Wind Wildlife Research Meeting IX

Presented By

November 28-30, 2012 • Omni Interlocken Resort • Broomfield, CO

Presentation and Poster Abstracts

Sorted by Session

***Notes**: Abstracts are listed by session. Posters will be on display throughout the meeting. Representatives will be asked to stand at their poster at specific times, which are listed in the meeting program.*

All information included in this document is provided as a reference for attendees of the NWCC Wind Wildlife Research Meeting IX. The information is preliminary and should not be quoted or cited.

Table of Contents

Presentations

Wednesday, November 28: Morning

Assessing Risk to Birds and Bats

"Using spatial models to predict relative collision risks of Horned Larks and Hoary Bats at wind farms in the central United States"

Presenter: Greg Forcey, Normandeau Associates

Authors: Greg M. Forcey, Christian Newman, Crissy Sutter (Normandeau Associates)

Abstract: Studies of avian and bat collision mortality most often occur at the site-specific scale of the wind power facility and overlook possible large-scale influences at the multi-state level. Meta-analyses utilizing existing datasets and spatial tools allow for exploration into large-scale relationships between collision mortality and landscape features that are not possible with site-specific studies. We modeled predicted relative collision mortality of Horned Lark and Hoary Bat as a function of habitat, weather, and behavior in the central United States from North Dakota to Texas using large-scale existing datasets including the North American Breeding Bird Survey, Christmas Bird Count, Ebird, National Landcover Dataset, National Climate Datacenter weather data, and known behaviors described in the literature. We built hierarchical linear mixed habitat models a priori based on known associations with habitat variables and then incorporated weather and behavioral information which can influence exposure to turbines. Separate models were constructed for each species for each season given differences among species life history, habitats, and behavior. Seasonal-specific abundance models, weather, and behavioral data were used to form a cumulative measure of predicted collision probability across all seasons for an entire year. Model evaluation was performed at two levels: 1) we compared mortality predictions to mortality recorded at seven publically available studies within the study region, and 2) we performed a sensitivity analysis to evaluate how different weighting of abundance and weather variables influence the models' ability to predict collisions. Relative collision predictions for Horned Larks were highest in the western-central and northwestern portions of the study region and lower elsewhere. Hoary Bat collision risks were predicted to be highest in areas containing tree cover and along stream and river corridors. Relatively higher risk was also found in the extreme southern portion of the study area (i.e., Texas); lower risk was found elsewhere. Model evaluation of Horned Lark revealed the model using only habitat data and no weather information performed the best (r=0.55 for observed vs predicted mortality). Model evaluation for Red Bat showed the best fit model occurred when abundance was weighted ½ as much as weather (r=0.85 observed vs predicted mortality). This large-scale modeling exercise was useful for understanding the relative importance of habitat and weather variables in influencing collision rates at wind farms in the central United States. Our research has application to regional-scale siting of wind power facilities, making comparisons of relative collision probabilities among sites, and developing site-specific priorities for additional research. This modeling approach can also be expanded to other species and geographic regions in the United States to aid in siting wind power facilities at large scales.

"Competing resource selection modeling predicts risk for preventing and mitigating impacts to flying birds from industrial wind energy developments"

Presenter: Tricia Miller, West Virginia University

Authors: Tricia Miller (Division of Forestry and Natural Resources, West Virginia University & Riparia, The Pennsylvania State University); Robert P. Brooks (Riparia, The Pennsylvania State University); Michael Lanzone (Cellular Tracking Technologies); Charles Maisonneuve, Junior Tremblay (Ministère des Ressources naturelles et de la Faune, Canada); Jeff Cooper (Virginia Department of Game and Inland Fisheries); Kieran

O'Malley (West Virginia Division of Natural Resources); Adam Duerr, Todd E. Katzner (Division of Forestry and Natural Resources, West Virginia University)

Abstract: Central to conservation biology is understanding threats to species and populations. As biologists, we focus on providing one-sided ecological information. However, solving complex threats to populations can be improved by providing a balanced approach to risk management that not only provides ecological information, but also provides managers with viable solutions. Animals select resources that improve their survival and fitness and similarly industries select resources that are important for their bottom-line and thus survival. Describing risk, the probability that a negative interaction will occur, in a two-sided manner can be achieved by overlaying resource selection models for each. The final risk model can then be used to spatially adjust industrial enterprises in a wildlife friendly way. We illustrate use of this approach in providing solutions for negative wind-wildlife interactions. We show not only where low altitude flight of eagles is most likely to occur, but also show where wind energy can be sustainably developed with decreased risk of negative interactions with eagles in the central Appalachian Mountains in Pennsylvania, USA. We modeled resource selection of low flying eagles and resource selection for wind turbines in three regions, the Allegheny Mountains (AM) of west central PA, Plateau Provinces (PL) of northern PA and the Ridge and Valley (RV) region of central PA. We combined these models to create regional spatially explicit risk models. We found that risk varies regionally. Areas available for development that do not overlap with eagle habitat are: 14% in AM, 9% in PL, and 2% in RV. Of the total area suitable for development in AM, PL and RV, 22%, 16%, and 80%, respectively, fall in the high-highest risk categories. In addition to determining regional levels of risk, we can make site level recommendations to wind developers regarding turbine placement that will reduce risk to eagles and allow for wind energy generation.

"Using Avian Radar to Quantify Bird and Bat Migration along the Shoreline of Lake Michigan and Implications for Analysis and Pre-construction Surveys"

Presenter: Jeff Gosse, U.S. Fish and Wildlife Service

Authors: Jeffrey Gosse, Erik Olson, Tim Bowden, Daniel Nolfi, Nathan Rathbun, Rebecca Horton, David Larson (U.S. Fish and Wildlife Service)

Abstract: Research Objective: The purpose of the research is to survey whether avian and bat migration is occurring along the landward shorelines of the Great Lakes (U.S.) in order to identify areas that should be avoided by wind facilities. The purpose of this presentation is to provide some initial findings demonstrating variations on avian and bat migration. The information can be used to better design pre-construction studies for wind facilities that are attempting to determine if a proposed site is located within a migration corridor. Abstract: Bird and bat presence along shorelines of the Great Lakes during migration has been previously documented, however the migration patterns and magnitude of numbers remains unknown in many areas, especially for bats. This uncertainty leads to regulatory burdens to address impacts of wind power development. Using two avian radar units (Merlin, DeTect Inc.)[1] and up to 34 acoustic/ultrasonic monitors, the U.S. Fish and Wildlife Service has collected migration specific data from multiple locations near the Great lakes shorelines during spring and fall of 2011 and 2012. This presentation will focus on fall 2011 data collected from a site located along eastern Lake Michigan and discuss patterns of migration documented at this location. We will demonstrate the type of data that would ideally be provided to document the presence or absence of bird and bat migration and suggest ways to analyze and present the data. Such analysis would ideally include observations on a seasonal, daily, and hourly basis. This preliminary data illuminates the need to analyze migration data on an hourly basis, rather than on 24-hour averages, or even nocturnal averages. We will also show time sequence graphs demonstrating how migration changes through the season and the implications for sampling. This information may assist other researchers who conduct pre-construction studies and highlights the importance of determining timing, frequency, and length of surveys in order to document patterns of migration in a particular area along with appropriate techniques for documenting migration. The information may be useful in designing improved pre-construction surveys to

demonstrate the presence or absence of migrational corridors. The data presented will also demonstrate preliminary methods for predicting heavy migration periods.
[1]Use of trade names does not indicate endorsement by the U.S. Fish and Wildlife Service

Birds and Wind Energy: Assessing Habitat-based Impacts

"Effects of Wind Power Development on Greater Prairie-Chickens in Kansas"

Presenter: Brett Sandercock, Kansas State University

Authors: Brett K. Sandercock, Lyla M. Hunt, Virginia Winder (Division of Biology, Kansas State University); Andrew J. Gregory (School of Forestry, Northern Arizona University); Lance B. McNew (USGS Alaska Science Center); Samantha M. Wisely (Department of Wildlife Ecology and Conservation, University of Florida)

Abstract: We investigated the impacts of wind power development on the demography, movements, and population genetics of Greater Prairie-Chickens at the 201MW Meridan Way Wind Power Facility in northcentral Kansas. We used pre/post comparisons and distance to turbines to test for seven possible impacts of wind power on population performance: lek attendance, breeding behavior, use of breeding habitat, fecundity, natal dispersal, female survival, and population numbers. In a 6-year period, we monitored 23 lek sites, 251 radio-marked females, 264 nesting attempts, and genotyped ~1,700 birds. Wind power development had a weak effect on lek attendance: probability of lek persistence increased with distance from turbines, and most abandoned lek sites were located <5 km from turbines. Habitat and lek size had the strongest effects on lek attendance: leks in native grasslands with > 10 males had the highest probability of persistence. Our molecular data provided some of the first evidence for multiple mating and conspecific nest parasitism in prairie chickens. Breeding behavior was related to landscape fragmentation but was not affected by wind power development. Nest site selection and female reproductive effort were not affected by development, but female movements provided some evidence for behavioral avoidance of turbines. Reproductive success of prairie chickens was a limiting demographic factor, and was strongly influenced by high rates of nest failure and losses to predation. The strongest correlate of nest survival was vegetative cover at the nest site, and reproductive success was not related to distance to turbines. Our molecular analyses suggested that development affected natal dispersal rates, and led to changes in lek and population structure. Unexpectedly, female survival was higher after wind power development, and we hypothesize that turbines may have disrupted foraging behavior of raptors that kill prairie chickens. During the postconstruction period, risk of mortality was reduced during the lekking season and raptor kills tended to be farther from turbine sites. Mortality from collisions or harvest were rare events. In summary, Greater Prairie-Chickens were not strongly affected by wind power development in Kansas. Negative impacts included a trend for reductions in lek persistence near turbines, behavioral avoidance of turbines by females during their breeding season movements, and changes in the genetic structure of males at leks consistent with reduced dispersal or recruitment. We found no impacts of wind power development on nest site selection, female reproductive effort or nesting success, or population numbers. Positive impacts included an increase in female survival rates. Our results were based on pre/post comparisons for a broad suite of response variables and robust sample sizes, but we had limited spatial replication with one field site. We studied Greater Prairie-Chickens breeding in fragmented landscapes in the Smoky Hills ecoregion of Kansas, and it will be interesting to see if our results can be extrapolated to other sensitive species. Future studies of wildlife impacts should use similar protocols to investigate interactions between wind power and lek-mating prairie grouse in other habitats.

"Avoidance of wind turbines by grassland birds"

Presenter: Douglas Johnson, USGS

Authors: Douglas H Johnson, Jill A. Shaffer (USGS)

Abstract: The USGS Northern Prairie Wildlife Research Center has investigated the possible avoidance of wind turbines by grassland birds for ten years, 2003 through 2012. Our study sites were three major wind farms in North Dakota and South Dakota, where we were able to obtain bird data in one year before wind turbines were constructed and in several years afterward. Data collection is still in progress for this year. We will present results by species, demonstrating how densities of each varied in relation to distance to nearest turbine location, and if and how those patterns changed from pre-construction through up to nine years after development.

"Short-Term Impacts to Greater Sage-Grouse from Wind Energy Development" *(accompanied by poster)*

Presenter: Chad LeBeau, University of Wyoming; WEST

Authors: Chad W. LeBeau (Department of Ecosystem Science and Management, University of Wyoming & WEST, Inc.); Jeffrey L. Beck (Department of Ecosystem Science and Management, University of Wyoming); Gregory D. Johnson (WEST, Inc.); Ryan M. Nielson (WEST, Inc.); Matt J. Holloran (Wyoming Wildlife Consultants, LLC)

Abstract: Wind energy development is increasing in rangeland habitats, which has raised concerns relative to impacts to avian species including the Greater Sage-Grouse (*Centrocercus urophasianus;* hereafter sage-grouse). Little information exists about the impacts of wind energy development on sage-grouse; however, wind energy infrastructure is likely to directly and indirectly impact sage-grouse movements because they avoid tall structures and human activities. Changing movements may equate to different habitat selection patterns, which are predicted to lead to reduced population fitness. The purpose of our study was to document habitat occurrence and fitness parameters associated with sage-grouse inhabiting areas in close proximity to wind turbines. In April 2009 and 2010, we captured 116 female sage-grouse near Medicine Bow, Wyoming and have monitored these grouse for 2 years to evaluate nest, brood, and female survival, and habitat occurrence. We used logistic regression to develop resource selection functions to estimate habitat occurrence. We used Cox proportional hazards regression to model nest, brood and female survival. The proximity to wind turbines did not influence nest site or brood-rearing occurrence but the relative probability of summer occurrence increased in habitats closer to wind turbines. Female survival was not influenced by wind turbines but nest and brood survival were both negatively affected by proximity to wind turbines. This is the first study to evaluate short-term effects of wind energy infrastructure--specifically wind turbines--on sage-grouse fitness parameters and habitat selection.

"Ecology of Male Greater Sage-Grouse Before Wind Energy Development in South-Central Wyoming"

Presenter: Christopher Hansen, University of Missouri

Authors: Joshua J. Millspaugh (Department of Fisheries and Wildlife Sciences, University of Missouri); Mark A. Rumble (U.S. Forest Service, Rocky Mountain Research Station, Forest and Grassland Research Laboratory); Aleshia Fremgen, Christopher Hansen (Department of Fisheries and Wildlife Sciences, University of Missouri); R. Scott Gamo (Wyoming Game and Fish Department); Jon Kehmeier, Nate Wojcik (SWCA Environmental Consultants)

Abstract: We are studying demography, resource selection, and lek ecology of male greater sage-grouse (Centrocercus urophasianus) using a before-after, control-impact design on a proposed 1,000-turbine, 2-3,000 megawatt wind farm southwest of Rawlins, WY. Results from this study will be used to help identify impacts, if any, of wind energy development on greater sage-grouse. All results presented are preliminary. In spring 2011, we placed GPS-PTTs on 36 male grouse and 50 VHF transmitters on yearling/adult male sage-grouse. In Fall 2011, we marked 53 juvenile sage-grouse (25 males and 28 females) with VHF transmitters. April to December survival of GPS marked males was 49% (SE= 11); survival of males with VHF transmitters

was 51% (SE= 11) and September to December survival of juvenile sage-grouse was 55% (SE= 8). Home ranges averaged 65 (SE=21) ha in spring, 422 (SE=21) ha in summer, and 233 (SE= 51) ha in early winter. Spatial overlap of seasonal ranges was 7% between spring/summer, 3% between summer/winter, and 29% between winter/spring. Resource selection by male sage-grouse suggested positive associations with canopy cover of forbs and sagebrush height, but negative associations with sagebrush density and sagebrush canopy cover. Sightability of male grouse on leks averaged 54% (SE= 14) and was negatively influenced by sagebrush canopy cover, vegetation height-density, and distance from observer. Hourly lek attendance averaged 32% (SE= 1) which declined steadily throughout the morning. Daily lek attendance averaged 56% (SE= 3) with peak attendance in early May. Probability of male sage-grouse transitioning leks was 0.14 (SE=0.03), and 0.26 (SE= 0.05) for returning to the originating lek. Probability of lek transitions increased later in the breeding season.

Wednesday, November 28: Afternoon

Raptors and Wind Energy

"A Review and Standardizing of Raptor Fatality Estimates at Wind Energy Facilities in the Columbia Plateau Ecoregion"

Presenter: Kimberly Bay, WEST, Inc.

Authors: Wallace Erickson, Kim Bay, Michelle Sonnenberg, Elizabeth Baumgartner (WEST Inc.)

Abstract: Wind energy development is occurring in Oregon and Washington within the Columbia Plateau physiographic region (ecoregion). With this development comes the potential for direct impacts to raptors through collision mortality. Based on a review of 30 publically-available post construction fatality studies within the Columbia Plateau ecoregion (CPE), estimates ranged from 0 - 0.29 raptors per MW per year over 12 years of research. Western EcoSystem Technology, Inc. (WEST) has standardized and normalized the different fatality estimates using a protocol approved by the Oregon Department of Fish and Wildlife (ODFW), US Fish and Wildlife Service (USFWS), Iberdrola Renewables (IRI), and Oregon Department of Energy (ODOE; WEST 2012). WEST updated diurnal raptor and species-specific mean fatality rates and associated confidence intervals. WEST calculated mean fatality estimates, confidence intervals, and other statistical metrics for diurnal raptors, provided a species composition list of raptor fatalities in the Pacific Northwest, and estimated species-specific fatality rates. These mean fatality rates were then used to develop a scientific basis for defining percentiles of fatality estimates using the kernel density estimator. WEST provided estimates of population size in the CPE for each species and the associated mortality estimate for the current development and expected expansion of wind energy facilities. The adjusted fatality estimates and percentiles were used to provide context of the regional cumulative impacts of wind energy development on raptor populations. WEST also described the variability of fatality estimates between years at facilities studied for multiple years. Combined, this data provides a more complete picture of the impacts of wind energy development on raptor populations in the CPE. To further expand understanding of the factors surrounding raptor-turbine collisions, WEST conducted a comprehensive analysis of the circumstances of raptor fatalities found at these projects based on protocol approved by ODFW, USFWS, IRI, and ODOE. Detailed maps showing locations of raptor fatalities by species, turbine locations, topography, land cover, and other readily available information were included in this analysis.

"Factors affecting bird mortality in wind farms, and mitigation measures: the state of the art in Spain."

Presenter: Miguel Ferrer, Doñana Biological Station

Authors: Miguel Ferrer, Manuela De Lucas (Department of Ethology and Biodiversity Conservation, Estación Biológica de Doñana (CSIC)); Marc J. Bechard (Raptor Research Center, Department of Biological Science, Boise State University); Antonio-Román Muñoz (Fundación Migres); Guyonne F. E. Janss (Asistencias Técnicas Clave S.L.); Eva Casado (Fundación Migres); Cecilia P. Calabuig (Department of Ethology and Biodiversity Conservation, Estación Biológica de Doñana (CSIC))

Abstract: To assess and monitor the impact of wind farms on fauna is crucial if we want to achieve ecologically sustainable development of this renewable energy resource. Today there are clear evidences that the probability of raptor collision depends critically on species behavior and weather conditions, and the topographic factors related to each windmill. In our study area environmental impact assessment (EIA) studies have been based on observations of birds before the construction of wind farms. We analysed data from 53 EIAs in relation to the actual recorded bird mortalities at 20 fully installed wind farms to determine whether this method is accurate in predicting the risk of new wind farm installations. We compared bird data from EIAs with bird collisions per turbine and year at functional postconstructed wind farms to identify any relationship between pre- and post-construction studies. No relationship between variables predicting risk from EIAs and actual recorded mortality was found. In these circumstances mitigating the causes of bird mortality becomes a task of major importance, especially to those wind farms located in the Strait of Gibraltar, a water crossing of 14 km at its shortest distance acting as a major migration bottleneck for Paleo-African soaring migrants. In order to mitigate the impact on raptors, and particularly on the Griffon Vulture, in 2007 a program based on selective stopping of turbines was imposed, in collaboration with the environmental competent authority, on new approved projects. During 2008 there was a reduction in mortality by 48%, which remained in 2009 with a remarkably lower economic cost. An analysis of the temporal collision patterns will be presented and discussed, with special attention to those species suffering higher mortality rate, and to those who have some degree of threat. Furthermore EIA should be improved. Predicting soaring birds trajectories by using simulated wind currents in a wind tunnel, will allow us to know the exact position of the turbines with high collision risk, which should be re-located in the planned wind farm. We simulated three different types of wind and we noted the main trajectories predicted in a wind tunnel. Afterwards, we compared these main trajectories with the real griffon vulture movements in the same area. And we found no statistical differences between the observed griffon vultures' flight trajectories and the three wind passages observed in our wind tunnel model.

"Condor Detection and Alert System"

Presenter: Crissy Sutter, Normandeau Associates

Authors: Crissy Sutter, Chuck Grandgent (Normandeau Associates); Kevin Martin (Terra-Gen Power LLC)

Abstract: In 2009 a California condor was detected approximately 4 miles north of the proposed Alta East Wind Energy Facility (WEF). Given the limited distribution of Condors and poor site quality condors are expected to occur infrequently at this WEF. However, over the operational life of WEF (30 years) the Condor population could increase and expand their range within California. This may result in greater exposure of Condors to turbines. Due to this concern Terra-Gen Power (TGP) has determined the need for monitoring potential occurrences and avoiding condor exposure to turbines at the WEF. Although such occurrences may be infrequent, failure to detect an event is significant, both legally and biologically. Nearly all Condors carry one or more transmitters (VHF and/or GPS) and these transmitters are actively managed by the agencies. Each Condor can be tracked, monitored and uniquely identified by their frequency number. There is no current standard for condor detection at WEF. Agencies recommend full time condor observers. This approach: is costly (>$2M over 30 years), is negatively affected by observer fatigue, allows for a short response time (<5 minutes) due to limited visual detection range (<5 miles) that is further reduced by atmospheric conditions. In contrast, TGP and Normandeau are developing an automated detection system that has a lower cost (<$400,000 over 30 years), is unaffected by observer fatigue, provides a longer response time (> 20 minutes) due to a larger detection range (15+ miles), and is relatively unaffected by

atmospheric conditions. Agency personnel have identified 3 issues as critical to regulatory acceptance of an automated system: minimal false negative rates, maximize alert notification reliability, and sufficient alert response time. These concerns are being addressed during the development of the Remote Condor Observation Network (ReCON) system prior to the Fall 2012 deployment. The false negative rate (FNR) is the proportion of tagged Condors present but undetected. The FNR will be quantified and compared to the recommended human observer using free-ranging Condors under field conditions. The FNR for the system is "acceptable" if it is less than or equal to the human observer FNR. The alert reliability is the likelihood that a Condor is detected but the WEF personnel are not alerted. This may result from the malfunction of a system component, power loss, etc. The ReCON system will include internal system health checks and functional assessments that are communicated to WEF personnel hourly. Absence of the hourly status update or one describing a system malfunction will trigger corrective action to restore system health. Alert response time is the number of minutes the WEF has to respond once a Condor is detected. The alert response time is estimated to be 20 minutes based on Condor flight speeds (28 mph) and system detection radius (16 mi). This estimate will be validated at the Alta East site. The results of the system tests and validated will form the core of this presentation. Information on system deployment and function at Alta East may also be provided.

Eagles and Wind Energy

"Meteorological and topographic drivers of migratory flight of golden eagles: implications for wind energy development"

Presenter: Todd Katzner, West Virginia University

Authors: Todd Katzner (Division of Forestry and Natural Resources, West Virginia University & USA and USDA Forest Service, Timber and Watershed Laboratory); Adam E. Duerr (Division of Forestry and Natural Resources, West Virginia University); Dave Brandes (Department of Civil and Environmental Engineering, Acopian Engineering Center, Lafayette College); Tricia A. Miller (Division of Forestry and Natural Resources, West Virginia University & Riparia, The Pennsylvania State University); Michael Lanzone (Cellular Tracking Technologies LLC); Charles Maisonneuve, Junior Tremblay (Ministère des Ressources naturelles et de la Faune); Robert Mulvihill (Audubon Society of Western Pennsylvania); George T. Merovich, Jr. (Division of Forestry and Natural Resources, West Virginia University); Kieran O'Malley (West Virginia Division of Natural Resources); Jeff Cooper (Virginia Department of Game and Inland Fisheries)

Abstract: Wind power is a fast-growing industry with broad potential to impact volant wildlife. Understanding these impacts is critical to developing effective strategies and recommendations for siting turbines and for minimizing impacts to animals. Understanding the drivers of migration behavior and flight behavior when migrating are important to evaluating risk of flighted species. We used GPS data collected from golden eagles Aquila chrysaetos tracked with satellite and GSM telemetry to evaluate potential risk to eagles and other raptors from wind turbines along migratory routes. Eagle movements during migration were classified as local or migratory and were characterized based on the type of terrain over which each bird was flying and its distance from wind resources preferred for energy development. Birds engaged in local movements turned more frequently and flew at lower altitude than they did in active migration. This flight behavior potentially exposes them to greater risk from turbines than they experience when engaged in longer distance movements. Eagles flew at relatively lower altitude over steep slopes and cliffs than over flats and gentle slopes. By comparing migratory movements with weather data (NOAA, NCEP, Regional Reanalysis) we show that the meteorological conditions during migration (e.g., wind speed, wind direction, and ground heat flux) differ between spring and fall. During spring, migration occurred low to moderate wind speeds, southwest winds, and negative ground heat flux (atmospheric heating). Such conditions facilitate thermal soaring and migration with a tail wind. During fall, migratory flights were associated with moderate to high wind speeds originating from the west and positive ground heat flux. Fall conditions facilitate use of orographic lift without head winds. Our research identifies generally how topography and

weather interact with raptor migration behavior to drive potential human-wildlife conflict that results from wind energy development. With global climate change, weather patterns in the northeast are expected to change, which will in turn alter migration strategies for Golden Eagles. At potential wind energy development sites, risk assessment for volant birds and mammals needs to incorporate understanding of both local topography and its relationship to the varied types of movement behavior that wildlife can exhibit. In addition, identifying specific weather patterns associated with high-risk flight will allow managers of wind-energy developments to identify when soaring birds are at highest risk.

