Presentation Abstracts

This file includes all abstracts for meeting presentations, organized alphabetically by title.

A Collaborative Approach to Coordinate Wildlife Regulatory Information Needs and Data Gaps for Offshore Wind Energy Development in New York State (Poster)

Presenter: Kate Williams (Biodiversity Research Institute)
Authors: M. Wing Goodale (Biodiversity Research Institute)

Abstract: There is limited precedent for offshore wind energy (OSW) facility permitting in the U.S., leading to uncertainties about environmental permitting processes and wildlife data needs for this type of development. The New York State Energy Research and Development Authority (NYSERDA) funded a collaborative process in which state and federal regulators and managers defined the goals of environmental assessments for OSW and wildlife in New York State, reviewed stakeholder perspectives on how to improve or clarify those regulations, and identified specific research needs and data gaps for marine wind and wildlife in New York. Participants responded to confidential surveys and attended virtual meetings that were structured around regulatory and taxonomic topics, such as coastal zone management and protected bird species. In addition, developers, environmental consultants, and nongovernmental organizations provided independent advisory input during this process. Altogether, more than 50 professionals were involved with regulatory and advisory groups.

Six overarching goals for environmental assessments were identified as part of this process. Specific recommendations focused on improving and clarifying the environmental assessment and permitting process for OSW in New York, for example by improving communications between developers, state agencies, and federal agencies, and clarifying how listed species regulations will be applied to OSW. Participants’ input on the potential effects of OSW on wildlife focused on disturbance of benthic habitats, disturbance to birds and fishes during construction and displacement/attraction during operations, sea turtle and marine mammal mortality and injury (as well as behavioral changes) from boat strikes and pile driving noise, and bird and bat mortality or injury from collision with turbines. Protected species and other species with limited or unknown populations, specifically those with life history traits likely to result in their interaction with OSW, were provided extra consideration.
The Environmental Research Program Plan developed during this process identified a clear and immediate need for baseline data on potential wildlife exposure by season, including distribution, abundance, and movement information, to improve upon the current understanding of offshore wildlife populations in New York. Study participants indicated that such broad-scale data could accelerate the permitting process for individual projects by providing key data to regulators and placing project-specific monitoring results in context. Suggested research priorities included: mapping of benthic habitats and patterns of primary productivity; identifying distribution patterns of focal species such as cetaceans, sea turtles, seabirds, and commercially important fishes; examining the movements and habitat use of focal aquatic species; and assessing the relative vulnerability of avian species to offshore wind energy development in New York, to guide future research activities.

This project will inform further discussions, research, and policy considerations for wildlife and marine wind power in New York State. The application of a similar collaborative, multi-step engagement process in other states could promote the development of a regional framework for identifying, prioritizing, and assessing impacts, and would assist developers and regulators in identifying approaches for regulatory compliance and effective wildlife monitoring and conservation.

A Comparative Example for Eagle Local Area Population Cumulative Effects Analysis Based on the USFWS Proposed Revisions (Poster)

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

Abstract: At the Wind Wildlife Research Meeting X, I presented a poster “Cumulative Effects Analysis Considerations for Eagle Take Permits and NEPA” which demonstrated the process for Local Area Population (LAP) Bald Eagle take benchmarking and cumulative effects analysis for an example project in Minnesota (Bald Eagle Management Unit 3). The U.S. Fish and Wildlife Service’s (USFWS or Service) proposed revisions to the regulations for permits for incidental eagle take (April 2016) includes some changes to the LAP calculations and cumulative effects analysis as well as updated eagle population estimates, natal dispersal distances, and administrative flyways as eagle management units. This presentation will revisit the example project under the 2009 Eagle Permit Rule (USFWS 2009) as compared to the new proposed revisions and updated population numbers. The proposed incorporation of the LAP 5% limit on authorized take into the regulations is an important component of the USFWS proposed revisions. Implications for eagle incidental take permits and NEPA analyses will be reviewed.

A Comparison of Species Offset Methodologies (Poster)

Presenter: Randy Wilgis (RES)

Authors: Russ Krauss (RES)

Abstract: Central to the concept of allowing take of a listed species is the offsetting of this take through the use of various offsets. The validity and success of offset implementation is critical to enabling economic development projects to move forward. The methodologies utilized to define the amount and type of offset required to allow a project to move forward also has business implications. Lack of clear and consistent offset policies extend project permitting timeframes, create additional risk due to the
unknown liabilities, create competitive variances between projects, and result in poor ecological outcomes. This presentation will provide an overview of various offset methodologies used to determine the type, quantity and location of habitat offsets, the implications of various assumptions built into these methodologies, and will present the business and ecological case for consistent and clear offset policies based on historical results.

What would we present:

1. Overview of RES approach
2. Why offset methodologies are needed
3. Examples from CWA §404 world (i.e. In-lieu fee program failure and 50% faster permitting times using advanced mitigation solutions like mitigation banks)
4. What is needed to ensure successful outcomes (operating company, balance sheet, ability to absorb risk, performance requirements over time)
5. Examples of current methodologies
6. What happens when offset methodologies are not clearly defined and consistently applied
7. How RES works to ensure superior ecological outcomes

A Non-traditional Approach to Compensatory Mitigation (Poster)

Presenter: Shelby Howard (HELIX Environmental Planning, Inc.)

Authors: Erik McCracken (HELIX Environmental Planning, Inc.), W. Larry Sward (HELIX Environmental Planning, Inc.), Erica Harris (HELIX Environmental Planning, Inc.), Erica Harris (HELIX Environmental Planning, Inc.), Justin Fischbeck (HELIX Environmental Planning, Inc.), Natalie McCue (Pattern Energy)

Abstract: While the project footprint of a wind project can be small relative to other types of renewable energy projects, compensatory mitigation requirements can be extensive, especially for projects involving multiple regulatory agencies. Non-traditional approaches to compensatory mitigation are a valuable alternative to traditional mitigation approaches, especially for projects requiring a large amount of mitigation. HELIX worked with Pattern Energy Group to develop a novel approach to mitigate for construction-related impacts associated with the Ocotillo Wind Energy Facility, which consisted of restoring the 318-acre Carrizo Marsh. The habitat restoration offsets the compensatory mitigation requirements of the U.S. Fish and Wildlife Service, Bureau of Land Management, U.S. Army Corps of Engineers, California Department of Fish and Wildlife, and County of Imperial. Although the acreage of the restoration area is less than the combined compensatory mitigation acreage, the mitigation package provided to the regulatory agencies demonstrated environmental benefits that exceeded the acreage expectations. Carrizo Marsh is a regionally significant water body in California State Parks and funding to restore the marsh had not been previously available due to the size and extent of the invasive trees in the marsh. The goal of the 6-year restoration program is to remove impenetrable stands of invasive salt cedar trees to provide baseline efforts for the long-term enhancement of the marsh and to allow natural re-establishment of native habitats; re-establish floodplain hydrology; and provide the initial efforts to restore bighorn sheep habitat. We will review the success of the various techniques used to remove the invasive trees, including prescribed burns, and the preliminary findings related to changes in wildlife usage of the marsh, native vegetation succession, and improvements in hydrology. We will also review
the costs, risks, and related challenges to implementation of a large program, and the applicability of non-traditional approaches to mitigation for other wind energy sites.

**A Summary of Recent Initiatives Conducted at the National Wind Technology Center in Support of Addressing Impacts to Birds and Bats at Wind Energy Facilities (Poster)**

**Presenter:** Lee Jay Fingersh (National Renewable Energy Laboratory)

**Authors:** Elise DeGeorge (National Renewable Energy Laboratory), Jason Roadman (National Renewable Energy Laboratory)

**Abstract:** Concerns regarding the negative impacts of wind energy projects on wildlife, especially birds and bats, pose challenges for project developers, both with public acceptance and in the permitting processes. Developers may be required to monitor projects for diurnal or nocturnal species-specific presence and abundance, collect collision data, or implement mitigation strategies to reduce fatalities even though risk parameters have not been adequately identified. To meet the current and future regulatory requirements, project developers need to know which technology solutions best meet the permitting requirements—both from a technical and cost perspective. Technological solutions may also vary by species of interest or by regulatory requirements; thus, it is expected that a range of solutions will be required to meet the needs for wind energy project development in various jurisdictions.

Many vendors claim to have commercial systems that can detect or deter bird and bat species or that are in different stages of development; however, many of these systems have not undergone independent testing and validation. Further, the requirement to implement these systems by the permitting agency results in additional costs for project developers but may not provide verifiable benefits to the species of interest. To date, there is no set standard by which to compare existing and emerging systems.

Over the past several years, NREL has participated in or led several directly relevant initiatives including:

- Testing of radar and visual camera systems using eagles and falcons;
- Installing thermal imagery systems, visual imagery systems, contact microphones, and accelerometers to evaluate technologies designed to detect bird strikes on wind turbines;
- Assisting with U.S. Geological Survey experiments by installing thermal imaging cameras and managing the collection of data from equipment mounted on turbines at the NWTC;
- Analyzing available avian detection and deterrent technology to help an offshore wind farm developer meet their pending permit requirements;
- Hosting an Association of Fish and Wildlife Agencies and Bats Conservation International meeting in support of bat impact mitigation and wind energy including three separate landscape classes; and
- Convening wildlife statisticians, biologists, and engineers to develop testing protocol to determine the effectiveness of emerging avian and bat detection and deterrent technologies.

Through this poster presentation (or presentation if preferred by the NWCC), NREL will provide a summary of efforts recently conducted and demonstrate how NWTC infrastructure and facilities can
A Tale of Two Countries: Similarities and contrasts in regulatory requirements for protected bat species relative to the development and operation of wind energy projects in the US and Canada. (Poster)

Presenter: Elizabeth Annand (Stantec Consulting Services Inc.)

Authors: Nicole Kopysh (Stantec Consulting Services Inc.), Andrew Taylor (Stantec Consulting Services Inc.)

Abstract: In recent years, concern has increased for the effect wind energy development may have on bat populations in North America, particularly in the light of the advancing spread of white-nose syndrome. The disease and its impact on bat populations occur in both the US and Canada, resulting in government agencies identifying several species of bats as “Species at Risk” or Endangered or Threatened. Thus, these species are afforded regulatory protections provided by relevant legislation.

Wind projects in both the US and Canada must comply with the applicable regulations for listed species, thus impacting the parameters within which wind project proponents are able to develop and operate facilities. Restrictions can be applied at the national, state, provincial, and/or local levels.

We compare and contrast regulatory requirements and protective measures being used in both Canada and the United States. We outline the provisions for bats that are afforded protection under applicable laws and regulatory processes as they apply to the permitting of the construction and operation of wind energy projects in Ontario, Canada and the US. We compare requirements under the Ontario’s Endangered Species Act and the United States’ Endangered Species Act with an emphasis on wind project development and operations, and incidental take permitting process. We compare the regulatory processes, as well as measures for avoidance, minimization, mitigation, and adaptive management in advance of and in response to observed consequences. Lastly, we then consider the associated successes and challenges that wind projects developers have faced on both sides of the border when complying with regulatory provisions for protected species.

Acoustic Bat Monitoring at a Southern Alberta Wind Farm (Oral Presentation)

Presenter: Katrina Lukianchuk (Tannas Conservation Services Ltd.)

Abstract: We deployed acoustic monitoring stations throughout a wind farm in southern Alberta to determine general and species-specific bat activity during spring and fall migratory periods, as well as the summer breeding period (March through October). The wind farm is located along a major migratory pathway for birds and bats, and therefore poses a high mortality risk to wildlife. The wind farm has been under post-construction monitoring for two consecutive years, which includes weekly carcass searches and seasonal carcass persistence and searcher efficiency trials to assess mortality rates at each turbine. However, little is known about how the area is utilized by Alberta’s bat species in general throughout the year. Carcass searches only provide information about mortality rates, which
may not be a good indicator of activity levels of different species. Each species has a unique ecology, which may lead to biases in which species are affected by wind turbines (e.g. forest species vs. open field species, gleaning species vs. species that hunt on the wing, etc.). Through the use of acoustic monitoring techniques we are able to provide a glimpse of the activity levels of different species of bats throughout the year, including bats that breed in area, as well as bats using the area as a migratory pathway. This information could be useful for determining when threatened or endangered species are present and at risk in the area. This includes specific times of the year and hours of the night where they are most active, which could be useful for informing mitigation decisions. We used Wildlife Acoustic Song Meters to record bats on a nightly basis from sunset to sunrise every night at five locations. We analyzed data with Kaleidoscope Pro (Wildlife Acoustics) and Analook (Titley-Scientific) software packages. Bat calls were identified using both autoID and manual ID techniques. Preliminary results show that different species tend to arrive and have peak activity levels at different times of year. Silver-haired bats and big brown bats tended to arrive first to the area (April) and had peak activity levels in August and September, whereas Myotis spp. bats appeared slightly later (May) and peaked in July. Hoary bats also arrived early (April) and peaked in July. Activity dropped steeply in October, with no bats detected past October 17th. Peak hourly activity throughout the night varied depending on the month, but in general was highest from 21:00 to 01:00. Bats were active for a longer portion of the night during the height of the breeding season (22:00 to 04:00 in July) and during the fall migration (21:00 to 05:00 in August and September). These data are useful for determining baseline activity levels of different species of bats in southern Alberta, an area where wind farm development is growing quickly. Mortality data from carcass searches alone may not be enough to make informed decisions about future wind farm developments and mitigation techniques, and acoustic monitoring could be a useful passive technique to help us understand and protect Alberta’s bats.

An Evaluation of Potential Pronghorn (Antilocapra americana) Responses to Wind Energy Development in North-Central Arizona (Oral Presentation)

Presenter: Martin Piorkowski (Arizona Game and Fish Department)

Authors: Daniel Sturla (Arizona Game and Fish Department), Joel Diamond (Arizona Game and Fish Department)

Abstract: Pronghorn (Antilocapra americana) are one of the most susceptible ungulate species to anthropogenic disturbances including various forms of energy extraction. Today pronghorn face a new, ever increasing presence on the landscape – wind energy facilities. Approximately 36% of all U.S. wind energy production occurs within the core distribution of pronghorn yet there is little published or unpublished research as to how wind turbines may impact pronghorn. We designed a study that measured pronghorn movement patterns using Browning Bridge Movement Models to calculate utilization distributions of free-ranging pronghorn in and around a wind facility. This study addressed three primary objectives in order to identify whether or not pronghorn displayed any avoidance to the wind facility or its turbines. These objectives were to: 1) identify movement patterns within and near an operational wind facility in north-central Arizona; 2) evaluate any measurable impacts the wind facility may have on pronghorn movement patterns; and 3) collect pre-construction movement data for future planned wind energy development in the area. In 2010-2011, we captured 17 female and 7 male pronghorn and fitted them with GPS-collars. These collars collected location data from the 24 individuals
for 18-months (between 2010 and 2013). We used the location data to calculate core (50%) and primary (95%) utilization distributions and travel distances for each pronghorn. Of those pronghorn crossing between turbines (~5% of all movements) there was no significant relationship between exterior and interior turbines (p = 0.275). Male pronghorn crossed further (more towards the center between turbines; 140 [SE ± 13.2] m vs. 80 [SE ± 2.5] m, respectively) and less frequently (23.8 vs. 64.6 crossings/individual, respectively) between turbines than did females in all cases of turbine operation (moving and non-moving turbine blades). Finally, pronghorn tended to utilize the areas within the wind facility more often in the winter months (November through February) than the summer months (April through October). Overall, we did not find any evidence that suggested pronghorn were avoiding the wind facility. However, we did identify that male pronghorn tended to cross more towards the center between turbines maximizing distance from the turbines. Additionally male crossed between turbines less frequently than did females although they both utilized habitat immediately adjacent to the turbines. These results suggest that pronghorn populations may not avoid otherwise suitable habitat in the presence of an operational wind facility, however, there may be management practices available that could improve connectivity and permeability for males with specific attention to turbine micro-siting (e.g., small increases in inter-turbine distances). Furthermore, by maintaining and enhancing pronghorn habitat in and around wind facilities during and post-construction, pronghorn should continue to utilize the landscape without experiencing negative impacts with the operation of the turbines.

An Examination of Wing Beat Frequency as a Species Signature for North American Birds At Risk from Wind Energy Development (Poster)

Presenter: Corey Duberstein (Pacific Northwest National Laboratory)

Authors: Valerie Cullinan (Pacific Northwest National Laboratory), Shari Matzner (Pacific Northwest National Laboratory)

Abstract: Standard approaches for assessing risk to birds from, and evaluating mitigation effectiveness for, wind energy development utilize human observers. Reliance on human observers can be expensive, can pose risk to health and safety, or may simply be impractical. In order to determine if remote detection and identification of birds can address these shortcomings, we explored the use of wing beat frequency to classify birds to species within three geographical groups of North American birds potentially at risk from both offshore and land-based wind energy development. We wanted to determine the degree of specificity to which one could classify birds based on wing beat frequency alone. The first species group selected was from pelagic birds of the Pacific Outer Continental Shelf; the second group was from the Northeast Atlantic Outer Continental Shelf; and the third was from large land birds from the Intermountain West. To calculate wing beat frequencies we collected allometric information from published sources, measured wing areas from digital bird wing photographs, and worked to simplify a published wing beat frequency model. Because wing areas derived from digital photos were comparable to published values we were able to estimate wing beat frequencies for 53 North American species, most of which were previously unpublished. The wing beat frequencies that we modeled were comparable to the few published values available, which supported previously published modeling efforts. No single species exhibited a wing beat frequency mutually exclusive of all others within its geographical group, but species could be reliably classified into small subgroups based on wing
beat frequency alone. Coupling wing beat frequency with additional information such as range, habitat preference, seasonality, expected frequency of occurrence, and possibly additional behavior, may enable classification of birds to species level, thus improving the assessment of risk and evaluation of mitigation actions at wind energy sites using remote sensing.

**Anthropogenic Bird Mortality - New Standardized Metrics for Better Comparisons and for Developing REA’s for Compensatory Mitigation** (Poster)

**Presenter:** Wallace Erickson (WEST)

**Authors:** Paul Rabie (Western Ecosystems Technology, Inc.), Kristen Nasman (Western Ecosystems Technology, Inc.), Kimberly Bay (Western Ecosystems Technology, Inc.), Kimberly Bay (Western Ecosystems Technology, Inc.), Chris Nations (Western Ecosystems Technology, Inc.), Daniel Riser-Espinoza (Western Ecosystems Technology, Inc.)

**Abstract:** Given the various types and levels of anthropogenic sources of bird mortality in the U.S., and the potential discussion of a future MBTA permit for incidental take of migratory birds, there is a need to evaluate and develop compensatory mitigation options for migratory birds. Based on a review of anthropogenic mortality sources, and a review of approaches that have been used and tested to reduce mortality from those sources, we develop guidance and models that could generally be used to help define and quantify compensatory mitigation options for bird mortality. We compare standardized mortality metrics from sources such as wind turbines, solar facilities, powerlines, fences, communication towers, roads, feral cats and other sources, and use this as a basis to develop some simple resource equivalency models. These models are then contrasted to evaluate practicality, effectiveness, cost, targeted species, and other factors.

**Area Correction Methods for Efficient Post-Construction Fatality Monitoring Studies** (Oral Presentation)

**Presenter:** Daniel Riser-Espinoza (Western EcoSystems Technology, Inc.)

**Authors:** Paul Rabie (Western EcoSystems Technology, Inc.), Daniel Dalthorp (USGS), Jared Studyvin (Western Ecosystems Technology, Inc.), Jared Studyvin (Western Ecosystems Technology, Inc.), Jerry Roppe (AVANGRID, Inc.)

**Abstract:** Post construction fatality monitoring studies at wind facilities sometimes include plots that are incompletely searched. Plots may be incompletely searched for logistical and safety reasons (e.g. rugged terrain), for improved searcher efficiency (e.g., high visibility of gravel substrate), or as a cost-saving measure (e.g. reduced crop/vegetation clearing with searches confined to existing road and turbine pad areas).

We present a new statistical method (weighted maximum likelihood estimation of density models for carcass distributions) to adjust fatality estimates for unsearched areas, and compare it to the polynomial logistic regression approach. Practical limits of the two methods are explored, including minimum numbers of carcasses needed and minimum searched area needed to obtain reliable estimates.
Additionally, data from several wind power generation facilities are analyzed to determine whether predictable patterns in carcass distribution emerge across turbine type, turbine size, carcass size, geographical location, or other turbine or carcass characteristics.

