern

One point per check is awarded for each site characteristic appearing on each checklist, except for the "Site of Special Conservation Status," which is weighted 2 points if applicable. Each checklist is assigned a divisor by dividing the number of possible points (i.e., boxes) on that checklist by the total number of possible points (boxes) from all three checklists which expands the spread of index values. The number of boxes in each checklist should be changed/altered to fit the specific geographic area, habitat type, species presence, and other local conditions. The sums on each checklist are adjusted using the pre-assigned divisor, and the adjusted scores are added to reveal the final score of each site. The sites are then ranked according to scores, where the highest score indicates the site with the most troublesome characteristics, greatest potential risk, and greatest potential impact to species and/or habitat (this *should* be the reference site). However, a high score does not always preclude development, nor does a low score necessarily eliminate the need for pre-construction assessments. The scores do allow developers to make a decision to proceed with the siting process or abandon the site. It also helps determine the degree and scope of studies needed in pre- and post- construction.

Because site location is so critical, the PII scoring process was developed to help determine "good" sites versus "bad" sites, preferably avoiding development of the latter. The PII process is intended to provide a conceptual framework, a so-called "first-cut" analysis of the suitability of a proposed site(s). The PII score is not intended to be all-inclusive regarding impact assessment, the specific research methodologies needed, nor the data analyses that may be/should be performed. There is, however, some hazard and risk to wildlife, individually and at a population level, and to their habitats that all commercial wind facilities will create, regardless of turbine design, configuration, placement, and operation. The PII scoring is designed to help select sites least hazardous and least risky to wildlife than are other more risky sites that might be selected and developed.

Case Study – Clear Spring Ranch (Lori Nielsen, EDM International)[2]
While designed as a macro-scale process, Colorado Springs Utilities asked EDM to perform a PII analysis on a micro-siting scale at the Clear Ranch Spring Property in Colorado.

From a wind developer's perspective, it would be advantageous to site a wind facility near the power plant due to existing transmission, transportation and maintenance infrastructure; EDM considered this in choosing the study sites.

After reviewing existing literature and data (including wildlife survey data from the municipality), EDM chose a **"**reference site**"** – a site expected to score "highly" likely to cause negative impacts if developed. This site exhibited a higher diversity of associated habitats and wildlife species. Six study sites – ranging from industrial to native habitat – were chosen, each with similar wind resource values. Each site was evaluated against the three checklists, and final scores were compared. As expected, the reference site obtained the highest score (highest ecological value and worst place to site a wind facility). The three lowest scores reflected proximity to the power plant, a higher rate of human traffic, and low habitat and species diversity.

Evaluations using the Physical Attributes and Ecological Attractiveness checklists were relatively straightforward; the Species Occurrence checklist was more subjective and would allow more variability for interpretation and application. The subjective nature of the species list may be the biggest challenge to using the PII. However, the checklist format does result in consistent interpretations across sites, if not between biologists.

EDM concluded the PII scoring process provides a standardized approach for a first-cut review for siting wind facilities, resulting in a better perspective on the relative risks to wildlife.

Discussion:

- Sometimes multiple reference sites are needed (e.g. when ideal reference site for birds differs from the ideal reference site for bats)
- Sites with different species lists are incomparable. Also, geographies should be similar. (i.e. Sites should only be compared to other sites in their wind resource area)
- Species status is not weighted to give a final decision. For example, a highly species-diverse marshland would likely have a higher PII score than less diverse grassland where an endangered species is present. Following the process would result in further endangerment of a protected species. (USFWS response: The presence of endangered species may be a "show-stopper", negating the possibility of using that site.)
- There is a need to adjust the scoring process to accommodate unique species found at study sites that do not appear at the reference site.

[2] http://www.nationalwind.org/pdf/Nielson.pdf

- There is a potential for a developer to "cherry pick" a reference site, especially if the developer is already invested in or leasing a site.
- Choosing an appropriate reference site with comparable characteristics to the study sites may be difficult in wind resource areas where segments are privately owned by entities other than the potential developer.
- The use of a reference site may not be critical to implementing this process. The tool's main utility is to allow comparison between potential sites.
- This tool does not address indirect impacts of site development, such as habitat fragmentation. *Lori suggested that the physical attributes checklist could be expanded to include these concerns.
- Existing wind projects with existing data might serve as good reference sites.