"The Bayesian eagle risk model: input implications, study design, and fatality estimates"

Presenter: Chris Farmer, Tetra Tech EC, Inc

Authors: Chris Farmer, Laura Nagy (Tetra Tech EC)

Abstract: The USFWS now allows for incidental eagle take under the Bald and Golden Eagle Protection Act. One of the critical parts of the permit application is the estimate of take of golden eagles. For a wind energy project, this value will drive the risk category assigned by USFWS and will provide the basis for the amount of compensatory mitigation. In its 2011 draft Eagle Conservation Plan Guidance, USFWS developed a quantitative model of take derived from pre-construction estimates of use by eagles. In the West Butte Wind Project's Ecological Assessment, the USFWS released a new Bayesian version of the fatality model. The objective of this presentation is to discuss the input values that drive eagle fatality projections and to provide guidance for pre-construction study design to minimize the loss of precision in fatality estimates that arises from scaling. We use model simulations to illustrate the effect of decisions regarding the input values. Changes in inputs to the model can have a dramatic impact on the model output. One of the most significant is the rotor diameter, because it drives the calculation for the hazardous area, or strike zone. In the West Butte EA, the USFWS suggested using 2x the rotor diameter to account for possible turbulence effects beyond the blade tip, although they often use 100 meters as their default value. The rotor diameter is squared in the calculation of hazardous area, placing a premium on ensuring the correct size of the rotor diameter and resulting in different fatality estimates among different turbine types. The new model has implications for survey design. The input value for the Bayesian model is eagle minutes over the project. The draft Guidance suggests limiting this to eagles flying below 175m, but collisions are only possible within the rotor swept zone, which is specific to the type of turbine, and generally well below this height. Eagle flight data are collected using point counts and the draft Guidance recommends that these point counts last 30 minutes. However, because the Bayesian model extrapolates each eagle minute based on the spatial area and daylight hours sampled by the point count surveys, conducting 30 minute point counts can cause high fatality estimates due to scaling. This scaling can be minimized by increasing the area of the project covered by the point counts and expanding the length of the point counts from 30 minutes to 1-2 hours. These parameters reduce the scaling by increasing the proportion of daylight hours and total area sampled. The Bayesian fatality model forces developers to carefully balance up-front survey cost with potential mitigation and opportunity costs when designing their pre-construction eagle surveys. Thought should be given to the data inputs necessary for the fatality model when designing pre-construction avian surveys to avoid costly duplication of effort later in the process.

"Understanding the USFWS Golden Eagle Collision Risk Model"

Presenter: Kenton Taylor, WEST, Inc.

Authors: Kenton Taylor, Wallace Erickson, Andy Merrill, Kim Bay, Elizabeth Baumgartner (WEST, Inc.)

Abstract: The USFWS has recommended the use of a Bayesian approach to predicting the level of anticipated golden eagle fatalities at proposed wind energy projects. The Bayesian approach uses information on golden eagle use and mortality at existing wind projects as a starting point or best guess of anticipated impacts (i.e., the "prior distribution") incorporated with site specific information collected on the project regarding golden

eagle use and turbine design and siting. Due to numerous inquiries regarding USFWS Bayesian Collision as well as inquiries into the level of take predicted by the USFWS method for currently proposed projects, Western Ecosystems Technology, Inc. (WEST) conducted a series of simulations to better understand the USWFS methodology. WEST will present the results of several simulation analyses examining various survey methodologies (e.g. survey length and total survey effort) and the effect of wind farm design on site-specific predicted eagle mortality. In addition, predicted eagle mortality under the USFWS methodology is strongly influenced by the 4 studies used to develop the USFWS model (three of which are known to consist of older generation turbines). WEST will compare and contrast the wind energy facilities used in model development to assess their impacts in evaluating predicted eagle mortality at other wind energy facilities. Guidance will also be given for the utilization of eagle risk metrics in turbine siting, eagle habitat conservation plans, and environmental permitting.

"Power Pole Retrofitting as a Compensatory Mitigation Option for Eagle Take: Opportunities, Constraints, and Logistical Considerations"

Presenter: Sherry Liguori, APLIC and PacifiCorp

Authors: Sherry Liguori (PacifiCorp & Avian Power Line Interaction Committee); Mike Best (Pacific Gas & Electric Co.)

Abstract: Power pole retrofitting has been proposed as one possible compensatory mitigation option for eagle take at wind facilities in the U.S. Other forms of compensatory mitigation are also being evaluated. This presentation discusses the opportunities and benefits of implementing a power pole retrofit program for compensatory mitigation, and the challenges and logistical considerations needed to be resolved as such programs are developed. Power pole retrofitting provides an opportunity to quantify mitigation efforts, and provides reasonable assurances of effectiveness, provided that proper retrofitting methods and materials are used. Such retrofitting efforts for compensatory mitigation would expedite and/or supplement proactive retrofitting efforts already being implemented by the electric utility industry. To effectively implement a quality program, the Avian Power Line Interaction Committee (APLIC) recommends that a recipient utility be able to demonstrate: (1) that they are accountable for retrofitting their own known mortality poles; (2) they have a mechanism in place to identify other high risk poles that would be eligible for retrofitting as part of a wind mitigation agreement; (3) they are using retrofitting methods and materials that meet or exceed APLIC recommendations. Typically, these would be components of an implemented Avian Protection Plan (APP). The eagle power pole compensatory mitigation would go above and beyond the commitments of a robust existing APP by either increasing the number of poles being retrofitted or expediting long-term retrofitting timeframes. Other concerns that would need to be addressed between a wind company and electric utility would include the average cost per pole for retrofitting, monitoring and long-term maintenance of retrofitted poles to ensure they continue to function as avian-safe for the duration of the agreement, and retrofitting methods (e.g., covers versus reframing). A quality control or inspection program to ensure complete retrofitting and proper installation of products is critical to long-term effectiveness. In addition, retrofitting methods and products should be applicable to local conditions (e.g., wind, salt spray, contamination) to increase the longevity of the retrofit. Retrofitting cost per pole is influenced by many factors and not necessarily indicative of retrofit quality or longevity; consequently, the utility should be able to determine the most appropriate retrofitting method for the given location and circumstances. As pole retrofitting agreements are developed between electric utilities and wind companies, lessons learned should be shared with both industries and the U.S. Fish and Wildlife Service so that subsequent agreements can be improved or refined. Likewise, there should be flexibility when developing such agreements so that local conditions and circumstances, eagle populations, etc. can be considered.

"Potential compensatory mitigation options for golden eagles"

Presenter: Laura Nagy, Tetra Tech

Authors: Laura Nagy, Chris Farmer, Julie Garvin (Tetra Tech)

Abstract: Programmatic permits for incidental take of eagles under the Bald and Golden Eagle Protection Act require compensatory mitigation for any unavoidable take. However, the only example provided in the 2011 USFWS Eagle Conservation Plan guidance is power pole retrofitting, which is not a viable option for most wind projects. Our objective was to evaluate alternative mitigation options for golden eagles for the Desert Renewable Energy Conservation Plan (DRECP). These can also be applied to wind projects outside of the DRECP region. Here, we 1) compile the documented causes of eagle fatalities in California, 2) evaluate which of those causes are most frequent and logistically feasible to address, and 3) describe the three best options – lead abatement, funding for wildlife rehabilitation centers, and roadside carcass removal to prevent vehicle collisions with golden eagles. Lead is known to directly and indirectly cause mortality in eagles. The primary sources of lead exposure for golden eagles are embedded lead shot or fragmented bullets ingested from animals wounded or killed with lead-based ammunition. We reviewed five lead abatement programs, both voluntary and involuntary, and concluded that both types of programs can be successful in reducing lead concentrations in raptors. Success was achieved through educating hunters on the ecological and health impacts of lead ammunition, and providing a financial incentive through free non-lead ammunition. This is a viable mitigation option because the large number of eagles with high lead levels indicates that a lead abatement program could benefit many eagles: success would require implementation on a large scale and financial support across multiple projects. Golden eagles are admitted and released from wildlife rehabilitation centers. Both banding and telemetry records show that golden eagles can live for years after being released. Funding is needed to maintain the current rehabilitation programs to cover housing, food, and veterinary costs; however, USFWS has expressed that they also want to see improvements. Improvements could include testing and treating all eagles for lead poisoning, funding the creation of flight cages, educating rehabilitators on the proper housing and treatment of eagles, and improving the transportation network for moving eagles among facilities. This is a viable mitigation option because it is economically and logistically feasible to offset take levels on a small scale. Golden eagles are at risk of collision with vehicles when they forage on road-killed wildlife. This fatality source may be offset by removing carcasses from roadsides to reduce the risk of vehicles colliding with feeding eagles. The reduction in number of eagles killed equates to the number of eagles "saved." To develop the number of miles required to offset an eagle, multiple assumptions are needed such as the number of roadside carcasses available, the percentage of roadside carcasses that have feeding eagles, and the percentage of eagles feeding on roadside carcasses that get hit by cars. This is a viable compensatory mitigation option for a range of take levels, but will require adaptive management throughout the process and will be most successful in areas with high densities of large mammals.

"Navigating the USFWS Eagle Guidance with respect to Bald Eagles"

Presenter: Mike Morgante, Ecology and Environment, Inc.

Authors: Mike Morgante (Ecology and Environment, Inc.)

Abstract: The U.S. Fish and Wildlife Service (USFWS) issued Draft Eagle Conservation Plan (ECP) Guidance in February 2011 and a revision is forthcoming. This guidance, issued under the auspices of the Bald and Golden Eagle Protection Act, is intended to assist parties to avoid, minimize, and mitigate adverse effects on eagles and defines the process for obtaining a non-purposeful take permit if avoidance and minimization efforts don't reduce the risk of a take to an "acceptable" level. Bald Eagles are increasing over much of their range and becoming a siting and permitting issue at more proposed wind sites; however, impacts on Bald Eagles from wind have been limited and much of the attention on the USFWS guidance has been on Golden Eagles. Advanced conservation practices (avoid/minimize/mitigate) will be evaluated for feasibility and practicability with wind projects. Wind siting challenges and permitting issues will be reviewed for this increasingly common species. The presentation will evaluate how the USFWS risk model treats Bald Eagles and whether the generic eagle modeling approach for avoidance/risk is applicable to Bald Eagles as much as

Golden Eagles in the absence of more pertinent information. The collision mortality rates predicted based on exposure rates generated from site surveys and other information will be evaluated and their importance as a tool to be used by developers in assessing the permitting risks of a particular site. The presentation will draw upon the experience we gained working at multiple proposed sites with Bald Eagle issues in the eastern U.S. and a review of Bald Eagle occurrence and impacts at existing sites. Study design with respect to proximity to eagle nests, number of surveys, geographical coverage, and seasonal coverage will be evaluated to identify critical issues early in the site development process and improve the confidence USFWS will place in the modeled results. The presentation will also discuss how the results of the modeling will be used to determine whether a non-purposeful take permit will be recommended and the schedule implications if a take permit is recommended. Learning Objectives • Gain understanding of the USFWS Eagle Conservation Plan Guidance with respect to Bald Eagles. • Evaluate practicability for advanced conservation practices for Bald Eagles • Apply knowledge of sensitivities to identify critical issues early in the site development process. • Apply knowledge of sensitivities to survey design approach. • Understand how the exposure modeling results will be used toward USFWS permit recommendations. • Identify schedule implications if a non-purposeful take permit is recommended.

Thursday, November 29: Morning

Estimating Fatalities of Birds and Bats

"An Empirical Approach to Fatality Estimation at Wind Energy Facilities"

Presenter: Shay Howlin, WEST, Inc.

Authors: Shay Howlin, Wallace Erickson, Michelle Sonnenberg (WEST, Inc.)

Abstract: The number of detected fatalities during standardized carcass searches below a subset of turbines at the facility can be used to estimate the expected number of fatalities attributed to a wind energy facility. Since observers are unable to discover all fatalities within a searched area (searcher efficiency) and scavenging of carcasses between searches (carcass removal) can occur between searches, bias correction factors have been established to account for this imperfect detection. Historically bias correction factors have been calculated from searcher efficiency and carcass removal trials. Multiple methods for conducting these trials and calculating the resultant bias correction factor have been established. WEST inc. has developed a novel approach to empirically estimate this bias correction factor. WEST will present the field methods to calculate this estimate and will compare its performance to four commonly used methods for estimating the bias correction factor: 1) Jain et al. (2009), 2) Smallwood (2007), 3) Huso (2010), and 4) Shoenfeld (2004). West will provide recommendations regarding the appropriate application of each method and their comparability.

"Statistical Examination of the Efficacy of Road and Pad Searches for Post-construction Monitoring"

Presenter: Michelle Sonnenberg, WEST, Inc.

Authors: Michelle Sonnenberg, Andy Merrill, Jon Cicarelli, Wally Erickson (WEST, Inc.)

Abstract: The USFWS guidelines recommend that all wind projects do at least one year of post-construction monitoring to determine impacts to birds and bats from the site. In the Midwestern United States, where land associated with wind farms is primarily used for agricultural purposes, these monitoring studies can be difficult and costly. Where standing crops are present, it is necessary to implement measures to counteract poor carcass detectability conditions. One such method is the double sampling approach consisting of searches on a select number of plots fully cleared of vegetation and a greater selection of plots on the gravel road and turbine pad. The road and pad are high visibility areas, which can be quickly and efficiently

searched. The effective area searched is similar or greater than that of a more typical study, but the chance of finding carcasses within the searched area is increased, and the cost is significantly reduced. To produce a fatality estimate, the number of fatalities falling on the road and pad of cleared plots is compared to the number of fatalities on the entire cleared plot. These values are used to calculate a correction factor, which is then applied to the fatalities on road and pad searches. Several studies have already been conducted implementing this method. However, since this method is relatively new, it was unknown whether or how the correction factor would change across project sites and/or time. To determine how much variability might exist in the correction factor and whether this factor is transferrable across projects or years, a study was done examining data from previous projects. Data was considered from Iberdrola Renewables' projects both past and present in which full plot searches were conducted. Using photographs, UTM locations, or notations by observers, it was determined which fatalities fell on the road and pad versus the full plot. Correction factors were retroactively calculated for each project and comparisons were made among geographic regions, turbine types, and years of study. Cross-validation methodology was applied to determine the sensitivity of the correction factor to changes in project selection. The optimal number of turbines that should be selected for clearing to achieve a reliable correction factor was also determined. Finally, correction factors were compared to the standard area correction factor calculated using 10m distance rings. Results of this study suggest that data can be combined across projects to determine and increase stability of road and pad correction factors. On a project-specific level, the necessary sample size for determining a robust road and pad correction factor varies by site and study characteristics. Results of this analysis can be used to determine the minimum number of cleared plots to achieve the desired level of precision in estimates. Finally, when an appropriate number of cleared plots are surveyed, the road and pad correction factor appears to perform similarly to the generally accepted area correction factor.

"Evaluating the validity of a protocol for long-term, post-construction fatality monitoring to assess wildlife impacts that integrates with operation's activities and personnel."

Presenter: Jerry Roppe, Iberdrola Renewables

Authors: Jerry Roppe, Tina Bartunek (Iberdrola Renewables); Michelle Sonnenberg, Wally Erickson (WEST, Inc.)

Abstract: The US Fish and Wildlife Service (USFWS) Wind Energy Guidelines (WEG) recommend that all wind projects conduct post-construction (baseline) wildlife fatality monitoring to determine impacts to birds and bats from the site. This monitoring uses standardized carcass searches, bias trials for searcher efficiency, and carcass removal conducted by trained biologists. The monitoring is conducted in accordance with industry standard or regulatory protocol, typically one to two years. Depending on actual protocols implemented, it provides fatality rates for the period but is often expensive and short-lived without an ongoing mechanism to monitoring impacts. IR is evaluating the validity of an alternative or supplemental approach to post-construction (baseline) wildlife fatality surveys using a long-term Operational Monitoring program integrated with operations and as part of the Company's Wildlife Monitoring and Reporting System (WMRS). This approach presents an opportunity to reduce initial baseline fatality survey effort and expense and provide a means to monitor long-term impacts from wind operation. The Operational Monitoring objectives are to systematically monitor and report wildlife casualties (dead and injured), assess the project's long-term operational impacts and casualty trends, and accumulate long-term data on species composition. It consists of a systematic approach to post-construction monitoring and reporting of bird and bat casualties, T&E species sightings, and nest management on plant power lines. It consists of 3 components: 1) incidental, 2) turbine checks, and 3) inspections. Incidental observations include all operations personnel reporting any wildlife incidents (i.e., fatalities, injuries, nests, sightings) observed on the project during their daily work activities. Turbine checks consist of monthly visits to every turbine. Trained personnel check around the turbine base (gravel pad) for any bird or bat casualties. The inspections are conducted weekly by a specially trained operations technician designated the Environmental Coordinator (EC) during spring (8 weeks) and fall

(10 weeks) of selected turbines (depending on the size of the facility) for bird and bat causalities. The EC will survey the areas surrounding the turbines and search an 80-meter (m) transect along the access road on either side of the turbine. Results (numbers, species, and spatial and temporal patterns) of Operational Monitoring conducted at over 40 projects in 2011 and 2012 will be presented with assessment of the validity of the approach and implication for future application. For example, this will based on approximately 2900 inspections conducted in 2011 at over 200 turbines on over 30 projects and supplemented by results through fall 2012.

"Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities: Modeling time dependence due to searcher proficiency and carcass persistence and implications for monitoring design"

Presenter: William Warren-Hicks, EcoStat/Cardno Entrix

Authors: William Warren-Hicks (EcoStat/Cardno Entrix); Brian Karas, Loan Tran (EcoStat, Inc.); James Newman (Normandeau Associates); Robert Wolpert (Duke University)

Abstract: Wind energy and wildlife stakeholders have collaborated to survey avian and bat activity and study the impacts of wind project operations, and policymakers have incorporated research protocols into the permitting process. The California Energy Commission (CEC) awarded a Public Interest Energy Research grant to the California Wind Energy Association (CalWEA) to rigorously evaluate the procedures provided in the California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development for estimating mortality of birds and bats associated with collisions with wind turbines. The goal of this project was to conduct research to improve the accuracy of methods for estimating the number of bird and bat fatalities at wind energy facilities by evaluating the effect of time-dependency on the probability of bird and bat scavenging and removal (carcass persistence) and detection by searchers (searcher proficiency). This study is the first to quantitatively document the long-term relationship between carcass age and the ability to detect the carcass and offers lessons and implications for experimental designs and the field monitoring recommendations provided in the CEC Guidelines. Data were collected from selected turbine strings located in the Altamont Pass Wind Resource Area near Livermore, CA from January 7, 2011 to April 30, 2011. These data can be used to create traditional scavenger removal and searcher proficiency functions, novel combined and cumulative proficiency functions, as well as to test commonly used searcher proficiency functions. Searcher proficiency and carcass persistence are shown to be time-based processes. Carcass size is a key variable that influenced both searcher proficiency and carcass persistence. Bats are harder to find than birds, and all carcasses have low searcher proficiency after three weeks. This finding of increased persistence of bats relative to birds may not be expected based on the current literature, and, coupled with the lower detection rates of bats than birds, could lead to gross error in the expected mortality of bats if new bat-specific estimating equations are not fully developed and tested. Study results indicate that searcher proficiency is a function not only of environmental variables but of carcass age. The study's finding that carcasses have the highest chance of being detected during the first two weeks has implications for study design. Further, searcher proficiency trials should occur on a year-round basis, and should be conducted over time periods recommended by the study. Conducting the trials at multiple times throughout the year is recommended to capture the interaction of carcass age and seasonal environmental changes on searcher proficiency.

Planning for Cumulative Impacts

"Part 1: Collaborative Landscape, Conservation Approach, and Benefits of the of the Great Plains Wind Energy HCP (GPWE HCP)." *(accompanied by poster)*

Presenter: Karen Tyrell, BHE Environmental

Authors: Karen Tyrell, Kely Mertz (BHE Environmental); Abby Arnold, Elana Kimbrell (Kearns & West)

Abstract: 19 wind industry companies, in collaboration with the US Fish and Wildlife Service (USFWS) and state agencies, are developing the Great Plains Wind Energy Habitat Conservation Plan (GPWE HCP) to evaluate and respond to potential impacts to federally listed species related to the future development of wind energy facilities in a nine-state, 200-mile wide region of the central US, extending from Canada to the Gulf of Mexico. Often, the proponent for an HCP is a single entity that prepares a permit application. In this case, wind companies have organized themselves through their affiliation with the American Wind Energy Association to develop a landscape level HCP. Throughout development of the HCP, industry has been collaborating with the USFWS as well as each of the state wildlife agencies included in this 268 million acre HCP plan area. When the process was launched, the companies and FWS set out a joint mission for the HCP process: "…to work cooperatively, to exercise flexibility and ingenuity, and to devote the necessary resources to craft a scientifically and legally defensible HCP that provides a means for reasonable wind power development in the planning area, that will support the survival and recovery of the species covered in the HCP." (December 2009). The GPWE HCP is analysing potential impacts resulting from the proposed development and operation of wind energy facilities on two endangered species: the whooping crane and interior least tern; one threatened species, the piping plover; and on the lesser prairie-chicken, a candidate species. Extensive and robust modelling approaches are being used to describe the proposed build-out of wind energy facilities to be covered by the HCP, as well as to determine the potential impacts of both the proposed covered actions and the conservation measures addressed in the plan. Empirical data and expert opinion from the scientific and resource agency communities have been incorporated to inform both effect analyses and the applicability of measures to avoid and minimize impacts to the species addressed in the HCP. The HCP will replace project-by-project permitting for included wind energy projects over a proposed permit duration of 45 years in one of the richest wind resource areas in the country. Because approval of the HCP will lead to issuance of a federal permit, a NEPA analysis will also be completed. An EIS, completed by the US Fish and Wildlife Service, is underway to evaluate effects of permit issuance in accordance with the proposed conservation plan. In addition, FWS will complete ESA Section 7 requirements on the proposed permitting action. These processes allow further evaluation of the analyses and conservation measures described in the HCP. The presentation will highlight the benefits of this regional conservation planning approach.

"Part 2: Collaborative Landscape Conservation Approach: Modeling potential impacts to migratory whooping cranes from wind power development" *(accompanied by poster)*

Presenter: Chris Nations, WEST, Inc.

Authors: Christopher S. Nations, Shay Howlin, David P. Young (WEST, Inc.)

Abstract: Nineteen wind energy companies in collaboration with the US Fish and Wildlife Service and state wildlife agencies are developing a regional Habitat Conservation Plan (HCP) to address potential incidental take of whooping cranes (Grus americana) resulting from construction and operation of wind facilities. The HCP permit area includes the US portion of the whooping crane migratory corridor, a 200-mile wide swath connecting the wintering grounds in south Texas with the breeding grounds in Canada. Our approach to estimating potential take of cranes over the 45-year duration of the HCP entails multiple interdependent mathematical and statistical components. Impacts are categorized as either indirect (energetic cost due to avoiding wind facilities) or direct (collision with wind turbines). The program build-out, addresses the siting of future wind projects for modeling purposes only. Siting relies on a "development potential" map based on landscape features (e.g., wind resource, proximity to transmission line) ranked in importance by industry participants. Total megawatt capacity within the corridor is based on US Department of Energy projections for 20% renewable energy goals by 2030. Within the build-out model, wind facilities of specified capacity are added to the landscape sequentially using an unequal probability sampling approach – areas with higher development potential have higher selection probability. The process stops when total capacity is reached.

The second component is a statistical model that predicts roosting/stopover habitat throughout the corridor. Resource selection function (RSF) models were fitted to data on confirmed sightings of cranes at stopover locations, separately for the fall and spring migratory seasons. Landscape-level covariates in both models included distance from the migratory corridor centerline, wetland density, distance to water, and either proximity or acreage of agriculture. The third component is a simulation model for whooping crane migration that uses both the build-out and the RSF results. RSF predictions influence selection of simulated roosting locations, while the build-out presents wind projects that may be encountered in flight. The objectives of this model are to estimate indirect impacts in terms of additional distance flown in avoiding projects, and to calculate the rate at which projects are encountered for subsequent estimation of direct impacts. Initial results indicate that indirect impacts are negligible and that the encounter rate, while low, may be important. The final component is a collision risk model based on whooping crane characteristics and assumptions regarding wind project layout, turbine size, and wind conditions. Preliminary simulations show that collision risk for cranes is high compared to other avian species, as expected given their large size and low flight speed. Using realistic assumptions of avoidance probabilities, final estimates of collision risk are combined with encounter rate estimates from the migration model and with projected population sizes to yield predicted take over the 45-year permit duration. Our approach to impact assessment provides a defensible component of the HCP that could be duplicated for other avian species.

"Lessons Learned from the Frontline: Challenges and Solutions to Habitat Conservation Planning for Indiana bats"

Presenter: Cara Meinke, WEST, Inc.

Authors: Cara Wolff Meinke, Dave Young (WEST, Inc.)

Abstract: Fatalities of five federally endangered Indiana bats (Myotis sodalis) at wind power projects over the past four years have increased awareness of the potential impact to this species from wind power development and have highlighted the need for proactive conservation planning for the species. Biologists at Western Ecosystems Technology, Inc. (WEST) are preparing seven project-level Habitat Conservation Plans (HCPs) one programmatic HCP for federally endangered Indiana bats for wind power projects across the species' range. Through this experience, WEST biologists have come to understand the challenges of preparing robust and scientifically defensible HCPs that are acceptable to both project proponents and the U.S. Fish and Wildlife Service. While the entire HCP development process is challenging to navigate, there are three key elements that have proved to be most challenging across all HCPs: 1) estimating the amount of take likely to occur from operation of the wind facility, 2) understanding and accurately determining the biological impacts of this taking, and 3) designing a conservation strategy that adequately minimizes and mitigates this impact. To address these challenges and provide potential solutions, we present currently available methods and approaches for each of these HCP components. We present three common methods for estimating take and the benefits and drawbacks of each approach. We then describe the factors that need to be considered when estimating the impacts of the take, including defining and estimating the size of the population at risk and making assumptions about population structure and expected future reproductive and survival rates. We then describe various strategies that have been used to minimize take, including feathering turbine blades below different wind speeds and consideration of various factors such as temperature and time of night adjustments to curtailment. Finally, we describe the challenges to developing a mitigation plan for take that cannot be avoided or minimized, including how to determine a value for each individual bat taken, where protected habitat should be located, and how to monitor for effectiveness of mitigation over time. Although each individual project will require a unique approach tailored to its specific needs, these lessons learned provide insight that can be used to guide development of future HCPs that support the survival and recovery of Indiana bats, while minimizing the time and resources needed from both wind power developers and the federal government.