Preliminary results suggest that both methods can provide reliable area correction factors but each has its limitations and the best choice may be context-specific. Incompletely searched plots are a common feature of post-construction monitoring studies. They are in some cases unavoidable, and in many cases have been deemed acceptable by regulatory agencies. The results presented here provide important guidance on methods to obtain accurate fatality estimates when plots are incompletely searched.

**Avian Mortality at Three Wind Energy Facilities on the Gulf Coast of Texas** (Oral Presentation)

**Presenter:** Elizabeth Baumgartner (Western EcoSystems Technology, Inc.)

**Authors:** Wallace Erickson (Western EcoSystems Technology, Inc.), Victoria Poulton (Western EcoSystems Technology, Inc.), Kimberly Bay (Western EcoSystems Technology, Inc.), Kimberly Bay (Western EcoSystems Technology, Inc.), Gregory Johnson (Western EcoSystems Technology, Inc.), Jerry Roppe (Iberdrola Renewables, LLC), Rene Braud (Pattern Energy)

**Abstract:** Three utility-scale wind energy facilities - Pattern Energy Gulf Wind Project and Iberdrola Renewables Peñascal I and II Wind Projects (Facilities) - were built adjacent to each other along the Lower Gulf Coast of Texas on the coastal sand plains west of the Laguna Madre. The unique ecology of the Texas Gulf Coast suggested the potential for significant adverse impacts to birds, particularly migrating songbirds, as a result of developing and operating these Facilities. In recognition of these concerns, multiple years of post-construction monitoring were conducted to estimate bird mortality at these facilities. Despite substantial concern that wind energy development along the Gulf Coast of Texas might lead to high levels of avian mortality, estimated total avian and diurnal raptor fatality rates at the Facilities were comparable to fatality estimates at other wind energy facilities in North America. The avian species composition of carcasses reflected the coastal location of these projects, with a larger diversity of aquatic bird species compared to the species composition of carcasses found at upland facilities across North America. Nocturnal migrant bird fatalities tended to be found in higher numbers following precipitation events, particularly in spring; however, no large-scale mortality events were discovered at the Facilities.

**Avian-Safe Assessment of Power Pole/Substation at Operating Wind Energy Plants** (Poster)

**Presenter:** Jim Burruss (Burns and McDonnell)

**Authors:** Jerry Roppe (AVANGRID, Inc.), Irv Walker (Utilatech), Mike Best (Pacific Gas & Electric), Mike Best (Pacific Gas & Electric), Kara Donohue (Southern California Edison),

**Abstract:** Wind energy facilities frequently use overhead 34.5 kV (collector) power lines to transfer the power from the plant (turbine) to the grid in conjunction with underground lines as a standard practice for routing power from the turbine strings. Use of these overhead power lines by birds for perching and nesting creates the potential for electrocution. To respond to this issue, the Avian Power Line
Interaction Committee (APLIC) developed a series of suggested practices for building or retrofitting power poles with raptor-safe designs and configurations. In 2008, Avangrid Renewables LLC (previously Iberdrola Renewables) adopted these suggested practices for their power lines but subsequent review of its collector system revealed issues in 3 areas: 1) review of 3rd party electrical designs found instances of inadequate covering and/or isolation and misrepresentation of the Suggested Practices (APLIC 2006); 2) inspection of as-built projects found that drawings or engineering specifications with adequate design were not always followed; and 3) assessment of riser poles that transition underground lines to overhead collectors found it was an atypical configuration from utility design with a combination of switches, arrestors, and other equipment that can create avian electrocution risk. To address these areas, Avangrid Renewables initiated an APLIC Conformance project to assess avian risk and recommend retrofits on overhead infrastructure designed to bring the entire operating fleet into conformance with APLIC guidelines. It established a core team to assess avian risk, to recommend and scope retrofit efforts, and to provide quality control and quality assurance (QA/QC) of contractor conducting retrofit installation of existing overhead collector lines and substations. These findings will be presented with additional recommendations on design and construction of overhead power lines and substations at wind energy facilities.

**Bald Eagle Use of Agricultural Project Areas in Minnesota and Iowa: Where We See Eagles and Where We Don't** (Poster)

**Presenter:** Jon Schubbe (HDR Engineering)

**Abstract:** HDR conducted bald eagle monitoring surveys at three proposed wind energy facilities, following USFWS guidelines, between 2014 and 2016. Projects were located in Central Minnesota, Southeast Minnesota and Southeast Iowa. A total of 62 survey points are distributed across the three sites, with each point surveyed for 60 minutes each month. Very few observations of bald eagles were made during these surveys. One hundred one (101) eagle flight minutes were documented within 800 meters of survey points over the course of the 30,120 survey minutes completed by publication. HDR investigates these eagle flight observations in relation to distance to nearest nest, distance to open water, if the points were within an active territory, land use surrounding survey points and the season during which observations were made.

**Bats at Sea: A Final 6-Year Summary of Bat Monitoring on Islands, Offshore Structures, and Coastal Sites in the Gulf of Maine, mid-Atlantic States, and Great Lakes Regions** (Oral Presentation)

**Presenter:** Steve Pelletier (Stantec Consulting Services Inc.)

**Authors:** Trevor Peterson (Stantec Consulting Services Inc.)

**Abstract:** The largest coordinated effort to monitor offshore bat activity in North America occurred in the Gulf of Maine, Great Lakes, and mid-Atlantic coastal regions between 2009 and 2015. This study, funded by the US Department of Energy and Stantec Consulting Services Inc., aimed to document seasonal and spatial patterns in bat presence offshore and to ultimately improve our understanding of potential risks associated with offshore wind energy development. Long-term monitoring of bat activity
using passive acoustic bat detectors occurred at 38 sites involving 7 coastal locations, 23 islands of
varying size, habitat structure, and remoteness, and 8 offshore structures such as weather buoys,
bridging islands, and observation/navigation platforms. We surveyed bat activity during 16,761 detector
nights across the study, recording a total of 538,248 bat passes and detecting bats at every site we
monitored. This presentation will summarize final results of the surveys, highlighting site-specific results
that exemplify bat activity across a variety of surveyed sites and will include results of regional statistical
analyses of the influence of weather variables, season, and site isolation on detection rates and
presence of bats overall and by species. We will also describe additional analyses of the dataset to be
conducted in coordination with other ongoing research efforts. This study was supported by a broad
coalition of federal, state, NGO, and academic organizations and provides an unprecedented
opportunity to describe regional and seasonal patterns in offshore bat activity. Finally, it establishes a
robust baseline for future offshore bat monitoring efforts as well as a basis for evaluating potential risks
associated with the development of individual offshore projects.

Bats in the Rotor Zone...Managing Risk with Acoustics (Oral Presentation)

Presenter: Trevor Peterson (Stantec Consulting Services Inc./University of Maine)

Abstract: Acoustic bat surveys provide an increasingly reliable and efficient method to monitor bat
activity in challenging environments. Acoustic monitoring has been a recommended component of pre-
construction surveys at proposed wind projects for a decade or more, with the typical resulting metric
being the number of bat passes detected per survey night over an extended survey period. However,
this metric has proven to be a poor predictor of bat mortality rates documented through post-
construction carcass searches. Instead of being used as a tool to measure overall activity levels, acoustic
survey results could be applied far more effectively as a means of actively identifying high risk conditions
in the rotor zone. The portion of the aerosphere in which wind turbines operate provides a highly
dynamic component of bat habitat, the suitability of which varies with changing conditions such as
temperature, wind speed, time of night, and season. Assuming a link between bat presence in the rotor
zone and risk of turbine-related impacts, modeling the relationship between these changing conditions
and bat activity could therefore help design and optimize wind turbine curtailment program based on
multiple parameters. We report results of a multi-year study at an operating wind project in the
northeast where bat activity measured at turbine nacelles was used to design a customized curtailment
system. Additional acoustic surveys and concurrent carcass searches were then conducted to validate
the effectiveness of the system at preventing turbine operation during conditions with higher predicted
bat risk and reducing bat mortality rates. This study represents the first commercial example of a highly
effective automated curtailment system designed using site-specific acoustic data and validated with
follow-up acoustic monitoring and carcass surveys. Results of this study indicate that analyzing bat
activity and weather conditions in the rotor zone can provide a reliable, quantitative method to design
data-driven curtailment systems and predict their effectiveness and cost. This approach can also provide
quantitative metrics to help inform adaptive management processes.

Bird and Bat Mortality and Wind Farms Across Great Lakes Landscapes: A Case Study (Poster)
**Presenter:** Joseph Carlo (Ecology and Environment, Inc.)

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

**Abstract:** Popular belief holds that wind farms located in close proximity to the Great Lakes shorelines will have greater bird mortality than wind farms located further from the shorelines; however, comparisons of recent mortality data from operating wind farms parsed by distance from the Great Lakes shoreline are lacking. Akios (2011) examined this based on the rather limited available data in 2011.

Ongoing research along the Great Lakes, including USFWS radar studies and TNC migratory bird stopover habitat mapping along the Great Lakes (2011, 2012) elucidates use by migratory birds near the Great Lakes shorelines. Findings from these and other studies drive the assumption that a positive correlation exists between bird usage and bird mortality at wind farms in proximity to the Great Lakes. In this case study, available mortality data from Great Lakes States and Provinces will be gathered and assessed to investigate the impacts associated with wind farms both within and outside five miles of lake shores (nearshore vs. inland). Bat mortality results will also be reviewed to investigate any differences or trends based on proximity to the lake shores.

Preliminary results of this case study suggest impacts associated with birds and wind farms near the Great Lakes shorelines are comparable to or slightly higher than those at inland sites, based on available mortality data. Results are also within the range of mortality rates experienced throughout the U.S. and Canada. Research into this subject area may reveal that heavily focused and intensive pre-construction and post-construction studies at lakeshore wind sites, relative to inland wind site locations, may not be rationalized based solely on proximity to the Great Lakes.

**Challenges in Estimating the Effectiveness of Low Wind Speed Curtailment to Reduce Take of Bats in Hawaii (Poster)**

**Presenter:** Thomas Snetsinger (Tetra Tech, Inc)

**Authors:** Jonathan Plissner (Tetra Tech, Inc), Brita Woeck (Tetra Tech, Inc), Alicia Oller (Tetra Tech, Inc), Alicia Oller (Tetra Tech, Inc), Marie VanZandt (Auwahi Wind Energy)

**Abstract:** Low wind speed curtailment (LWSC) has been demonstrated as an effective operational measure to reduce fatalities of migratory tree roosting bat species, including the hoary bat, on the U.S. mainland and Canada at wind farms. On this basis, state and federal wildlife agencies recommend LWSC be implemented at wind farms in Hawaii and incorporated in project Habitat Conservation Plans as a minimization measure to reduce fatalities of the endangered Hawaiian hoary bat. Accurate analysis of post-construction monitoring data requires an understanding of the effectiveness of operational changes that alter fatality risk; however, because bat fatalities in Hawaii are rare events, evaluating the potential benefits of this measure is challenging. Data from the only two commercial wind farms in Hawaii with both pre- and post-LWSC data are used to investigate evidence for the potential effectiveness of LWSC in Hawaii and to explore challenges to this goal in a data-poor environment.

We evaluated post-construction mortality monitoring data at the Kaheawa I and Auwahi wind Projects on Maui for 2-3 years prior to the implementation of LWSC and 1–2 year post-implementation of LWSC...
to examine evidence for the effectiveness of curtailment. The implementation approach at the two facilities differed, with a seasonal implementation (February 15 – December 15) of 5 – 5.5 meters/second curtailment at the Kaheawa I Wind Project and year-round curtailment at 5 meters/second at the Auwahi Wind Project. We used Dalthorp and Huso’s Evidence of Absence analysis tool to estimate the annual rate of take and its 95 percent confidence interval for the LWSC and non-LWSC periods. Within project results show broad overlap of the confidence intervals among years. Annual pre-LWSC estimates at Kaheawa I were 1.76 (0.00 – 9.03), 7.8 (1.23 – 21.1), and 11.44 (3.37 – 24.7) bats/year. The post-LWSC estimate was 2.53 (0.00 – 12.9) bats/year. At the Auwahi Project, pre-LWSC estimates were 5.83 (0.41 – 18.5) and 9.01 (2.65 – 19.40) bats/year. The Auwahi Wind Project post-LWSC estimates were 3.79 (0.27 – 11.90) and 19.5 (7.98 – 36.5) bats/year. The apparent spike in fatalities in the second year of LWSC at the Auwahi Wind Project suggests that other factors could mask benefits of LWSC and that additional information and greater sample sizes are necessary to understand the potential benefit of LWSC. We address how the occurrence of anomalous fatality events, temporal changes in fatality risk, differences between the projects (e.g., bat population, wind intensity, weather patterns), and the inter-annual variability of data may affect approaches to the analysis of curtailment effectiveness.

Challenges in Quantifying the Effectiveness of Impact Avoidance and Minimization Measures and Potential Solutions (Oral Presentation)

Presenter: Julie Garvin (Tetra Tech)

Authors: Thomas Snetsinger (Tetra Tech)

Abstract: There are numerous challenges to estimating the effectiveness of impact avoidance and minimization measures at reducing bird and bat fatalities at operational wind facilities. The objective of our study is to provide a review of a number of these challenges illustrated with case studies and to provide potential solutions. We draw upon our experience working with numerous wind energy facility owners and operators across the country as well as published information in both peer-reviewed and gray literature. There are two major categories of impact types with respect to collision mortality: 1) those in which fatality events are rare (e.g., eagles, endangered species), and 2) those in which fatality events are frequent. The former impact type poses its own specific set of challenges because of the difficulty of detecting the occurrence of rare events, and the inherent uncertainty of fatality estimation when events are rare. This uncertainty leads to large confidence intervals which can obscure any potential reductions in fatalities realized by the implementation of avoidance and minimization measures. In some instances, an alternative metric to fatality rates may be more appropriate to quantify effectiveness. Suitable alternative metrics are those that are well-correlated with risk, can be measured with relative accuracy, have good sample sizes, and have baseline data available. Examples of case studies using surrogate species or behavioral variables as alternative metrics are presented for both birds and bats as well as the implications the metric of interest has on study design. We also provide an overview of suitable metrics and study designs when fatality events are frequent. By successfully addressing these challenges, estimation of fatality rates should improve, and the effectiveness of avoidance and minimization measures should be better quantified. Having a suite of avoidance and minimization measures that have been verified to be effective will improve permit compliance and better enable adaptive management of impacts at operational wind facilities.
Challenges with the Multitude of Fatality Estimators and the Need for a Generalized Estimator (Oral Presentation)

**Presenter:** Cris Hein (Bat Conservation International)

**Authors:** Michael Schirmacher (Bat Conservation International), Manuela Huso (U.S. Geological Survey)

**Abstract:** Estimating fatality of bats and birds at wind energy facilities is a complicated endeavor and several correction factors must be combined with the number of raw carcasses observed to produce an unbiased estimate. Numerous fatality estimators have been developed and advances to reduce bias have been made over time. Yet, the availability of multiple estimators has resulted in confusion as to which estimator is the most appropriate given certain conditions. Moreover, given the same data, different estimators can produce significantly different results. In cases where regulatory agencies require specific minimization actions to be implemented if fatality exceeds a certain threshold, the variability in results derived from multiple estimators are problematic and potentially expensive. Here we present a case study highlighting this issue and call for a generalized estimator to eliminate unnecessary confusion, and loss of time and money. In 2013, we conducted a post-construction fatality monitoring study at a wind energy facility in Pennsylvania, and estimated fatality using two different fatality estimators, the Erickson and Huso estimators. Based on a sample size of 10 turbines, the estimated number of bat fatalities was 29.22 bats/turbine (95% CI: 23.08–40.49) and 69.14 (95% CI: 48.77–124.65) using the Erickson and Huso estimators, respectively. The 95% confidence intervals of each estimator do not contain the mean of the other, suggesting a statistically significant different between estimators. Furthermore, the Erickson estimate is below the 30 bats/turbine threshold set by the Pennsylvania Game Commission, whereas the Huso estimate is not. The disparity among estimates are likely the result of differences in the assumptions of each estimator. For example, the Erickson estimator assumes carcass removal occurs at a constant rate (i.e., exponential distribution), whereas the Huso estimator allows for model selection of carcass persistence based on the data. Assuming an exponential distribution rather than the best model, which in this case was a log-logistic model, resulted in an overestimation of carcass persistence and consequently an underestimate of fatality. However, in situations where there are short search intervals, high carcass persistence and low searcher efficiency, the Huso estimator can overestimate fatality, unless the observed carcasses are restricted to those believed to have been killed in the preceding interval. To alleviate the confusion of which estimator is the most appropriate to use, we recommend the development of a generalized fatality estimator that allows the user to test assumptions regarding input parameters, and select the approach that best reflects their particular situation and data. Ultimately, this will 1) provide guidance on study design to increase efficiency and reduce costs of fatality studies, 2) standardize carcass searches and data analyses, and 3) reduce bias and thereby improve accuracy and precision of fatality estimates generated from carcass searches.

Collision and Displacement Vulnerability among Marine Birds of the California Current System associated with Offshore Wind Energy Infrastructure (Oral Presentation)

**Presenter:** Emily Kelsey (USGS)
Authors: Jonathan Felis (USGS), David Pereksta (BOEM), Josh Adams (USGS), Josh Adams (USGS)

Abstract: Capitalizing on open areas with persistent winds, offshore wind-energy infrastructure (OWEI) has the potential to produce a significant proportion of the power necessary to reach the United States’ alternative energy needs. Marine birds are vulnerable to collision with and displacement by OWEI. We created a comprehensive database of marine bird vulnerability to OWEI development in the California Current System (CCS). Using published values on population size, demography, life history, flight heights, and avoidance behavior for the 62 seabird and 19 marine water bird species that occur in the CCS; we generated three vulnerability values: Population Vulnerability, Collision Vulnerability, and Displacement Vulnerability. Population Vulnerability was used as a scaling factor to Collision and Displacement Vulnerability to generate two comprehensive indices: Population Collision Vulnerability (PCV) and Population Displacement Vulnerability (PDV). Pelicans, terns, gulls, cormorants, and Ashy Storm-Petrel had the greatest PCV scores. Brown Pelican (Pelicanus occidentalis) had the greatest overall PCV score. Alcids, terns, loons, and Ashy Storm-Petrel had the greatest PDV scores. Ashy Storm-Petrel (Oceanodroma homochroa) had the greatest overall PDV score. Using at-sea survey data, we also mapped bird densities within the CCS as a function of their cumulative PCV and PDV scores. This spatial analysis indicated areas in the CCS where seabirds would be more vulnerable to collision with and displacement by OWEI development. The vulnerability assessment presented here can be applied to specific locations in the CCS where OWEI is being considered and can be used to help inform decisions that will impact seabird conservation.

Comparison of Operational Curtailment Strategies for Reducing Bat Mortality at Wind Facilities (Poster)

Presenter: Greg Forcey (Normandeau Associates)

Authors: Lauren Hooton (Normandeau Associates), Christine Sutter (Normandeau Associates)

Abstract: Wind power offers an alternative source of energy with a smaller carbon footprint compared to traditional fossil fuels; however, more operating wind turbines could increase bat mortality due to collisions with turbine blades. One approach to reduce bat mortality at operating wind facilities is to raise the cut-in speed (the wind speed which the turbine begins to generate electricity) from the standard 3.5 m/s to a higher level. We conducted a 2-year research study at the Raleigh Wind Energy Center in southwestern Ontario to compare bat mortality at wind turbines curtailed at 3.5 m/s vs 4.5 m/s (2014) and 4.0 m/s vs 4.5 m/s (2015). Estimated bat mortality rates were calculated using the Ontario Ministry of Natural Resources and Forestry (OMNRF) estimator using raw carcass counts, searcher efficiency trials, and scavenger rate trials collected using standardized searches. Within each year, comparisons between control and treatment turbines were performed by using a non-parametric permutation test and by examining 90% confidence intervals for overlap. In 2014, bat mortality at turbines with a 3.5 m/s cut-in speed were significantly higher than turbines curtailed at 4.5 m/s across all species (P = 0.001). During 2015, bat mortality at turbines curtailed at 4.0 m/s was similar to mortality at turbines curtailed at 4.5 m/s (P > 0.10). While the results of the 2014 study mirror those of other mitigation studies in North America, the 2015 study did not show significant differences in estimated bat mortality between 4.5 m/s and 4.0 m/s cut-in speeds. This suggests that implementing the 4.0 m/s cut-in speed compared to a 4.5 m/s cut-in speed would not increase estimated bat mortality, would increase
the electricity generated at the project through increased operational time, and keep the mortality below the 10 bats/turbine/year threshold prescribed by the OMNRF.