Reconnaissance Level Site Assessment

Methodology (Dick Anderson, California Energy Commission, retired)[3]

Also known as a "Phase 1 Assessment", "Desktop Assessment", and a variety of other names, this approach features a biologist familiar with the area visiting a site of interest. The biologist typically prepares for the visit by consulting existing literature, data, agencies, experts, and information on any nearby projects. When visiting the site, the biologist considers characteristics such as topography, vegetation, the presence and type of wildlife observed, and special features (e.g. water). The time and intensity of the site visit(s) will depend on the availability and credibility of existing data applicable to the site of interest and the sensitivity of species using the site. Where a good deal of relevant data is available, a less-intensive study may suffice. In an area where little is known, a more extensive site visit, or visits during a specific season may be required.

In preparing a report, the biologist will discuss the potential for impacts from collision with turbines, electrocution, habitat loss, and whether wildlife behaviors and use of the area are adversely affected by the presence and/or operation of the turbines. Reconnaissance level site assessments and resulting reports are intended to identify red flags, evaluate the site in comparison to nearby, regional and national sites, identify what further information and studies might be necessary, and suggest site development and mitigation strategies.

Case Study – Nebraska Public Power and Irrigation District (NPPD) Ainsworth (Dale Strickland, Western EcoSystems Technology)[4]

Asked to evaluate a site on a shortgrass prairie in the sandhills of north-central Nebraska in Brown County, Western EcoSystems Technology (WEST) utilized relevant literature, existing data for the site and for a nearby site and local agencies to determine that there was a need for a medium-intensity site visit to evaluate land cover, vegetation, topography, water bodies, etc.

During the analysis stage, a red flag was identified – the potential site was located within a 200 mile migration corridor utilized by whooping cranes. However, it was determined that historical sightings occurred in this region at locations providing habitat for "migratory stopover points" – places to roost and feed briefly before continuing to travel. According to the USFWS, Brown County is near

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[3] http://www.nationalwind.org/pdf/Anderson-Prob_of_impacts_Denver_2007.pdf

[4] http://www.nationalwind.org/pdf/Strickland-NPPD_Ainsworth.pdf

the center of the whooping crane migration corridor. Whooping cranes are listed as endangered on both the federal and state lists. There have been four confirmed sightings of whooping cranes in Brown County: 1) October 23-November 2, 2000, five birds confirmed 4 miles west and 1 mile south of Ainsworth; 2) March 28-April 1, 1998, two birds confirmed 1 mile south and 1 mile west of Ainsworth; 3) October 21-23, 1997, five birds confirmed 3 miles west and 3 miles south of Ainsworth; 4) November 1-2, 1982, five birds 12 miles south of Ainsworth. During migration, whooping cranes have been found to use palustrine wetland (68.8%), riverine wetlands (21.6%) and lacustrine wetlands (9.6%) for roosting locations (Austin and Richert 2001). Most feeding locations have been documented in non-wetland habitats (78%) (Austin and Richert 2001). While no streams were found at the proposed site, the study area did contain a limited number of wetlands and hay meadows. Based on the migration corridor information and the limited number of wetlands/hay meadows, it is possible that whooping cranes could use the proposed area during migration. However, because the whooping crane migration corridor includes approximately the central ½ of Nebraska, coupled with the low numbers of whooping cranes in this migratory flock (currently approximately 180 individuals), the likelihood of a whooping crane using the study area was considered remote. Zero to very limited mortality of common cranes has been documented at large wind farms located in Western Europe, where common cranes are far more abundant than whooping cranes in the United States (Hartwig Prange, pers. comm., during his presentation at the 2003 North American Crane Working Group Meeting). In their review of avian collisions with wind turbines, Erickson *et al.* 2001 did not find any studies that had documented crane mortality at wind plants. Therefore, WEST concluded that development of the site was unlikely to harm the whooping crane or other federally listed species.

The project was constructed and followed with fatality monitoring, which supported qualitative predictions regarding the potential for avian fatalities made in the pre-construction analysis.

Discussion:

- Post-construction site visitation at NPPD Ainsworth occurred, on average, every 14 days. However, this statistic does not capture the fact that researchers typically visited the site daily, but only searched near a few turbines. This sort of schedule enabled research to consider factors such as weather in their post-construction analysis.
- As prairie grouse were not observed or likely to occur on-site at NPPD Ainsworth, habitat avoidance by grouse was not considered a red-flag issue, nor was it monitored post-construction.