Bats and Wind Energy: Assessing Risks and Impacts

"A Computational and Analytical Study of Bats Flying Near Wind Turbines: Implications Regarding Barotrauma"

Presenter: Daniel Houck, NREL

Authors: Daniel R. Houck, M. J. Lawson, Robert W. Thresher (National Renewable Energy Lab, National Wind Technology Center)

Abstract: Dead bats are found around wind turbines with injuries that are indicative of barotrauma, which could be caused by the low-pressure regions around operating wind turbine blades. Recent studies have hypothesized that barotrauma may be a significant cause of bat fatalities [Baerwald et al. 2008, Kunz et al. 2007], although more recent research calls this hypothesis into question [Rollins et al. 2012]. To date, no research has studied the pressure variations that bats are exposed to while flying near modern utility-scale wind turbines to determine if the pressure variations are large enough to cause fatal barotrauma. In this study, computational fluid dynamic simulations and analytical calculations of flow around a rotating wind turbine blade were performed to estimate the range of pressure-time histories (i.e. pressures and pressure change durations) that bats are exposed to while flying around operating utility-scale wind turbines. We found that bats could be exposed to essentially instantaneous pressure decreases as large as 1390 Pa. The results were compared with survivable over- and under-pressure events for rats and mice, as there is no reference data on survivable pressure-time histories for bats. The comparisons suggest that the pressure changes experienced by bats flying near a typical utility-scale turbine are at least an order of magnitude smaller than the threshold for lethality in mammals of equal mass. It therefore appears unlikely that barotrauma is a significant cause of death for bats, and traumatic injuries from blade impacts are a more likely cause of death.

"Regional analysis of wind turbine-caused bat fatality"

Presenter: David Drake, Univ. of Wisconsin-Madison

Authors: David Drake, Jian-Nan Liu (Department of Forest and Wildlife Ecology, University of Wisconsin-Madison); Christopher S. Jennelle (Iowa Department of Natural Resources); Steven M. Grodsky (Department of Forestry and Environmental Resources, North Carolina State University); Susan Schumacher (We Energies); Mike Sponsler (BHE Environmental, Inc.)

Abstract: Wind energy has been the fastest-growing renewable energy source in the United States. Studies have estimated bat fatalities at wind facilities, but direct comparisons of results is difficult and can be misleading due to the numerous differences in protocols and methods used. We had a unique opportunity to compare fatality estimates from 3 wind facilities in southeastern Wisconsin. These 3 facilities are contained within 2 neighboring counties with similar land use and land cover, used similar post-construction study methodologies, have turbine models that are close in size and nameplate capacity, and all became operational within 7 months of each other. Our objectives were to combine bat mortality across all 3 wind facilities to: 1) examine species composition; 2) examine temporal and spatial patterns of bat mortality; and 3) investigate whether select structural, habitat, and landscape features influence mortality. Corrected bat mortality was higher than reported in most other previous research in midwestern, agricultural lands in the United States. Similarities within the data were shared by all 3 wind facilities, including temporal and spatial patterns of bat mortality. Differences across the 3 wind facilities included species composition of the bat mortalities and raw and corrected number of bat carcasses recovered. Our analysis suggested that the fall season was the predictor variable that best explained bat mortality. One of our recommendations is that

individual wind facilities conduct project-specific pre- and post-construction monitoring rather than rely on published results from other wind facilities.

"Modeling the Environmental Conditions that Predict Bat Activity at Wind Energy Facilities Can Improve Mitigation Efficiency"

Presenter: Theodore Weller, USDA Forest Service, Pacific Southwest Research Station

Authors: Theodore J. Weller, James A. Baldwin (USDA Forest Service, Pacific Southwest Research Station)

Abstract: Fatalities of migratory bats, many of which use low frequency (<35 kHz; LowF) echolocation calls, have become a primary environmental concern associated with wind energy development. Accordingly,strategies to improve compatibility between wind energy development and conservation of bat populations are needed. We combined results of continuous echolocation and meteorological monitoring at multiple stations to model conditions that explained presence of LowF bats at a wind energy facility in southern California. We used a site occupancy approach to model nightly LowF bat presence while accounting for variation in detection probability among echolocation detectors and heights. However, we transposed the spatial and temporal axes of the conventional detection history matrix such that occupancy represented proportion of nights, rather than monitoring points, on which LowF bats were detected. Detectors at 22 m and 52 m above ground had greater detection probabilities for LowF bats than detectors at 2 m above ground. Occupancy of LowF bats was associated with lower nightly wind speeds and higher nightly temperatures, mirroring results from other wind energy facilities. Nevertheless, we found that building separate models for each season and considering solutions with multiple covariates resulted in better fitting models. We demonstrate the use of a tool which allows visualization of multiple environmental variables to predict bat presence that be used to improve efficiency of turbine operational mitigations. Increased mitigation efficiencies could lead to greater use of mitigations at wind energy facilities with benefits to bat populations.

"The influence of specific atmospheric variables on fall bat activity varies among geographic regions and species"

Presenter: Lauren Hooton, Normandeau Associates, Inc.

Authors: Lauren Hooton, Allison Costello, Crissy Sutter, and Greg Forcey (Normandeau Associates)

Abstract: Normandeau Associates has been acoustically monitoring bat activity at proposed wind energy facilities (WEFs) throughout North America since 2008. The broad geographical range of installed acoustic monitoring equipment, combined with a large temporal dataset, allows for a unique opportunity to examine broad-scale patterns in activity of the bat species most at risk of turbine-associated mortality and to begin to understand how their activity correlates with atmospheric variables. Our objective was to elucidate weather-specific patterns in bat species activity, and to determine which atmospheric variables had the greatest influence on bat activity. We examined the acoustic bat activity of four species collected from 1 July – 31 October at 12 sites over the continental US, encompassing 5 states and three years (2009-2011). The two geographic regions we considered were the west (seven sites in Arizona, California, and Nevada), and the mid-west (five sites in Iowa and Missouri). Species considered were Lasiurus cinereus (Hoary bat), Lasiurus borealis (Eastern red bat; not at western sites), Lasionycteris noctivagans (Silver-haired bat), and Tadarida brasiliensis (Mexican free-tailed bat; western sites only). We examined the relationship between acoustic bat activity (mean passes/night) and four atmospheric variables: temperature, wind speed, wind direction, and relative humidity. Overall, temperature and wind speed had the strongest influence on bat activity. Wind speed had the strongest effect on activity of all three species in the west, with activity of each species decreasing with increasing wind speed. In the mid-west, temperature had the strongest effect on bat activity, with activity of each species increasing with increasing temperature. Our preliminary results suggest that multiple environmental variables influence bat activity at potential WEFs across the United

States, but that the influence of individual weather variables varies among geographic regions and species. These are important factors to consider for successful mortality mitigation at WEFs.

"Wind Development in a post-white nose syndrome world"

Presenter: Brad Steffen, BHE Environmental, Inc.

Authors: Bradley J. Steffen (BHE Environmental, Inc.)

Abstract: White nose syndrome (WNS) is a disease currently affecting cave-roosting bats in eastern North America. WNS has been rapidly spreading since its discovery in New York in winter 2006-2007, and is currently documented in 20 states and four Canadian provinces. WNS is caused by the fungus Geomyces destructans. Though not known to affect humans, this fungus has been responsible for the death of over 5.7 million bats since 2007. Mortality rates in affected caves can reach 100 percent and local extirpation of several species is possible. This paper examines the regulatory changes enacted or contemplated at the state and federal level within the range of Indiana and gray bats and identifies potential measures that can be taken during project siting, development and operation to address conservation concerns related to WNS. Two federally endangered species, the Indiana bat (Myotis sodalis) and gray bat (M. grisescens), are known to be affected. Because of the unprecedented mortality observed in other, unlisted species, the US Fish and Wildlife Service (USFWS) is now evaluating the addition of several species of bats to the endangered species list. While no additional bat species have yet been listed by the USFWS, there is a possibility that species most greatly impacted by WNS may be listed in the foreseeable future. In June 2011, the USFWS initiated a formal status review of Eastern small-footed and Northern long-eared bats. Following the status review, the USFWS will issue a 12-month finding stating whether Endangered Species Act (ESA) listing and critical habitat designation is warranted. While the formal process for listing species can be lengthy and time consuming, emergency ESA listing could be initiated due to the rapid decline of hibernating populations in the Northeast and the rapid spread of WNS into the Midwest. The USFWS is also requesting data regarding a number of additional cave-roosting species, potentially in anticipation of additional status reviews. Several states (MA, MN, NY, OH, VT, WI) have afforded legal protection of varying degrees to cave roosting bat species in light of WNS. With the possible, perhaps likely, expansion of the endangered species list in the near future, wind developers may be required to consider newly listed bat species when completing pre-construction surveys and environmental documentation, including documents prepared in compliance with ESA or the National Environmental Policy Act (NEPA). This may result in new survey guidelines, management, and monitoring actions to conserve bats. Understanding the need for, and application of, new survey and monitoring methods will help developers effectively plan project budgets and schedules.

Offshore Wind Energy: Siting and Assessment

Panel discussion; specific research presented as posters.

Friday, November 30: Morning

Lessons Learned: Syntheses Across Projects

"Relating Pre-Construction Bat Activity and Post-Construction Fatality To Predict Risk at Wind Energy Facilities"

Presenter: Cris Hein, Bat Conservation International

Authors: Cris Hein (Bat Conservation International); Wally Erickson, Jeff Gruver, Kimberly Bay (WEST, Inc.); Ed Arnett (Theodore Roosevelt Conservation Partnership)

Abstract: Risk assessment options are needed for wind energy development, particularly as concerns over the potential cumulative impacts of wind powered turbines on bat populations persist. Extensive resources are devoted to studying bat activity patterns at proposed wind energy facilities, but it remains unclear whether these studies provide natural resource managers and wind developers the necessary information required to predict impacts to bats. Pre-construction bat surveys commonly employ acoustic detectors to assess species composition, spatial and temporal activity patterns, and weather conditions under which bats are most active. These data may assist with on-site decision-making and optimizing potential minimization strategies (e.g., raising turbine cut-in speed during periods of high risk). However, using these data to predict post-construction fatality and quantify risk of a site is unproven. Until recently, our ability to investigate this relationship was limited because so few sites conducted both pre- and post-construction studies. Increases in the number and extent of surveys now make meta-analysis possible for a nation-wide assessment. In summer 2012, we compiled a list of available datasets and assessed which studies were appropriate for inclusion in our analysis. We synthesized these data and evaluated the efficacy of using pre-construction bat acoustic studies to predict post-construction impacts. We also examined factors (e.g., detector height, weather conditions or region) potentially influencing this relationship. Here we present our findings on whether bat activity, as measured by acoustic detectors, provides a useful metric in predicting fatality and offer ideas on how to best to proceed with future surveys.

"Assessing the Impact of Wind-Energy Facilities on North American Songbirds"

Presenter: Wallace Erickson, WEST, Inc.

Authors: Wallace Erickson (WEST Inc.), Joelle Gehring (Michigan State University), Douglas Johnson (USGS), Michelle Sonnenberg (WEST Inc.), Kimberly Bay (WEST Inc.) and Elizabeth Baumgartrner (WEST Inc.)

Abstract: The most recent detailed summary of songbird mortality at wind energy facilities was presented at the National Wind Coordinating Collaborative (NWCC) meeting in 2001 (Erickson et. al. 2001). Since that summary was published, there have been more than 80 additional fatality monitoring studies. An updated evaluation of songbird impacts is needed to provide agency personnel, the wind industry, and other stakeholders a better understanding of the current level of impact to songbirds from wind energy facilities and identify research gaps and future monitoring efforts needed for songbirds. Songbird fatalities are the most common fatality observed at wind energy facilities, and songbirds are also the most common bird group observed during pre-construction bird surveys in most areas. Based on results from over 103 publically-available studies at 64 different wind facilities, fatalities at wind energy facilities include 168 passerine and account for over 60% of all documented fatalities. We reviewed all studies and normalized the different fatality estimates based on statistical methods used. We adjusted species composition and mortality estimates based on carcass detection and removal rates. Species were classified into detection and carcass removal classes based on experimental carcass detection and removal rates. Songbird fatality estimates by region and national were calculated. Species and taxonomic group fatality estimates were calculated by region and compared to estimated population sizes. In addition, we reviewed factors affecting the probability large mortality events at communication towers and wind turbines. Large events at wind facilitie may be associated with adverse weather. We reviewed the effect of lighting: more nocturnal migrant songbird fatalities occurred at communication towers when a mix of red strobe-like and steady lighting was used than when only strobe-like lights were used. Recommendations are made from this information regarding potential avoidance strategies for songbirds at wind projects.

"Operational Mitigation of Wind Turbine Generators To Avoid Bat Fatalities: A Synthesis of Existing Studies"

Presenter: Ed Arnett, Theodore Roosevelt Conservation Partnership

Authors: Wally Erickson, Jeff Gruver, David Young (WEST, Inc.); Ed Arnett (Theodore Roosevelt Conservation Partnership); Cris Hein (Bat Conservation International)

Abstract: Efforts to minimize or reduce bat fatalities at operating wind energy facilities have been sought since realization that wind turbines can potentially kill large numbers of bats during certain times of the season. Results from some early fatality studies suggested that fatalities to bats might be highest when wind speeds were lower and that bat fatalities might by lower at non-spinning turbines. This led to the speculation that reducing or eliminating turbine rotation, during specific periods may result in reduction in bat fatalities. We have compiled data from a number of wind energy facilities in North America and in Europe that have conducted curtailment studies and experiments designed to examine the effects of experimentally raising the cut-in speed (i.e., the wind speed at which the turbines begin producing electricity) of turbines. Because of differences in both study design and site-specific conditions, we closely examined study methodologies, including cut-in speeds, fatality search methods, and fatality estimation methods and statistical inferences from this synthesis. We examined site-specific conditions such as differences in turbine height, different turbine designs and the behaviors of turbines below experimental cut-in speeds. Here we present our findings on the factors (both study- and site-specific) that influenced the results of the studies that we reviewed. We present the conclusions that are generalizable to other sites and those results that appear more site-specific. We also present optimal models (least cost for fixed mortality reduction) evaluated across these studies for cut-in speed curtailment. We present suggestions for future studies. This research is funded by DOE.

"Estimating direct fatality impacts at wind farms: How far we've come, where we have yet to go"

Presenter: Manuela Huso, US Geological Survey

Authors: Manuela Huso (USGS Forest and Rangeland Ecosystem Science Center)

Abstract: The potential impacts of wind farms on wildlife include reproductive disturbance, habitat loss, migratory disruption and direct fatality. Measuring these impacts can be difficult and may require development of new statistical tools and models to accurately reflect the measurement process. I review the recent history of approaches to estimating wildlife fatality under the unique conditions encountered at wind farms, their unifying themes and their potential shortcomings. I suggest avenues of future research to continue to address the needs of resource managers and industry in understanding direct impacts of wind turbine-caused wildlife fatality.

Posters

Assessing Risk to Birds and Bats

"Comparison of banding, acoustic, and NEXRAD radar data for studying passerine migration in upstate New York: A complementary approach"

Presenter: Evan Adams, Biodiversity Research Institute

Authors: E.M. Adams, K.A. Williams, C. Anderson, J. Fiely, R. Lambert, D. Yates (Biodiversity Research Institute); P.B. Chilson, C.M. Kuster (School of Meteorology and Atmospheric Radar Research Center, University of Oklahoma)

Abstract: We monitored bird and bat migration in the Thousand Islands region of New York using a variety of complementary methods, to provide insight for state and federal agencies and industry regarding the siting of wind power development in the region. The identification of high use areas, and an increased understanding of migratory timing, weather effects, and other variables is critical to accurately assess risk and minimize impacts from wind energy facilities. We (1) Quantified bird and bat migration on Grindstone

and Carleton Islands during the autumn 2011 and spring 2012 migration seasons, including data on species distributions, abundance, timing, diel patterns, and weather effects using bird and bat banding, avian point counts and passive acoustic nocturnal monitoring; and (2) Applied newly developed analysis methods to Next Generation Radar (NEXRAD) images to characterize migration patterns at a regional scale, and to analyze arrival and exodus patterns at five high priority islands in eastern Lake Ontario and the St. Lawrence River. The Grindstone Island bird banding station in the St. Lawrence River had high abundance and species diversity during the fall season, with an overall capture rate of 0.55 birds per net hour and 71 species banded; the spring season had a capture rate of 0.23 birds per net hour. A total of 99 new bats were banded in 98 nights of capture effort between the fall and spring seasons. Acoustic monitoring devices to detect nocturnal bird and bat movements were placed on both Grindstone and Carleton Islands in the St. Lawrence. We used Song Meter and Petterson acoustic recording setups; in the fall of 2011, 6,370 distinct avian flight calls were detected at the two locations, from a variety of species, while over 500 bat calls were detected from seven species. NEXRAD data are publicly available, and we developed tools in MATLAB and GRASS to process radar data, weather data, and the vector images for the focal islands in batch scripts. We conducted arrival and exodus analyses for five islands in the eastern Great Lakes region; created probability distribution maps to examine regional patterns over the time periods of interest; and examined migration patterns detected via radar in relation to weather patterns and acoustic and banding data. NEXRAD data was examined from multiple years, in order to place the two field seasons of data in a larger temporal perspective. Estimators of nighttime migratory activity were loosely correlated with daytime capture numbers on the subsequent day. Independent estimators of nighttime migratory activity were more highly correlated. A large proportion of migrants passing through on a given night probably do not land on island sites, and the difference between these estimators may be due to both local weather events and to the likelihood that these estimators are monitoring different populations. This study emphasizes the importance of measuring multiple endpoints during a study of migratory aerofauna, and explores the usefulness of these endpoints on different spatial and temporal scales.

"The Role of Population Modeling in Risk Assessment at Wind Energy Facilities"

Presenter: Matt Behum, Integral Consulting Inc.

Authors: Robert A. Pastorok, Damian V. Preziosi, Matthew E. Behum (Integral Consulting)

Abstract: Population modeling is an important tool for assessing risk to wildlife populations subject to multiple stressors, including increased fatality rates or habitat loss/fragmentation associated with wind energy facilities. Our objective is to demonstrate ways in which population modeling can support risk management at wind energy sites. For example, population modeling allows extrapolation of field results on increased fatality rates to ecologically relevant endpoints, such as change in mean population abundance, in age structure, or in potential population growth rate. Probabilistic models can help identify particularly vulnerable species and quantify uncertainty that is ignored in qualitative risk assessments. Data on fatality rates alone (i.e., without using population modeling to interpret them) can be a reasonable starting place for comparing potential impacts from different siting and operational alternatives. However, because the same impact on an organism-level trait, such as fatality rate, in different species may result in very different population-level outcomes depending on species life history characteristics, additional evaluation is needed. Research in other fields such as toxicological risk assessment has shown that measurements of fatality rate or other organism-level endpoints often do not translate into meaningful prediction of population-level impacts. Population modeling provides outputs that are useful for choosing among management alternatives, including mitigation/conservation measures, and for facilitating cost-benefit assessments. Resource selection functions and collision models can be combined with population modeling to provide integrated risk modeling systems to support wind energy management.

"Reproductive success of birds in relation to wind turbine proximity in Iowa"

Presenter: Molly Gillespie, Iowa State University, Department of Natural Resource Ecology and Management

Authors: Molly K. Gillespie, Stephen J. Dinsmore (Iowa State University Department of Natural Resource Ecology and Management)

Abstract: As concerns continue to rise over the costs and environmental impacts of traditional fuel sources such as fossil fuels and nuclear energy, wind energy is becoming an increasingly important factor in future energy development. Previous studies have assessed the impact of direct mortality for birds from wind turbines, but few have looked at indirect effects. Our objective was to model avian nest survival with relation to proximity to turbines to determine if turbine proximity altered the productivity of a site. We hypothesized that nest survival might be lower at the turbine sites versus the control sites, perhaps due to changes in stress levels or predator communities, both of which could be altered by the changes in land use, fragmentation of the landscape, or increased human traffic that is related with wind farms. We modeled the daily survival of > 400 Red-winged Blackbird nests at wind farms and paired control sites in three Iowa counties (Story, Osceola, and Hancock) from May through July of 2011 and 2012. Nests were visited every 3-4 days after discovery until they either failed or succeeded. We used Program MARK to model the survival of nests as a function of site- and nest-specific covariates during both incubation and nestling stages. During the incubation stage the best model included a site-by-treatment effect with differences in daily survival between the three counties, as well as greater success at control sites versus wind farms. There was also a quadratic pattern of seasonal variation, with daily survival decreasing early in the season and increasing later in the season. Daily survival (S) peaked at the beginning of the nesting season (S=0.99) and reached a low point at the wind farm sites mid-season (S=0.82). Nestling daily survival did not vary between the wind farm and control sites, and showed a linear decrease in survival over the season (S=0.99 to S=0.84). Patterns in the daily survival of nests illustrate a possible consequence of wind turbines on a nesting songbird and should be considered when creating wind turbine placement guidelines.

"Bird responses to wind turbine proximity in Iowa"

Presenter: Molly Gillespie, Iowa State University, Department of Natural Resource Ecology and Management

Authors: Molly K. Gillespie, Stephen J. Dinsmore (Iowa State University Department of Natural Resource Ecology and Management)

Abstract: The greatest threat facing birds today is habitat loss or degradation due to human development and disturbance. Previous studies at wind farms in Iowa have focused on the impact of direct mortality for birds from wind turbines, but few have looked at the indirect effects such as possible bird displacement. We hypothesized that birds with different life histories would have varied responses to turbines, depending on factors such as the nesting and foraging requirements of the species. These effects could range from no effect to attraction (e.g., Killdeer because of graveled access roads) or avoidance behavior (e.g., many area-sensitive grassland birds). We evaluated the response of ten common Iowa breeding birds to wind turbines in three Iowa counties (Story, Osceola, and Hancock). From June 1 through July 15 of 2011 and 2012, we conducted >1500 point counts utilizing distance sampling to assess bird community responses at wind farms and paired control sites. We used Program MARK to estimate the detection probability in relation to site- and observer-specific covariates and then estimated densities for common species as a function of distance from turbines. Detection probabilities varied based upon the observer, wind speed, distance of bird from observer, and cloud cover. Evidence for avoidance behavior was found with the Red-winged Blackbird, which tended to increase in density (from 0.01 to 3.10 birds/ha) as the distance from wind turbines increased. . The Dickcissel showed a strong treatment effect at distances up to 500 m from a turbine; densities out to this distance averaged 0.1 birds/ha at wind farm sites and 0.3 birds/ha at control sites. The Killdeer demonstrated attraction behavior and was found in significantly greater densities at wind farm sites, even out to 1000 m from wind turbines. Lastly, some species, such as the Vesper Sparrow, showed no change in density between

the wind farm or control sites. It seems clear that birds may respond differently to the presence of wind farms, which is why it is important to consider such possible effects across a range of species when creating guidelines for placement in various habitats.