**Comparison of the Relative Sensitivity of Four Mortality Estimation Equations to Variation in Correction Factor Values** (Poster)

**Presenter:** Catherine Jardine (Bird Studies Canada)

**Authors:** Ryan Zimmerling (Canadian Wildlife Service, Environment and Climate Change Canada)

**Abstract:** The number of carcasses recovered during post-construction mortality monitoring at wind energy projects is a subset of the actual mortalities that occur at a particular site due to several factors such as area searched, scavenger removal and searcher efficiency. Various correction factors and mortality estimating equations have been developed to generate estimates of true mortality levels. Our study compares four different commonly used mortality estimator equations (the Ontario Ministry of Natural Resources and Forestry estimator, the Huso estimator, the Schoenfeld-Erickson estimator and the Jain estimator) to determine their relative sensitivity to variation in underlying correction factors. We investigate the proportional change in estimated mortality for each of these four estimators following the manipulation of searcher efficiency and scavenger removal correction factors within the natural range of variation in Canada. We explore which correction factors are particularly sensitive to various combinations of scavenger removal and searcher efficiency and inherent biases and assumptions of each of these correction factors.

**Developing a Framework for Wind and Wildlife Interactions in Mongolia** (Poster)

**Presenter:** Katy Reagan (Sunbird Biological Consultants)

**Abstract:** Mongolian State Energy Policy is to increase the share of installed renewable energy capacity, in the total installed capacity, to 20% by 2020 and to 30% by 2030. A framework for wind and wildlife interactions in Mongolia is warranted. A synopsis of the Mongolian 7th National Annual Forum for Renewable Energy, review of existing Mongolian wildlife data and relevance to wind development, and summary of the year round (June 2016 to June 2017) bird and bat acoustic survey at Ikh Nart Nature Reserve will be provided. The current status and future goals of the wind wildlife collaborative in Mongolia will also be outlined.

**Developing an Approach to Assess and Regulate Cumulative Effects of Offshore Wind Farms** (Poster)

**Presenter:** Marijke Warnas (Rijkswaterstaat)

**Authors:** Suzanne Lubbe (Rijkswaterstaat), Maarten Platteeuw (Rijkswaterstaat), Martine Graafland (Rijkswaterstaat), Martine Graafland (Rijkswaterstaat), Aylin Erkman (Rijkswaterstaat), Joop Bakker (Rijkswaterstaat), Inger Van Den Bosch (Rijkswaterstaat)

**Abstract:** The national “Energy agreement for sustainable growth” in the Netherlands means that the offshore wind capacity of the country will increase from the current 1000 MW to 4500 MW in the
The construction of 10 windfarms with a total capacity of 3500 MW was the motive for the Dutch government to develop a framework for the assessment of ecological and cumulative effects of offshore windfarms. A framework that firstly focusses on the effects of the development of offshore windfarms on birds, bats and marine mammals. In time the framework can be expanded to other human activities and other species of concern. The framework utilizes models and results of scientific studies relating to effect thresholds. It can however accommodate other models and studies as they become available. During the work carried out for the framework the gaps in knowledge were also identified to be addressed in the future.

The framework is based on the DPSIR method. In a 6-step approach the relevant activities are selected, the pressures they represent identified and the impact it has on selected relevant species and habitats quantified. These effects are then assessed and if necessary mitigation measures are prescribed.

1. Identify the relevant pressures the envisaged activities could cause.
2. Identify the habitats and species that may be affected by these pressures.
3. Describe all other activities that could affect the same species.
4. Describe the nature and scale of the cumulative effects of all the activities selected in Step 3 on the selected habitats and species.
5. Evaluate the significance of the effects on the selected habitats and species.
6. If necessary, adapt the activity by taking measures to prevent the activity causing significant effects.

The quantification of effects on birds, bats and marine mammals most sensitive to disturbance on the Dutch continental shelf, has resulted in the implementation of multiple mitigation measures in the wind farm site decisions. These decisions contain the constraints under which offshore wind farms may be built. For birds and bats, limits were set to size in combination with number of turbines and rotor blades will need to be turned out of the wind during sensitive times. For marine mammals a flexible sound threshold for piling was determined. These mitigation measures aim to keep the effects under the determined thresholds. Additionally an offshore wind ecological program (Wozep) was started by the Dutch government: a 5-year research program that will further investigate the ecological effects of offshore wind. The framework will be regularly updated with results from this program and from other research around the world.

**Developing an Operations Staff-Based Monitoring Protocol for Eagle Fatalities at Wind Energy Facilities** (Oral Presentation)

**Presenter:** Paul Rabie (WEST, Inc.)

**Authors:** Eric Hallingstad (WEST, Inc.), Paul Rabie (WEST, Inc.), Andrew Telander (WEST, Inc.), Wallace Erickson (WEST, Inc.), Wallace Erickson (WEST, Inc.), Jerry Roppe (Avangrid Renewables, LLC)

**Abstract:** Fatality monitoring has long been a primary component of post-construction surveys aimed at determining a wind energy facility’s direct impacts on wildlife. Recently, additional emphasis has been placed on identifying impacts on eagle populations specifically, and mitigating those impacts when they occur. As eagle programmatic take permits are issued, permit holders will be required to conduct fatality monitoring to ensure compliance with regulatory requirements. In most cases, two years of fatality
monitoring may be needed; however, survey duration may be longer to assess the efficacy of additional conservation measures when implemented. Fatality monitoring can be a substantial expense for a facility, often costing thousands of dollars per turbine each year. Our objective was to develop a more cost-effective yet viable eagle fatality monitoring protocol that can be integrated into the regular maintenance routines of operations personnel at most wind energy facilities. A fatality estimate requires three components: 1) carcass detection rates using systematic carcass searches, 2) experimental data on carcass persistence, and 3) the proportion of carcasses expected to land in searched areas. We measured these parameters at three wind facilities in Washington and one wind facility in California. A preliminary study using feathered turkey decoys placed within 40 meters (m) of turbine bases showed that operations personnel and 3rd party biologists had similar rates of detection (both > 0.80) under these circumstances. Follow-up studies have focused on the decoy detection rates of operations personnel while conducting modified Spill Prevention, Control, and Countermeasure (SPCC) checks; these checks are typically done once a month as a routine maintenance requirement. Modified SPCC checks required operations personnel to scan along roadways and exit the vehicle at each turbine base to scan the surrounding terrain with binoculars. Decoys were placed out to 150 m from turbine bases to provide greater coverage of the anticipated carcass fall area. Detection rates during modified SPCC checks were generally high, with over 80% detection of all decoys placed within 100 m of turbine bases across easy and moderate visibility areas. Large raptor carcass persistence, estimated using an interval-censored modeling approach, varied from 28 to 61 days. We estimate that 95% of large avian carcasses fall within 100 m of turbine bases, while 99% fall within 150 m. Using these estimates, and assuming a 30 day search interval, the overall probability a large avian carcass would be available and detected by operations personnel ranged from 0.50 to 0.69. We feel that these rates offer a viable monitoring method for inclusion in facility Eagle Conservation Plans, therefore eliminating the need for 3rd party eagle fatality monitoring.

Eagle Nest Surveys – Insights Gained for Bald Eagles and Implications for the Future (Poster)

Presenter: Jenny Taylor (Tetra Tech, Inc)

Authors: Julie Garvin (Tetra Tech), Rich Young (Tetra Tech, Inc), Kristina Dick (Tetra Tech, Inc), Kristina Dick (Tetra Tech, Inc)

Abstract: The breeding population of bald eagles in the United States has undergone a remarkable recovery over the past 40 years. Tetra Tech has conducted aerial and ground-based raptor nest surveys throughout the Western U.S in association with development of wind energy facilities. Data collected from these surveys have provided a unique and broad-level perspective into bald eagle nesting biology. Here we summarize the insights gained over the course of these surveys and present potential implications for future wind energy project siting and permitting.

We reviewed results of raptor nest surveys conducted at approximately 25 energy projects across 16 states west of the Mississippi River including Arizona, California, Colorado, Idaho, Kansas, Minnesota, Nevada, Nebraska, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Washington and Wyoming. Our variables of interest included proximity to anthropogenic sources of disturbance and proximity to traditional prey sources (e.g., large water bodies). We used data from aerial raptor nest surveys as well as incorporated observations from ground-based nest surveys.
Two broad-scale patterns emerged from these survey results. First, a large number of previously undetected nests were located which is consistent with published studies on increasing bald eagle populations. Second, bald eagles appear to be utilizing increasingly marginal habitats for nesting; we suggest this trend may be a result of optimal habitats becoming saturated. Instances of marginal habitat use included 1) nesting at increased distances from large waterbodies and away from riparian corridors, and 2) nesting in closer proximity to anthropogenic sources of disturbance (e.g., roads, residential areas and wind turbines).

These apparent patterns have several management implications. If survey methods incorporate a habitat-based approach, an increased level of survey effort, including coverage of a broader spectrum of habitat, may be necessary to complete the inventory of all bald eagle nests within a given survey area. Relative to project planning and design, greater numbers of bald eagle breeding territories across the landscape increases the likelihood that a bald eagle nest will occur near a given wind project. Nests located near proposed wind energy projects are considered at risk of disturbance, which has permitting implications. The emerging pattern of nests in proximity to anthropogenic sources of disturbance, however, suggests that the relative risk of nest disturbance may be lower than previously thought. Taken together, these findings suggest that standard survey approaches and current regulatory protections for nesting bald eagles may need to be revisited to adapt to increasing populations and changes in nesting habitat utilized by this eagle species.

Effectiveness of Cut-in Speed Adjustments on Reducing Impacts to Mexican Free-tailed Bats at a Wind Energy Facility in Nevada (Oral Presentation)

Presenter: Joel Thompson (Western Ecosystems Technology, Inc.)
Authors: Wallace Erickson (Western Ecosystems Technology, Inc.), Rene Braud (Pattern Energy), Paul Rabie (Western EcoSystems Technology, Inc.), Paul Rabie (Western EcoSystems Technology, Inc.), Jason Williams (Nevada Department of Wildlife)

Abstract: Direct impacts to bats at wind energy development projects are one of the biggest issues facing the wind industry; however, much of the research on reducing bat mortality has largely focused on migratory tree-roosting (e.g., hoary bat [Lasiurus cinereus]) and listed bat species (e.g., Indiana bat [Myotis sodalis]) in the eastern US, where adjustments to turbine cut-in speeds have shown to be an effective tool for reducing impacts to these focal species. In general, direct impacts to bats have not been as great in the western US; therefore research on mitigation and minimization opportunities for bats have been less common in western parts of the country. The Mexican free-tailed bat (Tadarida brasiliensis) is among the most commonly found bat fatalities at some western wind energy facilities, whereas this species does not typically occur in the eastern US. In this presentation, we present the results of experimental studies conducted in the fall of 2012 and 2013 at a wind energy project in eastern Nevada that investigated the effects of increased turbine cut-in speeds on reducing bat mortality, with an emphasis on the strong-flying Mexican free-tailed bat. This project is located near a migratory stopover site/cave used by large numbers of migrating Mexican free-tailed bats from late spring through the fall and Mexican free-tailed bats account for a majority of the bat mortality at the Project. Forty of the project’s 66 turbines (60%) were searched daily for bat fatalities over a 64 day period each fall, with turbines randomly assigned to one of five cut-in speeds each night (one control...
and four treatments). Cut-in speed adjustments ranged from 4 m/sec to 6 m/sec during the two experimental periods, and included both partial- and all-night treatments. The studies demonstrated that increased cut-in speeds could significantly reduce bat mortality rates at the project. Based on the results of the experimental studies and other site-specific bat mortality monitoring data, the project implemented varied levels of cut-in speed adjustments during the summer and fall bat activity periods over a 3-year mortality monitoring study period from 2013 through 2015. Implementation of cut-in speed adjustments resulted in an estimated 83% reduction in bat mortality from year 1 to year 3 of the monitoring period, demonstrating how cut-in speed adjustments can be effectively used to reduce mortality of the common bat fatalities found at many western US projects.

Effects of Coastal Wind Farms on Bird Communities and Flight Paths: a Case Study in Taiwan (Poster)

Presenter: Mei-Ling Bai (Formosa Natural History Information Ltd.)

Authors: Fang-Yi Lin (Formosa Natural History Information Ltd.), Hsin-Yi Huang (National Taiwan University), Wen-Chieh Chih (Formosa Natural History Information Ltd.), Wen-Chieh Chih (Formosa Natural History Information Ltd.), Jerome Chie-Jen Ko (National Taiwan University), Yu-Yi Lien (Formosa Natural History Information Ltd.)

Abstract: Wind power is going to flourish in Asia in the coming years. Given the dense human population in Asia Pacific, many wind farms in the region have been constructed offshore or on coastal wetlands, and even more are under planning. Yet hardly any information about their impacts on wildlife is known.

To study the potential impacts of coastal wind farms on birds in the East Asian-Australasian Flyway, we conducted monthly census on bird communities at two artificial wetlands (WG and YH) in Changhua coast, Taiwan, between 2009 and 2011. Together with neighboring tidal flats, the region hosts a large number of waterbirds during migratory seasons and in winter. The construction of a small-scaled wind farm along the northern and western coastline of WG set about in summer 2009, and its operation started in autumn 2010. Thus we were able to compare the bird communities prior to construction, during the construction phase, and during the operational phase of the wind farm in WG, while using YH as a control site. We also recorded the flight paths of birds across the coastline, to investigate the effects of turbines on bird behavior.

We found that bird abundance in the two sites in general fluctuated parallelly, which indicated that seasonal and large-scale dynamics were the more likely driving force. Nevertheless there was a weak tendency that bird abundance in WG gradually declined relative to YH, which was mainly due to the decrease of egrets. Whether this decline resulted from the construction of the wind farm was in need of further investigation.

We also found that, since the operation of the wind farm, proportionally fewer birds took the northern path to cross the coastline, while more birds took the western path. This corresponded to the spacing of the turbines: the turbines were 200 m apart from one another at the north while 500 m apart at the west. Birds were likely to avoid passing densely spaced turbines, while turbines 500 m apart from one another appeared no significant obstacle. Continuous monitoring is necessary to evaluate whether the lack of avoidance behavior might instead lead to higher collision risk.
Effects of High-Brightness, Monochromatic LEDs on Osprey Nesting Activity (Poster)

Presenter: Carol Foss (Audubon Society of New Hampshire)

Authors: Donald Ronning (Lite Enterprises, Inc.)

Abstract: Lite Enterprises has developed a non-lethal deterrence technology to reduce the risk of bird strikes to wind turbines, aircraft, and other hazards. This technology employs pulsing, high brightness, monochromatic light-emitting diodes (LEDs), which cause no harm to avian or human eyes. We report on responses of Ospreys nesting on cell towers to deployments of prototype LEDs. Results from this and other field experiments suggest that birds react to this light much as humans react to solar glint, by changing location or direction of travel to avoid the glint. Ideal wavelengths, pulse characteristics, and distances required to induce this reaction vary among species and species groups. Extensive additional research will be required to adapt this technology for use at wind energy facilities. However, further development for other applications, such as aviation, will likely produce innovations useful in wind energy settings.

Estimating Inter-annual Variability in Project Take for Rare Events (Oral Presentation)

Presenter: Jonathan Plissner (Tetra Tech)

Authors: Thomas Snetsinger (Tetra Tech), Alicia Oller (Tetra Tech), Brita Woeck (Tetra Tech), Brita Woeck (Tetra Tech), Marie VanZandt (Auwahi Wind Energy)

Abstract: Compliance for incidental take permits (ITPs) requires monitoring to demonstrate that the number of fatalities identified are in compliance with estimated take limits established in an Eagle Conservation Plan or Habitat Conservation Plan. The duration of an ITP often ranges from 5 to 30 years; and understanding the potential sources and effects of annual variability in take estimates is important for identifying authorized take limits and for determining the amount of monitoring required to have confidence in the measurement of project impacts. If take is likely to be stable, one or two years of monitoring may effectively measure the take rate. However, if inter-annual variation is high or operational measures are implemented that are expected to change the fatality rate, longer or additional periods of monitoring will be required to confidently estimate project take.

Inter-annual variation in take can be driven by random natural temporal variation, landscape-scale variables such as temporal trends in population size, or operational changes (e.g., low wind speed curtailment [LWSC] or deterrents). It is important to distinguish between random natural temporal variation and the other two sources that drive change in the take rate. In analyzing data where the estimated rates of take change over time, it is important to have both a trigger for identifying when a change has occurred and a metric for measuring change. Triggers and metrics may vary depending on the cause of the change and the data available for estimating the change.

Hawaiian hoary bat take at the Auwahi Wind Farm is presented as a case study where the long-term monitoring strategy utilizes pulsed standardized monitoring periods. The monitoring pulses are timed to provide measures of estimated take over the life of the 25-year permit. Standardized monitoring allows for the identification of temporal changes resulting from landscape-scale changes such as population size and for the measurement of the effectiveness of implementation of LWSC. There is strong evidence
that LWSC is effective in reducing take of migratory tree-roosting bats, and we assume that implementation of LWSC is a source of change in the estimated take rate. Therefore, the implementation of LWSC alone serves as the trigger for incorporating a change in estimated take rate into the estimation of project take. The measurement of a perceived change in take is quantified by comparing the median value of annual take from the baseline to the changed condition.

Longer ITP terms and the need for adaptive management of operations require approaches to evaluating whether operational changes or temporal changes in the estimated take rate are occurring over time. Long term measurements of estimated take require quantification of these temporal changes. Because the take of listed species is typically infrequent at wind farms, approaches using metrics based on small sample sizes such as the case study presented here or surrogate measures may be required.

**Estimating the Minimum Number of Eagles Utilizing a Site in Northern Arizona Using Trail Cameras Deployed on Bait Stations** *(Poster)*

**Presenter:** Tom Koronkiewicz (SWCA Environmental Consultants)

**Authors:** Daniel Driscoll (American Eagle Research Institute)

**Abstract:** Detecting site use by non-breeding bald (Haliaeetus leucocephalus) and golden (Aquila chrysaetos) eagles can be problematic due to the nomadic nature and large ranges of these species. We attempted to estimate the minimum number of non-breeding eagles utilizing a 143,000-acre ranch in northern Arizona during winter, by placing trail cameras at four separate stations baited with road-killed deer and elk in February 2016. Over an approximate two-week period, the cameras recorded 8,423 photos. We separated the photos by time sequence, and then aged eagles within each sequence based on plumage characteristics. We then scrutinized eagles within each age class to identify individuals based on plumage or other physical characteristics. We recorded 274 visits to bait stations by 15 individual eagles; 236 visitations by 13 golden eagles (5 juveniles, 7 subadults, 1 adult), and 38 visitations by two adult bald eagles. A potential bias in this method involves attracting eagles to bait stations that would otherwise not have come to ground on the ranch; however, those eagles would presumably be in the airspace above the ranch to detect the bait sites. A benefit of this methodology is that we identified more individuals than would have been possible by observations alone. Future development of this method includes a standardized camera/bait station array, and statistical analyses to better model eagle use at sites. Eagle observation studies conducted as part of preconstruction wind energy facility siting are time intensive, costly, only subsample a site, and may not detect site use by non-resident individuals. The use of trail cameras deployed on bait stations may provide a means to develop an index of eagle use and risk across selected periods of time or sites.

**Evaluating and Adapting Surveys Designed to Predict Wind-Wildlife Interactions: A Simulation Approach Focused on Golden Eagles** *(Oral Presentation)*

**Presenter:** Todd Katzner (U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center)
**Authors:** Maitreyi Sur (Department of Biological Sciences, Boise State University), James R. Belthoff (Department of Biological Sciences, Boise State University)

**Abstract:** Wind energy development is rapidly expanding in North America, and this expansion causes potential conflict with conservation-reliant wildlife. Within the USA, estimates of golden eagle (Aquila chrysaetos) use of areas proposed for wind development are often generated with modified point counts. However, it is not always clear to what degree the data collected at on-site point counts relates to actual eagle use of an area. We investigated this relationship with GPS tracking data from individual eagles to understand the relationship between potentially observed and actual use of simulated wind project footprints by individual eagles.