Quantitative Data Collection

Methodology (Dale Strickland, WEST)[5] *[this summary has not yet been approved by the presenter]*
This approach utilizes basic approaches to quantitatively estimate impact and risk to wildlife, such as empirical fatality estimates, empirical estimates of population response, and empirical estimates of habitat loss.

In pre-construction phases, a biologist will collect empirical data such as estimates of abundance and reproduction. Tools such as radio telemetry and radar are utilized to determine use and behavioral patterns.

[5] http://www.nationalwind.org/pdf/Strickland-Quantitative_Methods_for_Predicting_Impact_Risk.pdf

Under this approach, a biologist will create models of collision risk based on estimated exposure in order to characterize the site for impact prediction and to evaluate the proposed wind plant design. Most physical models used by other approaches are "dart board models" using only physical characteristics of wind turbines and birds; most fail to adequately account for behavior. This approach considers potential for changes in avoidance in determining the probability of impact.

In post-construction studies, pre-construction predictions are validated using empirical data collected using methods like ground searches. In addition, technology like radar can be used to determine behavioral impacts from the development as well as fatality data. Post-construction studies are needed to identify flaws in pre-construction study designs, as well as needs for mitigation measures (and to test the effectiveness of mitigation measures implemented). Data obtained in post-construction studies of this type can be used to determine how avian and bat fatality rates compare to rates at other sites in the region, state, or nation.

Case Study 1: Stateline & Klondike (Wally Erickson, WEST)[6] *[this study has not yet been approved by the presenter]*

At Stateline, one of the first projects built after Altamont, there was a desire to characterize the site for impact prediction, wind plant design, and use in the permitting process. Studies/surveys were conducted to determine rates of avian use and raptor nests, as well as proximity of raptor nests to prey bases. Researchers mapped habitat areas and examined existing information from operating facilities (primarily from Vansycle, an adjacent site). They found comparatively low rates of raptor use overall, moderate nesting density, and higher use by raptors on "ridge sites" when compared to other sites. Due to this information, researchers recommended adjusting project siting to avoid existing nests, trees, and other high quality habitat as well as saddles (low points on/dips in a mountain or hill range) and windward sides of ridges.

In two years of post-construction monitoring, which included carcass searches, bias trials, nest surveys and displacement, researchers found that post-construction data affirmed pre-construction predictions.

At Klondike, a project also near Stateline, a quantitative data collection pre-construction study was performed. The study involved surveys of avian point counts, raptor nests, sensitive species, waterfowl, and vegetation mapping. The study revealed a low use by raptors, low diversity in bird species, and indicated a likelihood of low impact in the case of development. In one year of fatality monitoring, pre-construction predictions were validated.

Case Study 2: Big Horn (Sara McMahon Parsons, PPM)[7]

Prior to construction on Big Horn, a site in the Columbian Basin of eastern Washington, data was collected about avian and other wildlife use for breeding. Researchers reviewed data from and consulted with agencies on species composition at the site, reviewed fatality monitoring studies on comparable sites in the area and used data from the Klickitat County Energy Overlay Zone (EOZ) EIS in which data was collected during spring and early summer. Habitat was mapped, an avian use study was conducted and raptor nests were surveyed. Results were similar to Stateline and Vansycle's. After construction, 100% of the turbines were surveyed every 14 days in spring and fall

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[6] http://www.nationalwind.org/pdf/Erickson-Stateline_and_Klondike.pdf

[7] http://www.nationalwind.org/pdf/Parsons-Big_Horn_public.pdf

and every 28 days during summer and winter for one full year. Researchers found fairly evenly distributed fatalities across the site, and that preliminary data show that fatalities fall near or within the predicted ranges.

In conducting this study, researchers found that:

- Studies from existing facilities provided useful fatality information on a macro-scale.
- Avian Risk Assessment and avian use surveys provided useful information on species composition and relative levels of avian risk compared to other sites. For example, no federal Threatened/Endangered (T/E) species issues were identified during pre-construction surveys and no federal T/E carcasses found.
- On-site studies conducted after fatality predictions were made provided supplemental information that would not have been available using only the countywide Energy Overlay EIS
- Preliminary findings that songbird and bat fatalities appear to fall within the predicted range. Data presented at the conference was still in the preliminary stage of analysis, before statistical corrections have been made.
- Findings showed that raptor fatalities were higher than expected; PPM is working with the agencies and stakeholders to address these impacts.
- Raptor nest surveys may provide a predictor for raptor fatalities during nesting season; turbine proximity to raptor nests and the density of turbines within one-mile proximity of nests should be reviewed during the planning stage as a way to potentially minimize risk of collision.
- Records of special status species assists in confirming persistence of those species at a site.