"Understanding Migration Corridors Along the Great Lakes"

Presenter: Jeff Gosse, U.S. Fish and Wildlife Service

Authors: Jeffrey Gosse, David Larson, Daniel Nolfi, Nathan Rathbun, Rebecca Horton, Tim Bowden, Erik Olson (U.S. Fish and Wildlife Service)

Abstract: Research Objectives: Objectives of this study are to increase knowledge of bird and bat migratory corridors and stopover habitat along shorelines (landward) of the Great Lakes. Data obtained from this study will help to ensure that wind projects are developed in a manner that reduces impacts to migratory bats and birds. Abstract: The shorelines of the Great Lakes offer excellent opportunities for wind power development based upon wind speed maps. However, decades of visual observations indicate these areas also provide important habitat and potential migration corridors for many species of birds and possibly bats. To evaluate migration patterns and identify areas of concentrated use along these shorelines the U.S. Fish and Wildlife Service is using mobile avian radar systems (Merlin, Detect, Inc.)[1] each containing a Vantage Pro 2 weather station (Davis, Vernon Hills, IL)[1], over 30acoustic/ultrasonic monitors (Wildlife Acoustics, Inc)[1], avian observations, and digitization of historical avian observations to provide a comprehensive view of current and historical use of these shorelines by birds and bats. This effort will be used to help guide wind power and other development away from areas of high impact. As part of this ongoing project we have collected radar data from multiple sites per migration season during spring and fall 2011 and 2012. Areas within 2 miles of the shoreline along Lakes Michigan, Huron, and Erie have been targeted to date with data being collected continuously, 24 hours per day, from March – June and August – mid-November. These initial efforts have documented the onset and cessation of migration activity, diurnal and nocturnal patterns of movement that show large waves of activity when weather conditions appear favorable, and nightly movements as high as 3,000 targets per hour within a 1 km front. While radar data provide information on the approximate size, flight direction, altitude, time observed, and density of bird and bat targets they are not capable of distinguishing among taxa or species. To better understand the radar data we used acoustic monitor data to identify bat species and changes in activity along with field observations to identify the timing and composition of bird species within the areas where radars were placed. This poster focuses primarily on providing an overview of the project and the types of data than on results. It is intended to provide an overview and background for a U.S. Fish and Wildlife presentation and an additional poster that will focus on specific aspects of the study. Continuing research using avian radar units and acoustic monitors over the next few years along with additional historical records of bird migration will aid in evaluating and prioritizing lands for conservation, and help to inform industry of migrant distribution and behavior along the Great Lakes. [1] Use of trade names does not indicate endorsement by the U.S. Fish and Wildlife Service

"Wind turbines and birds: A phylogenetic and morphological approach"

Presenter: Leonel Herrera- Alsina, Universidad Nacional Autonóma de México

Authors: Leonel Herrera-Alsina, Héctor Arita (Centro de Investigaciones en Ecosistemas Universidad Nacional Autónoma de México)

Abstract: Wind turbines and other structures are major obstacles for bird movement, in many cases causing lethal collisions. Identifying those traits that make birds more prone to collisions is of paramount importance in reducing the risks associated with the operation of wind turbines. Here we analyze an extensive database of bird occurrence and fatalities caused by a wind farm in the Tehuantepec Isthmus of southern Mexico. We examined the set of collided bird species looking for morphological and ecological traits that could explain their proneness to collisions. We also examined how these traits are reflected in a phylogeny of all species

present in the area, producing trends that can be detected by phylogenetic structure metrics. This study was based on four nested sets of species: species potentially occurring in the area (species pool), species actually recorded, species flying in the collision risk zone, and species with documented fatal collisions. Using maximum likelihood methods, a phylogeny that included all the species in the pool was constructed. Also, four morphological traits linked to aerodynamics were quantified for each species. Null models were constructed simulating 10 000 random subsets of species; for each simulated subset, phylogenetic metrics and the means of the morphological traits were calculated and compared to real figures. Null models were performed either considering the relative abundance of species, measured during monitoring in the field ("restricted null models" that assigned probabilities of selection proportional to abundance) or ignoring abundance ("open null models"). Observed subsets differed from expectations drawn from null models, showing that collision and death risk is not randomly distributed among species. Open null models showed that birds that flew within the risk zone had wingspans and wing loadings greater than expected by chance, and their phylogenetic metrics of dispersion were lower than expected showing clustering. Restricted null-model simulations showed that birds involved in collisions are on average smaller and lighter than expected. Within the phylogeny, species in this set are less related to each other than expected (showing phylogenetic overdispersion). In summary, birds with longer wingspans and higher wing loadings are more likely to fly into the risk zone and, when flying close to the blades, smaller birds has an increased risk of crashing and dying. From a phylogenetic perspective, birds venturing into the risk zone tend to be related to each other, but species that are actually hit by the blades are small birds belonging to the several clades represented in the phylogeny.

"Effects of wind energy development and ranch management on greater prairie-chickens in the Flint Hills of Kansas"

Presenter: Greg Johnson, WEST, Inc.

Authors: Greg Johnson (WEST, Inc.); Jerry Roppe (Iberdrola Renewables)

Abstract: In 2006, Iberdrola Renewables completed the Elk River Wind Farm (ERWF) three miles south of Beaumont in Butler County, Kansas. Due to concerns over potential impacts of wind energy development on greater prairie-chickens, pre-construction greater prairie-chicken lek surveys of the ERWF were conducted in 2003, 2004, and 2005. Post-construction lek surveys of the same area were then conducted in 2006 and from 2008 – 2012 to determine response of greater prairie-chickens to the ERWF. The 100-turbine ERWF covers approximately 8,000 acres in the Flint Hills of southeast Kansas and consists of rolling hills dominated by tall-grass prairie. The ERWF is used primarily for cattle grazing, and much of the rangeland is burned each spring to increase livestock forage production. The number of active leks and the total number of greater prairie-chickens counted on leks near the ERWF decreased from 10 leks with 103 birds one year preceding construction of the facility (2005) to one presumably active lek with three birds four years after construction (2009). In 2011, six years after construction, the number of active leks (8) was nearly equal to the number of active leks one year before construction (10 leks), and the total number of birds on leks (130) was greater than one year prior to construction in 2005 (103). The number of birds on leks declined slightly in 2012 to 107 individuals on six leks, but was still greater than prior to construction and the decline may have been influenced by poor reproduction due to severe drought in 2011. Although the initial decline in prairie-chicken lek attendance after the facility was constructed may be attributable to development of the wind energy facility, greater prairie-chicken populations declined significantly in the Flint Hills over this same time period due to the practice of annual spring burning, followed by heavy cattle stocking, which removes nesting and brood-rearing cover for greater prairie-chickens. Although more greater prairie-chickens were observed on leks in 2011 and 2012 than were observed one year prior to construction in 2005, many of the active leks in 2011 and 2012 were located further from turbines than they were in 2005. The mean distance to the nearest turbines of the 10 leks located in 2005 was 0.36 mile, as compared to 0.95 mile in 2011 and 1.11 miles in 2012. This indicates that, overall, lekking greater prairie-chickens in the area may avoid lekking

in close proximity to turbines, although one active lek in 2011 was present only 288 meters from the nearest turbine, five years after the project became operational. Data on pasture burning and cattle stocking rates for each pasture at the ERWF were obtained for the entire study period (2003-2012). The increase in the number of leks and birds attending leks since 2010 was concurrent with a change in ranch management practices that resulted in reduced annual burning of pastures at the ERWF. The role that ranch management and wind energy development may have played in influencing greater prairie-chicken populations in the project area will be discussed.

"Bird and Bat Movement Patterns and Mortality at the Montezuma Hills Wind Resource Area, California"

Presenter: Dave Johnston, H. T. Harvey & Associates

Authors: Dave Johnston, Judd Howell, Scott Terrill, Jim Castle, Nellie Thorngate, Jeff Smith (H. T. Harvey & Associates); Todd Mabee (ABR Inc.)

Abstract: Our primary question was to determine if there is a correlation between the fatalities and the number of migrants passing through a wind energy area. Few studies on wind turbine bat mortality have been conducted in California and none before this study have included the needed daily carcass searches to accurately study environmental conditions and the timing of bats' and birds' movements. This study comprised daily carcass searches at 48 turbines with marine radar, enhanced night vision, full-spectrum acoustic monitoring, activity indices, spatial variables, habitat variables and weather variables to collect data on flight directions, passage rates, and flight altitudes of birds and bats during fall 2009 and 2010. The authors used Poisson regression analysis, general linear models and GIS-based spatial analyses. Mean nocturnal passage rates in the study area ranged from 326—454 targets/km/hr. across sites and years, a higher rate than reported elsewhere in the United States and especially among the western states. Only 2–6% of the total nocturnal birds and bats recorded by radar passed through the area at altitudes below 125 m agl, and the fall turbine passage-rate indices of 0.5—10.5 migrants/turbine/night are lower rates than documented at other California sites. Migrating bats and birds showed specific direction above 125 m but showed no uniform direction below 125 m when bats and birds are at risk. The field personnel observed few migrating nocturnal bird fatalities (n=6), but 22 hoary bats (Lasiurus cinereus), 30 Mexican free-tailed bats (Tadarida brasiliensis mexicanus) and 1 western red bat (Lasiurus blossevillii) were observed fatalities during the two 40-day survey periods. Carcass trial-specific detection ratios ranged between 0.13 and 0.67 depending mostly upon substrate type. In contrast to hoary bats, the probability of finding a Mexican free-tailed bat fatality increased with higher wind speeds ($F = 4.5$; $p = 0.037$), and higher altitude passage rate of migrants ($F = 4.5$; $p = 0.037$). Using the GIS-based Hot Spot statistical analysis, we found hot spots for hoary bats at 2 turbines, each with a Z Score of 3.60 and $p < 0.01$ and 1 hot spot for Mexican free-tailed bats, also with a Z score of 3.60 and $p < 0.01$. Both hot spots for hoary bat fatalities occurred southeast of a eucalyptus grove and for all fatalities, direction to a eucalyptus grove within 2 km is significant ($p = 0.013$). All hoary bat fatalities during the fall months of 2009 and 2010 were males with relatively full stomachs suggesting hoary bat fatalities at Montezuma Hills are related to foraging behavior. Birds as a group were clustered by turbines and all bird fatalities were associated with turbines southeast of the nearest riparian area. These data suggest wind turbines are not acting as simple filters; other factors are likely involved in fatalities. Lights and structures that attract insects should be avoided, and the proximity and direction to trees and woodlots should be considered when locating turbines. Our final report was submitted in Spring 2012 to the funding agency, the California Energy Commission.

"A Comparison of Pre- and Post-Construction Avian Use at a Northern Arizona Wind Energy Facility"

Presenter: Thomas Koronkiewicz, SWCA Environmental Consultants

Authors: Thomas J. Koronkiewicz, L. Dickson, E. Koster (SWCA Environmental Consultants)

Abstract: Pre- and post-construction avian use studies were conducted on a wind energy facility in northern Arizona in 2010-2011 and 2012, respectively. The wind energy facility, Perrin Ranch, is located in Great Basin Coniferous Woodland, with the dominant vegetation being pinyon and juniper forest interspersed with grassland. The facility has 62 1.6-megawatt turbines distributed across 39,833 acres of land. For large and small bird assemblages, two breeding seasons of pre-construction point count data were compared with one breeding season of post-construction point count data. Results show that for both large and small birds, species composition, relative abundance, and observation frequency during the pre-and post-construction sampling periods are comparable. Post-construction large and small species composition, abundance, frequency data will be collected for the non-breeding season starting in November 2012; therefore, data outside of the breeding season are not available at this time. Results from this study strongly suggest that the presence and operation of wind energy facility of this structural configuration in this habitat type may not negatively alter avian species composition and abundance.

"A Critical Review of the Effects of Tall Structures on Birds"

Presenter: Karl Kosciuch, Tetra Tech

Authors: Karl Kosciuch, Jason Jones (Tetra Tech); Kim Walters (HEMMERA)

Abstract: As technology and energy development increases, undeveloped land and land traditionally used for farming or ranching now host structures not part of the historical landscape. Communication towers, transmission lines, wind turbines, and drilling rigs are taller than many objects in natural or agricultural landscapes. As development increases, concerns have been raised regarding the effects of tall structures on birds with a primary concern being functional habitat loss due to avoidance. We examined the literature to determine how tall structures affect birds and if the fact that the structure was tall could be isolated from other aspects of development. In most studies, a structure's "tallness" could not be isolated from other factors such as road activity or human disturbance. We did not detect any consistent response to the presence of tall structures on the landscape, nor did we find evidence to support the hypothesis that birds avoid tall structures because of an increased perceived predation risk or the novelty of the structure. Thus, studies of causal mechanisms are needed to understand patterns observed at development projects.

"Reactions to turbines by birds and bats, an objective assessment"

Presenter: Ronald Larkin, Illinois Natural History Survey, University of Illinois

Authors: Ronald P. Larkin (Illinois Natural History Survey)

Abstract: Reactions to turbines by birds and bats, an objective assessment Based on field work with tracking radar at night at two commercial wind energy facilities, extensive analysis is completed showing reactions to turbines by flying wildlife. The objective is to provide an objective basis for deciding whether bats and birds avoid or approach commercial-scale turbines. Migrating birds avoid turbines both by climbing above them and turning right or left. Most turns left or right took place within 700 m of individual turbines; most height changes much closer. As discussed in an earlier NWCC presentation, convoluted paths of bats often prevented analysis of their paths so that the number of reactions that could be analyzed was smaller despite the presence of many bats. Unlike birds, bats showed no evidence of avoiding turbines and some evidence of attraction. The radar is a unique instrument capable of tracking individual animals approaching turbines and recording their flight paths in three dimensions and, using wing beat data, identifying them as bats or birds. The difference in size between a flying animal and a 40-story structure limited the radar's ability to follow animals close to the large, moving metal turbines. Several metrics examined in the analysis were evaluated for horizontal (turns) and vertical (changes in height), such as angle of turn toward or away from turbine, extrapolated versus actual distance from turbine at closest approach, rate of climb, and change in height above ground. Inflection points (turns and changes in climb rate or rise/run slope) were identified by a

software algorithm developed for the purpose. At one site airflow patterns over a ridge presented an additional complication. Further analysis is in progress examining ambient conditions such as phase of the moon and wind direction and speed. Plots of birds and bats show reactions clearly and quantification of tracks supports inferential statistics. The research is supported by the US Department of Energy.

"Short-Term Impacts to Greater Sage-Grouse from Wind Energy Development" *(accompanies a presentation)*

Presenter: Chad LeBeau, University of Wyoming & WEST, Inc.

Authors: Chad W. LeBeau (Department of Ecosystem Science and Management, University of Wyoming & WEST, Inc.); Jeffrey L. Beck (Department of Ecosystem Science and Management, University of Wyoming); Gregory D. Johnson (WEST, Inc.); Ryan M. Nielson (WEST, Inc.); Matt J. Holloran (Wyoming Wildlife Consultants, LLC)

Abstract: Wind energy development is increasing in rangeland habitats, which has raised concerns relative to impacts to avian species including the Greater Sage-Grouse (*Centrocercus urophasianus;* hereafter sage-grouse). Little information exists about the impacts of wind energy development on sage-grouse; however, wind energy infrastructure is likely to directly and indirectly impact sage-grouse movements because they avoid tall structures and human activities. Changing movements may equate to different habitat selection patterns, which are predicted to lead to reduced population fitness. The purpose of our study was to document habitat occurrence and fitness parameters associated with sage-grouse inhabiting areas in close proximity to wind turbines. In April 2009 and 2010, we captured 116 female sage-grouse near Medicine Bow, Wyoming and have monitored these grouse for 2 years to evaluate nest, brood, and female survival, and habitat occurrence. We used logistic regression to develop resource selection functions to estimate habitat occurrence. We used Cox proportional hazards regression to model nest, brood and female survival. The proximity to wind turbines did not influence nest site or brood-rearing occurrence but the relative probability of summer occurrence increased in habitats closer to wind turbines. Female survival was not influenced by wind turbines but nest and brood survival were both negatively affected by proximity to wind turbines. This is the first study to evaluate short-term effects of wind energy infrastructure--specifically wind turbines--on sage-grouse fitness parameters and habitat selection.

"Minnesota Department of Natural Resources Guidance For Commercial Wind Energy Projects"

Presenter: Kevin Mixon, Minnesota Department of Natural Resources

Authors: Kevin Mixon (Minnesota Department of Natural Resources)

Abstract: The Minnesota Department of Natural Resources has developed Guidance For Commercial Wind Energy Projects that is designed to assist the wind industry with recognizing and avoiding high value habitats during the planning and permitting processes. The high value habitats consist of state and federal lands, listed species habitat, native prairie, areas in conservation easements, and much more. The document can be provided with an email request or can be viewed at: http://www.dnr.state.mn.us/eco/ereview/additional_resources.html . The potential also exists to provide information on Avian and Bat Survey Protocol for Large Wind Energy Conversion Systems in Minnesota (Draft but near completion). The document can be provided with an email request. **Sorry about the short abstract, but I was just approved to attend a couple minutes ago and I wanted to meet the deadline.

"The Conservation of Airspace and Habitat in a Major Bird Migration Corridor"

Presenter: Anna Peterson, University of Minnesota

Authors: Anna Peterson (Conservation Biology Program, University of Minnesota); Gerald J Niemi (Natural Resources Research Institute, University of Minnesota); Douglas H Johnson (U.S. Geological Survey, Dept. of Fisheries, Wildlife, and Conservation Biology, University of Minnesota)

Abstract: A narrow strip of land paralleling the northern shore of Lake Superior in Minnesota, the North Shore Migration Corridor (NSMC), hosts a massive diurnal migratory bird movement far more massive than had been realized previously. The NSMC is also a priority area for wind turbine development, and habitat and airspace within the corridor are experiencing increased pressure from other forms of development. Our three-year study (2008-2010) of autumn migratory movement found that millions of birds involving over 100 species utilized the NSMC. Preliminary results indicate that migrant movement was nonrandom, but was influenced by both landscape and vegetationfeatures. In addition, most migrant movement occurred at flight heights between the forest canopy and 100 meters, a height that directly corresponds with heights of wind turbines and communication towers. The results of this study can guide environmentally friendly development of wind energy and other activities on the North Shore and in the Great Lakes region by identifying migrant flyway and stopover habitat use patterns, and by prioritizing areas for airspace and habitat conservation.

"Research Priorities for Wind Energy and Migratory Wildlife"

Presenter: Martin Piorkowski, Arizona Game and Fish Department

Authors: Martin D. Piorkowski (Arizona Game and Fish Department); Ronald W. Rohrbaugh, Andrew J. Farnsworth, Kenneth V. Rosenberg, John W. Fitzpatrick (The Cornell Lab of Ornithology); Michael Fry (U.S. Fish and Wildlife Service)

Abstract: With upcoming global wind-energy build-out estimated in millions of units, cumulative environmental impacts must be considered and understood to promote responsible expansion of this renewable energy source. In June 2009, 30 wildlife scientists convened in Racine, Wisconsin, USA to identify key research priorities concerning wind energy's potential impacts on migratory wildlife (birds and bats). This working group suggested 4 areas where improved science is most needed to evaluate the impacts of wind-energy development on migrating animals more accurately than can be accomplished today: 1) standardized protocols and definitions; 2) new methods and models for assessing and forecasting risk; 3) documenting lethal and sub-lethal effects at existing wind facilities; and 4) improved facility-site access, data access, and data management for researchers. Focused research based on these priorities will both quantify potential risks associated with wind-energy development and help derive science-based, peer-reviewed, best-management practices for existing and future wind projects.

"A synthesis of bird and bat fatalities in Quebec wind facilities between 2008 and 2011"

Presenter: Junior A. Tremblay, Ministère des Ressources naturelles et de la Faune

Authors: Junior A. Tremblay (Ministère des Ressources naturelles et de la Faune)

Abstract: Wind power is expanding all around the world and Quebec plans to increase its production to more than 1000 MW in 2012 and will reach 1700 MW in 2013. Whereas wind energy, like other renewable energy resources, offers the prospect of significant environmental benefits, the effects of wind energy developments mainly on birds and bats have raised important legal and ecological issues in the permitting and operation of wind facilities. To ensure the protection of biodiversity, especially birds and bats, Quebec government requires, since 2008, a post-construction mortality surveys during the first three operational years. These surveys present the same methodology and are thus adequately comparable. I present a synthesis of bird and bat fatalities reported during post-construction mortality surveys of 4 wind facilities during the 2008-2011 period. Estimates of bird mortality during this period ranged from 0 to 0.019 fatalities/turbine/day, or 0 to 6.801 fatalities/turbine/year and range from 0 to 0.015 fatalities/turbine/day, or 0 to 5.546 fatalities/turbine/year for bats. Mortality rates of birds and bats have a seasonal variability. A wind farm has

more than 90 % of bat fatalities reported and in this wind facility, more than 87.7 % of bat fatalities have been reported during the breeding season (June-July) and 40.8 % thereof in a short period of 10 days, from July 20 to 29 (2010 and 2011). However, it is important to note that wind facility presenting high bat fatalities is the only facility to have carried out surveys between 16 and 30 July. Bat fatalities affected mainly the hoary bat, with more than 70 % (35/49) of all deaths reported. Several bat fatalities have been reported for the only facility where surveys were done late in July this could suggest that the estimated mortality of bats could be underestimated in some wind facility in Quebec. To adapt the methodology and be able to adequately document the mortality of bats in wind facilities, an update of the protocol for monitoring bird and bat fatalities in wind facilities is in progress. The main changes concern the interval between visits and periods of inventories.

Estimating Fatalities of Birds and Bats

"'Catch you scavenger!', camera trapping of carcass removal by scavengers at two Portuguese wind farms"

Presenter: Joana Bernardino, Bio3, Lda

Authors: João Paula, Pedro Pereira, Joana Bernardino, Hugo Costa, Miguel Mascarenhas (Bio3)

Abstract: With the increasing number of wind turbines installed worldwide it has became fundamental to fully understand their impact on bat and bird populations, resulting from collision and barotrauma. It is now well known that mortality estimates are biased in several criteria such as carcass removal (e.g. by scavengers or decay), given the time elapsed between consecutive searches. However, advanced techniques using automated registration of animal activity could be an important tool to perceive removals almost in real time. Improve knowledge about scavenger community responsible for the removal of dead bats and birds that result of wind turbines collisions, their specific richness, diet habits like carrion foraging, their response to different amounts of carcasses and activity patterns in a spatio-temporal context may provide a great contribute to the accurate estimates of the removal correction factor. This way we aimed to characterize the vertebrate scavenger community and its role in carcass removal in two wind farms, located in Serra de Aire e Candeeiros Natural Park (Central Portugal), using camera-trapping techniques. Scavengers removal trials were conducted in spring and summer (two campaigns), covering two different activity periods in a total of 60 camera-stations (30 for each wind farm). Red-legged partridges and mice carcasses (total of 30 for each) randomly placed around the turbines were used. The number of carcasses placed at the same time was limited in order to avoid scavenger swamping. The preliminary results revealed a well structured community of at least 7 species of vertebrate scavengers (birds and mammals), which represent 4 orders: passerines, raptors, rodents and carnivores. The red fox (Vulpes vulpes) was the more abundant scavenger exhibiting an opportunistic character in terms of feeding habits. The garden dormouse (Eliomys quercinus) was an unexpected scavenger. Camera-trapping showed to be an appropriate non-time consuming methodology to community characterization and recording the exactly removal time of the carcasses. The use of these techniques in removal trials contributes not only to a better understanding of the carcass removal process at each wind farm, but also to the optimization of future trials design and definition of the ideal carcass search interval.

"Siting wind farms for wildlife: Predicting bird and bat fatality risk at prospective wind farm sites using acoustic detectors"

Presenter: Kevin Heist, University of Minnesota

Authors: Kevin Heist (University of Minnesota Conservation Biology Graduate Program); Douglas H. Johnson (Northern Prairie Wildlife Research Center)

Abstract: Wind power is essential for reducing greenhouse gas emissions from electricity production, but large-scale wind energy facilities can have serious impacts on wildlife. Bird and bat collision fatality rates at some sites have been alarming, and proper siting of wind facilities is necessary to minimize collision impacts as the wind energy industry continues to grow. Bird and bat fatality rates vary greatly among sites; however there is no reliable method for assessing collision risk levels prior to development. Our goal is to develop a method for predicting fatality levels at potential wind energy sites based on nocturnal call rates of birds and bats. For the past two years, we have been recording bird and bat activity at over 90 locations in 8 states using a dual acoustic/ultrasonic detector. Our objectives are 1) to examine the capabilities of this detector for use in pre-construction site assessments, 2) to find the relationship between call rates and fatality rates for use in predictive models based on pre-construction recordings, 3) to examine how call rates differ before vs. after a wind facility is built, and 4) to observe how call rates vary with respect to prominent landscape features. In order to address each objective, detectors have been located at active wind farms, prospective wind farm sites, and in proximity to specified landscape features. Preliminary results from the first four migration seasons show a positive relationship between bat call rates and estimated fatality rates among wind farms. Also, we have found a similar landscape-dependent pattern at two river corridor arrays, with high bat activity at forested edges and decreasing activity with distance from edge. Call data also appear to indicate differences in bat activity at broader regional scales, with high activity near Great Lakes shorelines and less activity at interior sites.

"A Projectile Motion Modeling Approach for Estimating Carcass Distributions of Avian and Bat Fatalities at Wind Farms"

Presenter: Ling Ong, SWCA Environmental Consultants

Authors: Adam Miyamoto, Ling Ong, Chad Cross (SWCA Environmental Consultants); Dave Cowan, Robert Roy, Greg Spencer, Mitchell Craig (First Wind)

Abstract: An important goal when developing a monitoring strategy for wind farms is determining an estimate of the number of avian and bat fatalities. Fatality monitoring programs are labor intensive and expensive. Additionally, because any monitoring program likely will detect only a subset of the total fatalities that occur, there is a need to make statistical adjustments in order to estimate the total numbers of fatalities at a site. The most reliable method to obtain fatality estimates is to regularly investigate a search radius around every wind turbine in a wind farm. A difficulty with this method is in determining an appropriate search radius that balances the uncertainty of fatality estimates when a search radius is too small with the cost associated with increased labor required to investigate larger search areas. Thus, there is an interest in developing methods to focus sampling efforts in a way that maximizes the probability of detecting fatalities as a function of search radius. Our goal in this study was to develop a method of generating probability distributions of avian and bat fatality carcasses around turbines of any size. Due to the lack of understanding of interactions between flying wildlife and turbines, we investigated the use of a projectile-motion based argument to equally treat data from various wind farms, regardless of differences in turbine heights or wildlife flight speeds. Our model uses a distribution of the ratio of observed and predicted carcass distances from turbines to develop an empirical probability distribution, and ultimately define a relationship between target flight speed, turbine height, search radius, and the proportion of carcasses that are expected to fall within the search radius. Our current model for avian fatalities is preliminary due to both the small size of our dataset, and because it was developed primarily for medium sized, fast flying birds in Hawaii. Our model for bats is considered final with adequate sample sizes and goodness of fit. However, both models provide tools for determining search radii that balance the uncertainty of fatality estimates with the economics of wind farm operation. In particular, they suggest proportion values that can be applied in addition to searcher efficiency and carcass removal values to give a better perspective on how many fatalities have occurred.

"Post-Construction Monitoring at Arizona's First Commercial Wind Farm"

Presenter: Joel Thompson, WEST, Inc.