Our analyses used telemetry data collected every 15 minutes from seven territorial eagles and six fledglings tracked in the Mojave Desert of California. We overlaid telemetry data on simulated project footprints and generated survey data for a variety of potential point count sampling strategies. We then compared eagle use within point count areas to eagle use within the simulated project footprints and evaluated the strength of that relationship for a variety of (a) point count sampling types (n = 3 designs; random, systematic, stratified), (b) sampling intensities (n=2 intensities; 30% or 60% area coverage), and (c) project footprint sizes (n=4 footprint sizes; 20, 40, 90 and 180 square km) by month in 2012 and 2013. We also evaluated how survey results would vary if surveys were conducted weekly, bi-weekly, monthly or every 4 months (variation in sampling frequency).

We found that in 2012, 3-way interactions among month of year, sampling intensity and size of the project footprint influenced the effectiveness of surveys in describing use of project footprints. Similarly, in 2013, 2-way interactions between month of year and intensity of sampling and between month of year and size of project footprints influenced the effectiveness of the surveys. We also found that when sampling frequency was reduced, the effectiveness of the surveys was drastically reduced. Although our work focuses on individual eagles (not eagle populations), our analysis shows the utility of simulations to improve surveys at wind energy facilities by considering the context-specific way point counts are laid out on the landscape.

**Evaluation of the Application of Warning and Discouraging Sounds Automatically Emitted from Wind Turbines on Bird Collision Risk: Case Studies in Sweden and Switzerland** (Poster)

**Presenter:** Agustin Rioperez (DTBird)

**Authors:** Marcos Puente (DTBird)

**Abstract:** Wind energy is expanding worldwide, and there is an increasing demand to reduce the collision risk of birds with wind turbines (WTG, hereinafter). Methods commonly proposed include:

- “Deter” birds flying in the proximity of WTG.
- Stop the WTG before birds fly across the rotor swept area.

Useful technologies applying these methods should be able to efficiently detect bird flights in real-time, and to take the proposed actions on time to reduce the collision risk.

The aim of this research is to evaluate the effect on bird collision risk of warning and discouraging sounds emitted automatically from WTGs, to birds detected in real-time flying in the WTG vicinity.
The evaluation has been performed by DTBird® Team using DTBird® System:

- Detection Module surveys the airspace around WTGs detecting bird flights in real-time.
- Collision Avoidance Module emits warning and discouraging sounds from the WTG to birds flying in collision risk.
- Collision Control Module records bird flights in collision risk and potential collisions.

DTBird® System produces video and sound records of every detected flight, and stores them in a Data Center.

The evaluation has included 2 WTGs:

- Switzerland. WTG: Vestas 3MW, tower height of 119 m, rotor diameter 112 m. Testing period: Autumn 2014.
  - Detection Module recorded bird activity: 4.2 flights/day (274 flights, 423 birds): Corvids 15%, Raptors 3%, Medium size birds 61%, others 21%.
- Sweden. WTG: Vestas 850 KW, tower height of 74 m, rotor diameter 52 m. Testing period: Summer 2015.
  - Detection Module recorded bird activity: 5.8 flights/day (285 flights, 604 birds): Seabirds, 27%, Corvids 19%, Raptors 10%, Geese 4%, Cranes 4%, others 36%.

The research has been focused in bird flights detected at the rotor swept area (RSA, hereinafter) height, <100 m to the blades, and with the rotor running. It has considered High Collision Risk Flights (HCR) those detected at <1 blade length to the RSA.

The evaluation methodology consisted of the activation/deactivation of sound emission on a weekly basis, and the comparison of collision risk variables determined from the video records.

The results have been:

- Nº HCR Flights reduction with sound activated:
  - 100% in Switzerland (at 1/2 HCR area)
  - 31% in Sweden.
- % HCR Flight Pattern Changes with sound emitted compared with sound deactivated:
  - 60% to 0% in Switzerland.
  - 82% to 44% in Sweden.
- Flight duration reduction with sound activated:
  - >50% in Switzerland
  - >50% in Sweden.
- % Collision Avoidance Flights with sound emitted compared with sound deactivated:
  - 100% to 0% in Switzerland.
  - 87% to 33% in Sweden.
- Nº RSA crosses: No crosses with sound emitted on both sites, and 1 cross with sound deactivated in Switzerland.
- Nº Collisions: No collision observed in flight video records (DTBird Collision Control) on both sites and treatments.
The research points out that the automatic emission of warning and discouraging sounds from the operating WTG, to birds detected in real-time flying in their proximity, has reduced the bird collision risk.

**Expansion of WREN – An International Collaborative Under International Energy Agency Wind** (Poster)

**Presenter:** Karin Sinclair (National Renewable Energy Laboratory)

**Abstract:** Land-based and offshore wind energy projects must address concerns of environmental effects if project permits are to be secured. While deployment thresholds have been established in many countries, access to information on efficient monitoring programs and effective mitigation strategies has been problematic. To address this challenge at an international level, the International Energy Agency (IEA) Wind supports Task 34, known as WREN (working together to resolve environmental effects of wind energy). Current members include France, Ireland, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom, and the United States. The objective of WREN is to facilitate international collaboration that advances the global understanding of environmental effects of land-based and offshore wind energy development. WREN is a shared global knowledge base and community of practice around research, monitoring and management of the environmental effects of wind energy development.

Membership in WREN has grown since the NWCC Research Meeting X. As a result of the ongoing interest in WREN, a task extension was recently approved by the IEA Wind Executive Committee allowing WREN to continue through September 2020. During Phase 1, two key products were developed: 1) WREN Hub, a database platform where all WREN-related information is located and 2) a white paper focused on adaptive management. This poster presentation will inform the audience about the activities that will be conducted during Phase 2, including expansion of WREN Hub; development of several white papers; continuation of the webinar series; and, outreach and engagement efforts. All these activities are aimed at contributing to supporting the expansion of land-based and offshore wind energy deployment.

**Exploring the Displacement of Seabirds From Offshore Wind Farms** (Oral Presentation)

**Presenter:** Fraser Carter (Joint Nature Conservation Committee)

**Abstract:** The development of offshore wind farms is a rapidly growing renewable energy industry worldwide. Europe has already seen a substantial surge in its offshore wind energy production, reaching 11 GW in 2015.

Many planned and existing wind farm installations coincide with important foraging areas for breeding, wintering and migrating marine birds. This interaction poses a number of potential threats to marine birds including direct mortality through collision, and indirect threats such as displacement.

Displacement effects have the potential to impact populations in several ways including exclusion from important foraging areas. This could have knock-on effects to the wider population. Displacement may therefore be seen as functional habitat loss and some species, such as the Red-throated Diver, are...
particularly vulnerable to this. This species, along with around 500 others, are afforded protection under the Birds Directive, which aims to protect and conserve wild bird species across Europe. One of the conservation mechanisms is the classification of Special Protection Areas. Despite this protection, the scale of potential effects of displacement on marine bird populations is still largely unknown. Fortunately, an increasing number of monitoring studies are beginning to improve our understanding of displacement effects.

There is, however, still a significant amount of uncertainty surrounding the potential population consequences that displaced birds face. Empirical evidence of species specific reactions to wind farms, displacement rates, and the fate of birds displaced from offshore wind farms is still limited.

Gaining an understanding of displacement and potential consequences to the population is vital in order to make sensible assessments of the cumulative effects of multiple wind farms. This is particularly pressing given that global marine bird populations have declined dramatically over the past half a century. This may be of particular interest to wind farm developers as the legal requirement to protect birds under the Birds Directive can delay or even prevent wind farm construction.

This individual presentation will discuss the underpinning causes of, the potential impacts resulting from, and the uncertainty surrounding the assessment of, displacement of marine birds from offshore wind farms in Europe. It will also look to explore the cumulative impacts of multiple developments and the implications this may have for wind farm developments.

Flight Response to Topographic, Vegetative, and Temporal Correlates Predicts Risk from Wind Turbines to an Obligate-Soaring Bird, the California Condor (Oral Presentation)

Presenter: Sharon Poessel (U.S. Geological Survey)

Authors: Joseph Brandt (U.S. Fish and Wildlife Service), Laura Mendenhall (U.S. Fish and Wildlife Service), Melissa Braham (West Virginia University), Melissa Braham (West Virginia University), Michael Lanzzone (Cellular Tracking Technologies LLC), Andrew McGann (Cellular Tracking Technologies LLC), Todd Katzner (U.S. Geological Survey)

Abstract: Wind power is a fast-growing energy source in the United States, and the state of California is a national leader in wind energy development. However, the flight behavior of soaring birds may place them at risk of collision with these structures. The objectives of our research were to evaluate patterns in individual-specific flight responses of critically-endangered California Condors (Gymnogyps californianus) to topographic, vegetative, and temporal variation in their environment, and to place these flight responses in the perspective of potential risk from collision with wind turbines. We hypothesized that condors would vary their flight altitude with spatially-, temporally-, and sex-specific responses to topography and land cover, and that risk from wind energy development would vary seasonally. We analyzed altitudinal data from GPS telemetry collected between December 2013 and November 2015 from 24 condors in southern California. We examined the types of terrain and land cover over which condors flew and daily and seasonal patterns in flight behaviors. We also measured the distance from each flight location to the nearest commercially-valuable wind and calculated the proportion of flight locations that were within the rotor-swept zone of wind turbines. We evaluated multivariate relationships within our data with linear mixed-effects models. Our as yet unpublished
results indicate that condor flight behavior was strongly influenced by topography and land cover, such that birds flew at lower altitudes when over ridge lines and steep slopes and over forested and grassland cover types. Condor flight behavior also was strongly cyclical, such that birds flew lower during early morning and evening hours and during the winter months, when thermal updrafts were weakest. Although condors infrequently flew at altitudes placing them in the rotor-swept zone of modern horizontal-axis wind turbines, they regularly did fly near or within wind resources preferred by energy developers. The strong response of condors to variation in the spatial and temporal updraft environment they experience provides insight into risk management for this species. Our analyses indicate that this risk should vary seasonally and may be greatest when condors fly over areas with high topographic relief and from turbines placed near locations where they fly at lower altitudes, such as near their nocturnal roosting sites. In contrast, risk should be relatively lower when condors fly over less rough areas and from turbines placed in habitat they use during daytime soaring. Although the condors we studied were from the southern California population, our results should be applicable throughout their range. Development planners can incorporate knowledge about the flight behaviors of condors to reduce the potential for wind-wildlife conflicts.

Genomic Resources for the Management and Conservation of Bald and Golden Eagles (Oral Presentation)

Presenter: Ronald Van Den Bussche (Oklahoma State University)

Authors: Megan Judkins (Oklahoma State University/Grey Snow Eagle House), Brian Couger (Oklahoma State University), Stephen Clark (Oklahoma State University), Stephen Clark (Oklahoma State University), Wes Warren (McDonnell Genome Institute, Washington University)

Abstract: Delineating the biologically relevant boundaries within a species’ range should constitute the first step in any conservation or management program. This critical step informs the wildlife managers, biologists, and policy makers of the “units” they are attempting to conserve or manage while also setting the biological and theoretical foundations for future decisions. Unfortunately, elucidating the genetic variation within and among populations of Bald (Haliaeetus leucocephalus) and Golden (Aquila chrysaetos) eagles has proven exceedingly challenging. Currently, U.S. Fish and Wildlife are managing these species either via Eagle Management Units, which are different for the two species or via flyways, which are the same for both species. However, the existence of discrete population units for either species, if they exist, has yet to be evaluated with genetic data. The purpose of this study was to utilize a genomic approach to evaluate these competing hypotheses for eagle management units as well as a purely genetically based delineation of eagle populations. Addressing this overarching objective will allow for mitigation of population losses due to unintended “takes” of eagles at wind farms by determining the individuals natal origin. Utilizing a reduced genomic sequencing of 200 bald eagle genomes and 32 golden eagle genomes resulted in approximately 1.5 million genetic loci (Single Nucleotide Polymorphisms [SNPs] per species and preliminary population genomic analysis of 21,259 bald eagle SNPs and 30,006 golden eagle SNPs provided contrasting pictures of population subdivision that we interpret as being related to historical anthropogenic factors but provided evidence for continuing with this approach. We therefore reduced the initial 1.5 million SNPs per species to 50,054 bald eagle SNPs and 37,562 golden eagle SNPs. These 87,616 SNPs have been place on a SNP Chip and represent coding and intergenic regions of the genome. This study represents the first population
genomics approach for bald and golden eagles and the development of these species specific SNP Chips will allow for the delineation of biologically relevant population boundaries as well as assign individuals of unknown origin to their natal area.

**Golden Eagle Migration Corridors Along the Rocky Mountain Front and Intermountain Flyways** (Oral Presentation)

**Presenter:** Adam Shreading (Raptor View Research Institute)

**Authors:** Bryan Bedrosian (Teton Raptor Center), Robert Domenech (Raptor View Research Institute), Matthew Hayes (Lone Pine Analytics), Matthew Hayes (Lone Pine Analytics)

**Abstract:** Golden Eagles (Aquila chrysaetos) have been receiving increased attention in the western United States due to an increase in anthropogenic population threats, including wind and other industrial energy developments. Conservation of migratory Golden Eagles hinges on knowledge of threats within breeding ranges, migratory corridors, and over-wintering areas. Often, understanding threats along migration corridors can be difficult due to the short temporal use of migration paths and because pathways can often be dispersed across the landscape. We used satellite tracking data from three Golden Eagle studies across Montana to estimate key migration routes and bottlenecks for migratory Golden Eagles wintering or passing through Montana, with an emphasis on the Rocky Mountain Front. We gathered data from 35 individuals, including from 21 adult and 14 sub-adult Golden Eagles. We created individual dynamic Brownian Bridge Movement Models (dBBMM) for each migration event to estimate migratory pathways of individuals. We also created a population level migratory pathway estimate to determine key migration corridors and bottlenecks by summing the individual dBBMMs after accounting for age and study location. These models can be used for future risk assessments for developments and conservation measures for Golden Eagle migration routes.

**Golden Eagle Movements in the Upper Midwest: New Insight into Wind Energy Siting** (Poster)

**Presenter:** Mark Martell (Tetra Tech Inc)

**Authors:** Kristin Hall (National Audubon Society)

**Abstract:** Golden eagles (Aquila chrysaetos) are protected by the Bald and Golden Eagle Protection Act (BGEPA) which makes their presence important to wind development. Currently the U.S. Fish and Wildlife Service (USFWS) can issue Take Permits west of the 100th meridian but not east of that line, although is USFWS is proposing to provide Take Permits east of the 100th meridian. Understanding eagle spatial and temporal movements is critical when siting wind projects to avoid violating BGEPA. In upper Midwestern states, golden eagles are regular migrants and winter visitors; however, little is known about their movements, raising challenges for wind project siting. We used satellite telemetry to identify wintering areas and migration routes of six golden eagles over a period of 6 years. Winter home ranges were 41 – 357 sq km in size in hilly, forested habitat interspersed by agriculture and were re-used in multiple years. Wintering areas did not occur near existing wind projects. Spring migration occurred from February to May and fall migration occurred from September to December. Spring and fall migration routes were similar and individual birds showed yearly fidelity to migration routes and timing.
Tracked eagles did not move through existing wind projects. Understanding spatial and temporal parameters of golden eagle wintering areas and migratory paths will help inform future successful wind project siting.

**Heterogeneous Sensor Fusion for Autonomous Detection of Wildlife Collisions with Wind Turbines**  
(Oral Presentation)

**Presenter:** Roberto Albertani (Oregon State University)

**Authors:** Matthew Johnston (Oregon State University), Robert Suryan (Oregon State University), Congcong Hu (Oregon State University), Congcong Hu (Oregon State University)

**Abstract:** Mortality of endangered or protected avian and bat species resulting from interactions with onshore and offshore wind turbines is a major conservation concern. Wildlife interaction monitoring systems can support turbines installation decisions and effective siting verification. Wind farm operation procedures for wildlife damage control and active or passive wildlife deterrent measures must be applied. In any of the above options, an autonomous monitoring system for strike detection and taxonomic verification must be applied for verification, validation and eventual siting permission process. Such autonomous and efficient system currently does not exist.

A novel multi-sensor system designed on the wake of an existing proof-of-concept sensor array developed and field-tested under a recent US Department of Energy grant for removing market barriers to offshore wind development is presented. The existing system, consisting of an integrated sensor package developed around five fundamental sensor types: 1) accelerometers 2) contact microphones, 3) visual cameras, 4) infrared cameras and 5) bioacoustics microphones was tested at wind turbine sites at the North American Wind Research and Training Center (NAWRTC) at Mesalands Community College in Tucumcari, NM and the NREL-National Wind Technology Center (NWTC) in Boulder, CO. Field tests results on vibrations node and bioacoustics will be presented as well as lessons learned for system design and components with inferences on the sensors types and number required for best performance versus cost ratio.

The future version of the platform, currently under development, prioritizes board-level integration to significantly decrease the size, weight, and power consumption of the sensor unit. The new research platform, designed for extremely small size, will integrate a 3-axis MEMS accelerometer, 3-axis gyro, low-power CMOS imager, and contact microphone with on-board computation to enable local processing of sensor signals and detection of strikes in real time. Heterogeneous sensor fusion will allow removal of blade rotation motion artifacts and generator-induced vibrations to lower the overall noise floor. Importantly, localized computation also enables wireless transmission of only detected events in place of continuously streaming raw data, which dramatically reduces power consumption. The platform will be powered through a battery with possible integration from rotational or vibrational energy harvesting and small solar panels. This core sensor platform can be adapted for on-blade use or modified for permanent, embedded installation during blade fabrication. The unit will integrate both Bluetooth Low Energy (BLE) and WiFi modules for investigation of appropriate node-node and node-nacelle communication links, and it may include a 3G uplink for cloud-based data logging. The system can also be integrated with appropriate deterrent systems.
How Effective are Mitigation Measures in Ontario at Reducing Bat Mortality? (Poster)

Presenter: Ryan Zimmerling (Canadian Wildlife Service, Environment and Climate Change Canada)

Authors: Lauren Hooton (Normandeau Associates)

Abstract: The effectiveness of mitigation measures at reducing bat mortality has not been adequately assessed for most jurisdictions in Canada. In the province of Ontario, wind farms that exceed the mortality threshold of 10 bats / turbine / year must implement an increased cut-in speed of 5.5 m / sec from July 15 to September 30 for all wind turbines across the entire wind farm for the life of the project.

We conducted a large-scale assessment of the effectiveness of mitigation in Ontario by comparing pre- and post-mitigation bat mortality within and among wind farms. We also compared the species-specific effectiveness of mitigation at reducing mortality. Overall, our results demonstrate that increasing the cut-in speed of wind turbines to 5.5 m / sec reduces bat mortality to varying degrees, although it is somewhat species dependent. We suggest that the effectiveness of mitigation measures in Ontario could be further increased by utilizing an adaptive management framework.

Identification of Offshore Nocturnal Avian Migration Patterns Using Weather Radar (Poster)

Presenter: Kate Williams (Biodiversity Research Institute)

Authors: Evan Adams (Biodiversity Research Institute), Phillip Chilson (University of Oklahoma)

Abstract: Despite evidence of passerine and shorebird migration over the northwestern Atlantic, oceanic flyways and migrant use of these offshore regions are poorly known. WSR-88D (NEXRAD) weather radar units can detect migratory animals in the atmosphere and are used to document migratory activity over large areas, but the limitations of NEXRAD data collection offshore have prevented their widespread use for monitoring migrations in the marine environment. Specific issues have included an inability to detect animals during precipitation events; limitations in radars’ geographic detection range offshore; and limitations related to the altitudes at which offshore migration can be detected. New analytical approaches developed for the mid-Atlantic U.S. address these limitations by 1) Filtering out precipitation events that interfere with detection of migratory activity, so that we could monitor offshore migration in a wider range of environmental conditions, and 2) Utilizing a modeling framework that allows for less biased predictions of migratory activity levels at varying altitudes and distances from shore. We assessed 144 sampling sites over land and water along the Atlantic coast of the U.S., from New York to North Carolina, during spring and fall migration in 2010-2013. Analysis focused on comparing nocturnal migratory activity levels between sites and determining how weather influenced overwater migrations. Sites were located up to 80 km offshore and NEXRAD units could detect birds as low as 82 m above sea level at most sites. During spring migration, most migratory activity occurred onshore, with the exception of areas offshore of the Carolinas. During fall migration, offshore migratory activity was statistically indistinguishable from onshore migration levels, with offshore activity highest near Long Island and the Carolinas. Autumn offshore activity in the northern part of the radar coverage area was largely dependent on westerly winds, while offshore activity in the south was high regardless of wind direction. This study provides evidence that birds are regularly
migrating overwater up to 80 km out on the mid-Atlantic Outer Continental Shelf, and that nocturnal migratory activity is higher at certain locations and times of year, as well as under particular weather conditions. Given the levels of migratory activity predicted in offshore locations, regulators for offshore wind energy development may want to consider potential impacts to migrants in development scenarios, particularly in locations with consistently higher levels of migratory activity, such as the New York Bight and areas offshore of North Carolina.