Researchers noted the importance of correcting for searcher efficiency in carcass removal trials, and cautioned that data in the slides presented has not yet been adjusted to correct for this.

Case Study 3: Leaning Juniper (Sara McMahon Parsons, PPM)[8]
Located in the Columbia Basin in eastern Oregon, Leaning Juniper is located on land owned by a waste management company. Several pre-construction surveys were conducted to collect information about raptor nests, avian use and other wildlife use (special status ground squirrels, potential bat species, etc.). The objective of the surveys and preconstruction risk assessment was to assist in the prediction of potential impacts to birds, mammals, and nesting raptors; identify options for avoiding or mitigating impacts; and predict whether overall avian and bat fatality rates or raptor fatality rates are low, moderate, or high relative to other projects in similar landscape settings (habitat, topography, etc.).Researchers consulted agencies and databases for species in the area and reviewed previous fatality monitoring studies. Avian use surveys were conducted for four seasons. Habitat and raptor nests were mapped and the presence of special species use was surveyed. Bat data was also reviewed to determine potential species in the area.

Researchers made fatality predictions based on the information review and field surveys, and these have been supported by the preliminary post-construction data collected. Through extensive pre-construction surveys, areas of high environmental value were documented and closed to construction traffic and other potential disturbances. Results again support the idea that existing fatality data can provide useful information on a macro-scale, and that avian use surveys and risk

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[8] http://www.nationalwind.org/pdf/Parsons-Leaning_Juniper_public.pdf

assessment can provide helpful data on species composition and a comparative level of risk. Researchers noted the importance of correcting for searcher efficiency and carcass removal trials, and warned that data in the slides presented has not yet been adjusted to correct for this as this is the first year of a two year study.

Discussion:

- At the time the Stateline predictions were made, turbines had a comparatively small capacity. Predictions were then made on a per turbine basis rather than on a per MW basis. Some researchers believe the fatality metric should be measured on a fatality per rotor swept area (which relates to the area of the blades) or on a per Megawatt hour basis (which relates to the amount of time the blades rotate and produce electricity).
- The Big Horn and Leaning Juniper pre and post-construction studies were very labor and cost intensive, and some conference members expressed concern that more funding should go to habitat conservation than studies. However, others expressed the opinion that the cost intensity of this process can pay off, especially in wind resource areas that lack existing fatality data and where a company hopes to continue to develop wind projects (future development in the area will be able to use the previously collected data in permit applications and fatality predictions).
- This process can allow for avoiding (micrositing away from sensitive areas) and minimizing impacts and determining mitigation objectives as needed.

Reconnaissance Level Risk Assessment and Quantitative Data Collection

Case Study – Maple Ridge (Sara McMahon Parsons, PPM)[9]

At Maple Ridge, near Syracuse, New York, a reconnaissance level risk assessment (or "Phase One Avian Risk Assessment") was completed in pre-construction. This study featured a review of agency data, interviews with local and regional experts, habitat evaluation, local avian studies, as well as a review of the literature on impacts to birds at wind power facilities. Habitat on site was evaluated via on-site examination for its potential to support breeding, foraging, migration stopovers, and winter habitat. An additional bird breeding survey was recommended and conducted, based on the presence of habitat that could have supported New York State listed species. The avian risk assessment also recommended post-construction studies for both fatalities and potential displacement of nesting birds. Researchers found no evidence that the site would attract large concentrations of migrating or wintering birds as few risk factors were present at the site. In addition, no federal threatened or endangered species were recorded within 1 mile of site, nor was there any suitable habitat on site for significant use by these species. However, there was some concern about grassland nesting birds being displaced from areas near turbines.

During the development of a Federal Environmental Impact Statement, however, concerns about potential risks to bats became apparent. Additional study was planned to delve further into the issue. Adjustments to monitoring (inclusion of spring and fall seasons) were made to incorporate information on migratory bats. An assessment of bats on site was performed at both the ground level and at met towers using migratory acoustic monitoring and mist net surveys. Researchers found that the project was unlikely to have a significant impact on resident bats; however risk to migratory bats remains unclear. Compared to the nearby Mountaineer site, risk is expected to be lower because of a lack of caves or forested ridge. Based on these results, a site monitoring protocol was developed.