Authors: Joel Thompson, Kimberly Bay (WEST, Inc.)

Abstract: The Dry Lake Wind Farm was the first commercial wind energy facility constructed in Arizona. The project is located on the Colorado Plateau in northeastern Arizona and is owned and operated by Iberdrola Renewables, LLC (IR). The facility consists of two phases (Dry Lake I and Dry Lake II) totaling 61 2.1-MW turbines and is located on a mix of private, state, and federal lands. Commercial operations commenced at Dry Lake I in the fall of 2009 and at Dry Lake II in the winter of 2011. Western Ecosystems Technology, Inc. (WEST) conducted one year of formal post-construction fatality monitoring at each phase of the Dry Lake project immediately following commencement of commercial operations. Monitoring studies were designed to estimate the number of bird and bat fatalities attributable to wind turbine operation and were conducted from September 2009 through November 2010 at Dry Lake I and from February 2011 through February 2012 at Dry Lake II. In addition to standardized fatality searches, carcass removal and searcher efficiency trials were conducted to estimate potential sources of bias inherent in the studies. Fatality estimates were generated for bats, small birds, large birds, and all birds using methods consistent with the approach outlined by Shoenfeld (2004) and Erickson et al. (2005). In addition, acoustic bat data was collected concurrent with fatality monitoring studies. Estimated fatality rates for bats were 3.43 bats/MW/year at Dry Lake I and 1.66 bats/MW/year at Dry Lake II. Six species of bat were identified as fatalities (hoary bat, Mexican free-tailed bat, silver-haired bat, big free-tailed bat, pocketed free-tailed bat, and big brown bat); however, two species (Mexican free-tailed and hoary bat) accounted for 69% of fatalities found on search plots. Estimated fatality rates for all birds were 2.02 birds/MW/year at Dry Lake I and 1.57 birds/MW/year at Dry Lake II. Fourteen bird species were identified as fatalities during fatality monitoring studies, none of which were raptors. Four species (ruby-crowned kinglet, mourning dove, black-throated gray warbler, and horned lark) accounted for 40% of all bird fatalities found on search plots. Based on acoustic bat data, bat activity increased steadily from mid May through July and then peaked in August and September. This period of elevated bat activity (late summer through fall) coincided with the peak in bat fatality rates. This data represents the only publicly available post-construction fatality monitoring data from a commercial wind facility in the state of Arizona. As such, the data provides the best available dataset for making comparisons to other proposed wind energy facilities in the Colorado Plateau region of the southwestern US.

"Scavenger removal: Bird and bat carcass persistence in a tropical wind farm"

Presenter: Rafael Villegas-Patraca, Instituto de Ecologia

Authors: Rafael Villegas-Patraca, Samuel Macías-Sánchez, Ian MacGregor-Fors, Carlos Muñoz-Robles (Instituto de Ecología, A.C.)

Abstract: Energy produced by wind farms has diverse positive environmental effects, but can also be related to negative impacts, including wildlife mortality through collisions with wind turbines. Bird and bat mortality caused by collisions with wind turbines can be estimated indirectly by counting carcasses within wind farms. However, carcass removal by scavengers often biases such measurements. In this study, we identified the main scavengers removing bird and bat carcasses in a tropical wind farm. A known fate analysis was done to assess the effect of carcass type (i.e., small bird, large bird, bat), vegetation type (i.e., secondary vegetation, croplands) and season (dry and rainy seasons of 2009) on carcass persistence rates. We identified three main scavenger groups, with mammals being the most abundant group. Our results show high rates of carcass removal relative to previous studies, especially for bats; there were fewer remaining carcasses after 20 days in our tropical site than in non-tropical environments reported elsewhere. We found a higher carcass persistence rate during the rainy season than in the dry season, possibly due to a greater abundance of food resources for scavenger organisms in the rainy season. Although we found some evidence for higher persistence rates for large bird carcasses than for small bird and bat carcasses during the rainy season,

overall carcass type was not a strong predictor of persistence rates. Similarly, we did not find a strong effect of vegetation type on carcass persistence rates. Results suggest that in order to estimate accurate bird and bat mortality in tropical wind farm areas, seasonality should be incorporated to correction factors of carcass removal rates.

"Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities: Evaluation of accuracy of existing equations, including assumptions and statistical bias"

Presenter: William Warren-Hicks, EcoStat/Cardno Entrix

Authors: Robert Wolpert (Duke University); William Warren-Hicks (EcoStat/Cardno Entrix), Brian Karas (EcoStat, Inc.), Loan Tran (EcoStat, Inc.); James Newman (Normandeau Associates)

Abstract: The California Energy Commission (CEC) and California Department of Fish and Game California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development provide recommended protocols for assessing and minimizing impacts from wind energy development to birds and bats. The Guidelines provide an equation that can be used to adjust the number of bird or bat carcasses that are visually observed during an environmental monitoring survey of a wind facility, in an attempt to estimate the true mortality at the wind site or facility. The equation adjusts for the inability of a searcher to locate all carcasses on the survey plot at the time of observation (searcher proficiency), and for the probability of removal by scavengers or other processes prior to the time of observation (carcass persistence). The California Wind Energy Association (CalWEA) was awarded a grant from the CEC to rigorously evaluate the procedures provided in the Guidelines for estimating mortality of birds and bats associated with collisions with wind turbines in California. Information gathered from this study will apply to wind development projects in California, and the fundamental principles evaluated and discovered in this project may apply to wind development in other parts of the US and Europe. This poster investigates the fatality estimation equation provided in the Guidelines (Pollock) and three other equations from the literature (Erickson & Johnson, Shoenfeld and Huso). The estimators are evaluated with respect to the estimation of the true number of fatalities at a wind facility. Both the two estimators assume that carcasses from earlier periods exist (Erickson & Johnson and Shoenfeld), and the two estimators that assume the interval begins with new carcasses only (Pollock and Huso), can result in both positive and negative bias. For all equations evaluated, Huso generally provides the largest estimate, followed by Pollock, Shoenfeld, and Erickson & Johnson. Rigorous site-specific trials are required to generate carcass persistence and searcher proficiency curves that will minimize bias in the estimated true mortality. In general, when carcass persistence time is long, short search intervals can result in overestimation in true mortality. The results and findings of this study provide insight into needed changes in current monitoring practices and estimation procedures at wind facilities.

Raptors and Wind Energy (Including Eagles)

"Long term survey of wind farms impacts on Common Kestrel's populations and definition of an appropriate mitigation plan"

Presenter: Joana Bernardino, Bio3, Lda

Authors: Ana Cordeiro, Joana Bernardino, Hugo Costa, Miguel Mascarenhas (Bio3)

Abstract: Between 2005 and 2007, the Portuguese company Bio3 implemented a survey of the bird community in two wind farms promoted by Iberwind, Candeeiros and Chão Falcão I and II, both located in central Portugal. At the end of this period of monitoring, the estimates indicated a high mortality of common kestrels (Falco tinnunculus) that could be impairing the local populations of this species. To better understand the impact of these two wind farms, we developed a protocol that aimed to accurately estimate the size of these two kestrels' populations, in order to obtain mortality rates. The methodology consisted on nest searching, transects and observation points to detect the falcons, ringing of individuals and weekly

searches of all wind farms' turbines to detect dead birds. The results, obtained between 2008 and 2012, indicated a population size of 4-5 breeding pairs in Chão Falcão I e II and 8-12 breeding pairs in Candeeiros area. It was possible to identify the most important areas for the species in both areas. The findings seem to indicate a high turnover of the populations, with the birds being rapidly replaced by sub-adult individuals. The mortality rate was higher in Candeeiros wind farm, therefore we are developing a site-specific mitigation program that aims to reduce the mortality of this species in this wind farm, by keeping the falcons away from the turbines vicinity.

"Implementation of compensation and offset measures for large birds of prey"

Presenter: Joana Bernardino, Bio3, Lda

Authors: Joana Santos, Ana Teresa Marques, Anabela Paula, Joana Bernardino, Miguel Mascarenhas, Hugo Costa (Bio3)

Abstract: The installation of Wind Energy facilities entails the risk of negative impacts on wildlife. Avian communities, and specially raptors, are pointed as one of the most affected groups. In "Serra do Caldeirão" (Southern Portugal) a new Wind Farm (WF) consisting of 29 turbines is being built on the border with the SCI and SPA Caldeirão (Natura 2000 Network). This project has undergone a study of flora and fauna communities, resulting in the identification of important values for nature conservation, including two couples of Bonelli´s eagle (Aquila fasciata), an "Endangered" species in Portugal. The Environmental Impact Statement has approved the construction of the WF conditioned to development and execution of a Compensation Measures (CM) program for this species, based on the recovery of the European rabbit (Oryctolagus cuniculus) populations. European rabbit is classified as "Near Threatened" in Portugal and it is simultaneously considered a key species in Mediterranean Ecosystems, playing a vital role as a prey for a large spectrum of top predators. Bio3, Ltd. has developed and executed, since 2011, a CM Program for the WF. Our goal is to promote and recover European rabbit populations exclusively through habitat management techniques in an area inside the local Bonelli eagle's home range, but further away from the WF. This off-site scheme intends to mitigate the negative impacts by promoting eagles' activity outside WF's area and compensate eventual mortality by improving eagles' survival and annual productivity. This project will run for 3 years and is based on habitat management techniques already tested successfully in Northeastern Portugal: creation of small pasture lands, supplementary food and water provision in the dry season (feeders and drinkers) and construction of artificial warrens. To ascertain management scheme's progression and success we are monitoring the installation and development of habitat management techniques, including its use by rabbits (camera-trapping). During the project we are also studying rabbit and eagle population dynamics through periodic censuses (management and control areas), which will ultimately allow us to evaluate the effectiveness of our CM program. Habitat management started in the summer of 2011 with the installation of 30 artificial feeders and drinkers. Small pasture lands (6.5 hectares, 54 patches) were created between the fall 2011 and spring 2012 to provide quality food throughout the year. Both habitat management measures have been successfully used by rabbits, which is a very positive result, since rabbit populations occur in low densities in the study area. In the beginning of the summer of 2012 the first 15 artificial warrens were build. In this communication we will present the preliminary results achieved until the second year of the project, including some photos of rabbit activity in the managed areas.

"High-resolution Modeling of Updrafts to Investigate Griffon Vulture (Gyps fulvus) Collision Risk with Wind Turbines"

Presenter: David Brandes, Lafayette College

Authors: David Brandes (Department of Civil & Environmental Engineering, Lafayette College); Luis Barrios (Greensigns S.L.); Alejandro Rodríguez (Department of Conservation Biology, Estación Biológica de Doñana CSIC)

Abstract: Eurasian Griffon Vultures (Griffons) are one of several species of raptors known to be susceptible to collisions with wind turbines. Griffons are large birds with high wing loading (thus low climb rates) and within wind farms sometimes engage in slope-soaring at altitudes that put them at risk of collision with turbines, particular when lift is weak. We use a spatially explicit high resolution model of terrain-induced updrafts at two wind farms (E3 and Pesur) near the Strait of Gibraltar to quantitatively investigate mechanisms for Griffon mortality proposed by Barrios and Rodríguez, 2004. We apply the model to predict which wind farm will have higher collision rates for a given set of wind conditions, and the locations at which collisions are most likely. Although our results are preliminary, locations of updrafts at or slightly above the threshold needed for lift show good correspondence with spatial variation in mortality and risky flight behavior recorded at the Pesur site under low to moderate wind speeds. At E3, and at Pesur with higher wind speeds, terrain updrafts are strong enough that Griffons are more easily able to avoid collisions. We propose that spatially explicit modeling of orographic updrafts at proposed wind energy sites can be used to predict locations of relatively high and low collision risk for Griffon Vultures and other large raptors, and thus can be used to site turbines where risks are minimal.

"Ridgetop Modeling: Identifying Critical Raptor Migration Corridors for Conservation and Wind Development Planning"

Presenter: Kylan Frye Christensen, HawkWatch International

Authors: Markus Mika, Kylan Frye Christensen, Steven J Slater, Shawn Hawks (HawkWatch International)

Abstract: Because many areas of high wind potential in the western United States are located along mountain ridges, a landscape that also attracts migrating and hunting raptors, there is considerable potential for direct risk to raptors from poorly sited wind developments. Identifying critical migration corridors to be avoided during future development as well as areas with good wind potential that are minimally used by migrating raptors and therefore better suited to wind power generation is crucial for site choice and planning. In June of 2012, HWI received funding from the USFWS to investigate factors that contribute to the level of raptor use among topographic features beneficial to migration. Over the past 25 years, HWI has conducted raptor migration monitoring at 11 sites across the Western US and Gulf Coast. This long-term data set represents migration trends at a large landscape scale, and has been an important source for industry and conservation groups seeking to aid in thoughtful wind development. In order to make this data set applicable to large scales, we are translating our count data into functional predictive models and maps of migration corridors in the western U.S. We will apply GIS grid layers of climate, landscape, and topographic variables using generalized additive modeling (GAM) and maximum entropy (Maxent) algorithms to model spatial characteristics of high-use migration ridges. We will present our preliminary models and maps from our initial modeling efforts, which will serve as the basis for groundtruthing during the next fall migration season in 2013. Results of the final models will be used by USFWS, the renewable energy industry, and other key stakeholders as a decision support tool to make conservation prioritizations. It is the hope that this tool will allow for streamlined pre-development site evaluations addressing what currently requires a time consuming case-by-case approach. Subsequently, our approach will support USFWS goals of no-net loss among eagle populations while also allowing timely development of wind projects at appropriate sites.

"Flight behavior of Griffon Vultures near wind turbines in Tarifa, Spain"

Presenter: Brian Cooper, ABR, Inc.

Authors: Brian A. Cooper, Robert H. Day (ABR, Inc.); Richard C. Curry (Curry & Kerlinger LLC)

Abstract: We studied the flight behavior of Griffon Vultures (Gyps fulvus) near wind turbines in Tarifa, Spain, during 1994-1995. Over 3,000 groups of vultures were observed within 100m of the Kenetech 33 MVS turbines that were under observation. Approximately 97% of those groups exhibited no apparent reaction, 1.4% changed direction, 1.0% changed altitude, and 0.7% exhibited flaring reactions. While Griffon Vultures

have been known to collide with wind turbines, no collisions were observed. Thus, the avoidance rate of the 3,119 groups within 100m (including the 94 groups that exhibited reactions) of turbines was 100%, suggesting that although collisions sometimes occur, the avoidance rates are very high. We also examined the effects of weather and topography on flight behavior. Griffon Vultures are very similar in size and behavior to California Condors (Gymnogyps californianus), a listed species in which little is known about flight behavior near wind turbines or ability to avoid turbine collisions. We discuss the potential implications of our (and other's) Griffon Vulture data for California Condors.

"Impacts of wind turbines on Buteo hawk fledgling mortality in the Columbia Plateau Ecoregion"

Presenter: Patrick Kolar, Boise State University

Authors: Patrick Kolar, Marc Bechard (Department of Biology Boise State University)

Abstract: Research objectives, including hypotheses being tested: The primary goal of this study was to determine how the spatial distribution of wind turbines affects fledgling mortality. Specifically, we sought to determine if wind turbine collisions contribute to mortality for juvenile hawks during the post-fledging period and, if so, does the increased mortality have an additive effect. We hypothesized that the mortality rate of juvenile hawks during the post-fledging period would differ depending upon exposure to wind turbines. Furthermore, we predicted that fledglings from nests closer to turbines would incur greater mortality if specific behaviors placed them at risk of collisions. Abstract: Standardized post-construction raptor fatality monitoring is typically conducted at wind projects nationwide, including in the Columbia Plateau Ecoregion (CPE), and is useful for assessing species-specific risk of collisions and comparing mortality rates for individual projects with larger geographic areas. However, with this type of monitoring, it is difficult to assess age and breeding stage-specific collision mortality rates, determine underlying mechanisms that result in collisions, or determine if collision mortality is additive or compensatory; all of which can have implications for raptor population demographics. Collision mortality for fledgling raptors associated with nests near wind turbines may be of particular concern because juveniles at this stage exhibit increased flight and foraging behaviors, but could lack the necessary flight skills to avoid turbines. We examined sources of mortality for three sympatric species of juvenile Buteo hawks [Ferruginous Hawks (Buteo regalis), Red-tailed Hawks (Buteo jamaicensis), and Swainson's Hawks (Buteo swainsoni)] during the post-fledging dependency period in the CPE of north-central Oregon to assess the direct impact of wind turbines. We selected nests within 3.5-5.5 km of the nearest wind turbines using a gradient-response design, then radio-marked and monitored 60 nestlings during the 2010 and 2011 breeding seasons. In total, the juvenile mortality rate was 30% for Ferruginous Hawks (3/10), 20% for Red-tailed Hawks (5/25, excluding two juveniles with failed transmitters), and 22% for Swainson's Hawks (5/23); no deaths resulting from direct collisions with wind turbines were found. The results of this study and post-construction monitoring in the area provide evidence that fledglings are less vulnerable to collisions compared to other age classes; this could be primarily due to low activity, limited natal range, and the relatively short duration of exposure to wind turbines. We recommend future studies focus on the risk of collisions and implications of increased mortality for other ages and life history stages, such as sub-adults and breeding adults.

"Bald Eagle Flight Path Data Comparison"

Presenter: Scott Krych, HDR Engineering

Authors: Scott Schubbe Krych, Bruce Jon Moreira (HDR Engineering)

Abstract: HDR Biologists conducted avian flight path studies during pre-construction monitoring at several wind farms and at two high-voltage transmission line/river crossings in Minnesota. A comparison of eagle flight path data identified use patterns which appear to be driven by a combination of geologic and ecological features (such as topography) and availability of forage habitat (such as wetlands and rivers). Results from these studies provide useful information to developers as they consider effects on eagles in the

development of sites for wind farms and transmission line projects. Eagle flight paths were documented by biologists during one-hour point counts from November 20, 2010 to March 1, 2012. Observation points were established at locations where flight paths could be documented within 800 meters of the point and were approved by US Fish and Wildlife Service staff at all of the wind farm sites and at the Minnesota River crossings. All point count locations were situated near potential waterfowl flight corridors between wetlands, lakes, rivers, or other man-made water features that provide potential prey opportunities. Flight path studies were conducted at five wind farms located within the Prairie Parkland Province (MDNR 2005) on agricultural lands. All wind farm sites had less than 100 feet of topographic relief and abundant wetlands and lakes. The two locations along the Minnesota River were also located in the Prairie Parkland Province; these sites exhibited topographic elevation changes greater than 270 feet and included the river, numerous floodplain wetlands, and sewage treatment ponds. The studies indicate that eagle flights occur in higher numbers where topography and foraging habitat occur together. Eagle flight observations at the wind farm sites showed random patterns of flight and lower numbers of flights despite higher observation effort. All of the wind farm sites and both sites along the river contain abundant water and waterfowl for eagles to forage in while migrating and breeding. At the wind farm sites, where topographic variety was low but wetlands, lakes, and other waterbodies was abundant, flights per hour of observation effort was 0.18. At the Minnesota River where topographic variety was high and wetlands, lakes, and rivers were also abundant, eagle flights per hour of observation were 6.42. HDR biologists observed 60 eagle flights at five wind farm sites during 316 hours of flight path monitoring, while 315 eagle flights were documented during 49 hours of flight path monitoring at the Minnesota River valley sites.

"Raptor behavior at a wind power project in Oaxaca, Mexico: implications for U.S. species"

Presenter: Todd Mabee, ABR Inc.

Authors: Todd J. Mabee (ABR Inc.); Rafael Villegas (Instituto de Ecologia)

Abstract: Raptor fatalities have been a focal point of concern since the construction of early generation wind power projects in the U.S. Although much research has been conducted at these early generation wind power projects, the environmental conditions and the avian behaviors leading to these collisions remains unclear. I conducted behavioral observations of raptors at one of Mexico's first wind power projects (La Venta) in fall 2008, where 1-2 million raptors pass overhead during fall migration. I will provide preliminary findings on how raptors varied in their response as they encountered wind turbines. These results have relevance and implications for wind projects in the US, as little is known regarding raptors ability to detect and avoid wind turbines.

"Bald Eagle Breeding Habitat Model"

Presenter: Jon Schubbe, HDR Engineering

Authors: Jon Schubbe, Sean Tuohey, Scott Krych, Bruce Moreira (HDR Engineering)

Abstract: HDR developed a Bald Eagle breeding habitat model for use within the upper Midwest. The original target area for the model was the Prairie Parkland ecological province but later development demonstrated wider application. By narrowing search areas to potentially suitable habitat, the model reduces field efforts required to review areas for eagle nests and allows users to concentrate their time in areas where eagles are more likely to be present. The habitat model is based on scientifically documented positive habitat influences, primarily proximity to open water and the presence of forested habitat (Buehler 2000, Guinn 2004). The model was based on publically available data such as landcover mapping and national hydrography data. The model identifies forested habitat within one mile of open water and gives additional ranking to forested habitat within 160 meters of open water. A score between 0 (low) and 3 (high) is assigned to target areas by the model based on model parameters. Overall, HDR survey teams have found a very strong correlation between areas identified as high quality habitat by the model and the quality of

nesting and foraging opportunities actually present in these areas. This model was applied to successfully locate bald eagle nests in project areas of various sizes, some of which were hundreds or thousands of square miles. It also accurately predicted nesting locations of previously known breeding sites. In one project, 69 percent of bald eagle observations were within areas identified as high or moderate quality and over 97 percent were located within a 250 meter buffer of those same areas.

"Bald eagle behavior before and after construction of the Pillar Mountain Wind Project at Kodiak, Alaska, and its effect on modeled collision risk"

Presenter: Lynn Sharp, Tetra Tech

Authors: Lynn Sharp, Christina Herrmann, Robert Friedel, Chris Farmer (Tetra Tech); Richard MacIntosh

Abstract: Understanding risk to eagles at wind facilities is especially important in relation to the recent changes in interpretation of the Bald and Golden Eagle Protection Act. Until this study, no empirical data had been collected on bald eagle-wind turbine interactions to inform our understanding of risk for this species. We conducted a 3-year study of bald eagles at Kodiak Electric Association's Pillar Mountain Wind Project in Kodiak, Alaska to examine use and flight patterns pre- and post-construction. Our research objective was to document the behavior of bald eagles at a wind project before and after construction to determine how the birds responded to the turbines and to identify the level of collision risk. For each 30-minute survey period, the observer recorded data including number of birds; flight behavior, direction, and height range; and mapped flight paths of all eagles observed within an 800-m radius of a single observation point located in the middle of the proposed string of six GE 1.5-MW wind turbines. Pre-construction surveys in 2006-2007 showed that bald eagle use was higher in spring than the other seasons. Three wind turbines were constructed at Pillar Mountain in the summer of 2009 and bald eagle use was monitored using the same protocol and observer during the spring of 2010 and 2011. Bald eagles flew parallel to, crossed over, and circled to gain altitude over the ridge during all 3 years of survey. Bald eagles did not avoid the area and their use of the ridge did not decline after project construction. Bald eagle mean use was 2.57, 3.15, and 3.7 birds/30 minutes for 2007, 2010, and 2011, respectively. The proportion of bald eagles flying across the ridge in 2007 and 2010/2011 did not differ between years, but, the proportion of bald eagles crossing the ridge between the wind turbine locations was significantly lower in 2010/2011 than in 2007. Eagles did not cross between operating turbines in 2010 and 2011, but did cross between non-operating turbines in 2011 indicating that habituation may be occurring. No fatalities have been recorded at Pillar Mountain although formal post-construction fatality monitoring has not been conducted. The three additional turbines are under construction in 2012 and we hope to conduct monitoring in the spring of 2013. The data are being analyzed using the collision model in the USFWS' 2011 Draft Eagle Conservation Plan Guidance and the results will be included in the presentation. These results are preliminary and we are working on publishing the results. If bald eagles are capable of actively avoiding operating turbines, these results may partially explain why so few bald eagle fatalities have been recorded at wind farms to date. This type of study should be replicated elsewhere in the U.S. or Canada for both bald and golden eagles.

"A Roadmap for Mitigating Raptor Risk at Windfarms: Application of Advanced Avian Radar Technology"

Presenter: Karen Voltura, DeTect, Inc.

Authors: Karen Voltura, Adam Kelly, Tim West, Jesse Lewis, Jenny Davenport (DeTect, Inc.); Andreas Smith, Javier Vidao (DeTect EU)

Abstract: Raptor collision risk at wind energy projects is a potential but critical roadblock to successful development of certain projects. We describe a roadmap for building a successful mitigation strategy for windfarms with likely but poorly understood raptor risk. Avian radar is an important part of this roadmap, with recent advances in radar technology proving vital for allowing or enhancing avian surveys at wind

energy sites normally presenting challenges to radars. Avian radar is an important tool for gathering unparalleled information on bird activity at proposed and existing wind energy projects. As wind energy expands into increasingly diverse environments, ground clutter from mountainous terrain, vegetation, and even wave clutter hinder the potential usefulness of traditional avian radars at these sites. Raptors in particular often inhabit areas with complex terrain and vegetation that produce significant ground clutter that complicates detection with traditional avian radars. Recent advances in several radar technologies, including both Doppler and solid state radar with pulse compression, have proven capable of reducing high clutter in radar data. Solid state radars produce better imaging under difficult conditions with high clutter and are also an ideal host for Doppler. When these signal processing techniques are used together the reduction in clutter is amplified and produces super-high resolution data in which clutter is confined in both range and azimuth. This ultimately frees up areas for detecting and tracking biological targets. Together, these radar technologies now allow us to detect birds at sites with strong background clutter such as heavy ground vegetation and challenging terrain. Detecting birds and their associated activity patterns is only the first step in a roadmap towards successful raptor risk mitigation. With the ability to collect large amounts of data on targets of interest, it is then possible to identify risk criteria (when, where, under what conditions raptors are at risk) and integrate these risk criteria into a predictive model. The integration and leveraging of SQL database technology permits data assimilation from multiple sources, aids in decision making, and allows for data retrieval and distribution. Additional steps include using biologists as decision-makers during preliminary implementation of mitigation strategies, working towards automating decision steps, and refining the mitigation strategy with adaptive management. This roadmap has been developed and continues to be tested on several projects having a high risk of raptor mortality. One such project is Torsa's El Pino Wind Park in southwestern Spain, which has implemented a radar-based mitigation system in order to reduce risk for Griffon Vultures. A real-time, web-based operator interface displays the current, color-coded risk for each turbine based on radar detections of Griffon Vultures using a "Turbine Centric" model. Currently, a human operator can manually curtail/restart individual turbines by clicking a button on the interface, but the system can also be set to curtail automatically when pre-defined high risk situations occur. Similar roadmaps for mitigating raptor risk are being applied to sites with Golden Eagles and potentially California Condors.