Impact of Estimating a Site-specific “K” for the Design of Post-construction Monitoring at the EDPR Timber Road II Wind-Energy Facility, Ohio (Poster)

Presenter: Rhett Good (Western EcoSystems Technology, Inc.)

Authors: Paul Rabie (Western EcoSystems Technology, Inc.), Shay Howlin (Western EcoSystems Technology, Inc.), Kristen Nasman (Western EcoSystems Technology, Inc.), Kristen Nasman (Western EcoSystems Technology, Inc.)

Abstract: The Evidence of Absence (EoA) approach was developed by the USGS and recommend by the USFWS to design post-construction monitoring studies to detect rare bat casualties under prescribed levels of certainty. One of the inputs in to the EoA software is “k”, also known as the factor by which search efficiency changes between searches. This parameter takes on values from 0 to 1, with a recommended value of 0.67. When k is equal to zero, searcher efficiency is equal to 0 after the first search, meaning observers have only one chance of finding a carcass. When k=1 the search efficiency is assumed to be constant throughout the searches. We estimated “k” at EDPR’s Timber Road II Wind-Energy Facility, Ohio. Per Ohio DNR protocol requirements, crops were cleared to increase searcher efficiency. We measured “k” by assessing carcass availability and searcher efficiency through multiple search attempts. The estimated “k” value was 0.81 with a 90% confidence interval from 0.71 to 0.95, meaning there was an approximately 20% decrease in the searcher efficiency rate with each successive search. Designing a study using EoA with a value of “k” equal to 0.81 had a significant impact on the estimated probability of detection when there were long removal times and a short search interval. The level of effort and cost required to detect rare bat casualties can be high in areas dominated by valuable cash crops where crop clearing is required. We recommend designing searcher efficiency trials to allow for the calculation of site-specific k values at wind-energy sites where detection probabilities for rare bat casualties are important and carcass removal times are long relative to search intervals. Calculation of site-specific k values can increase the accuracy of rare event mortality estimation and significantly reduce the cost of future monitoring at projects where prescribed levels of detection are needed.

Learning by Doing: Montana Fish, Wildlife and Parks Conducts Post Construction Monitoring at Spion Kop Wind Farm (Poster)

Presenter: Kimberly Linnell (Montana Fish, Wildlife and Parks)

Abstract: As wind energy continues to grow within the state of Montana, it is important that agencies, particularly Montana Fish, Wildlife and Parks (MT FWP), understand the wildlife monitoring processes to better advise and assist energy personnel with wind projects. To become more knowledgeable, MT FWP
is working with NorthWestern Energy to conduct the post construction monitoring (PCM) at Spion Kop Wind Farm, located east of Great Falls, MT, on the southern slopes of the Highwood Mountains. Spion Kop Wind Farm consists of 25 General Electric wind turbines that produce a total of 40 MW and has a project footprint of 3,000 acres on private ranch land. Topography contains mountainous slopes and grassland, prairie is dominant and trees are few, with the exception of conifer forest and some rocky cliffs to the north of the project area. Before construction, several mitigation measures were taken to reduce bird and bat conflict. To assess the success of these measures, MT FWP is monitoring for bird and bat fatalities through formal search protocols. Ten of 25 turbines have been randomly selected and are being searched for carcasses via 160m x 160m plots every seven days April-October. Included in this work are trials for searcher efficiency and carcass persistence. The first field season began in April 2016, data being collected will be analyzed using Manuela Huso’s estimator of wildlife fatality from observed carcasses (Huso, 2011). Fatality results from the first field season will be presented. Other studies of indirect impact are also being conducted for management purposes and interests, including Sharp-tailed Grouse surveys, Eagle use surveys, raptor nest monitoring and bat activity monitoring. These surveys have resulted in the finding of two active Sharp-tailed Grouse leks and one active Golden Eagle nest all within the project area. Results are preliminary and will be presented and discussed after the first field season is completed. The objectives of this project are not only to assess the bird and bat fatalities and impacts of habitat loss as a result of construction and operation, but to work together to make a standard for wind energy monitoring in Montana, implementing any further mitigation measures and research as determined by the outcome of the PCM, and eventually making all findings available to the public for reference.

Lessons Learnt through Delivery of Ecological Impact Assessments for UK Offshore Wind with Reference to the North American Market (Poster)

Presenter: Nancy McLean (Natural Power)

Authors: Ross McGregor (Natural Power), Chris Pendlebury (Natural Power)

Abstract: The process of permitting of offshore wind projects within UK waters has developed in complexity over the last five years. This complexity is a direct consequence of the proposal of offshore projects within deeper waters and more complex soil types than were developed in the early phases of European offshore wind development. The final design of a UK offshore wind farm is now not typically fixed until Financial Investment Decision (FID), immediately prior to the appointment of the Principle Contractor for construction. One of the drivers of this approach is that it enables the Developer to de-risk expenditure associated with expensive geotechnical surveys and resulting foundation design studies. This means that foundation design and turbine choice (including rotor diameter) are not known during impact assessment or when a licence application is made. Therefore, the impact assessment and permitting process is undertaken on a range of project designs, termed the Design Envelope, to allow for flexibility in final design.

To achieve an ecological impact assessment against this Design Envelope that complies with the relevant assessment legislation, assessment is conducted against a ‘worst case’ for each receptor. For example, a pinned jacket foundation would constitute worst case with respect to underwater noise impacts to marine mammals, while a gravity foundation would constitute worse case for benthic ecology and scour.
Noise propagation modelling will require estimation of the highest blow energies required to pile drive the foundation structure to the greatest depth needed to secure the foundations, as detailed ground conditions at each turbine location are unknown. Conversely, assessments for benthic and water quality impacts will need to consider the largest volume of sediment removal and rock placement required to provide weight bearing substrate and scour protection for large gravity base foundations. With regards to turbine size, a larger number of smaller turbines is often considered worst case for ornithological receptors for displacement and collision risk. This will mean that impact assessments, by design, will conclude that a greater impact than is likely could result from the Project.

This approach to the Design Envelope has required a step change in approach from ecological impact assessment practitioners. It requires ecological consultants with detailed knowledge of receptors to work closely with engineers to determine the Design Envelope. Working together to achieve the required definition where receptor impacts are pivotal to the permitting process can make the difference between permitting and refusal.

Natural Power has been instrumental in working with Developers, Determining Authorities and Stakeholders to refine the Design Envelope to allow ‘most credible’ worst case scenarios to be utilized in impact assessment. In our presentation we will provide key lessons learnt to disseminate knowledge to generate a similar understanding of the drivers of the Design Envelope and impact assessment consequences within a US context. We would hope to promote discussion with regards to the relevancy of the approach within a North American context, as the US offshore market moves to larger projects in deeper water, utilising engineering lessons from delivery in similar conditions in Europe.

**Low Ecological Risk Wind Energy Development Areas Analysis (Oral Presentation)**

**Presenter:** Jim Hays (The Nature Conservancy)

**Authors:** Chris Hise (The Nature Conservancy), Jay Pruett (The Nature Conservancy), Brian Obermeyer (The Nature Conservancy), Brian Obermeyer (The Nature Conservancy),

**Abstract:** In order to facilitate the rapid deployment of renewable wind-generated electrical energy with minimal ecological impacts, The Nature Conservancy is providing science-based siting information to wind power stakeholders to support wind energy deployment and procurement processes. Whereas developers of individual wind energy facilities should have information regarding potential ecological impacts at their specific sites, other stakeholders in deployment and procurement of wind energy processes may not. Having such information available for their decision-making protocols can reduce impacts to sensitive species and habitats, provide significant business benefits, and help achieve true sustainability in the use of wind energy.

Deploying wind energy in an ecologically compatible manner requires siting facilities in areas where wind turbines and related infrastructure minimize direct wildlife mortalities and do not displace sensitive species or degrade or fragment their habitats. If developers utilize this analysis, it would not preclude them from needing to undertake communication and coordination with appropriate state and federal regulatory agencies early in their planning process. Key collaborators with wind energy developers include transmission entities, utilities and other electricity off-takers, wind energy project financiers and insurers, some regulators, and other organizations encouraging sustainability in wind
energy development and use. The intent is to allow all wind energy stakeholders to be aware of locations of low risk for potential wildlife impacts (and conversely, areas of higher risk of such impacts) and to be able to provide informed participation in decisions related to the suitability of specific locations, either before or after siting has taken place.

The foundational component of the analysis is a multi-layered geospatial data system that allows users to readily identify areas where ecological risks are low and wind energy potential is high. This non-regulatory, market-driven system can facilitate more rapid deployment of renewable wind energy; avoid most serious ecological threats; minimize potential environmental review project delays; reduce development costs; and help to protect corporate reputations of wind energy development stakeholders. The system synthesizes published scientific information on species potentially impacted by wind energy facilities, such as whooping cranes, prairie grouse, bats, and eagles. Also included are habitats (and their inhabitants) which could be potentially impacted by wind facilities, such as very high quality playas (waterfowl), major wetlands, protected wildlife areas and intact native grasslands and forests. The analysis maps are easy to use, with no cost or commitment required from the user. The Nature Conservancy has assembled this information and is making it available to everyone via open website access. Coverage is being provided for areas of significant wind speed in the Great Plains, both through this analysis and via linkage to similar efforts. Mapping will be updated as new scientific information becomes available. TNC is informing wind energy stakeholder organizations regarding the components, implications, and benefits of this system. The use of the analysis system by wind energy deployment stakeholders can become a voice from the sustainable wind energy market. The analysis became available July 1, 2016.

Managing Wind Farms – What is the Role of Adaptive Management? (Oral Presentation)

Presenter: Andrea Copping (Pacific Northwest National Laboratory)

Authors: Luke Hanna (Pacific Northwest National Laboratory)

Abstract: The international collaboration WREN (Working Together to Resolve Environmental Effects of Wind Energy) under the IEA Wind Committee identified the application of adaptive management (AM) principles and practices as an important aspect for improving planning, monitoring, and management of wind farms in the US and internationally. WREN is led by the US and involves 10 nations.

AM is a systematic process intended to improve policies and practices by learning from the outcome of management decisions, and has been considered to balance promoting the development of the wind energy industry with significant uncertainty concerning environmental effects. While many nations are considering the use of AM for wind energy, application in practice and in policy has been limited. Recent application of AM has led to fundamental differences in the definition of AM, its application, and to which projects or planning processes it might apply.

This paper suggests a common definition and framework for AM, based on the US Department of the Interior’s AM definition and guidance. The process of defining and applying AM to land-based and offshore wind farms was examined and examples gathered of the use of the system from US and European countries. The challenges and opportunities associated with implementation of AM for wind
development are addressed; management actions in several nations that exhibit attributes of AM are compared; and pathways to appropriate application and potential broader use of AM are addressed.

The paper recommends improvements that could be made to AM guidance including:

- Adoption of a universal definition of adaptive management, coupled with an agreed-upon set of eligibility criteria;
- Careful consideration to the optimal spatial and temporal scales for wind energy AM that can be meaningfully informed by reducing scientific uncertainty. For example, AM may be applied to a single project but is more likely to be useful applied at a larger scale to inform planning for future projects;
- Careful application of AM to wind energy is needed to ensure that it does not interfere with project financing models or harm resources protected by each nation; and
- Formal processes and structures are needed within regulatory bodies for the use of environmental impact data from existing projects in order to create learning and useful application to future projects.

Marine Windfarms and Wildlife – Selecting the Most Effective Digital Aerial Survey Design (Poster)

**Presenter:** Christian Newman (APEM, Inc)

**Authors:** Stephanie Mcgovern (APEM Ltd), Stuart Clough (APEM Ltd), Mark Rehfisch (APEM, Inc), Mark Rehfisch (APEM, Inc), Julia Robinson Willmott (Normandeau Associates, Inc)

**Abstract:** Environmental impact assessments based on inadequate survey data pose a significant planning and permitting risk for offshore windfarms. Potential displacement effects on waterbirds and marine mammals have traditionally been based on a small number of visual line-transect surveys using ships or low-flying aircraft. These methods rely on a statistical correction to account for birds and mammals that are missed by the human observers. In addition, the presence of the survey platform is known to impact the distribution of birds, with some species being deterred by low flying aircraft and survey vessels, and others being attracted to vessels. Thus, aerial digital surveying techniques using aircraft flying at significantly higher (safer) altitudes are a key tool in EIA of offshore windfarms. Permanent digital record also overcomes the need for observers to estimate bird numbers and allows for data to be quality assured.

While there is general agreement on the methodological advantages of digital aerial over observer-based surveys techniques, there remains an urgent need to establish statistically sound (and cost-effective) sampling designs that generate interpretable geospatial data. Here, we demonstrate how a grid-based survey design using high resolution still imagery makes best use of digital aerial technology for seabird population studies and impact assessments. We carried out simulations based on sub-samples of gapless vertical imagery collected in areas with high numbers of waterbirds to assess the levels of confidence of population estimates resulting from contrasting sampling designs (grid design versus continuous transect design). We found that the statistical power of the transect sampling was generally lower than that of the grid approach. The grid design generated larger numbers of independent samples, the standard error remained lower and precision was higher.
Digital aerial surveys deliver high-quality and auditable data on marine wildlife for monitoring all phases of offshore and nearshore windfarm developments. Linear-transects require a greater percentage coverage than grid design to achieve an equivalent level of data quality and confidence in population estimates. Therefore, in many cases grid-based methods should be favored over continuous transects in future EIA of offshore wind farms, especially in cases where species show high degrees of ecological patchiness.

Maximizing Comparability Among Bat Acoustic Studies (Poster)

Presenter: Susan Hurley (Tetra Tech, Inc)
Authors: Nathan Schwab (Tetra Tech, Inc)

Abstract: One goal of bat acoustic monitoring during pre-construction studies at wind energy facilities is to provide some level of risk assessment for post-construction impacts to bats. To date, however, few studies have shown correlations between pre-construction bat activity and post-construction fatality. Several factors may contribute to this lack of a relationship. We address the influence of bat detector settings (e.g., trigger window and gain) on reported activity rates and how the lack of standardized settings and resultant differences in activity rates limit incorporation of data into meta analyses and reduce our ability to draw larger inferences. The increased diversity of bat detector systems currently available, and the more control users have to modify settings, emphasize the need for standardization. A more standardized approach in data collection and analyses could facilitate the inclusion of more data into meta analyses and provide an opportunity to draw real conclusions from the large amount of bat acoustic data currently collected across the United States and beyond. We present recommended settings for various detector systems, discuss the merits of reporting data that minimizes the influence of detector settings, and propose a bat acoustic monitoring working group to establish standards in data collection and data analysis.

Micro-scale Movements of Nocturnal Migrants Around a Wind Energy Facility in Northeast British Columbia, Canada During Pre-operational and Operational Periods (Poster)

Presenter: Marc d'Entremont (LGL Limited environmental research associates)
Authors: Isobel Hartley (University of Northern British Columbia), Ken Otter (University of Northern British Columbia)

Abstract: We investigated the passage of nocturnal migrants at a wind energy project in northeast British Columbia during the pre-operational and operational periods using two open array marine surveillance radars from 2008 to 2012. Micro-scale movements were examined as the deviation between average hourly track bearings of nocturnal migrants and the average wind vector on a nightly basis, the average hourly altitude of migrants and the average hourly number of migrants flying in the airspace closest to the wind turbines. In general, passage rates and flight trajectories did not significantly change between the pre-operational and operational periods, suggesting there was little effect on migratory directionality from the presence of wind turbines. Despite variations in wind conditions between seasons, migrants showed consistent directionality and general trends of broad-front
migration patterns. The altitude at which migrants flew did differ with development phase of the wind facility, with migrants flying at higher altitudes during years when the turbines were operational. In general, though, the overall altitudes used by migrants were typically higher than turbine height, so the adjustments we documented were further reducing the current low levels of collision risk. In conclusion, at the micro-scale level nocturnal migrants were not significantly adjusting their movements around the wind energy facility during the operational period and their typical migratory behaviour did not place them in potential collision risk situations.

Migratory Tree Bat Roost-Site Use and Movements (Poster)

Presenter: Nathan Schwab (Tetra Tech, Inc)

Authors: Susan Hurley (Tetra Tech, Inc)

Abstract: Silver-haired (Lasionycteris noctivagans) and hoary (Lasiurus cinereus) bats are migratory, tree-roosting bats frequently encountered during post-construction fatality searches at wind energy facilities. Basic biological information such as tree characteristics associated with their roost sites, and local and migratory movements are poorly understood. Understanding the tree and landscape characteristics associated with migratory tree bat roosts and movements during the summer season could help inform the siting of wind energy development. Furthermore, access to migratory bat species during the summer residency period and recent advances in GPS tag technology provides an opportunity to examine migratory movements of these species. We captured and placed VHF transmitters on migratory tree bats in the Rocky Mountains of western Montana during the summer to identify day roosts, characterize the vegetation associated with these roosts, and assess daily fidelity to day roost locations. We also marked individual bats with PIT tags to provide the foundation for understanding inter-annual fidelity to summer habitats, and possibly migration pathways through studies in subsequent years. This project provided the first documented roost locations and descriptions for this species in Montana and one of the first known efforts to quantify roost-site fidelity within the summer season. The preliminary results presented here represent the first year of a three-year study. The second year of this study will include attaching GPS transmitters onto bats to determine migratory movements between summer residency periods. Subsequent recoveries of individually marked individuals in mist nets or at wind energy facilities, may also help to piece together movements of these species.

Minimizing Wildlife and Wind Energy Conflicts Through Species Distribution Models (Poster)

Presenter: Chris Jorgensen (Olsson Associates)

Authors: Joan Darling (Olsson Associates), Matthew Gregor (Olsson Associates), Eric Petterson (Olsson Associates), Eric Petterson (Olsson Associates)

Abstract: The wind industry has been dedicated to proactively addressing impacts to wildlife and their habitats. Despite best intentions, however, modest impacts to wildlife can and have occurred at operational wind facilities. Exploring and reducing these impacts prior to development is paramount, but the distribution and timing of species occurrence may be driven by landscape factors that occur well
Modeling the Effect of Roadkill Carcass Removal on Eagle Mortality (Poster)

**Presenter:** Taber Allison (American Wind Wildlife Institute (AWWI)),

**Authors:** Clint Boal (Texas Tech University), Jean Fitts Cochrane (AWWI), Eric Lonsdorf (University of Minnesota), and Carol A. Sanders-Reed (AWWI)

**Abstract:** Mitigation actions to compensate for mortality of protected species succeed when three critical capacities are achieved. Successful ‘offsetting’ must be (1) equivalent – the biological gains qualify as acceptable replacements for lost organisms; (2) sufficient – the quantity of replacements will offset specific losses, including buffers to hedge against possible short-falls due to uncertainty; and (3) efficient - the tactical strategies produce the greatest degree of direct compensation per increment of investment in the mitigation program. We illustrate with a case study on abating vehicle collisions with golden eagles in the western United States. Our model estimates eagle scavenging, avoidance, and vehicle collision rates as a function of eagle densities, roads and traffic volumes, and animal carcass abundance at the scale of a rural Wyoming county during fall-winter. The prototype model indicates collision abatement could reduce eagle deaths by 1-5 per winter at a ‘cost’ of 12,000-34,800 km driven per eagle saved, depending on the removal strategy. Removal efficiency (eagles saved/km) was tied to average carcass persistence times and concentrated on lower traffic volume roads where fewer eagles avoid scavenging yet routine road maintenance is infrequent. Collision abatement is a potentially useful addition to the mitigation toolbox where wind energy development is constrained by potential predicted eagle mortality. Simulation modeling and scenarios provided a rigorous yet practical approach to analyzing the sufficiency and efficiency of compensatory offsets, and identifying the best available mitigation and research strategies.