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[9] http://www.nationalwind.org/pdf/Parsons-Maple_Ridge_public.pdf

A one year, post-construction fatality pilot study was conducted to determine the statistically appropriate frequency of carcass searches and to determine the duration of monitoring studies. The search interval varied during the pilot study, with 10 turbines searched daily, 10 searched at three day intervals, and 30 searched at weekly intervals. Monitoring found that raptor and waterbird fatalities were minimal. Night migrant bird fatalities were consistent with findings at other eastern sites. Bat fatalities were greater than found at western and Midwestern sites, but less than found at other eastern sites.

From this experience, PPM learned that the Phase I risk assessment approach does work for birds, and that the most useful tool is existing fatality data. Pre-construction assessment of bat risk appeared to accurately predict the impact of the project of summer resident bats, and possibly spring migration. However, the lack of pre-construction assessment during the peak risk period (fall migration) precludes an analysis of the value of pre-construction bat surveys on predicting post-construction bat mortality. PPM is working with the state and USFWS to determine the cause of these bat fatalities, potential mitigation strategies, and methods for identifying this risk at future development sites.

Discussion:

- There was interest in the pilot study's evaluation of the appropriate frequency of carcass searches. Alaska FWS performed a robust scavenging survey at one sight and found rates of 50% scavenging per 24 hours. That Service is now asking developers to survey scavenger rates and adjust carcass search schedules accordingly. Others discussed how search intervals may vary by region depending on the carcass removal rates.
- The Maple Ridge post-construction grassland bird nesting displacement study may be repeated to determine if habituation has occurred. Perhaps displacement studies at other projects should also be extended to gather data on habituation.

Ecological Risk Assessment

Methodology (Crissy Sutter, Pandion Systems)[10] *[this summary has not yet been approved by the presenter]*

Ecological Risk Assessment (ERA) "evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors". Pre-construction, it is intended to predict risk of avian mortality from collision with turbine structures and to predict spatial distribution of risk. The approach includes three major phases:

1) Problem Formulation – During this phase, goals are evaluated; stressors, receptors and variables are identified; assessment endpoints are selected; a conceptual model is prepared; and an analysis plan is developed. At a wind resource area, the problem will likely be understood as "potential for collisions with wind turbines". This will then be formulated into two or more parts, depending on the wildlife present. At a site where concern exists only about birds, the problem would be broken down into potential risk to migrating birds and potential risk to resident birds.
2) Analysis – During this phase, exposure to stressors and their relationship to ecological impacts is evaluated. At a wind site, a researcher would need to collect data on exposure and study population indicators.
3) Risk Characterization – In this phase, a researcher will consider exposure and behavioral response to stressors in reporting an estimate of risk. This report will include confidence levels,

[10] http://www.nationalwind.org/pdf/Sutter_Environmental_Risk_Assessment_Methodology.pdf

provide supporting evidence for the risk estimate, and interpret ecological effects that have been documented. It is intended to provide data to decision makers.

Case Study – Chautauqua (Crissy Sutter, Pandion Systems)[11] *[this summary has not yet been approved by the presenter]*
Prior to beginning an ERA, researchers reviewed existing data, performed a literature review, and conducted field surveys to identify species of special concern; breeding, migratory or wintering species; species known to be susceptible to collision; and known migration corridors. This data was needed to quantify the risk of avian mortality from the project.

In the problem formulation phase, Pandion Systems divided the problem into two sections: potential risk to migrating birds, and potential risk to resident birds. Effects were characterized as direct, indirect, or contributing factors. Other variables identified included avoidance behaviors towards wind resource areas, turbines, and blades; distracting behaviors; flock size; and species differences. Environmental factors such as visibility (nocturnal v. diurnal, weather-related, topography-related) and wind direction and speed. Researchers also reviewed a number of engineering factors (e.g. rotor speed, turbine position/alignment).

During the analysis phase, Pandion measured exposure and effects using information on the number of birds in the area of risk, and alterations in population levels. These data were inputted into the problem formulation to output a calculation of predicted annual and seasonal mortality risk.

A report was developed in the characterization phase identifying data gaps and assumptions and the level of conservatism in problem formulation. It also provided overall conclusions about annual mortality to be expected for each species.