Bats and Wind Energy: Assessing Risks and Impacts

"Can resource and activity hotspot mapping predict bat fatalities at wind turbines?"

Presenter: Victoria Bennett, Texas Christian University

Authors: Victoria J. Bennett, Amanda M. Hale (Texas Christian University)

Abstract: Wind farms are an important source of renewable energy; however, with this rapidly growing industry are increasing concerns about impacts to wildlife, especially tree-dwelling bats. Thus, there is a real need for tools that can assist in wind turbine siting and help develop effective curtailment strategies to reduce wind turbine associated fatalities. To address these needs, we conducted resource and activity mapping surveys for six bat species found at Wolf Ridge Wind, LLC in north-central Texas. In ArcGIS (Esri ArcMAP 10), we mapped resources by locating potential roosting opportunities, foraging sites, water sources and commuting routes for each species within the wind resource area. We mapped bat activity and movement patterns of each species using passive and active acoustic surveys, mist netting and roost emergence surveys. We then compared both resource and activity maps to fatality data collected from on-going fatality searches conducted since 2009. Our surveys revealed that resource, activity and fatality hotspots were correlated for three of the species present at our site (Mexican free-tailed bat Tadarida brasiliensis, evening bat Nycticeius humeralis, and tri-colored bat Perimyotis subflavus), suggesting that resource mapping for these species could be used to aid wind turbine siting. Similarly, activity rates and resource availability for the silver-haired bat Lasionycteris noctivagans were positively correlated, yet we recorded no fatalities for this species in the >5,000 fatality searches conducted since 2009. This suggests that

at Wolf Ridge Wind, silver-haired bats are actively utilizing the area around the wind turbines without incurring fatal interactions. In contrast, approximately 40% of eastern red bat (Lasiurus borealis) and hoary bat (Lasiurus cinereus) fatalities did not correspond with resource availability or activity. Fatality hotspots for eastern red and hoary bats were consistent across all years, suggesting that 1) migrating individuals of these species are at greatest risk of colliding with wind turbines, and 2) frequently used migration routes may be identifiable, even at a small geographic scale.

"Can bat fatality be predicted from bat acoustic activity within the rotor-swept zone?"

Presenter: Victoria Bennett, Texas Christian University

Authors: Victoria J. Bennett, Amanda M. Hale (Dept of Biology, Texas Christian University); Crissy Sutter, Alison Costello (Normandeau Associates); Kevin W. Heist (Conservation Biology Graduate Program, University of Minnesota)

Abstract: As an important source of renewable energy, the installation of wind farms across the United States has become a rapidly growing industry. Nevertheless, there are concerns about the impacts of wind tur_bines on wildlife, particularly tree-dwelling bats. Thus, wind developers are under increasing pressure to select sites that will have little or no negative implications for bats. Acoustic surveys are gaining popularity as a pre-construction technique and involve placing bat echolocation detectors at proposed sites to assess local bat activity prior to wind turbine installation and operation. The goal of such studies is to assess the risk to bats and could potentially provide data that would inform site selection, including placement of individual wind turbines, and mitigation strategies. To date, however, there are no best practice guidelines as to the placement and time of year bat detectors should be deployed and these variables may dictate the effectiveness of pre-construction acoustic surveys at predicting risk, especially for species of conservation concern. To address this, we placed four SM2BAT+ Passive Ultrasonic Bat Recorders 1-m above ground level and two ReBAT acoustic monitoring systems on the nacelles of wind turbines (~ 85-m above ground) at Wolf Ridge Wind, LLC in North Central Texas in 2010-2011. In addition, from 2009 to 2012 we have conducted fatality searches at 30 of the 75 wind turbines at the site, including those turbines with the two bat detectors on their nacelles. We then compared fatality data with acoustic activity. We used SonoBat 3.04 to analyze call sequences (i.e. where more than one call file represents a passing bat) to species (if possible). During our acoustic surveys, we recorded calls from six bat species, including Mexican free-tailed (Tadarida brasiliensis), silver-haired (Lasionycteris noctivagans), evening (Nycticeius humeralis), tri-colored (Perimyotis subflavus), eastern red (Lasiurus borealis) and hoary bats (Lasiurus cinereus). We found that species-specific fatality rates were not correlated with activity levels. For example, calls from the silver-haired bat were frequently recorded within the rotor-swept zone, and yet we have not detected a single silver-haired bat carcass during more than 5,000 fatality searches at this site. Similarly, we found great variation between calls recorded 1-m above ground compared to those recorded at the nacelles. For example, 10% of hoary bat calls were recorded on the ground, whereas 50% of the calls recorded at the nacelles were from this species. Our surveys also showed that eastern red bats were either not active or actively echolocating in the immediate vicinity of the rotor swept zone, yet they made up 60% of the observed fatalities. Our results indicate that for some species, the vertical placement of bat detectors is important if we are going to effectively assess the potential risk of bat-turbine-collisions at proposed wind resource sites. In contrast, for other species, like the eastern red bat, acoustic surveys may not be an effective pre-construction survey technique.

"First approach to pre-construction bat monitoring at 5 South African Wind Farms: initial results and potential issues at a regional level"

Presenter: Joana Bernardino, Bio3

Authors: Karen Jodas, Robyn Kadis (NatureCounts); Bárbara Monteiro, Miguel Mascarenhas (Bio3)

Abstract: South Africa is about to see the construction of a number of new large-scale wind energy facilities around the country. The environmental authorities have realised the need to collect reliable information about those biological groups that have the potential to be more affected by wind farm projects, which includes investing in bird and bat pre-construction monitoring. We have been surveying bat activity and species richness at five wind energy facilities and five control areas in three South African Provinces using manual and automated ultra-sound detection. The manual detection data is collected using time expansion detectors (Pettersson D240X), and the automated detection data is collected using SM2BAT+ devices. Vehicle transects and 5 minute sampling points form part of the manual detection, and the automated detection has been done with a punctual method (wind farm site vs control area). The total number of species and activity indexes (average number of passages/point in manual detection and average number of passages/night in the automated detection) has been obtained for each area. A total of 6 species have been identified to date in the studied areas, with the most common species being Neoromicia capensis. The activity indexes, calculated through manual and automated detection, vary between the species within the same wind facility. The manual detection data covers a larger area and a higher variety of biotopes. On the other hand, the automated detection registers activity for a longer period of time but in a single place. In the studied areas the average activity index values for the manual detection were higher than the values obtained using the automated detection. Nevertheless, both manual and automated detection methods are complementary, so if one uses the automated detection in the most common biotope of the site, the average activity index for most of the area can be obtained. The manual detection can then be used not only to confirm the index for the most common biotope, but also to obtain the activity index for other biotopes that present in the area, allowing a better understanding of their importance for bats, and avoiding possible impacts in higher activity areas. Updated data will be presented in the proposed poster and a comparison between areas will be done. In South Africa the information about bat echolocation calls characteristics and behaviour is still deficient, so these studies are contributing to increase that knowledge at a regional and a national level. One should have in mind that the collection of recordings of very good quality is essential, so that maximum knowledge about the species echolocation parameters and behaviour can be obtained. Therefore the time expansion data is the most advantageous collection method since it enables the collection of amplitude, frequency and harmonic structure of the pulses, which allows detailed analyses of calls characteristics.

"Variation in bat activity in Portuguese uplands: effects of wind speed, temperature and moonlight in different biotopes"

Presenter: Joana Bernardino, Bio3, Lda

Authors: Bárbara Monteiro, Rita Ferreira, Joana Santos, Teresa Marques, Joana Bernardino, Miguel Mascarenhas, Hugo Costa (Bio3)

Abstract: Bat presence and abundance are affected by environmental factors. This influence must be considered when monitoring the dynamics of bat communities in wind farms for Environmental Impact Assessment studies. We used Generalized Linear Models (GLM) to assess the influence of wind speed, temperature, moon fraction and biotopes on bat activity patterns (presence and abundance), considering the data obtained from monitoring schemes developed on 24 wind farms and 18 control areas in several regions of Portugal. We found a significant temporal correlation in patterns of average abundance between wind farms and control areas; therefore both areas were included in the final data analysis. Since wind speed and temperature vary significantly between biotopes, we assessed the influence of these factors and moon fraction on bat activity in farmlands, scrublands, forests and mixed biotope of forests and scrublands. The influence of the environmental factors analysed is relatively homogenous in the different biotopes. Higher temperatures are especially important as it increases the probability of bats being present in all the biotopes due to the increasing number of insect activity at higher temperatures. Wind speed decreases bat presence significantly; that influence is softened in forests since the presence of trees may work as wind shield. The

illuminated lunar fraction influence in bat presence is not as strong as the influence of the other two factors considered. Bat abundance is also influenced by environmental variables but their importance and direction varies with biotope. Our results show the importance of locating sampling points on different biotopes when doing bat surveys, in order to increase the robustness of the assessment, and reveal that environmental factors act in different ways concerning bat presence and abundance. Wind speed and temperature thresholds for bat presence should be measured and considered in monitoring schemes.

"Meteorological Data and Bat Activity: Developing Conservation Measures for Wind Energy"

Presenter: Tim Bowden, U.S. Fish and Wildlife Service

Authors: Tim Bowden, David Larson, Jeffrey Gosse, Daniel Nolfi, Rebecca Horton, Nathan Rathbun, Erik Olson (U.S. Fish and Wildlife Service)

Abstract: Research Objective: We undertook this study to evaluate proposed conservation measures that may reduce bat fatalities at wind power facilities within the Great Lakes region. Our objective was to compare vocal activity of bats to wind speed, temperature, and date within the fall season to see if these variables could be used to identify conditions with limited bat activity. Abstract: While providing an important source of energy, operating utility-scale wind turbines can result in avian and bat fatalities. Research has shown that bat fatalities at wind facilities can be reduced by operating wind turbines when wind speeds are above a threshold and bat activity is likely limited. This concept is being adopted by some wind facilities as a potential means to protect bats, including the Federally endangered Indiana bat (Myotis sodalis). The U.S. Fish and Wildlife Service collected information on bat vocalizations, wind speed, ambient temperature, and duration of migration season in an area along the shoreline of Lakes Michigan and Huron as part of a broader project. Our objective was to document vocal activity of bats during the fall 2011 migration season and compare this activity to environmental conditions. We operated two ultrasonic Song Meter SM2 acoustic monitors (Wildlife Acoustics, Concord, MA)[1] from dusk to dawn in both Oceana and Huron counties, Michigan. Each pair of monitors was associated with a Vantage Pro 21 weather station (Davis, Vernon Hills, IL)[1]. Acoustic monitors were staggered, one directly associated with and one within 3 km of the weather station. Bat passes were compared to environmental conditions on a 10 minute basis. Our results indicated that ultrasonic monitors can be used to document the onset and duration of the migratory season. These dates are likely influenced by geographic location and may vary annually. Bat activity was strongest during the hour after dusk. Ten-minute mean wind speeds were good indicators of high bat activity periods but instantaneous wind speeds were not. The results from this study support those reported from previous research and indicate that operating turbines in conjunction with meteorological thresholds may prove an effective conservation strategy. However, implementation of this strategy would greatly benefit from developing standard methods for measuring wind speed (e.g., height of anemometers, frequency of calculating mean speeds, using a running-mean versus point estimate), collecting and using acoustic monitor data (e.g., ultrasonic monitor height, detection rate per species, etc.) and ensuring that these readings are well correlated with turbine operations and changes in environmental conditions. Further, selecting a threshold for turbine operations may vary by region or bat species and the use of acoustic monitors and weather stations may provide an efficient means to inform this conservation effort.
[1]Use of trade names does not indicate endorsement by the U.S. Fish and Wildlife Service

"Reduction of Myotis activity relative to total bat activity in long-term acoustic bat surveys pre- and post-exposure to white nose syndrome"

Presenter: Sarah Boyden, Stantec Consulting, Inc.

Authors: Sarah Boyden, Trevor Peterson, Kristen Watrous (Stantec)

Abstract: White-nose syndrome (WNS) has led to unprecedented declines in populations of cave-roosting bats throughout the eastern United States, documented first through winter cave surveys, and more recently

through substantial reductions in mist-netting capture results for affected species. Stantec has conducted long-term passive acoustic bat monitoring throughout the northeast beginning in 2004 and continuing through the present, providing a unique opportunity to assess the degree to which acoustic activity patterns and species composition have changed after the appearance of WNS in various states. We hypothesize that the activity level of Myotis species as a percentage of total bat activity declines on a regional level after WNS has become established. Suitable acoustic datasets were categorized on a regional basis as pre- or post-exposure to WNS and adjusted for survey effort, habitat characteristics, and time of year. We calculated the percentage of Myotis species activity relative to total bat activity for each dataset and tested whether the change in percent of Myotis could be attributed to WNS. Preliminary observations suggest a marked decrease in the percentage of Myotis calls relative to overall activity levels, and final results of our analysis will be available at the time of the presentation. This analysis will provide an opportunity to compare observed reductions from cave surveys, mist-netting capture results, and acoustic data, helping understand how survey methods and biases of each technique may affect assessments of the extent and severity of WNS.

"Use of pre-construction acoustic bat and meteorological data to design and forecast site-specific curtailment scenarios"

Presenter: Jessica Costa, Stantec Consulting, Inc.

Authors: Trevor Peterson, Jessica Costa, Kristian Omland (Stantec Consulting)

Abstract: Most states now require some level of pre-construction passive acoustic bat surveys, and post-construction monitoring increasingly includes acoustic bat sampling as well. At the same time, many regulatory agencies are in the process of developing curtailment recommendations or requirements for wind projects that are deemed higher risk to bats based either on pre-construction consultation or on the results of post-construction monitoring. However, there is little consensus on what constitutes a sufficient level of curtailment, how it should be designed or implemented, and to what extent acoustic bat survey results may help design effective and efficient curtailment scenarios. We present an analysis of pre-construction acoustic bat surveys and meteorological data from multiple sites in the eastern United States to better understand the relationship between bat activity levels and weather conditions and to provide an example of how acoustic data could help design appropriate level of curtailment and predict the cost of such a curtailment plan. Specifically, we compare the distribution of acoustic bat activity in or near the rotor zone of wind turbines with temperature and wind speeds measured at the same height to determine the conditions under which bats are most active. Identification of conditions with higher levels of activity could then provide the basis for designing a customized curtailment system based on site-specific acoustic data, which developers could use to forecast the cost and potential effectiveness of such curtailment strategies early in project development.

"The Effects of Weatherproofing on Acoustic Bat Detection"

Presenter: Allison Costello, Normandeau Associates

Authors: Allison Costello, Lauren Hooton, Crissy Sutter (Normandeau Associates)

Abstract: Long-term passive bat acoustic monitoring is the survey method most often used during preconstruction bat surveys at proposed wind energy facilities. Bat detectors deployed on meteorological towers or other tall structures within a project area are exposed to wind, rain, condensation, and temperature extremes over long periods of time, and thus require protection from the elements. Weatherproofing can alter acoustic data quality and quantity, and it is important for researchers to understand the effects of weatherproofing when designing a bat acoustic monitoring study, to ensure accurate interpretation of the data. Various weatherproofing configurations are currently used by researchers, including the use of reflector plates, and the use of a curved polyvinal chloride (PVC) tube (PVC

elbow). A study conducted by Britzke et al. 2010 indicated that the use of the PVC elbow configuration results in performance similar to unprotected bat detectors, and that the reflector plate configuration commonly used in the BatHat (PVC housing pointed down at a 6" x 6" acrylic-glass plate), was outperformed by all other treatments used in the study. Subsequently, it has been recommended in the first draft of the Rangewide Indiana Bat Summer Survey Guidance Draft – February 3, 2012, that the PVC elbow configuration be used as the preferred weather proofing method. The use of the flat reflector plate is currently not accepted. Normandeau's ReBAT bat acoustic monitoring system uses a weather-resistant aluminum housing unit with a large reflector plate (8" x 10") attached to the housing at a 45° angle to protect an AR125 (Binary Acoustic Technology) detector from the elements. To understand the effects of weatherproofing on acoustic data collected with ReBAT, Normandeau investigated detection performance of the AR125 detector in both the ReBAT aluminum housing with reflector plate, and the PVC elbow configuration. Results from these two weatherproofing configurations were compared to performance results of a bare AR125 detector. Trials were conducted at 0, 90, and 270 degrees by using an Avisoft ultrasonic speaker to play recorded bat echolocation passes at 5-m intervals from 5 to 75 m away from the microphone. Detection performance was measured by the number of files containing bat calls recorded, as well as the number of high frequency and low frequency passes detected per treatment per distance per direction. Additionally, the distance of detection was determined per treatment per direction. Field tests in natural settings are scheduled for July 2012. Preliminary results indicate that ReBAT aluminum housing with reflector plate recorded more files with bat calls, more high frequency bat passes, and had a greater distance of detection compared to the PVC elbow and bare AR125 detector from the 0 degree trial. There were no differences among the three treatments in number of files recorded, high frequency bat passes, and distance of detection from the 90 and 270 degrees trials. These results illustrate the importance of understanding the effects of weatherproofing on bat detection, especially in acoustic monitoring studies geared specifically at detecting high frequency echolocating bats, such as Myotis sodalis.

"Comparing the Efficacy of Various Monitoring Technologies for the Detection of Bats on Wind Farms"

Presenter: Robert Gierschick, Wildlife Acoustics

Authors: Ian Agranat, Sherwood Snyder (Wildlife Acoustics)

Abstract: Background Unattended recordings allow for surveys of legally protected species whose scarce presence might go undetected. This presentation will compare the efficacy of omnidirectional against directional microphones and full spectrum against zero crossing monitoring technologies with respect to the air volume for bat detection. Performance is tested in a controlled laboratory as well as in an open field using a playback system. Omnidirectional microphones have a spherical range of detection for sampling a bat habitat. Directional microphones detect a conical cross section of the sphere. To support the investigative objective, we compared the SMX-US omnidirectional microphone with and without the SMX-Horn directional attachment and the Senscomp 600 directional microphone. The directionality of the SMX-US is not exactly spherical, nor is the Senscomp and SMX-Horn exactly conical, but their mathematical representations are sufficiently close to a sphere and a cone to theoretically compare their relative detection volumes. Zero crossing technology measures the time interval between positive and negative transitions of the ultrasonic signal while full spectrum technology samples the ultrasonic signal and measures its amplitude at discrete points. Zero crossing records the frequency of the signal with the highest amplitude only. Full-spectrum recordings are analyzed in the "frequency domain", which allows the viewing of all signals regardless of relative amplitude. This allows full spectrum recordings to detect bats from within the noise that would not be possible using zero crossing technology. Methodology For theoretical analysis, an independent ultrasonic lab was commissioned to measure the polar patterns, frequency response and signal to noise ratio of the three microphone systems. Using this data, the detection volume for bats echolocating at different frequencies is modeled. Theoretical differences between three microphone systems as well as

the two monitoring technologies are compared in an open field experiment. Bat echolocations are played through a custom system comprised of a National Instrument data acquisition device and an Avisoft-UltraSoundGate ultrasonic playback speaker. A cycle of bat echolocations alternating between the Myotis lucifugus and the Eptesicus fuscus is played through the system. An AnaBat SD2 zero crossing detector using a Senscomp microphone is positioned next to a SM2BAT+ full spectrum detector using an SMX-US microphone and next to an SM2BAT+ full spectrum detector using the SMX-US with an SMX-Horn directional attachment. The echolocations are played in a polar pattern at various distances from the detectors. Preliminary Findings The SMX-US omnidirectional microphone has 8 times the detection rate of the Senscomp 600 when placed at sufficient height above ground and up to 4 times the detection rate when placed at ground level. We anticipate that the detection rate of the SMX-US with the SMX-Horn attachment and the Senscomp 600 will be comparable (test to be performed shortly). Results from the independent lab will be available next week. Full spectrum recordings yield up to 5 times the bat detection rate of zero crossing. Future direction Future comparisons should be done in an open field and on a wind farm with bats present verses the current playback system.

"Can genetics and stable isotopes be used to gain geographical insights into the seasonal movement patterns and population structure of eastern red bats (Lasiurus borealis)?"

Presenter: Amanda Hale, Texas Christian University

Authors: Amanda M. Hale, Jennifer M. Korstian, Victoria, J. Bennett, Dean A. Williams (Dept. of Biology, TCU)

Abstract: Large numbers of migratory tree bats are being killed at wind facilities worldwide, and yet we know very little about the factors contributing to bat-turbine collisions. The purpose of our study was to characterize the genetic diversity of eastern red bats (Lasiurus borealis) killed during fall migration at a wind farm in north-central Texas over a three-year period (2009-2011). We examined the data for any evidence of population genetic structure, which if present, could provide much needed information about migratory patterns and population connectivity to improve future wind farm siting. In addition, to identify the geographic origins of bats killed at our study site, we measured the stable hydrogen isotope ratios of bat hair and compared these values to stable hydrogen isotope ratios of precipitation. As a preliminary investigation, we selected a subset of hair samples from 96 bats collected over the three year study. For the genetic analysis, we genotyped 405 eastern red bats at 7 microsatellite loci and sequenced a 550bp segment of the mitochondrial COI gene. Both microsatellite loci and mitochondrial haplotypes showed high levels of genetic diversity in this species. The pattern of diversity observed in the haplotype network is consistent with what is seen in species that have undergone rapid population and range expansions since the last ice age. Both clustering analysis (i.e., grouping individuals by genetics alone) and partitioning analysis (i.e., grouping by specific characteristics such as year, fatality pulse, sex) indicated that our samples represented a single population without genetically distinct subunits. The eastern red bats sampled from our study site, which includes both migratory and resident individuals, likely represented one, large population of bats with high levels of gene flow among local populations. From the genetic analysis alone, we still do not know, however, if eastern red bats migrating through north-central Texas in late summer come from populations dispersed across eastern North America or if they come from populations located just to the north and east of Texas. The hair isotope analysis should complement the genetic analysis by providing much needed information on the geographic origins of bats killed at our study site. This two-stage analysis technique has the potential to predict seasonal movements and inform risk assessments for eastern red bats and possibly other at-risk species of bats.

"Novel Approach to Bird and Bat Mortality Reduction Using High Intensity Ultraviolet Lights"

Presenter: Donald Ronning, Lite Enterprises Inc

Authors: Donald Ronning (Lite Enterprises, Inc); Steve Pelletier, Trevor Peterson (Stantec Consulting Services)

Abstract: Research objectives, including hypotheses being tested: The research aims to discuss a novel method of reducing mortality of birds and bats at wind farms. We present the novel approach for minimizing the interaction of birds and bats with wind turbines through the use of high intensity ultraviolet lights. Abstract: Avoidance and mitigation of widespread bird and bat mortality at wind farms has and continues to be a priority of the renewable energy industry worldwide. Mortality of bats and other flying wildlife caused by collision with wind turbines or barotrauma affects existing and proposed wind energy projects in a variety of ways. Although current attempts to reduce or avoid bat and bird collision at existing wind farms have focused on operational curtailment, we report on a pilot study evaluating the effectiveness of a deterrent system using recently developed high intensity ultraviolet (UV) light. Many animals including birds and bats are able to see UV light, suggesting that an intense UV light source could serve as a deterrent, as intense illumination is known to induce an involuntary 'escape' or avoidance response in certain cases. We report on a pilot study funded by the National Science Foundation in which we conducted field trials to test the effectiveness of a high intensity UV light deterrent designed to be deployed on commercial wind turbines. In addition to field trials, we will discuss the theory of operation, safety considerations, site installation, and operational considerations. Our review will assist managers, biologists, and wind developers with understanding the potential for applying this novel technique to a wide range of species across diverse geographical locations, seasons, weather conditions, and time of day. The design of future research needed to develop optimum mitigation strategies using ultraviolet light in combination with other mitigation strategies for minimizing bird and bat fatality at wind facilities will be discussed.