Modelling the Impact of Wind Energy on Hoary Bat Populations (Oral Presentation)

**Presenter:** Erin Baerwald (AWWI)

**Abstract:** As concerns over rising costs and environmental impacts of fossil fuels grow, wind energy is increasingly popular. However, large numbers of bats are killed at some wind energy facilities, which
raises concerns about cumulative impacts on bat populations. An estimated 0.84 and 1.7 million bats have been killed in the U.S. and Canada from 2000-2011, and this increases by over 500,000 individuals annually, 38% of which are hoary bats (Lasiurus cinereus). Given these estimates, our objective was to determine whether fatalities threaten the North American populations of hoary bats. We investigated this by using repeated measures analyses to examine how fatality rates change through time at 53 North American wind facilities with two-years of post-construction monitoring. If fatalities consistently decline, then this may indicate declines in population sizes. However, population estimates are lacking for bats, especially for migratory tree-roosting species like hoary bats, so we then used parameters derived from expert elicitation to model population trends of hoary bats. Both of our analyses suggest that fatalities at wind energy facilities may be negatively affecting hoary bat populations. Fatality rates declined over time at 63.5% of wind energy sites examined and the mean fatality rate was significantly lower overall in the second year of studies. Population modelling suggests that current fatality levels could cause a 91% decrease in the continental population of hoary bats within 50 years. Only in the unlikely scenario of an initial population greater than 4 million and baseline growth of at least 3% per year ($\lambda = 1.03$) did mortality from wind turbines have no impact on hoary bat populations. Our analyses highlight the need for effective policy and mitigation strategies that embrace adaptive and flexible management and address cumulative impacts.

**Mortality Data as an Indicator of Ecological Trends** *(Poster)*

**Presenter:** Andrew Ryckman (Natural Resource Solutions Inc.)

**Authors:** Charlotte Teat (Natural Resource Solutions Inc.), Christy Humphrey (Natural Resource Solutions Inc.), Erin Thompson (Natural Resource Solutions Inc.), Erin Thompson (Natural Resource Solutions Inc.)

**Abstract:** The information collected at operational wind turbines provides a unique opportunity to assess general population and behavior trends of a wide variety of bird and bat species, including some species that are otherwise difficult to study.

Using a dataset collected at more than 30 operational projects in Ontario over the last 6 years (2009-2015), a unique opportunity exists to analyze the dataset as a whole to assess larger ecological trends, such as migration timing, or even to assess the relative population dynamics over time to assess whether the species is showing signs of population decline.

Using Little Brown Myotis as a case study, an analysis of the mortality data indicate a steady and continuous decline in observed mortalities from 5.33 Little Brown Myotis/turbine in 2009 to 0.06 Little Brown Myotis/turbine in 2015. Although this decline in observed Little Brown Myotis observations is due to the spread of white-nose syndrome in Ontario during those years, the decline in observed mortality is nonetheless linked to the population dynamics as a whole.

Using this link between observed mortalities and known populations declines of Little Brown Myotis during this time period, this presentation will use a similar comparison of data to assess whether any other species appear to be showing population declines. Preliminary information indicates that although annual fluctuation is observed in each of Eastern Red Bat, Hoary Bat, Silver-haired Bat, and Big Brown Bat, most results show no indications of a decline in per turbine interactions which can be very loosely attributed to confirmation that populations are not undergoing dramatic population declines.
This presentation will provide a detailed look at the preliminary assessment made in this review of annual per turbine mortality rates and will provide further insight into the current status of other Ontario bat species in the context of general population, seasonal behaviour, and migratory activity. This comparison is particularly important for many of the bat species, where little is known about population numbers and therefore cumulative effects are difficult to assess.

Multi-sensor Monitoring System for Determination of Bird Behaviour in Wind Farms (Poster)

Presenter: Henrik Skov (DHI)

Authors: Jord Prangsma (FaunaPhotonics), Frederik Taarnhøj (FaunaPhotonics), Niels Einar Jensen (Furuno), Niels Einar Jensen (Furuno)

Abstract: Compliance with regulatory requirements increasingly demands clear evidence on how birds behave within and around wind farms. To meet this demand, a consortium of research institutes and innovation firms engaged with environmental monitoring technologies is developing a multi-sensor monitoring system designed to provide robust data on real life bird behaviour at and within a wind farm. In the past, monitoring of bird behaviour in wind farms has been focused on the application of single sensors, like bird radars, used by observers or as an automated operation detached from the wind farm control system. Using a network of state of the art technology such as high definition radars, thermal imaging cameras, bird lidar and acoustics in digital communication, bird behaviour can be monitored more efficiently over parts or entire wind farms. The sensors involved are currently at different technology readiness levels. A camera system in digital communication with one or more radars has been tested in an offshore wind farm since July 2014, and is fully prepared for application in onshore and offshore wind farms. Depending on air space coverage (2D/3D) needed, the radar solution may be both in the form of a single radar and as a network of medium- and long-range radars. The digital communication with the cameras allows coverage and species identification day and night in real time. The integration of bird lidar with the radars and cameras is being tested in a wind farm during 2016-2017, and capitalises on development of novel lidar application for bird monitoring. The addition of lidar to the sensor system will enhance the potential for achieving long-range identification of bird targets at the species group level. The addition of acoustics will enable identification of bat species approaching the wind farm in real time. The multi-sensor system is controlled by a FPGA based Data Aquisition and Preprocessing System and software for controlling the data stream, automated tracking, geo-referencing and interfacing. The speed of advancement of the next generation multi-sensor system providing automatic recordings of 3-dimensional track data at species level will depend on available R&D funding and support and collaboration from industry.

Multi-year operational minimization study in West Virginia: Potential novel strategy to reducing bat fatalities at wind turbines (Oral Presentation)

Presenter: Michael Schirmacher (Bat Conservation International)

Authors: Alex Prichard (ABR, Inc.), Todd Mabee (ABR, Inc.), Cris Hein (Bat Conservation International), Cris Hein (Bat Conservation International)
Abstract: Limiting blade rotation at relatively low wind speeds (e.g. <5.0 m/s or <6.5 m/s) has proven to be successful in reducing bat fatalities at wind turbines. Yet, this operational minimization strategy appears to be cost prohibitive and is rarely implemented. Thus, strategies to reduce the economic impact to the industry, while maintaining the conservation value, are needed to maximize adoption. In 2012, we initiated a 3-year study at a wind energy facility in West Virginia to test the effectiveness of different operational minimization strategies to reduce bat fatalities. In 2012, we tested normal turbine operation (3.0 m/s cut-in; control) versus turbines that were feathered below 5.0 m/s for the first four hours of the night (5m/s-half-3min) and the entire night (5m/s-all-3min), with all operational changes based on 3-minute wind speed averages measured at the meteorological (met) tower. In 2013, we tested normal turbine operation versus increased cut-in speeds of 5.0 m/s all night (5m/s-all-10min) and 6.5 m/s all night (6.5m/s-all-10min), with operational changes based on 10-minute wind speed averages measured at the met tower. In 2015, we used 5.0 m/s all night based on 10-minute wind speed averages at the met tower (5m/s-all-10min-met) as the control group since turbines were operating under that regime as a minimization strategy at the site during the autumn migration period. We compared this control group to two treatments using 20-minute wind speed average measured either at the met tower (5m/s-all-20min-met) or at each individual turbine (5m/s-all-20min-turbine). In 2012, we found a significant difference between 5m/s-all-3min and the control group, but no difference between the control and the 5m/s-half-3min treatment. In 2013, we found a significant difference for both the 5m/s-all-10min and 6.5m/s-all-10min treatments versus the control, but no significant difference between the two treatment groups. In 2012, the 5m/s-all-3min treatment showed an average reduction of 47%. In 2013, the 5m/s-all-10min treatment showed an average reduction of 58% and the 6.5 m/s-all-10min treatment showed an average reduction of 75%. In 2015, our results indicated significantly fewer bat fatalities occurred when turbine operations were based on the met tower rather than individual turbines. Furthermore, extending the decision time, from 10 to 20 minutes, to initiate start-up, may have contributed to lower fatalities by reducing the number of transitions (i.e., turbine start-ups and shut-downs). Minimizing the number of start-ups/shut-downs also may assist in reducing wear-and-tear on turbines and, at least in this study, may reduce the power loss related to this minimization strategy. Thus, 5m/s-all-20min-met represented a decision framework with fewer fatalities, significantly fewer than 5m/s-all-20min-turbine, and compared to 5m/s-all-10min-met had less transitions (i.e., potential turbine wear-and-tear) with slightly more power production. Therefore, the 5m/s-all-20min-met may be the most cost effective option of the 3 treatments studied in 2015. To better determine the cost-effectiveness of this novel strategy, future research should investigate the potential of modifying traditional operational minimization strategies by increasing the decision time to initiate turbine operation in other regions and as an alternative to raising the cut-in speed greater than 5.0 m/s.

Ontario’s Permitting Approach to Species at Risk (Poster)

Presenter: Andrew Ryckman (Natural Resource Solutions Inc.)

Authors: Pam Hammer (Natural Resource Solutions Inc.), Christina Carter (Natural Resource Solutions Inc.)

Abstract: With many regulating agencies, at least in Canada, expressing resistance and hesitancy relating to the issue of "precautionary" permits while also not allowing incidental take of Species at Risk, wind
operators have previously been left with no other option than to accept the risk associated with even a single impact to a Species at Risk.

In 2013, Ontario introduced an innovative permitting approach that, in part, addresses these unpredictable encounters with Species at Risk birds and bats at operational wind turbines. This approach maintains the proponent-driven process that is typical of Ontario’s Endangered Species Act, and allows for operators to self-register a likely impact to most protected species. Following the registration of a likely impact, a detailed Operational Mitigation Plan must be prepared to outline exactly how these impacts will be documented and addressed. With few exceptions, this Operational Mitigation Plan requires review and approval by the provincial regulator, the Ontario Ministry of Natural Resources and Forestry.

This innovative approach to permitting unpredictable impacts to Species at Risk maintains the responsibility on the operator to recognize and address a potential impact, protects the operator from contravening Species at Risk legislation if a mortality were to occur, all while requiring that a plan is in place to ensure any impacts are quickly identified and mitigated through the development of an approved Operational Mitigation Plan, ultimately protecting the species. This approach also allows an operator to implement other industry-accepted mitigation strategies for targeted curtailment (i.e. seasonal, turbine-specific, etc.) or for the implementation of other proven and/or innovative approaches for addressing potential impacts, rather than mandated and inflexible mitigation strategies that many jurisdictions, including Ontario, rely upon.

This poster will highlight the key aspects of the legislation that have made this an effective tool for both provincial regulators and operators of wind energy developments. It will also walk through an example mitigation strategy to demonstrate the flexibility and comprehensiveness that can be incorporated into an approved Operational Mitigation Plan, based on species considerations, project geography, or results of baseline monitoring.

**Overcoming Challenges to Conducting Meaningful Cumulative Impact Analysis (Poster)**

**Presenter:** Chris Rutledge (Environmental Resources Management (ERM))

**Abstract:** With numerous efforts underway to develop and clarify permit programs to potentially authorize take of federally-listed species, eagles, and even migratory birds for wind energy projects – it is foreseeable that the number of wind energy facility operators pursuing take authorization from the U.S. Fish and Wildlife Service (USFWS) will significantly increase in the near future. “Take” permits will require an evaluation of potential impacts, including cumulative impact analysis, to federally protected species.

There are inherent challenges to cumulative impact analysis, including lack of an established framework; lack of data or clear understanding of the study area; budget and schedule limitations; and challenges associated with communication, collaboration, and other external factors. As a result, cumulative impact analysis is often one of the most challenging aspects of preparing an impact assessment document and has also been the grounds for legal challenges to federal agency decisions.
This presentation will share lessons learned on conducting defensible cumulative impact analysis, using the Environmental Impact Statement (EIS) for the Buckeye Wind Power Project as a case study. The Buckeye Wind Power Project received the first Incidental Take Permit issued to a wind energy project for take of the federally-endangered Indiana bat (Myotis sodalis). The EIS successfully withstood a challenge of the NEPA analysis, with the U.S. District Court concluding that the USFWS was within their rights in issuing the Incidental Take Permit. This presentation describes the steps used to conduct a cumulative impact analysis for bats for the Buckeye Wind power project; how challenges of multiple jurisdictions, community concerns, and synergistic effects were handled; and the “key ingredients”, identified through this experience, for a defensible cumulative impact analysis.

Overview of USFWS Western Golden Eagle Team’s Risk Assessment and Conservation Planning Program (Oral Presentation)

Presenter: Brian Woodbridge (U.S. Fish and Wildlife Service)

Authors: Gary Williams (U.S. Fish and Wildlife Service), Todd Lickfett (U.S. Fish and Wildlife Service), Geoffrey Bedrosian (U.S. Fish and Wildlife Service), Geoffrey Bedrosian (U.S. Fish and Wildlife Service)

Abstract: U.S. Fish and Wildlife Service Regions 1, 2, 6 and 8 established the Western Golden Eagle Team (WGET) in June 2013 to proactively address energy-related conservation needs of Golden Eagles (Aquila chrysaetos) by developing landscape-scale conservation strategies. Our conservation strategies are informed by: 1) predictive models of the relative density of exposure (eagle presence) of Golden Eagles throughout the western U.S. during three overlapping life history stages; breeding, dispersal and migration, and overwintering; 2) spatially explicit assessments of hazards including electrocution, contaminants, and collisions with vehicles; and 3) information resources to support management of Golden Eagles and their prey. Integration of our exposure models with mapping or predictive models of hazards such as proposed wind development or electrocution on power distribution structures provides a proactive risk assessment and decision support framework for evaluating siting of renewable energy development as well as potential mitigation actions.

Working in collaboration with scientists and managers from state and federal government, academic, Tribal and private organizations, WGET is developing a range of assessments and information resources intended to provide additional foundation for conservation strategies. Focusing on potential mitigation approaches, we are evaluating and modeling (for example) spatial aspects of eagle electrocution hazard and remediation, spatial attributes of Golden Eagle responses to disturbance, and the incidence and exposure routes of lead and anticoagulant rodenticides. In support of habitat-based conservation measures, we are working on extensive analyses of Golden Eagle diets, composition and variability of prey communities, and habitat management strategies for important prey species.

Effective implementation of risk assessment and decision support tools, and conservation measures is an adaptive process. To evaluate and refine these products, WGET and partners will be reliant on feedback from practitioners, incorporation of new research, and targeted field surveys to fill data gaps.
Potential effects of using machine vision monitoring to estimate eagle fatality risk at wind facilities. (Poster)

Presenter: Kimberly Peters (DNV GL Energy)

Authors: Tom Hiester (Renewable Energy Systems)

Abstract: Much emphasis has been placed on obtaining accurate and reliable estimates of eagle activity at prospective and operational wind facilities because of concerns about potential strike-risk from wind turbines. Projected collision risk for a specific wind project is typically estimated using the U.S. Fish & Wildlife (USFWS) Bayesian Model, which incorporates prior probability distributions based on external projects to relate eagle activity to risk. The model is then parameterized by site-specific eagle counts; however, the model is highly sensitive to survey effort, which can be limited when using standard point-count surveys by biologists. Recent developments in machine vision technology offer an opportunity for substantially increasing survey effort and could therefore influence eagle fatality estimates as a function of effort alone. We conducted a series of simulation studies based on the monitoring capabilities of a newly-developed machine vision system, IdentiFlight (Renewable Energy Systems), under varied project and eagle use conditions to determine how automated monitoring could affect strike-risk estimates. Results showed that risk estimates were markedly lowered as compared to using standard point-count methods, particularly under conditions in which eagles were rarely observed on site or were temporarily using the site (e.g. migratory periods, subadult wandering). The Bayesian eagle risk model assumed that expected eagle observations increased linearly at a 1:1 (or lower) ratio as observation time increased, and our application of the model further assumed that machine vision for a given time window is comparable to human observers; these assumption have yet to be verified with field testing. The potential regulatory and economic impacts of using machine vision monitoring at planned and operational wind facilities are discussed in the context of the USFWS Eagle Conservation Plan Guidance recommendations, including expected impacts if model assumptions are violated.

Potential of Marine Spatial Planning as a Basis for Offshore Wind Impact Assessments (Poster)

Presenter: Kendra Ryan (University of Massachusetts Amherst)

Abstract: Offshore wind energy (OWE) is a reality in European waters for the last 25 years; however, no offshore turbines are yet operational in the United States. A cumbersome environmental permitting process, which includes environmental impact assessments, is cited as one barrier to development. Impact assessments require adequate biological data of appropriate temporal and spatial scales, such as the distribution and abundance of cetaceans. These data are often lacking at project sites, thus additional research and surveys must be conducted, further lengthening the development process. Marine spatial planning (MSP) is a method of incorporating the interests of various stakeholders, such as OWE, into the spatial allocation of the marine space. Using a case study approach, the MSP processes and OWE development in Rhode Island, Germany, and Denmark were examined to determine if the scale of cetacean data needed for OWE environmental impact assessments could be gathered from the outcomes of MSP.

Preliminary results show that data management in MSP processes is not universal and the influence of this data on OWE impact assessments is varied. In Germany, OWE impact assessment data requirements
were satisfied with existing data and the Danish constructed 1,271 MW of OWE installed capacity without a formal MSP process. However, in Rhode Island, a MSP process that focused on the OWE sector effectively streamlined data collection, analysis, and management in order to accelerate OWE development of the Block Island project. Offshore wind development is possible without MSP; however, the biological data used in impact assessments may be outdated or its acquisition may cause lengthy delays in the development process. Directed biological data collection, analysis, and management efforts should thus be conducted during MSP processes, prior to OWE development, to ensure appropriate and adequate scales of data are included in impact assessments to inform the permitting process.

**Power Line Infrastructure – Bird Electrocution and Collision Risk Assessments and Applying Compensatory Mitigation: Historic Issues Evolving into a New Paradigm for Wind Energy** (Poster)

**Presenter:** Lori Nielsen (Western EcoSystems Technology)

**Authors:** Wallace Erickson (Western EcoSystems Technology, Inc.)

**Abstract:** Power lines are the common denominator for electric generation, transmission, and distribution, whether it involves renewable or conventional energy development and use. Bird interactions with power lines are multi-dimensional, and have been recognized over the last 25 years; however, the science in assessing bird fatalities from power line electrocutions and collisions has progressed significantly in the last decade and has become an emerging concern for the wind energy industry as they own and operate many of their own lines. The Avian Power Line Interaction Committee (APLIC) is often cited as a source for conservation strategies, but current approaches in discerning between avian-power line electrocution and collision risks are inconsistent in the U.S. and recommended mitigation can be flawed. It often is not clear what a commitment to “build aboveground power lines to APLIC guidelines” involves or how these guidelines are applied to eagle compensatory mitigation in an Eagle Take Permit. Bird electrocution risks are dictated by voltage, structure configuration, and potential at-risk species. Bird collision risk applies to a range of voltage classes, typically reflecting site-specific ecological factors combined with infrastructure design. Understanding these variables is integral to the ever-evolving state-of-the-art science relative to birds, power line infrastructure, and regulatory requirements and will be even more important as the federal Eagle Rule and compensatory mitigation program is finalized by the U.S. Fish and Wildlife Service. Minimizing long-term risks to birds requires balancing regulations, engineering considerations, management goals, environmental due diligence, and associated costs. We will cover these emerging issues for wind energy, the communication challenges, tools and resources available to assess and minimize avian electrocution and collision risks with power lines, how these risk assessments should be structured, and recommended resolutions moving forward.

**Predicting Bat Activity in the Rotor Swept Area by Modeling Bat Activity at High and Low Elevations in Open Habitats** (Poster)

**Presenter:** Kim Chapman (Applied Ecological Services, Inc.)
Authors: Ingrid Paulsen (Applied Ecological Services, Inc.), Patrick Daniels (Applied Ecological Services, Inc.)