Discussion:
- This model can consider indirect impacts by handling each separately, calculating endpoints and stressors of each.
- ERA does not need to be categorized as a specific approach like the others discussed. It can be adapted and incorporated into the other approaches; it can also serve as a framework incorporating the other approaches.
- There is a need to identify scientifically valid, peer-reviewed protocols that can be prescribed nationally. At present, use of this model can be too subjective.

Summary and Analysis of Methods[12] *(Wally Erickson, WEST) [this summary has not yet been approved by the presenter]*
In preparing a summary of methods commonly used, WEST performed a literature review and surveyed publicly available quantitative data from existing projects. Of those surveyed, 19 projects contain data suitable for use in making predictions. However, there is too little data for statistical analysis, especially given the paucity of data from the Eastern U.S. Even in the Pacific Northwest, there is a need for additional data. Additionally, while the amount of available data continues to grow, much of it comes from joint/adjacent projects, creating difficulty in identifying regional and national trends. The fifth slide, entitled "Fatality Monitoring Studies", shows a geographical distribution of known available studies.

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[11] http://www.nationalwind.org/pdf/Sutter_Environmental_Risk_Assessment_Methodology.pdf
[12] http://www.nationalwind.org/pdf/Erickson-Summary.pdf

Taking into account non-standardized data (e.g. bats were not studied at Altamont, but turbines were smaller then and less likely to impact bats), the summary analyzes fatalities observed by species on a national and regional basis (slides 8-12) as well as by habitat type (slides 13-14). It compares the predicted fatalities vs. empirically estimated fatalities from seven wind projects. It also illustrates site use by raptors at 27 sites, includes a regression model illustrating the relationship between raptor/vulture use and fatalities, and discusses possible biases that may influence survey results.

Other points of analysis:

- WEST examines use of radar in predicting impacts (slides 22-23) and asserts that more research is needed before radar can be confirmed as a useful tool. Slides 27 and 28 summarize findings at three wind projects which conducted fatality monitoring and radar studies for migratory nocturnal birds and bats.
- WEST does find that bat call data may be a good predictor of post-construction impacts, as sites with high bat calls tend to see high numbers of fatalities.
- Predictions in displacement studies tend to vary according to study assembly/design, but WEST believes that level of displacement likely is species-dependent.

In summary, WEST found:

- Additional studies and data are needed on pre-construction diurnal avian use and post-construction fatality
- Similar information for bats and migratory birds is even more scarce, but needed
- Raptor use and mortality appear to be related
- Where fatality data in the region is available, predictions tend to be relatively accurate
- There is a significant need to examine cumulative impacts; increasing numbers of projects may lead to more cumulative impacts

Discussion:

- Fatality data is useful and important, but there is an equal – potentially primary – need to examine impacts of wind energy developments to wildlife habitat.
- There is a significant need to evaluate tools and methods for determining impacts to habitat.
- When considering the footprint of a wind energy facility, especially as it relates to habitat and displacement, there is a need to perform empirical studies rather than compute square mileage.
- Impacts from new and existing transmission should be considered when evaluating impacts from wind. However, in comparing impacts from various energy sources, it is critical to include the impacts from transmission for other energies. There is a need to consider whether transmission impacts are the same across energy sources.
- Continuing fatality data is useful for estimating cumulative population impacts.
- There is a need to consider positive impacts to wildlife from wind (e.g. wind farms on private land may preserve habitat by preventing plowing or development of land for residential purposes or solar development; development in existing brownfields; scientific knowledge gained due to efforts by wind industry).

Evaluation of the strengths and weaknesses of each method:
At the conclusion of the meeting, participants created a chart identifying strengths and weaknesses associated with each method.

Meeting Themes:

- Methods of prediction and siting policies must be altered to address issues associated with habitat depletion and fragmentation, as well as other cumulative impacts.
- There is a need for public availability of additional studies of impacts to birds and bats for use in literature reviews and statistical analysis.
- Assuming best available methods are used, these tools provide a decent toolbox for pre-construction assessment of likely impacts to birds.
- Perception of "risk" differs – biologists may understand "risk assessment" to mean a determination of the probability of harming an animal, while industry perceives "risk assessment" to determine the value of a site to a company (may even be considered "regulatory risk"). While both depend on similar information, data is interpreted with diverging focus.
- Negative impacts to wildlife and wildlife habitat will translate into negative community relations for the industry (e.g. Altamont's reputation has negatively impacted the entire industry). Locally, it may result in delayed production from a site.
- There is a need for a framework providing standardization of methods and directions for use by developers.