"Relating Post-Construction Bat Activity and Fatality at a Pennsylvania Wind Power Project"

Presenter: Michael Schirmacher, Bat Conservation International

Authors: Cris Hein, Michael Schirmacher (Bat Conservation International); Manuela Huso (US Geological Survey Forest and Rangeland Ecosystems Science Center, Forest Sciences Lab); Ed Arnett (Theodore Roosevelt Conservation Partnership)

Abstract: Pre-construction surveys at wind-energy facilities commonly employ acoustic detectors to assess activity patterns of bats. The strong, but as yet unsubstantiated, assumption behind these efforts is that a positive and predictive relationship exists between bat activity and fatality (i.e., high pre-construction activity equals predictably high post-construction fatality). Yet, if this relationship is weak or non-existent, then attempts to model risk based on pre-construction measures of activity may be unfounded. In fall 2011, we initiated a study examining the relationship between post-construction activity, measured at the height of the turbine nacelle (approximately 80 m above ground level), and fatality. Our objectives were to 1) develop predictive models of bat activity from easily measured weather variables (e.g., temperature and wind speed), and 2) determine whether turbine specific bat fatality can be predicted by activity. We recorded nightly bat activity and conducted daily fatality searches at 15 turbines. We assigned each echolocation sequence to one of two phonic groups based on the minimum frequency of the pass; high frequency bats ((≥33 kHz) or low frequency bats (<33 kHz). We also identified a subset of the low frequency phonic group, hoary bats (Lasiurus cinereus), because their echolocation sequences are relatively easy to distinguish among those of other low-frequency emitting bats and because this species is vulnerable to wind-energy development We recorded a total of 3,945 passes, of which 26% (n = 1,019) were identified as high frequency bats, 74% (n = 2,926) as low frequency bats. Of the low frequency phonic group, we identified 26% (n = 789) as hoary bats. We recovered 91 fatalities, of which 86 were identified to the 3 phonic groups. Estimated fatality for high frequency, low frequency and hoary bats were 12.44 (95% CI: 6.65, 33.65), 26.91 (95% CI: 12.71, 81.32), and 18.58 (95% CI: 9.00, 53.98) bats/turbine, respectively. We fit models at two scales: the turbine scale relating total estimated fatality at each turbine to total activity throughout the period and the site scale relating total observed fatality among all turbines each night to total activity among all turbines throughout the period. Each of these analyses was carried out for two periods: evening, defined as sunset to 4 hours pre-dawn and entire night defined as sunset to sunrise. We found no correlation between total fatality and total activity for high

frequency bats at the turbine scale, regardless of period of night, but did observe significant correlations for low frequency and hoary bats for both periods of the night. However, the strength of these relationships was moderate, with adjusted R2 values between 0.39–0.65. Model selection results provided little evidence for nightly fatality related to activity, weather, and turbine operations for any combination of phonic group or period. Although we observed moderate correlations at the turbine scale, we were unable to develop models useful relating fatality of bats to activity on a nightly basis. Our analyses are exploratory, in part because so little data exist upon which to develop a priori, confirmatory hypotheses and associated candidate models.

"Activity Rates and Call Quality by Full-Spectrum Detectors"

Presenter: Donald Solick, WEST, Inc.

Authors: Donald I. Solick, Christopher S. Nations, Jeffery C. Gruver (WEST, Inc.)

Abstract: Assessing potential risk to bats at proposed wind energy facilities relies primarily on estimates of overall bat activity collected by ultrasonic detectors. To date, the Anabat™ ultrasonic detector has been the industry standard for passive monitoring of bat activity, but full-spectrum (FS) detectors such as the Pettersson D500x, Wildlife Acoustics SM2, and Binary Acoustics AR125 are gaining popularity. Because Anabat and FS detectors use different types of microphones, utilize different sensitivity settings, and process the data differently, they may not produce comparable activity rate data, and thus could yield very different risk assessments. The goals of this study were to determine which settings on the D500x, SM2, and AR125 produce similar activity rates to the Anabat, and which settings produce the best call quality for species identification. We initially tested a wide range of settings by broadcasting a 30-second sequence of known echolocation calls at side-by-side detectors. Detectors were also placed side-by-side in the field to record nightly bat activity May - August, 2011. FS detector settings were varied, while Anabat sensitivity was held constant. Call quality was assessed using the SonoBat West 3.02 automatic species classification algorithm, and the FS settings that yielded the highest number of classified calls were identified for each detector. We will present data on which settings for each FS detector yielded activity rates similar to the Anabat, and which settings yielded the highest proportion of classified calls. The results of this study will help ensure consistency in measured levels of activity across studies.

"Indiana bat home range size and habitat use in a Midwestern project area dominated by agriculture"

Presenter: Bradley Steffen, BHE Environmental, Inc.

Authors: Bradley J. Steffen, Andrew R. Carson (BHE Environmental, Inc.); Timothy C. Carter (Department of Biology, Ball State University)

Abstract: Challenges to timely and cost-effective project development within the range of the Indiana bat can occur when this species utilizes land selected for development of wind energy facilities. It is known that Indiana bats (Myotis sodalis) occupy distinct home ranges; however, few studies have estimated home range size and relative use of habitat within that home range, particularly in areas dominated by agriculture. Understanding home range size and habitat use is important for both impact assessment and resource conservation at wind facilities throughout the Midwestern and Eastern United States. To address this knowledge gap, we present home range estimates for three lactating female Indiana bats that utilized maternity roosts in a rural proposed wind project study area dominated by agriculture in central Ohio. Telemetry data were collected for each bat from10 July through 21 July, 2008. Point locations were determined using simultaneous triangulation from at least two separate telemetry stations. Points were recorded every five minutes from approximately dusk until 02:00. Data errors and outliers were discarded from analysis, and the resultant points were run through the "Outlier Removal" tool using ArcView 3.3 (ESRI 2002) and the Animal Movement extension (Hooge and Eichenlaub 2000), resulting in a 95% minimum convex polygon describing the approximate home range utilized by each bat during the study period. The

mean number of points used to calculate home range was 180 (range=142-232). Mean home range size for Indiana bats tracked during this study was 458.8 ha (range=812.2-157.6 ha). Results from this study are generally consistent with previous findings, however, observed distances from roost trees to the furthest point within the observed home ranges tended to fall toward the upper end of the range of distances cited in existing literature. In addition to calculating home range size, relative habitat selection was visually determined within the observed home ranges of each bat. Results of this study differ from other home range telemetry studies in regard to the type of habitat utilized by Indiana bats for foraging. Studies of vespertilionid species document bats using edges (treelines, hedgerows, forest edges, and river/stream banks) as travel corridors. In contrast to those studies, the Indiana bats tracked over the course of this study regularly traversed over and foraged within open agricultural fields. Indiana bat home range determination allows developers to complete informed effects analyses that satisfy regulatory concerns and supports efficient and effective coordination with the USFWS, including during preparation of an HCP. This study has direct implications for projects planned in areas with similar landscape features. As shown by the literature, Indiana bats were thought to limit foraging activities within, or in close proximity to, forested habitats. As such, USFWS recommends setbacks of varying distances from these habitat features to provide protection for Indiana bats that occur within a project area. However, results of this study show that current setbacks may not always be sufficient to prevent bats from interacting with turbines.

"A Data Visualization Tool for Incorporating Migratory Bat Records into Wind Energy Development Siting Decisions"

Presenter: Theodore Weller, USDA Forest Service, Pacific Southwest Research Station

Authors: Theodore J. Weller (USDA Forest Service, Pacific Southwest Research Station)

Abstract: Fatalities of migratory bats have become one of the most important siting concerns for new wind energy sites in North America. However migratory routes and habitat features favored by bats during migration are virtually unknown. Thus, an ongoing challenge for wind energy developers and regulators is how to evaluate the sites and time periods of greatest risk to bats. Several efforts are underway to facilitate landscape-level screening of proposed wind energy facilities with respect to birds, but it is difficult to include bats because of a lack of centralized repository of occurrence records. A tool that merges field-based echolocation monitoring with existing mapping technology to provide guidance on when and where bats are located during migration will be demonstrated. Specifically, we have developed a publicly-available, interactive, web-portal where users can upload and visualize echolocation data from individual sites and time periods. Detections from multiple sites are plotted on maps of topography, vegetation, land use, and bioclimatic variables at regional scales, to generate inferences about migratory ecology and routes. The timing of migratory movements can also be visualized. The prototype of the portal was built using multiple datasets from California, but the benefits of expanding its geographic scope are clear. Use of the portal by developers, agencies, consultants, and individuals is encouraged and ease of participation will be demonstrated. Ultimately, use of such a tool is vital for both understanding migratory ecology of bats and landscape-level screening of wind energy facilities with respect to bats.

Planning for Cumulative Impacts

"Compliance Management System"

Presenter: Tina Bartunek, Iberdrola Renewables, LLC

Authors: Tina Bartunek, Nadine May (Iberdrola Renewables)

Abstract: Iberdrola Renewables implemented the wind industry's first company-wide Avian and Bat Protection Plan (ABPP) in collaboration with the U.S. Fish and Wildlife Service (USFWS) in October 2008. The ABPP documents the bird and bat impact avoidance, minimization, and (if applicable) mitigation measures

for IR Wind projects. The ABPP provides a decision framework for collecting information in increasing detail to evaluate risk and make siting and operational decisions. To implement the ABPP, IR developed a compliance management system (CMS) that serves as a framework for integrating the ABPP policy into all aspects of project development, construction, and operations. While a major component of the CMS is a web-based tracking system, the CMS is actually a collection of business processes performed by IR with certain applications supported by the Gensuite system. IR designed the CMS in 2009 by studying applicable policies; the IR project development, construction, and operations lifecycles; the earlier versions of the Wildlife Monitoring and Reporting System (WMRS, IRI 2011b); and early stages of the USFWS wind energy and wildlife guidance (USFWS 2010). As a result of this research, IR was able to delineate the parameters of a comprehensive system that would conform with our ABPP while reducing impacts to project development and operations.

"Wind & Biodiversity project: integrated solutions for managing biodiversity in wind farms"

Presenter: Joana Bernardino, Bio3

Authors: Miguel Mascarenhas, Hugo Costa, Joana Bernardino (Bio3); José Vieira, Carlos Bastos (IEETA – Instituto de Engenharia Electrónica Telemática de Aveiro); Maria João Pereira, Carlos Fonseca (Departamento de Biologia & CESAM, Universidade de Aveiro)

Abstract: The R&D project Wind & Biodiversity arises from the need of reconciling wind energy developments and biodiversity. As widely known, when inadequately located and designed, wind farms can be responsible for negative impacts on birds and bats. Hence, it is crucial to ensure that the construction of wind farms is founded on good environmental management rules, establishing a compromise between economic sustainability and biodiversity conservation. In order to accomplish that, first it is mandatory to fully understand the real impacts and then to develop the best mitigation and offset measures. Thus, the main goals of this research project are 1) to understand the ecology and the dynamics of bird and bat populations; 2) to accurately quantify and also understand the reasons beyond bird and bat mortality; 3) to develop equipments and technology to mitigate bird and bat fatalities; 4) to develop, adapt and validate compensation measures to implement in wind farms with high mortality rates; and ultimately 5) to develop integrated and sustainable management solutions/services adapted to wind farms, according to its engineering, performance and ecological context. This 4-year project (2011-2015) is lead by Bio3 in partnership with the University of Aveiro, (through the Center for Environmental and Marine Studies and the Institute of Electronics and Telematics Engineering). The project is partially funded by the European Union, under the European Regional Development Fund.

"Wind Development and Wildlife Mitigation: A Primer"

Presenter: Anne Jakle, Ruckelshaus Institute, University of Wyoming

Authors: Anne Jakle (Ruckelshaus Institute of Environment and Natural Resources, University of Wyoming)

Abstract: As more wind facilities are constructed in Wyoming and across the nation, site-specific and cumulative impacts to wildlife are increasingly a concern. Wildlife mitigation is the sequential process of (1) avoiding impacts when possible, (2) minimizing remaining impacts, and (3) compensating for unavoidable impacts. Despite the use of comprehensive avoidance and minimization measures, impacts to wildlife can still occur, and the last step of the mitigation hierarchy is to compensate for these impacts. Compensatory mitigation is relatively rare within the wind industry, primarily because there is little regulatory structure requiring or guiding compensation for wind–wildlife impacts. Projects across the country that have engaged in this third stage of mitigation have done so primarily through voluntarily purchases of replacement habitat via conservation easements or providing in-lieu fees to fund compensatory mitigation projects. This primer draws from both working and statutory knowledge to provide a survey of current wildlife mitigation practices for wind energy projects—both in Wyoming and outside the state—and explore what might be next for

wildlife mitigation and wind as development moves increasingly to federal lands and may be subject to increased permitting and mitigation requirements.

"Facilitating Progress: Wildlife Monitoring and Mitigation Measures for Wind Energy in the United States"

Presenter: Nathan Jones, Colorado State University

Authors: Nathan Jones, Liba Pejchar (Colorado State University)

Abstract: Energy production in the United States is in the midst of a substantial transformation propelled by demands for clean, cheap and domestic power which has resulted in the rapid growth of wind energy. Past energy booms such as oil, natural gas and hydro-electric energy development have at times been hasty and unregulated, resulting in dramatic negative impacts to native ecosystems and society. Wind energy is an attractive renewable and domestic fuel source that has the potential to provide clean energy and reduce the magnitude of climate change. Central to increasing our ability to develop responsibly is the completion of quality pre-construction wildlife studies, the implementation of mitigation measures based on this information and post-construction monitoring to evaluate mitigation success. The USFWS Land-based Wind Energy Guidelines aim to increase the prevalence and quality of this research and mitigation, but remain only recommendations. Unfortunately, there is a strong indication that pre- and post-construction studies are not always done, and when they are, they are often ad-hoc and inconsistent in design. Additionally, there is very little information on how many projects have used these studies to implement and evaluate mitigation measures. Finally, there is good reason to believe that planning and permitting by local and regional governments is often done at the scale of individual projects without carefully considering large-scale, cumulative impacts. The primary objective of this proposed research is to quantify the extent to which wind facilities across the United States have been permitted and developed based on pre-construction studies, appropriate mitigation measures and employ post-construction monitoring. In instances where pre- and/or post-construction studies were completed, we will evaluate this process, focusing on basic ecological study design principles such as control, replication and randomization. We will test for a correlation between pre-construction studies and mitigation measures. We will also identify spatial and temporal trends and other factors such as land ownership that may influence the incidence and quality of monitoring and mitigation. We will evaluate our results in the context of the institutions that permit these projects and in particular, we will identify the extent to which projects were approved as part of a large-scale planning process. Finally, we will recommend a protocol for monitoring and a policy framework for project evaluation and mitigation that could streamline this process for developers and provide substantial benefits for species of concern, ecosystems and the services they provide society.

"APLIC Recommendations for Power Pole Configurations at Wind Energy Projects"

Presenter: Andrew Milner, Iberdrola Renewables

Authors: Andrew Milner, Jerry Roppe (Iberdrola Renewables); Sherry Liguori (PacifiCorp); Mike Best (Pacific Gas and Electric), Jim Burruss (Cardo Entrix), and Jim Lindsay (Florida Power and Light)

Abstract: Significant growth in wind energy (turbines and power lines) as a renewable energy source has occurred with 43,461 MW installed as of Q3 2011. As part of this development, wind energy facilities frequently uses overhead 34.5 kV electrical power (collector) lines to transfer power from the plant to the grid. Underground lines are a standard practice but overhead collection designs are atypical from utility design, and generally, are not addressed in the Suggested Practices from the Avian Power Line Interaction Committee (APLIC). Plant (as-bulit) inspections and reviews of 3rd-party electrical designs have indicated instances of inadequate insulation and/or isolation and misinterpretation of raptor-safe designs. Issues were also noted during construction due to failure to follow drawings with adequate design. Areas identified were: • "Varying interpretations" of APLIC practices • Riser poles with electrical switches and arresters • Bonded

hardware • Uncovered ground wire and OPGW • Inadequate "air" gaps. Suggested practice to resolve or minimize risk to raptors using wind facility power lines will be presented. These include: 1. Retrofit and new construction designs 2. Implement QA/QC program during development and construction 3. Encourage training and general awareness for wind personnel/industry and contracted firms 4. Work with APLIC and AWEA to familiarize wind industry and other groups to identify designs issues. These recommendations have been incorporated into the suggested practices for the APLIC workshop/short course training and into the suggested practices on the APLIC website.

"Part 2: Collaborative Landscape Conservation Approach: Modeling potential impacts to migratory whooping cranes from wind power development" *(Accompanies a presentation)*

Presenter: Chris Nations, WEST, Inc.

Authors: Christopher S. Nations, Shay Howlin, David P. Young (WEST, Inc.)

Abstract: Nineteen wind energy companies in collaboration with the US Fish and Wildlife Service and state wildlife agencies are developing a regional Habitat Conservation Plan (HCP) to address potential incidental take of whooping cranes (Grus americana) resulting from construction and operation of wind facilities. The HCP permit area includes the US portion of the whooping crane migratory corridor, a 200-mile wide swath connecting the wintering grounds in south Texas with the breeding grounds in Canada. Our approach to estimating potential take of cranes over the 45-year duration of the HCP entails multiple interdependent mathematical and statistical components. Impacts are categorized as either indirect (energetic cost due to avoiding wind facilities) or direct (collision with wind turbines). The program build-out, addresses the siting of future wind projects for modeling purposes only. Siting relies on a "development potential" map based on landscape features (e.g., wind resource, proximity to transmission line) ranked in importance by industry participants. Total megawatt capacity within the corridor is based on US Department of Energy projections for 20% renewable energy goals by 2030. Within the build-out model, wind facilities of specified capacity are added to the landscape sequentially using an unequal probability sampling approach – areas with higher development potential have higher selection probability. The process stops when total capacity is reached. The second component is a statistical model that predicts roosting/stopover habitat throughout the corridor. Resource selection function (RSF) models were fitted to data on confirmed sightings of cranes at stopover locations, separately for the fall and spring migratory seasons. Landscape-level covariates in both models included distance from the migratory corridor centerline, wetland density, distance to water, and either proximity or acreage of agriculture. The third component is a simulation model for whooping crane migration that uses both the build-out and the RSF results. RSF predictions influence selection of simulated roosting locations, while the build-out presents wind projects that may be encountered in flight. The objectives of this model are to estimate indirect impacts in terms of additional distance flown in avoiding projects, and to calculate the rate at which projects are encountered for subsequent estimation of direct impacts. Initial results indicate that indirect impacts are negligible and that the encounter rate, while low, may be important. The final component is a collision risk model based on whooping crane characteristics and assumptions regarding wind project layout, turbine size, and wind conditions. Preliminary simulations show that collision risk for cranes is high compared to other avian species, as expected given their large size and low flight speed. Using realistic assumptions of avoidance probabilities, final estimates of collision risk are combined with encounter rate estimates from the migration model and with projected population sizes to yield predicted take over the 45-year permit duration. Our approach to impact assessment provides a defensible component of the HCP that could be duplicated for other avian species.

"Part 1: Collaborative Landscape, Conservation Approach, and Benefits of the of the Great Plains Wind Energy HCP (GPWE HCP)." *(Accompanies a presentation)*

Presenter: Karen Tyrell, BHE Environmental

Authors: Karen Tyrell, Kely Mertz (BHE Environmental); Abby Arnold, Elana Kimbrell (Kearns & West)

Abstract: 19 wind industry companies, in collaboration with the US Fish and Wildlife Service (USFWS) and state agencies, are developing the Great Plains Wind Energy Habitat Conservation Plan (GPWE HCP) to evaluate and respond to potential impacts to federally listed species related to the future development of wind energy facilities in a nine-state, 200-mile wide region of the central US, extending from Canada to the Gulf of Mexico. Often, the proponent for an HCP is a single entity that prepares a permit application. In this case, wind companies have organized themselves through their affiliation with the American Wind Energy Association to develop a landscape level HCP. Throughout development of the HCP, industry has been collaborating with the USFWS as well as each of the state wildlife agencies included in this 268 million acre HCP plan area. When the process was launched, the companies and FWS set out a joint mission for the HCP process: "…to work cooperatively, to exercise flexibility and ingenuity, and to devote the necessary resources to craft a scientifically and legally defensible HCP that provides a means for reasonable wind power development in the planning area, that will support the survival and recovery of the species covered in the HCP." (December 2009). The GPWE HCP is analysing potential impacts resulting from the proposed development and operation of wind energy facilities on two endangered species: the whooping crane and interior least tern; one threatened species, the piping plover; and on the lesser prairie-chicken, a candidate species. Extensive and robust modelling approaches are being used to describe the proposed build-out of wind energy facilities to be covered by the HCP, as well as to determine the potential impacts of both the proposed covered actions and the conservation measures addressed in the plan. Empirical data and expert opinion from the scientific and resource agency communities have been incorporated to inform both effect analyses and the applicability of measures to avoid and minimize impacts to the species addressed in the HCP. The HCP will replace project-by-project permitting for included wind energy projects over a proposed permit duration of 45 years in one of the richest wind resource areas in the country. Because approval of the HCP will lead to issuance of a federal permit, a NEPA analysis will also be completed. An EIS, completed by the US Fish and Wildlife Service, is underway to evaluate effects of permit issuance in accordance with the proposed conservation plan. In addition, FWS will complete ESA Section 7 requirements on the proposed permitting action. These processes allow further evaluation of the analyses and conservation measures described in the HCP. The presentation will highlight the benefits of this regional conservation planning approach.

Offshore Wind Energy: Siting and Assessment

"Guidelines for offshore renewables in the Portuguese Pilot Zone based on a pre-construction assessment"

Presenter: Joana Bernardino, Bio3, Lda.

Authors: Helena Coelho, Rita Ferreira, Sandra Rodrigues, Joana Bernardino, Miguel Mascarenhas, Hugo Costa (Bio3); Ruth De Silva, Chris Pendlebury, Richard Walls (Natural Power Consultants)

Abstract: Pre-implementation knowledge is crucial to mitigate impacts on wildlife. Thus, baseline environmental data and careful planning are key phases to an efficient environmental management strategy. The Portuguese Pilot Zone (PPZ) located in the Eastern Atlantic Ocean was created to support the deployment of offshore renewable energy technologies in Portugal and baseline information on birds and marine mammals has been gathered in order to be used in the consenting process. Bird and marine mammal surveys were carried out between May and June of 2011 in the Portuguese oceanographic vessel Almirante Gago Coutinho. Methodologies included ESAS (European Seabirds at Sea) techniques for seabirds surveys and dedicated marine mammals observer surveys; both were carried out by skilled observers. Biological data recorded was used to create density plots and to explore distribution patterns of birds and marine mammals along the area, to allow supporting the definition of environmental management recommendations for the development of different offshore energy devices at both spatial and temporal scales. A desktop assessment

was also performed to complement the results with current knowledge on the potential impacts of energy devices in marine biodiversity. This information was used to sustain the definition of crucial guidance for the development of different energy devices (wind/wave) and to produce baseline guidelines to developers/stakeholders across the project life-cycle (pre-construction, construction, operation and decommissioning). These guidelines have taken into account the ecological requirements of different biological groups, namely benthos, mammals, birds and fish. In the future these recommendations should be used by the PPZ management company, OceanPlug, and also by the developers to avoid unnecessary studies or unexpected problems, to improve site selection and to define appropriated plans and programs for biodiversity management.

"Monitoring and Mitigation Alternatives for Protection of North Atlantic Right Whales during Offshore Wind Farm Installation"

Presenter: Corey Duberstein, Pacific Northwest National Laboratory

Authors: Andrea Copping, Tom Carlson, Shari Matzner, Michele Halvorsen, Jessica Stavole (Pacific Northwest National Laboratory)

Abstract: The U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM) has recently proposed potential sites for offshore wind (OSW) development along the Atlantic Coast. The North Atlantic Right Whale (NARW) ranges along the Atlantic coast and the population is highly endangered, with only 300-600 left. Since 1980, the North Atlantic Right Whale (NARW) population has been declining rapidly mainly due to collisions with shipping vessels and fishing gear entanglements. Studies from the oil and construction industries have shown that underwater sound puts these and other marine animals at risk. Installation of offshore wind turbines on the Atlantic coast will be accomplished by driving piles into the seabed, an activity that generates loud noises throughout construction. Ensuring the safety of the NARW from the acoustic challenges of pile driving will require real time monitoring and mitigation, which must be integrated into construction planning. Researchers from Pacific Northwest National Laboratory are developing a system of monitoring and mitigation activities that will be integrated into the flow of construction. Monitoring can be done in one or a combination of three ways: Marine Mammal Observation (MMO), Passive Acoustics Monitoring (PAM), and Active Acoustics Monitoring (sonar). In addition to further developing monitoring techniques, mitigation for acoustic challenges to NARW during offshore wind installation requires: 1) understanding the distribution of the animals throughout the year to mitigate the intersection of the NARW and construction activities; 2) developing performance specifications for marine mammal monitoring systems; and 3) deploying those systems at a cost that is acceptable to the industry.

"Avian Risk Assessment for Offshore Wind Projects"

Presenter: Chris Nations, WEST, Inc.

Authors: Christopher S. Nations, Dale M. Strickland (WEST, Inc.)

Abstract: Offshore wind projects present several challenges for avian risk assessments. Because offshore wind farms are still rare, there is little information on potential impacts to birds. Furthermore, gathering new information is both more difficult and more costly than for comparable studies for terrestrial wind farms. We present a case study of a risk assessment that dealt with these difficulties at a proposed, but never constructed, offshore project. Our analysis consisted of several stages. First, we processed data from several site-specific studies including boat-based and aerial visual surveys of bird use, marine radar surveys of aerial targets conducted primarily from shore and supplemented with occasional boat-based surveys, and NEXRAD (Doppler weather radar) studies of avian migration patterns on broader temporal and spatial scales. Analyses of these data were conducted for multiple taxonomic groups, their diurnal and seasonal patterns of abundance, and their spatial distributions and flight altitudes. Furthermore, analyses addressed inevitable limitations in the survey data, such as distance-related declines in detection probability for both visual and

marine radar surveys. Information from the mutliple on-site surveys was integrated to yield estimates of passage rates (number of flights per unit time) through the project site. In the second stage of the analysis, we conducted literature reviews to supplement limitations in the survey data, for example, to provide estimates of avoidance probabilities and additional information on bird behavior and flight characteristics. A computer model was developed in the third stage to estimate probabilities of bird collisions with wind turbines. This model relied on avian characteristics determined from the site-specific surveys and the literature reviews. In addition, the model was based explicitly on the proposed wind farm layout, turbine design features including dimensions and rotational velocities, as well as local wind conditions. Collision probabilities were assessed separately for each taxonomic group, season, and for different periods of the day. In the final stage, numbers of fatalities were predicted by combining estimated passage rates and collision probabilities. The predicted overall fatality rate (number of fatalities per megawatt per year) was consistent with observed fatality rates at several existing terrestrial wind projects. Furthermore, the expected numbers of fatalities were very small relative to bird population sizes, such that bird/turbine collisions would not likely have had measureable demographic impacts. While our example does not address risks such as habitat loss, we argue that an approach based on integrated data analyses and modeling is broadly applicable to other forms of risk to birds.