Abstract: Most wind facilities in the Midwestern United States are in open habitats, typically cropland, where spatial activity patterns of migratory tree bats (hoary, silver-haired, eastern red) may differ from that in woodland. Past studies investigating the spatial activity patterns of bats focused on woodlands and riparian zones and concluded that bat activity detected at ground level was insufficient to represent bat activity at high elevations in the rotor-swept area (RSA)(Menzel et al. 2005, Collins & Jones 2009). To address this issue and describe bat activity and diversity across the vertical airspace of wind facilities in Midwestern farmed landscapes, project owners often install detectors on towers at high and low elevations. We investigated whether detectors installed at low elevations (~4 m) in open, primarily cropland habitat accurately reflected bat activity at high elevations (~55 m) at 13 towers in Michigan and Ohio in the high bat-fatality migration period (July 15-October 15, 2009-2011). This study’s objective was to investigate correlations between high and low elevation bat activity in order to develop confidence intervals (CIs) of bat activity at high elevations using a regression-based model and low-elevation data. We used R for linear regression analysis, calculated CIs from regression equations, and validated results with actual data. We found that there was significantly more bat activity and higher species diversity at low elevations compared to high elevations (t[n=5-11]<0.05), except for hoary bat, whose activity did not significantly differ across elevations (t[n=11]>0.05). The proportion of migratory tree bats was higher at 55 meters than at 4 meters; in addition, total migratory tree bat activity, as measured by calls/detector-night, was significantly correlated between high and low elevations (adj. r²=0.83, p<0.001). This was largely due to the frequent presence and strong correlation of hoary bats at both elevations (adj. r²=0.86, p<0.001). Eastern red bat activity also had a significant high-low positive correlation, but a lower adjusted r² (adj. r²=0.38, p<0.03). We concluded that bat activity detected at low elevations in midwestern open habitats may be sufficient to partially model hoary bat activity in the RSA. It does not, however, fully represent the spatial activity pattern of other migratory tree bat species, especially at sites with high bat activity at low elevations, which results in large CIs at high elevations, making prediction difficult. With additional data from other high-low bat detectors deployed simultaneously in the migratory period, the model may be useful for predicting hoary bat activity in the rotor-swept area of open Midwestern landscapes, as well as for predicting total migratory tree bat activity, and perhaps eventually eastern red bat activity. This would be more flexible and cost-efficient than deploying bat detectors on high towers to detect these two common migratory tree bats, or migratory tree bats in general. These findings may best be applied early in the project development stages for evaluating sites before met towers are available, or for the rapid detection of migratory bat concentration areas at multiple locations across a region.

Predicting habitat use by bats to protect bats and inform wind energy development (Poster)

Presenter: Clarissa Starbuck (Northern Arizona University)

Authors: Carol Chambers (Northern Arizona University)

Abstract: Although wind turbines are a clean, renewable source of energy, sometimes they incidentally kill bats and birds in large numbers. In 2012 for example, an estimated 600,000 bats died due to encounters with turbines at wind energy facilities in the U.S. alone. Migratory species such as the
Mexican free-tailed bat (Tadarida brasiliensis) and hoary bat (Lasiurus cinereus) have the highest mortality at wind energy facilities. Arizona has both high species richness of bats and a high proportion of migratory species (bats that migrate long distances or regionally) that creates a high risk of mortality from interactions at wind energy facilities. Our objectives are to determine the species composition, examine bat use, study topographic features on the landscape that might influence bat movement (e.g., long distance migration), and identify elevational movements (e.g., regional migration) by bats. Our study area encompasses open grassland and shrubland in northern Arizona in areas where wind energy development might be suitable. We are sampling bat activity to determine habitat use and migratory patterns by bats in northern Arizona. Across our study area, we are deploying 34 acoustic detectors (Song Meter SM3BAT) at randomly-selected points that represent a range of measures for each habitat covariate (e.g., slope, aspect, elevation). We surveyed points during the summer of 2015, and we are surveying points during spring, summer, and fall of 2016 and 2017. We are using SonoBat 3 software to identify bat calls to species. We analyzed data from the summer of 2015 using linear regression in R, and we separated the collected calls in to 5 groups: all call files, low frequency calls, high frequency calls, Q25 group (calls with characteristic frequencies around 25 kHz), and less than 15 kHz calls. In these preliminary results, we found that there is higher bat activity for all groups in valleys and lower slopes than other topographic features. Using our models, we will create a map that predicts bat use in areas of northern Arizona that may also be suitable for wind energy development.

Presence of bald eagles (Haliaeetus leucocephalus) in upland landscapes of the Upper Midwest during winter: implications for wind energy (Poster)

Presenter: Sara Schmuecker (U.S. Fish and Wildlife Service, Western Illinois University)

Authors: Drew Becker (U.S. Fish and Wildlife Service), Michael Lanzone (Cellular Tracking Technologies LLC), Todd Katzner (U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center), Todd Katzner (U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center), Bob Fogg (Cellular Tracking Technologies LLC), Tricia Miller (Division of Forestry and Natural Resources, West Virginia University)

Abstract: Over the next 35 years, the United States’ energy produced by wind power is expected to increase dramatically, resulting in construction of many new wind facilities. The Upper Midwest is likely to be a focal area for this development. Over the past five years, the Upper Midwest has experienced the greatest number of bald eagle mortalities at wind facilities. Because bald eagles are strongly associated with waterbodies, research to-date on this species has primarily been limited to riparian corridors. Consequently, upland agricultural landscapes, where wind energy development is occurring, were thought to be benign environments in term of risk to eagles from wind energy. However, a substantial bald eagle presence has since been documented outside of riparian areas; for example, nesting, wintering, and migrating bald eagles have been documented in all counties in Iowa. Significant eagle mortality and increasing eagle use of upland areas have resulted in the need for more information regarding bald eagle biology and movements in non-riparian Midwestern landscapes. In order to guide management and reduce eagle interactions with potentially hazardous anthropogenic structures, we captured and telemetered (GPS-GSM telemetry units) 22 adult and sub-adult eagles in Iowa and Illinois during the winters of 2013-2016. The local movements of these birds were recorded from their capture or arrival on wintering grounds until they departed on spring migration. We collected 328,945 GPS data
points as we tracked eagles for an average of 59.1 ± 39.0 (SD) days per bird through the states of Minnesota, Wisconsin, Iowa, Illinois, and Missouri. To understand the environmental correlates of eagle habitat use, we used logistic mixed effects models to compare conditions when eagles were present in upland areas to conditions when eagles were present in riparian areas. We evaluated five models that were comprised of variables describing extreme cold, storm systems, and spring migration conditions, in addition to global and null models. Unpublished results indicated that bald eagles were more likely to be present on upland landscapes during extreme cold events. This suggests that when ice cover restricts foraging on open water, eagles moved into areas where other food sources may have been available and thus may more frequently encounter wind turbines. The relationship between weather and bald eagle foraging behavior may be useful to understand how bald eagles use Midwestern landscapes and thus may help to guide management decisions to aid in the conservation of this iconic species.

Prospective Wind Energy Projects Posing Low Risk to Golden Eagles in the U.S. Southern Great Plains: A Conceptual Approach for Rapid Risk Categorization and Take Permitting (Poster)

Presenter: Robert Murphy (U.S. Fish and Wildlife Service)

Abstract: I propose development of a risk-scoring tool to distinguish prospective wind energy projects posing relatively low risk to golden eagles (Aquila chrysaetos) (i.e., unlikely to take more than a small number of eagles over the life of a project) from those posing greater levels of risk. Application of the tool probably would be limited to landscapes where (1) land cover and land use patterns are relatively simple and the eagle’s habitat associations are straightforward, and (2) golden eagles are, for the most part, widely scattered. The southern Great Plains, a region experiencing the most rapid, extensive growth in wind energy development in the United States, seems unique in these respects. The risk-scoring tool would be part of the Stage 1 assessment per the U.S. Fish and Wildlife Service’s Eagle Conservation Plan Guidance, and could conceivably limit the need for extensive pre-construction surveys for predicting eagle fatality rates. The tool also could help expedite issuance of permits from the Service authorizing take of golden eagles at such projects. For the Southern Great Plains, I propose that the “scoring” be based on seven attributes important to golden eagle occurrence or risk at wind energy projects; six are landscape attributes (percentage cropland, occurrence of eagle nests, proximity to waterbird concentrations, ha of playa wetlands, ha of prairie dog colony, and km of escarpment/ridges for uplift) and the other is total hazardous area of proposed turbines. Attributes could be weighted based on known or likely importance. The intent would be for scoring to be done via desktop with modest field verification. Influences of various project and turbine siting scenarios on the risk score could be readily assessed to support adjustments for reducing risk level. Ideally, multiple low-risk projects could be evaluated under a single, programmatic Environmental Assessment rather than project-specific EAs. A conservative fatality rate could be assumed for the first 5 years of a project’s operation; robust, post-construction monitoring would then be needed to validate and adjust the fatality estimate. Under the Service’s current permitting framework, authorized take of golden eagles would be offset by compensatory mitigation. In the Southern Great Plains, a tool like this could conceivably help steer wind energy development towards landscapes where risks posed by projects to golden eagles are smallest. Implementation of such a tool would, however, require considerable policy development and review by the Service.
Reducing Uncertainty through Experimental Design and Appropriate Analysis: Lessons Learned through Post-EIA Ornithological Monitoring of Offshore Wind Developments in the UK (Poster)

Presenter: Nancy McLean (Natural Power)

Authors: Gillian Vallejo (Natural Power), Chris Pendlebury (Natural Power)

Abstract: The offshore wind industry in the UK is maturing and as a result, UK practitioners have accumulated a wealth of experience in both ornithological site characterisation and impact assessment, and design of post-EIA monitoring programs promoting a better understanding of the responses of seabirds to offshore wind developments. The accuracy of conclusions drawn from these is subject to uncertainties arising from data collection, modelling approach and presentation of findings, as well as stakeholder perspectives and biases. In the UK, due to the precautionary nature of decisions made when permitting projects, it is beneficial to design post construction monitoring to generate data on impacts in order to minimise uncertainty where possible. This enables the generation of reliable, realistic estimates of impact rather than relying on worst case scenario approaches. In a North American context, careful design of monitoring programs for offshore wind developments will enable assessment of project compliance and inform future permitting decisions.

Appropriate experimental design is a key driver in reducing uncertainty associated with impact assessment. Yet too often, ornithological surveys are carried out with little regard for the purpose of the surveys and the types of analysis that will need to be carried out. In the recent past, within delivery of UK offshore Rounds 1 and 2, it has been common for generic surveys to be carried out with little thought as to the key receptors of interest and how data collection could be optimised to provide valuable data for these. This is particularly surprising during the construction and operational phases, when key issues and species have been identified and baseline data are available to inform the planning and execution of monitoring and assessment.

Based on our extensive experience, we recommend a question-driven approach to data collection and analysis for post-permit ornithological impact assessment. We advocate that site-specific information and identification of appropriate analysis methodology be used to optimise survey methodology in order to address specific concerns. This approach allows targeted data collection that minimises uncertainties associated with impact assessment, providing a framework within which impacts can be assessed as accurately as possible, facilitating demonstration of project compliance. In addition, this framework will generate data that can contribute to our global understanding of the impacts of offshore wind farms on birds, further reducing sources of uncertainty for future, or life extension of existing developments. This is the approach being developed for the delivery of post construction monitoring regimes for ornithological impacts of recently permitted, 1GW+ offshore projects within the UK.

In this poster, we present this framework, with the aid of case studies demonstrating good practise approaches and tools used in the UK to develop and assess the feasibility of proposed monitoring programs and inform experimental design for assessment of realised impacts at offshore wind farm sites. We demonstrate that careful planning can allow targeted data collection, minimising uncertainty associated with predictions and increasing stakeholder confidence in findings.
Reduction Of Eagle Take At Windfarms Through Machine Vision Enhanced Informed Curtailment (Oral Presentation)

Presenter: Tom Hiester (Renewable Energy Systems)

Authors: Tim Hayes (Duke Energy Renewables), Greg Aldrich (Duke Energy Renewables)

Abstract: Preliminary statistics are shown of informed curtailment using human observers, complemented by machine vision, at an operating windfarm in Wyoming. Informed curtailment is a method whereby individual wind turbines in a project are shut down when an eagle is in imminent danger of a collision with rotating wind turbine blades. The decision to curtail is based upon observational data gathered by human observers. Human observation techniques have strengths and weaknesses. Machine vision solutions overcome some of these disadvantages thereby creating a stronger informed curtailment program than is achievable by human observers alone. These capabilities may enable species specific automated curtailment capability that minimizes take risk and maximizes wind turbine operating revenues subject to wildlife protection constraints. In this paper, a comparison of human biomonitor observation of eagle activity and resulting curtailment decisions are directly compared with machine vision observations and a variety of curtailment recommendations based on varying curtailment prescriptions.

Regulatory Dynamics: Application of Bat REA to Mitigation Delivery (Poster)

Presenter: Russ Krauss (RES)

Authors: Dheepa Jayakumar (RES)

Abstract: Assessment of habitat mitigation solutions begins by quantifying the potential underlying impacts of direct and indirect take of potentially impacted species. REA models for bat take are in flux as agency personnel work to optimize the equations for more realistic assessments and predictable outcomes. When applying RA model outputs to developing land-based mitigation offsets, it was noticable that the required mitigation acreage had doubled with the updated version of the REA model. What happened and how to address and adapt to this change?

Response of Golden Eagle Flight Altitude to Topographic Variation in California and Implications for Potential for Wind-Wildlife Interactions (Oral Presentation)

Presenter: Adam Duerr (Division of Forestry and Natural Resources, West Virginia University)

Authors: Leah Dunn (Department of Public Policy and Administration, Boise State University), Melissa Braham (Division of Forestry and Natural Resources, Division of Geology and Geography, West Virginia University), Tricia Miller (Division of Forestry and Natural Resources, West Virginia University), Tricia Miller (Division of Forestry and Natural Resources, West Virginia University), Amy Fesnock (California State Office, Bureau of Land Management), Douglas A. Bell (East Bay Regional Park District), Peter Bloom (Bloom Research, Inc.), Robert Fisher (U.S. Geological Survey, San Diego Field Station), Jeff Tracey (U.S. Geological Survey, San Diego Field Station), Todd Katzner (U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center)
Abstract: Planning renewable-energy development to minimize effects to sensitive species of wildlife requires knowledge of how those species use the environment. In the case of wind-wildlife interactions and volant species, it is helpful to understand how flying animals select the altitude above ground level (AGL) at which they fly. To aid understanding of interactions between wind energy and golden eagles, we investigated how flight altitude of 97 GPS-tagged golden eagles changed relative to topography in each of 5 Bird Conservation Regions (BCRs) within California. We associated flight locations from these data with four measures of the topography directly below each point. The first, a topographic position index, was categorized along a gradient that included valleys, gentle slopes, steep slopes, and ridges. The second, a topographic roughness index, was categorized into 5 classes that included smooth or flat areas, and areas with slight, low, moderate and high roughness. We also included measures of slope and aspect of the terrain. Unpublished results suggest that flight altitude above ground level (AGL) for golden eagles differed by BCR and, in each region, responded distinctly to topographic position, topographic roughness, slope and northing (north-south component of aspect). In contrast, response to topographic roughness and easting (east-west component of aspect) did not vary among BCRs. Empirical estimates of eagle flight AGL were highest over the Sonoran and Mojave Desert BCRs (250 ± 112 m; grand mean by bird ± SE); intermediate over the Sierra Nevada (234 ± 178), Coastal California (227 ± 150) and Great Basin BCRs (210 ± 147) and lowest over Northern Pacific Rainforest BCR (161 ± 104 m). Model results projected eagle flight AGL was highest over valleys and lower over other topographic positions. However, flight AGL increased on gentle slopes in Coastal California and increased on gentle and steep slopes in both Northern Pacific Rainforests and the Sierra Nevadas. For all BCRs, flight AGL decreased as the terrain became rougher. Flight AGL also decreased as slopes increased in steepness, with the strongest effects in Coastal California and the Sonoran and Mojave Deserts. The compass direction of slope also influenced flight altitude, such that flight AGL always was higher on east-facing slopes and varied by region when slopes faced other directions. Eagle-turbine interactions are most risky when flight is within the rotor swept zone of turbines, generally ~20 – 130 m. Although eagles may have flown within the rotor-swept zone in all settings, our data suggests that this occurred most frequently over steep slopes and ridges, and over terrain that had moderate to high roughness. Developers may be able to use this information to target relatively less risky areas for turbine siting. Likewise, in cases where turbines have already been built, managers may implement cost-effective mitigation strategies targeted at relatively more risky areas to minimize turbine blade-eagle collisions.

Responses of Marine Top Predators to an Offshore Wind Farm in UK Waters: Does Evidence Exist for Displacement? (Oral Presentation)

Presenter: Nancy McLean (Natural Power)

Authors: Gillian Vallejo (Natural Power), Kate Grellier (Natural Power), Emily Nelson (Natural Power), Ross McGregor (Natural Power)

Abstract: The number of offshore wind farms is rapidly increasing as they constitute a significant component of global renewable energy strategies. Deployment of the technology within UK waters contributes a significant, and growing, component of the UK renewable energy generation. There are currently over 3 GW in the UK permitting system, 13.5 GW awaiting construction and 6 GW either under construction or operational. This has given the UK legislators the opportunity to impose post permit-
award monitoring requirements upon Developers aimed at providing scientific evidence to the degree of impact experienced by the marine ecological receptors from offshore wind deployment.

A key concern expressed during the permitting phase of a project is displacement of marine top predators from important habitat during offshore wind farm construction and operation. We present the first cross-taxon evidence for no significant long-term displacement from a UK offshore wind farm for two broadly-distributed species of conservation concern: common murre (Uria aalge) and harbour porpoise (Phocoena phocoena). Data were collected during boat-based line transect surveys across a 360 km² study area that included the Robin Rigg offshore wind farm in UK Waters. Surveys were conducted over ten years across the pre-construction, construction and operational phases of the development. We estimated changes in common murre and harbour porpoise abundance and distribution in response to offshore wind farm construction and operation using generalised mixed models to test for evidence of displacement. Both common murre and harbour porpoise were present across the study area throughout all three development phases, providing evidence for no wide-scale displacement during construction and operation. Results will be presented that indicate there was a significant reduction in harbour porpoise within the Robin Rigg offshore wind farm during construction, but numbers returned to pre-construction levels during operation. Common murre abundance remained similar across all development phases.

Both common murre and harbour porpoise showed significant, local scale density distribution changes across the survey area that appeared to be independent of the presence of the offshore wind farm. Over the same 10 year period of surveys described above, benthos and fish surveys were also undertaken to monitor changes occurring in the highly mobile, estuarine environment in which the Robin Rigg offshore wind farm is located. The results of these surveys suggest that storm and tide related sediment movement, that is unrelated to offshore wind farm presence, is responsible for changes in prey species distribution. Thus our results indicate that local prey availability is likely to be more important in determining the abundance and distribution of marine top predators than perturbations associated with offshore wind farm construction and operation.

These results will be presented and discussed within the context of the developing understanding of potential displacement effect being observed from European offshore wind farms.

**Rotor-mouted Bat Impact Deterrence System** (Poster)

**Presenter:** Myron Miller (Frontier Wind)

**Authors:** Robert Giebel (Frontier Wind)

**Abstract:** Frontier Wind, supported by grants from the California Energy Commission (CEC) and the US Department of Energy (DOE), is developing a system to deter bats from flying/foraging near the blades of wind energy generators. Frontier Wind designed and will study the effectiveness of a bat impact deterrence system that utilizes ultrasound transmitters mounted on a wind turbine rotor. Prior attempts at ultrasound deterrents only mounted the transmitters to the tower or nacelle were limited due to the rapid attenuation of ultrasonic frequencies and their ability to ensonify the full rotor swept area. Coverage is estimated at 5-20 meters, leaving a substantial area of the rotor as well as high and low pressure areas around the rotor blades unprotected. Frontier Wind’s innovative approach will mount a
minimally invasive array of ultrasound transmitters along the length of the turbine blades, providing coverage of the entire rotor envelope and as well as a buffer zone beyond the envelope.