"Update on Current Progress of Offshore Bat Research Activities in Atlantic and Great Lakes Regions"

Presenter: Steve Pelletier, Stantec Consulting, Inc.

Authors: Steve Pelletier, Trevor Peterson, Kristian Watrous, Sarah Boyden (Stantec)

Abstract: We report on ongoing progress of the first of a three-year research effort of offshore bat activity in the Great Lakes, Gulf of Maine, and mid-Atlantic coastal states regions. The Department of Energy (DOE) sponsored study is based on concurrent, spring through late fall deployments of acoustic echolocation detectors at coastline, remote island, and offshore tower and buoy locations, and focuses on seasonal offshore presence and migration activities of bats within each of the three regions. The three year DOE-study follows a similar three year research effort initiated by Stantec in late summer 2009 at 2 coastline and 10 offshore sites up to 26 miles off the coast of Maine. Surveys were again repeated in 2010 and 2011 at most locations and additional new sites including a NERACOOS buoy. Survey effort totaled 2349 survey nights conducted over a 240 mile coastline transect extending from Kent Island, New Brunswick to Gloucester, Massachusetts. The study was conducted in cooperation with federal, state, and NGO partners, and provided previously undocumented information and data on the seasonal presence, geographic distribution, and migration of individual bat species in offshore New England waters. A variety of bat species were documented at all 16 survey locations, with resident and migratory bat activity documented from late April to mid-November. Myotis species, silver-haired, hoary, and red bats were the most commonly detected species, with big brown and red bats locally abundant at some sites and long distance migrants at all sites. The study also made available important technical and logistical information on the effectiveness of survey equipment and methods in the marine environment, with guidance toward future offshore research. Survey periods and locations were further expanded with DOE funding in 2012 with additional sites within the Gulf of Maine, Great Lakes, and mid-Atlantic coastal states regions. Studies are expected to continue through 2014. Preliminary results to be reported include regional and seasonal variations of silver-haired bat (Lasionycteris noctivagans) presence/absence as an example of information being collected in conjunction with the survey effort. Information gathered from the ongoing research effort is further paired with results of a comprehensive literature review of impacts of offshore wind energy development on bats and a compilation of studies documenting bat occurrences on the Atlantic. Results of that compilation are to be statistically compared with survey results from land based wind facilities. The compilation and analysis, funded by the Bureau of Ocean Management (BOEM), is currently underway with final results anticipated by January 2014. Research results will provide direct information and data on the timing and extent of seasonal

and regional movements of bat species in the coastal and offshore areas, and in turn support key management and resource guidance decisions for reducing potential reource risks related to offshore wind energy development.

"Integrated Ecological Monitoring Plans (IEMP) for Offshore Wind Projects"

Presenter: Chris Pendlebury, Natural Power Consultants

Authors: Chris Pendlebury, Jane Lancaster, Sarah Canning, Kate Grellier, Richard Walls (Natural Power Consultants)

Abstract: A structured approach for ornithological baseline surveys for offshore wind farms has previously been proposed in order to build up an appropriate understanding of the site during the impact assessment process. As such an Integrated Ornithological Monitoring Program (IOMP) would use a selection of complimentary techniques targeted towards the range of species highlighted as being at potential risk. This approach is widened in order to incorporate other ecological taxa, including marine mammals, fish and benthic habitats. These techniques may include: boat-based and/or aerial surveys; complimentary remote methods such as radar, tracking studies and acoustic monitoring; and then modelling approaches such as collision risk, population viability analysis and cumulative impact assessment. The IEMP approach will be discussed using examples of offshore wind projects from the UK.

"Selection of mixed effects models for bird and marine mammal analysis undertaken for Robin Rigg offshore wind farm, Solway, Scotland"

Presenter: Chris Pendlebury, Natural Power

Authors: Chris Pendlebury, Gillian Lye, Sarah Canning, Richard Walls (Natural Power Consultants); Sally Shenton (EON Climate & Renewables)

Abstract: Robin Rigg in the Solway was Scotland's first commercial scale offshore wind farm development, operational from April 2010. This presentation will provide specific details of the analysis used for the long-term ecological monitoring (circa 10 years) undertaken as part of the Marine Environment Monitoring Program (MEMP). In particular, this presentation will focus on the techniques used to determine the changes in bird and porpoise numbers and distributions at the site, comparing the siteuation pre-construction, during construction and then during the two years of operation. The key species that the analysis has been undertaken for are harbour porpoise Phocoena phocoena, guillemot Uria aalge, razorbill Alca torda, gannet Morus bassanus, red-throated diver Gavia stellata, and cormorant Phalacrocorax carbo. The analysis techniques discussed by this presentation are mixed effects models. The aim will be to show how the models have been selected for each species.

"The Mid-Atlantic Baseline Studies Project: Study design and results to date, with a focus on high-definition aerial surveying and video analysis"

Presenter: Kate Williams, Biodiversity Research Institute

Authors: Kathryn A Williams, Iain J Stenhouse, Evan M. Adams (Biodiversity Research Institute), Andrew Webb (HiDef Aerial Surveying, Ltd.), Emily Connelly (Biodiversity Research Institute)

Abstract: Compared to terrestrial locations, offshore wind energy developers and regulators are faced with a relative paucity of information on wildlife distributions and habitats in marine areas. However, they must have access to the best available information and technical methodologies in order to make informed decisions during siting and permitting processes. The U.S. Department of Energy has funded a three-year project to gather baseline data and reduce market barriers for the mid-Atlantic continental shelf region of the United States. Partners in the Mid-Atlantic Baseline Studies Project include federal agencies, nonprofits,

academic institutions, and for-profit companies. The project is providing essential baseline information for assessing the effects of planned offshore developments on birds, marine mammals, and sea turtles. Components include: (1) Two years of high-definition aerial video surveys and boat surveys to obtain accurate, detectability-controlled wildlife density estimates, and compare high-definition aerial survey results to boat-based data, (2) Satellite telemetry studies to assess fine-scale spatial movements and behavior of focal bird species, and (3) Modeling of oceanographic and wildlife data from the above activities within a hierarchical framework, a statistical method intended to separate observational and ecological processes and understand factors that influence species distributions and relative abundance. The products developed during this project will be used to assess the potential for interactions between wildlife populations and wind turbines; develop U.S.-based technological resources aimed at simplifying and minimizing the cost of environmental risk assessments; and provide federal regulators and wind energy developers with two years of high-quality baseline monitoring data for the study area on the mid-Atlantic continental shelf. Aerial surveillance employing high-definition video cameras has become a commonly used method for broad-scale environmental and wildlife surveys in Europe. As part of the Mid-Atlantic Baseline Studies Project, we recently initiated the first broad-scale use of this technique in North America. Multiple video cameras mounted on the underside of twin-engine aircraft capture high-resolution images of objects, and video footage is later reviewed by a ground-based team of biologists to identify animals to the lowest possible taxonomic group. The video is linked to a GPS system that provides each frame with a precise geographical location, and parallax technology that estimates the flight height of avian targets. Compared with traditional direct observational aerial surveys, the advantages of this technique include faster coverage of the study area, reduced disturbance of wildlife, improved quality control, auditable data, and safer flying at much higher elevations. Here, we present preliminary results of these surveys in U.S. waters, focusing on the accuracy and ease of identification of different taxonomic groups, as well as the challenges faced. We provide recommendations on the application of this technique moving forward.

"Offshore Wind Development in the United States: A Review of Known and Hypothesized Impacts to Wildlife and Current Research Needs"

Presenter: Kate Williams, Biodiversity Research Institute

Authors: Kate Williams, Wing Goodale (Biodiversity Research Institute)

Abstract: Siting and permitting decisions for wind power facilities in the offshore environment of the United States will involve a complex balance of competing factors, including direct and indirect environmental impacts. We present the results of a 2011 workshop in which 35 European and U.S. researchers reviewed existing scientific knowledge on the issue of offshore wind's effects on wildlife (birds, bats, marine mammals, sea turtles, and fish), and summarize what we believe to be the major research needs to address current knowledge gaps and inform regulatory policy.

Emerging Issues

"Integrating Sportsmen's Values and Outdoor-Based Economic Analyses into Landscape-Scale Wind Energy Planning"

Presenter: Ed Arnett, Theodore Roosevelt Conservation Partnership

Authors: Ed Arnett, Neil Thagard, Tom Franklin, Steve Belinda (Theodore Roosevelt Conservation Partnership)

Abstract: All too often, the voice of sportsmen and the importance of our Nation's hunting and fishing legacy, coupled with an $820 billion dollar outdoor-recreation-based economy, are not integrated into planning and decision-making for energy development, including wind energy. To ensure that sportsmen are represented in management decisions that may affect where and how they pursue their passions, the Theodore Roosevelt

Conservation Partnership (TRCP) developed the Sportsmen Values Mapping Project (SVMP). The SVMP captures sportsmen's input by meeting with local sportsmen and women, sporting groups, conservation associations and rod and gun clubs and having them delineate the most important areas for hunting and fishing. The results are digitized in a geographic information system (GIS) database and the value of identified areas are presented along a categorical gradient based on the number of entities identifying a particular area as being important to them (low – 1-4 groups, moderate – 5-8 groups, and high - >9 groups). This data layer can then be merged with others such as critical winter range for big game or sage grouse core areas, and compliment either project-level or landscape-scale analyses to identify high value areas where energy development should be avoided or implemented so as to maintain the associated ecological and social values. Additionally, the TRCP along with other partners of the Sportsmen for Responsible Energy Development coalition collaborated on economic analyses examining the relationship between economic factors and varying land use and management strategies in rural Rocky Mountain West communities. GIS was used to analyze the percentage of land in each county managed under three scenarios: 1) recreation and conservation; 2) development of commodity resources; and 3) a combination thereof. Results demonstrated that counties with greater areas actively conserved for recreation and conservation, coupled with lower impact commodity uses including balanced levels of timber, mining and energy development, have higher income, population and employment growth relative to those counties having greater development of commodities. Counties dominated by conservation and recreation lands also have higher property values and high proportions of higher-income workers. While communities need the energy and materials provided by the commodities sector, quality of life provided by the region's fish, wildlife and scenic resources are also important, and nearly all rural Rocky Mountain communities need the jobs and income generated by both sectors. As such, public officials at the local, state and federal levels must carefully balance the needs and impacts from land use management decisions on all economic sectors to ensure the most rewarding economic future. The SVMP and economic analyses reported here provide critically important and previously unavailable data that will aid in balancing energy development with the needs of fish, wildlife and sportsmen. This information can aid with implementing the U. S. Fish and Wildlife Service land-based wind energy guidelines during the early stages of planning and also supports other efforts such as the Western Governors Association's crucial areas and corridors initiative.

"Whooping and Sandhill Crane Use Monitoring at Five Operating Wind Facilities in North and South Dakota"

Presenter: Clayton Derby, Western EcoSystems Technology, Inc.

Authors: Clayton Derby, Terri Thorn, Melissa Wolfe (WEST, Inc.)

Abstract: Significant concerns have been raised regarding the potential impact that wind energy development may have on whooping cranes, particularly within their migratory corridor. This concern is related to both the potential for direct impacts (i.e., mortality) and indirect impacts (i.e., decrease in habitat suitability or displacement). Several wind energy facilities have been implementing post-construction monitoring activities related to whooping and sandhill cranes. The purpose of the monitoring has been to document use of the facilities and buffer areas by whooping and sandhill cranes as well as to search for and document any crane casualties. Five facilities have been monitored in North Dakota and South Dakota, with monitoring extending back to 2009. These facilities are located at varying distances from the defined whooping crane migration centerline and within both native habitats and mixtures of native/cropland landscapes. Researchers continually survey (morning and evening hours) the project areas during both spring and fall migrations. Surveys are done visually while driving and from vantage points as well as auditory sincecranes can be heard from several miles away under the correct conditions. We will report the results of the monitoring activities as they relate to crane use within the facilities and buffers, potential displacement of cranes from the facilities, amount of effort in searching for casualties, and results of casualty searches. This information can help future wind facility permitting and siting.

"The impacts of wind power on terrestrial mammals – a review"

Presenter: Jan Olof Helldin, Swedish Biodiversity Centre

Authors: Jan Olof Helldin (Swedish Biodiversity Centre, SLU, Uppsala); Jens Jung (Dept of Animal Environment and Health, Swedish SLU,Skara); Jonas Kindberg (Dept of Wildlife, Fish and Environmental Studies, SLU,Umeå); Niklas Lindberg (Enetjärn Natur, Umeå); Wiebke Neumann (Dept of Wildlife, Fish and Environmental Studies, SLU, Umeå); Mattias Olsson (EnviroPlanning, Gothenburg); Anna Skarin (Dept of Animal Nutrition and Management, SLU, Uppsala); Fredrik Widemo (Swedish Association for Hunting and Wildlife Management, Nyköping)

Abstract: We synthesised available knowledge on the effects of wind power development on terrestrial mammals (excluding bats). Wind energy is on a strong increase in Sweden, and most new wind plants are planned in the boreal forest region. Concerns are hence raised on the impact on forest wildlife and semi-domestic reindeer. Studies of terrestrial mammals in relation to wind power are however few, so the conclusions must to a large extent be extrapolated from research on related impacts, such as noise, disturbance from roads, construction work or recreational activities, and habitat changes. The review give at hand that ungulates and large carnivores may be disturbed by i) human recreation (including hunting and leisure traffic) facilitated in wind plants by the new road network, and ii) construction work (intensive but of short duration). Wind plants will often be sited in hilly or rugged terrain far from human settlements; areas which often serve as refugia for large mammals, in particular large carnivores. Hereby, wind power development may despite a limited geographical extent have population level effects. We point out the importance of assessing the cumulative effects of multiple wind plants, and to establish scientifically sound monitoring programs to improve the knowledge base.

"The Impact of Energy Sprawl on Biodiversity and Ecosystem Services: A Landscape Scale Assessment in Colorado and Wyoming"

Presenter: Nathan Jones, Colorado State University

Authors: Nathan Forrest Jones, Liba Pejchar (Colorado State University)

Abstract: Energy production in the U.S. is in transition as the demand for clean and domestic power increases. Wind energy offers the benefit of reduced emissions, yet, like conventional sources such as oil and natural gas, it also contributes to energy sprawl, which is defined as the use and degradation of land due to energy production. To understand the relative nature and magnitude of energy sprawl, we used a diverse set of indicators to quantify the impacts of oil, natural gas, and wind energy development on biodiversity and ecosystem services in Colorado and Wyoming. Aerial imagery was supplemented with empirical data to estimate habitat loss, fragmentation, noise and light pollution, potential for wildlife mortality, susceptibility to weed invasion, carbon storage and water resources. To quantify these impacts we digitized the land-use footprint within 375 randomly selected 1-km diameter plots, stratified across each energy type. We found substantial differences in impacts between energy types for most indicators, although the magnitude and direction of the differences varied. Wind energy resulted in more noise and light pollution whereas oil and natural gas development resulted in greater impacts to fragmentation, carbon sequestration and water resources. However, the underlying land use and location of production activities were critical; more wind energy development occurred on already disturbed lands, resulting in less additional habitat loss and fragmentation compared with oil and natural gas development. The capacity for wind energy to develop on previously disturbed lands promises to be a benefit for the industry and the environment. Responsible siting of wind energy facilities also promises to reduce direct wildlife mortality, but requires an increase in the number and quality of investigations. Finally, our results support the importance of long-term and large-scale planning to address cumulative impacts at various spatial levels. This novel technique and our specific

findings can be used by developers, planners and policy-makers to design energy development that minimizes impacts to natural ecosystems while maximizing benefits to society.

"Whooping and sandhill crane behavior at an operating wind farm"

Presenter: Laura Nagy, Tetra Tech

Authors: Laura Nagy, Karl Kosciuch, Jenny Taylor (Tetra Tech)

Abstract: The objective of this study was to determine if the operation of the 10 turbine, 25 Megawatt Titan I Wind Farm (Project) in South Dakota affects migratory movements of cranes. Although the motivation for this study was to understand the behavior of whooping cranes, collecting data on whooping crane behavior is difficult due to the small number of individuals. Therefore, sandhill cranes were used as surrogates. We collected flight behavior data on all cranes seen on and within 3.2 km of the Project during the spring and fall migration seasons of 2010 and 2011. Whooping cranes were observed within 3.2 km of the Project for 3 days in 2010. Curtailment procedures were implemented when the whooping cranes were in the area. Whooping cranes roosted in a wetland approximately 3.2 km south of the Project and foraged in surrounding grain fields. When the whooping cranes re-initiated their migration, they flew within 0.8 km of the wind farm. No whooping cranes were observed in 2011. One hundred and twenty-three flocks totaling 7,775 sandhill cranes flew over, around, and through the Project. Most cranes in spring flew above the Project without changing course (93 and 100 percent of flocks in spring 2010 and 2011, respectively). In the fall, cranes that flew above the Project either stayed on course (66 and 57 percent of flocks in fall 2010 and 2011, respectively) or changed their flight trajectory in response to turbines (34 and 43 percent of flocks in fall 2010 and 2011, respectively). Sandhill cranes changed flight trajectories to fly between or around turbines significantly more often when they were flying within the rotor zone (93 percent of flocks) than when they were flying above it 25 percent of flocks; $\chi 2 = 25.83$, $P < 0.001$, $N = 108$). Of the sandhill cranes flying within the rotor zone, 4 flocks flew between the turbines with the greatest spacing (1,085 m separation, turbine separation ranges from 381 m to 773 m for all other turbines). This result suggests that there may be an acceptable separation distance for the cranes and should be further researched as minimization measures for larger wind energy projects. The behavioral response of cranes to turbines when flying within the rotor zone suggests that cranes are aware of turbines as obstacles and respond to them to reduce their risk of collision. Three sandhill crane flocks stopped-over near the Project in each year, with stopover distances ranging from (0.79 to 2.3 km) to the nearest turbine. Interpreting sandhill crane stopover behavior is challenging because stopover locations are dependent on many factors including the availability of wetlands among years, the presence of other foraging opportunities), and traditional stopover locations. The data collected here represent one of the first studies to systematically collect data on the behavior of cranes associated with an operational wind farm. Overall, cranes appear to have low risk of collision due to their ability to avoid the wind turbines either by flying over them, around them, or through gaps between them.

"Ecological Impacts of Wind Farms on Mammalian Mesocarnivores"

Presenter: Brian Tanis, Fort Hays State University

Authors: Brian P. Tanis, Elmer J. Finck (Fort Hays State University, Department of Biological Sciences)

Abstract: Wind energy is among the most rapidly growing industries in the United States, with support for development coming from both state and federal governments. While the industry strives to be environmentally friendly the addition of infrastructure associated with wind farms alters ecosystems in novel ways. Numerous studies have shown the impacts wind turbines have on bird and bat species mortality; however, far less attention has been given to responses of terrestrial organisms to wind facilities. Mammalian mesocarnivores are model organisms to document the alteration of communities surrounding wind turbines as they respond to addition of turbines and human activity, addition and improvement of roadways as movement corridors, and increases in turbine-induced carrion. In October of 2011, a yearlong

study was established surrounding the Central Plains Wind Facility in western Kansas to document patterns associated with the occupancy of mammalian mesocarnivores within turbine and turbine-free habitats. We placed thirty four scent-baited trail cameras among turbine and control habitats, with a subset randomly placed along roadways. We recorded mesocarnivores detection histories during 28 day survey periods along with habitat covariates by using PRESENCE 4.1. Preliminary analysis shows that Coyote (Canis latrans) and swift fox (Vulpes velox) were the most abundant mesocarnivors detected with a trap success around three percent. Mesocarnivores were detected significantly more in control habitat ($\chi 20.05,1=11.79$). Coyote occupancy was impacted negatively by roadways (p=.52) and turbines (p=.91) while swift fox occupancy was associated positively to turbines(p=8.3). This may be due to the propensity of coyotes to avoid human activities and may alter the overall ecosystem function surrounding wind facilities.

"Winter survival risk for pronghorn encountering wind energy development in south-central, Wyoming"

Presenter: Katie Taylor, University of Wyoming

Authors: Katie L. Taylor, Jeffrey L. Beck (Department of Ecosystems Science and Management, University of Wyoming, Laramie, WY); Snehalata Huzurbazar (Department of Statistics, University of Wyoming, Laramie, WY & Statistical and Applied Mathematical Sciences Institute, RTP, NC)

Abstract: In recent years the demand for sources of renewable energy, including wind energy, has increased substantially in the United States. Landscapes with high potential for wind energy development often coincide with suitable wintering habitat for pronghorn (*Antilocapra americana*). Evaluating the influence of energy development on pronghorn winter survival is particularly critical given that they encounter elevated energetic demands during this time of year. The purpose of our study was to evaluate pronghorn survival risk on a landscape developed for wind energy production (Dunlap Ranch [DR]) in comparison to an offsite reference area (Walcott Junction [WJ]) over 3 winters (2010, 2010–2011, and 2011–2012) in south-central Wyoming, USA. In January 2010 we captured and attached GPS-transmitters to 70 doe pronghorn (35 in the DR and 35 in the WJ). We monitored these animals via fixed-wing flights approximately 5 times per year and recovered locational data from collars attached to dead pronghorn over the course of the study period. The remaining GPS collars were recovered in early May 2012. We used the Kaplan-Meier product-limit estimator to estimate survival for each population. Overall, 23 pronghorn died in the DR and 10 in the WJ with the majority of deaths occurring in winter 2010–2011 for DR pronghorn and in the summer months for WJ pronghorn. At the end of our 2.5-yr study period, survival ($\hat{S}$) was 0.30 (95% CI: 0.14–0.46) in the DR and 0.68 (95% CI: 0.52–0.85) in the WJ. Using locational data, we plan to model survival risk for pronghorn using Cox proportional hazard model. We carefully identified several key environmental and anthropogenic variables, including wind energy infrastructure, that are known or thought to potentially influence pronghorn survival on winter range. We will consider these variables when modeling survival risk for DR and WJ pronghorn in south-central Wyoming.

"Black bear use response to a wind energy facility in Vermont"

Presenter: David Tidhar, WEST Inc.

Authors: David Tidhar, Cecily Costello, Trent McDonald (WEST, Inc.); Forrest Hammond (Vermont Fish and Wildlife Department, Vermont Agency of Natural Resources)

Abstract: Bear scarred beech (BSB) - American beech trees scarred by black bears - are considered by the Vermont Fish and Wildlife Department (VFWD) to be indicators of high-value bear habitat. VFWD is concerned that a wind-energy facility proposed to be developed within a BSB area considered by VFWD to be important to a regional population of bears, could lead to indirect effects on bears. VFWD contracted WEST to design and carry out a study with three principal objectives: 1) Evaluate the movements and habitat use of bears in response to the construction and operations of the project and determine the extent of indirect

effects; 2) Evaluate the behavioral response of bears to wind turbines during days when turbines are operating, feathered, or shut down completely; and 3) Determine if animals using BSB are more or less likely to be involved in human-bear conflicts than bears not using BSB habitat. This poster summarizes the methods being used and provides example model outputs used to quantify indirect impacts. Three hypotheses are proposed: 1) During and after construction bears will reduce activity in habitats close to the facility, especially when turbines are operating; 2) After construction bears will reduce activity in habitats within direct view of turbines, especially when turbines are operating; and 3) Beginning 1–2 years after construction bears will increase use of regenerating habitats associated with construction of the project. The following statistical analyses will be utilized: Brownian bridge home ranges and home range spatial shifts will be calculated to assess bear movement; resource selection function models adjusted for GPS fix success, combining a classic logistic discrete-choice model and a GPS fix success model, will be utilized to determine habitat use; and seasonal habitat selection will be modeled for each year for each individual using Akaike Information Criteria model selection to identify the most informative natural and anthropogenic covariates for an appropriate subset of individuals (e.g. females). After refitting models to each individual with a common set of covariates, model coefficients will be averaged among individuals for each year to obtain a population level mode. Relative probability of habitat selection will be calculated for all habitat units within the study area, and habitat units will be ranked in quantiles according to their relative probability of selection to map annual model predictions. Finally, to determine the relationship between BSB use and human-bear conflict the relative use of BSB among individuals will be evaluated by comparing model coefficients from habitat use models described above. Correlation between BSB use and number of human-bear conflicts documented will then be calculated using multiple linear regression. The aim of the project is to live-capture up to 12 bears, fit them with GPS collars, and monitor for eight years during pre-construction, construction, and post-construction periods. Bear captures began in 2011 and will continue through summer 2012. Potentially, results of the study will be used by VFWD to help in impact evaluation of future wind energy projects proposed for similar high – elevation habitats within bear range in Vermont.