The goal of the project is to develop and demonstrate an effective bat impact deterrence system which will reduce curtailment at wind farms and allow for expansion of wind farm generation. Specific objectives of this project include designing and fabricating the deterrence system, assessing the effectiveness of the installed system in reducing bat fatalities at operating wind turbines, creating processes for installation on the population of operating turbines and new turbines, and creating system controller settings optimized for a range of bat species.

The project will field a system that meets the bat mitigation requirements for the turbine operating life in a matter that is cost effective in both system fabrication and installation while not negatively impacting turbine operations. Frontier Wind developed and tested an acoustic model utilizing the wind turbine blade design/dimensions to determine the optimal configuration of transmitters to provide sound transmission coverage across the turbine rotor swept volume.

Pattern Energy has agreed to partner with Frontier Wind to allow testing of the deterrent system to occur at Pattern’s Hatchet Ridge Wind Facility (HRWF) in California on 13 of the farm’s 44 turbines. Bat carcass data collected from the field study benefits from and will expand upon work from previous deterrent studies. The research will indicate the system’s effectiveness in reducing bat fatalities, relative to control turbines that will operate normally and without deterrents. Frontier Wind has partnered with experienced bat specialists known in the industry to plan and conduct the bat impact study.

The proposed research will be conducted over an eight-week period in August and September during 2016 and 2017. This time frame overlaps with the fall migration period for bats at HRWF. This also targets the period when the majority of bat fatalities at wind energy facilities have occurred. During 3 years of previous carcass monitoring at HRWF, 64.2% carcasses were collected in August and September.

Introducing this technology to the market will have the broad impact of reducing curtailment activities at wind farms as well as increasing the rate of additional wind farm development across the country.

Satellite Tracking Highlights Use of Ocean Habitat by Diving Bird Species in Federal Waters of the US Mid-Atlantic. (Oral Presentation)

Presenter: Alicia Berlin (USGS Patuxent Wildlife Research Center)

Authors: Scott Ford (Brook-Falls Veterinary Hospital), Andrew Gilbert (Biodiversity Research Institute), Carrie Gray (Biodiversity Research Institute), Carrie Gray (Biodiversity Research Institute), Scott Johnston (U.S. Fish and Wildlife Service), William Montvecchi (Memorial University of Newfoundland), Glenn Olsen (USGS Patuxent Wildlife Research Center), Lucas Savoy (Biodiversity Research Institute), Caleb Spiegel (U.S. Fish and Wildlife Service), Iain Stenhouse (Biodiversity Research Institute)

Abstract: Offshore wind energy is one of the fastest-growing sectors of world energy development, offering a clean abundant source of electricity to meet demands. Offshore wind facilities may however impact many bird species, exposing them to increased mortality through turbine collisions, and by altering behavior and flight pathways. Several wind energy facilities are currently being planned for
offshore U.S. Atlantic waters. To evaluate the potential for effects on marine birds posed by wind turbines in Federal waters (>5.6 km from shore), there is a need to collect information on the distribution, seasonal occupancy and behavior (e.g., flight pathways timing, etc.) of a broad suite of birds in these areas. Our project evaluated the fine-scale occurrence and movement patterns of three diving bird species with different flight and foraging characteristics in the near-coastal federal waters of the U.S. mid-Atlantic area (North Carolina to Long Island, New York). From 2012-2016, we tracked the movements of Northern Gannets (n=75) and Red-throated Loons (n=66), and from 2001-2016, Surf Scoters (n=217) in mid-Atlantic waters, on their northward migration to their breeding colonies, and on their southward migration back to and through the mid-Atlantic region. The mid-Atlantic region and the Gulf of Mexico are hotspots for Northern Gannets during winter. Different age classes of gannets from colonies in both major breeding areas (Gulf of St. Lawrence and eastern Newfoundland) use estuarine, bay, coastal, and pelagic habitats during winter. During the return fall migration, both colony and winter-caught gannets move from shelf to coastal waters, as they travel to or pass through the mid-Atlantic region on their way to the South Atlantic Bight or Gulf of Mexico. The use of coastal waters appears to be more pronounced among females. Red-throated Loons’ winter use near potential wind energy lease areas was greatest along the western edge of the North Carolina wind-planning area off the Outer Banks; spring and fall migration movements also overlapped with that area. Migration trajectories through New Jersey and Delaware lease blocks were heavier during the spring than fall. In general, the greatest chance for interaction between Red-throated Loons and potential wind energy areas occurred during the migration periods rather than winter. Kernel density estimations for both sexes of Surf Scoters showed that core-use areas during the wintering period encompassed the majority of both Chesapeake Bay and Delaware Bay, with additional smaller core-use areas occurring south of Cape Cod near Nantucket Shoals, in Long Island Sound, and in Pamlico Sound, NC. During migration scoters followed a route within 18.5 km of the Atlantic coastline to staging areas near the Gulf of St. Lawrence, therefore, may not be influenced by the proposed wind energy areas controlled under Bureau of Ocean and Energy Management (BOEM) jurisdiction, but state plans may impact this species. Data are designed to inform permitting and regulation of future offshore wind development in the Atlantic region and provide important information on key habitat use and migration of a suite of species with different ecological niches.

Scientific insights and lessons learned from the 9 year monitoring program in the Altamont Pass Wind Resource Area (Oral Presentation)

Presenter: Douglas Leslie (ICF)

Abstract: A lawsuit over the high number of raptor fatalities in the Altamont Pass Wind Resource Area (APWRA) prompted Alameda County to institute the largest avian fatality monitoring program in the history of the wind industry. The monitoring program lasted over 9 years (ending September 2014), and was overseen by a scientific review committee with representatives appointed by the County, the Wind Energy Industry, and environmental groups. Previous estimates of facility-wide fatalities were based on detection probabilities that were not measured, and different “guesses” about what those detection probabilities were lead to widely variable estimates and generated considerable controversy and confusion. Facility-wide fatality estimates from the most recent effort were based on detection probabilities that were actually measured, although estimates were produced using data collected from
several studies implemented by the monitoring team over several years. Insights derived from this program with respect to sampling design, statistical rigor, and setting up and implementing a scientifically credible, responsible, and effective scientific oversight process have widespread applicability. In the end, the monitoring program produced a new paradigm for estimating detection probability, implemented several important ancillary studies including estimating the size of the burrowing owl population in the study area, assessing the role of background mortality factors, and shedding light on the relationships between raptor use, fatality rates, turbine size and type, and the effectiveness of shutting down turbines during the winter period when raptor use was highest.

**Smart Curtailment: Improving Efficiency by Using More Than Wind Speed** (Oral Presentation)

**Presenter:** Manuela Huso (U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center)

**Authors:** Joseph Maurer (Oregon State University)

**Abstract:** Industry members of the American Wind Energy Association have voluntarily agreed to curtail rotation of turbine blades below manufacturer cut-in speed (MCI: the wind speed at which turbines operating normally are able to send power into the grid) to reduce bat mortality. In some areas, however, regulators require additional curtailment at wind speeds higher than MCI during the peak period of bat migration, further reducing bat mortality, but incurring unanticipated losses in revenue. We use data collected at a facility in the Midwestern U.S. to ask whether curtailment during this period can be relaxed under certain conditions, e.g., high precipitation, low temperatures, high humidity, dropping barometric pressure, etc., to reduce loss of revenue without compromising the reduction in bat mortality. Vegetation within a 90m circle was cleared below 15 turbines at the site. Carcass searches were conducted daily at these turbines from early April through mid-November with the objective of relating bat mortality to weather conditions. A conundrum arises because the fatality events are not directly observed hence the actual conditions under which they occur are unknown. Typically, analysis is carried out relating carcass counts to statistics summarizing the conditions of the fateful night, e.g., median wind speed or average temperature. A further conundrum arises with this approach: even if a strong relationship were discovered, because the median wind speed or average temperature of a night cannot be calculated until the night has passed, its usefulness in predictive models of mortality related to weather variables is limited. To address this, we used in our analysis only summary statistics that could be calculated within an hour of sunset to relate to the night’s fatality count. We used categorical and regression tree (CART) analysis to determine the combination of conditions under which the highest and lowest mortality occurred. We compared loss of power production under the classic scenarios of curtailing at 4, 5 and 6 mps vs under the combination of conditions identified by CART as having the highest mortality. We present results with the caveat that further study is needed at other sites in other years to ascertain the effectiveness of the CART algorithm in reducing bat mortality as well as revenue loss.

**Species Conservation Banking as a Tool for Mitigating the Impacts of Wind Energy: Opportunities and Challenges** (Poster)

**Presenter:** Al Pfister (Western WildScapes, LLC)
Authors: Bob Williams (ICF), Leo Lentsch (ICF International)

Abstract: Conservation banks are permanently protected lands that contain natural resource values. These lands are conserved and permanently managed for species that are endangered, threatened, candidates for listing as endangered or threatened, or are otherwise species-at-risk (e.g. raptors).

Conservation banks function to offset adverse impacts to these species that occurred elsewhere, sometimes referred to as off-site mitigation. In exchange for permanently protecting the land and managing it for these species, the U.S. Fish and Wildlife Service (FWS) approves a specified number of habitat or species credits that bank owners may sell (FWS 2012).

Species Conservation Banking is a conservation tool that is increasingly being utilized for listed and at-risk species, with a large preponderance of those banks occurring in California (105 of 141) and Florida (11). The number of banks permitted has risen from 4 in 1995 to 141 in 2015. In comparison, the number of wetland banks has risen from 32 in 1995 to 1,300 in 2015. Opportunities exist for mitigating impacts on bald and golden eagles, migratory birds, at-risk species (e.g. greater sage-grouse, raptors) and listed species (e.g. bats) that are impacted by wind facilities. Recent strategies, policies and memorandum have been issued by the Secretary of Interior, FWS, and President, respectively, encouraging the use of mitigation banks and guidelines for their establishment. The Bureau of Land Management is developing mitigation guidance. The US Forest Service is expected to have final mitigation regulations and directives by November 2017. Challenges to and opportunities for establishing and implementing banks, such as those listed below, will be discussed.

Opportunities:

- Under-utilized conservation tool
- Provides economic incentives for landowners to create a viable income to support their conservation practices while also continuing species compatible land use practices
- Landscape scale mitigation provides better species conservation
- Greater flexibility for project proponents to mitigate (e.g., power pole retrofits currently one of the only mitigation options available)
- Expedited compliance process
- Pre-construction & post-construction monitoring provide metric by which to scale mitigation in species conservation banks

Challenges:

- Lack of awareness of applicability as a tool
- USFWS use of conservation banking tool – lack of staff knowledgeable about banking and/or time to participate in bank development
- Determining basis of Credits for different species (ex. Bald and golden eagles)
- Establishing Service Area of banks
- Banks for species impacted by wind - Limited geography
- Lack of regulatory authority for issuance of migratory bird take permit
- Lack of specific guidance at a national level, potentially leading to inconsistency & uncertainty; but simultaneously providing flexibility in implementation. Guidance in development.

Relevant Examples will be presented.
Spring migration of Indiana bats (Myotis sodalis) and what it means for the wind industry (Oral Presentation)

**Presenter:** Piper Roby (Copperhead Environmental Consulting, Inc.)

**Authors:** Mark Gumbert (Copperhead Environmental Consulting, Inc.)

**Abstract:** The Indiana bat has been federally endangered for almost 50 years, yet there are still important information gaps in the species life history. How these bats migrate is a gap that we set out to fill. This research could also aid the wind industry in determining effective mitigation to reduce bat mortality at wind turbines. We hypothesized that bats would migrate north, require foraging stopovers during migration flight, and be negatively affected by inclement weather. We partnered with state and federal agencies in Tennessee and Indiana to learn where hibernating bats in each state were summering, with the intention of locating previously unknown maternity colonies. We radio-tagged bats from multiple hibernacula in April of each year from 2009 – 2016 and actively tracked them using aerial and ground tracking techniques. We collected individual location points throughout the night while the bats were active to determine the direction migrated, the duration and speed of nightly flights and the overall migration journey, data about foraging areas, and activity correlated with ambient weather. We documented connections to 16 maternity colonies in 6 states from 5 caves, 14 of which were newly discovered summer colonies. We found that there was no consistency in migration direction, i.e., they did not all migrate north. On average, it took bats $2.7 \pm 0.4$ (SE) nights (1 – 5 nights) of active flight to arrive at their summer grounds. However, the average duration of the entire migration journey was $5.3 \pm 1.3$ nights (1 – 16 nights). This discrepancy was due in part to the overall distance bats were traveling ($\bar{x} = 162.5 \pm 24.1$ km, range: 5.8 – 368.1 km) and the nightly speed ($\bar{x} = 9.4 \pm 0.8$ km/hr, range: 0.7 – 19.0 km/hr). However, the chief cause for extended layovers during the migration journey was due to cold temperatures and/or significant rain during the night. We never documented an active bat when the ambient temperature was below 10°C. Although bat activity in general has been observed at lower temperatures for other species and other regions, spring migrating Indiana bats may not have built up the physiological resources necessary to withstand colder temperatures and thus enter into torpor to conserve energy. Therefore, wind turbine curtailment could be reduced when ambient air temperatures drop below this minimum migration temperature. Over the years, we have tracked several migrating Indiana bats to the same maternity colonies, providing information about migration corridors for this species. Although there is some variation, it would be reasonable to map known straight-line connections between hibernacula and summer grounds and buffer them by 35 km (based on multiple bats tracked to the same summer grounds) in order to aid in siting decisions. Conservation measures could also be implemented for the habitat used by migrating Indiana bats. Landscape analysis of areas used by foraging bats could be utilized in conservation measures as well. Although we are starting to understand how Indiana bats move across the landscape, additional studies in other regions would help to supplement these data, as well as studies during fall migration.
Stereo-optic High Definition Imaging: A Technology to Understand Bird Avoidance of Wind Turbines (Oral Presentation)

**Presenter:** Evan Adams (Biodiversity Research Institute)

**Authors:** Steve Burns (HiDef Aerial Surveying Limited), Emily Connelly (Biodiversity Research Institute), Christopher Dorr (University of Maine), Christopher Dorr (University of Maine), Melissa Duron (Biodiversity Research Institute), Andrew Gilbert (Biodiversity Research Institute), M. Wing Goodale (Biodiversity Research Institute), Reinhard Moratz (University of Maine)

**Abstract:** Monitoring bird interactions with wind turbines is a challenge in any environment. New technologies are needed to document bird behavior around turbines at a variety of spatial scales, particularly those that can identify species of conservation concern, quantify movement patterns accurately, and consistently monitor turbines in a variety of environmental conditions. As Bald and Golden Eagles are significant issues for wind farm permitting in terrestrial environments, we focused our development efforts on these species to improve the opportunities for mitigating collision risk and understanding the mechanism of turbine avoidance. To address this need, a collaboration between Biodiversity Research Institute, HiDef Aerial Surveying, Sun Edison, and the University of Maine has been developing a stereo-optic high definition camera system designed to detect animals then track their movements around wind turbines. Using motion segmentation, this system can automatically detect moving objects and mask aspects of the image that are not moving allowing focus on objects of interest. The system employs two offset ultra-high definition cameras to create a stereo-optic view of the area surrounding the turbine for estimating the position of animals in each frame they are observed. To assess the camera system’s ability to detect and track eagles in 3-D, the system was deployed at an operational wind farm as well as sites with high eagle activity in Maine. Here, we report on the results of the efficacy of the system in detecting eagles and other birds around turbines and other study sites. Eagles were consistently detected by the system, which allowed for position estimation. Further developments to the camera system should provide enhanced capabilities for filtering objects, in turn improving eagle detection. Understanding eagle (and other protected species) movements around wind farms will be important for reducing permitting uncertainty for developers and reducing the adverse effects of wind energy development to birds.

Synthesis of Bat Curtailment Studies (Poster)

**Presenter:** Jeff Gruver (Western EcoSystems Technology, Inc.)

**Authors:** Timothy Sichmeller (Western EcoSystems Technology, Inc.), Wallace Erickson (Western EcoSystems Technology, Inc.), David Young (Western EcoSystems Technology, Inc.), David Young (Western EcoSystems Technology, Inc.), Karen Tyrell (Western EcoSystems Technology, Inc.),

**Abstract:** Bat fatalities at wind energy facilities have been widely known since 2003. To reduce bat fatalities operational minimization strategies have been developed and implemented with successful results. In 2015, voluntary operational practices aimed at reducing bat fatalities from wind turbines by up to 30 percent were established by the wind power industry. These strategies will adjust the operation of wind turbines during the fall migration season when bats are at the highest risk of collision with moving turbine blades. Adjusting turbine blade rotation by changing cut-in speed (“turbine curtailment”)
does potentially reduce energy generation and therefore leads to monetary losses to wind energy
companies, as well as losses in generated renewable energy which must then be generated by other
means.

Here we provide an updated synthesis of results from publicly available turbine curtailment studies
designed to reduce bat fatalities at wind energy facilities since 2009. Summaries and evaluations of the
studies are provided. A synthesis of the results shows strong correlation between all bat fatality
reductions with increasing cut-in speeds at operational facilities in North America. Additionally, studies
that include feathering of turbine blades below the normal cut-in wind speed are evaluated and
summarized. We provide examples of different curtailment strategies employed at different wind
energy facilities and a summary of lessons learned from the most recent curtailment studies to be used
for future operational wind facilities.

The Conservation Opportunity Cost of Monitoring Programs – Are Available Funds Put to the Best Use
for the Species? (Poster)

Presenter: Amanda Aurora (SWCA Environmental Consultants)

Abstract: The U.S. Fish and Wildlife Service’s (USFWS) Land-based Wind Energy Guidelines outline an
integrated process for evaluating impacts to wildlife across each of the major federal wildlife regulations
that relies on data-driven decision making and adaptive management. While this process undoubtedly
improves the precision and accuracy of predictions and estimates of impact, the data needed to
implement the Guidelines is costly and time-consuming to collect. Multiple years of data collection
stretch out the permitting process for new and operating wind energy projects in ways that interfere
with the fast-paced and highly competitive nature of the industry. Dollars spent on field studies, ranging
from the tens of thousands to several millions per project, to describe and monitor wildlife at wind
energy project sites divert limited funds away from on-the-ground conservation. SWCA reviews trends
regarding the scope, methods, and costs for predicting and monitoring wildlife impacts from wind
energy projects. Given the large and growing body of research now available on wind-wildlife impacts, is
extensive pre-construction, construction-phase, and post-construction monitoring the best use of
limited resources available for the conservation of species of concern? Some researchers have
estimated that roughly 25% of the land in the coterminous United States may be necessary to create a
comprehensive national system of habitat conservation areas that represent the ecosystems and
habitats necessary for the survival of at-risk species. Researchers estimate that creation of such a system
could cost hundreds of billions of dollars over the next 30 to 40 years. The USFWS is stepping up efforts
to address conservation challenges, such as loss of habitats and climate change, with proposed revisions
to its Mitigation Policy that would apply to all actions for which the USFWS has specific authority to
recommend or require the mitigation of impacts to fish, wildlife, plants, and their habitats. The USFWS
proposes a landscape-scale approach to achieve a net gain in conservation outcomes, or at a minimum,
no net loss of resources and their values, services, and functions. Application of this proposed Mitigation
Policy to wind energy projects could substantially increase the amount of mitigation, including
commitments for habitat conservation, the USFWS expects from developers. In light of the potentially
substantial need for landscape-scale habitat conservation for species of conservation concern and the
proposed new policy direction towards improving conservation outcomes for these species and their
habitats, SWCA explores how wildlife and the wind industry could benefit from reallocating resources from lengthy permitting processes and extensive monitoring programs to on-the-ground conservation.

**The Effects of a Wind Energy Development on a Greater Sage-Grouse Population** *(Oral Presentation)*

**Presenter:** Chad LeBeau (Western EcoSystems Technology, Inc.)

**Authors:** Gregory Johnson (Western EcoSystems Technology, Inc.), Matthew Holloran (Wyoming Wildlife Consultants, LLC), Jeffrey Beck (University of Wyoming), Jeffrey Beck (University of Wyoming), Ryan Nielson (Western EcoSystems Technology, Inc.), Mandy Kaufffman (Western EcoSystems Technology, Inc.), Eli Rodemaker (Image Spatial Consulting), Trent Mcdonald (Western EcoSystems Technology, Inc.)

**Abstract:** Increases in wind energy development are especially noticeable in prairie habitats with high wind capacity. This has raised concerns over impacts to prairie grouse species including greater sage-grouse (*Centrocercus urophasianus*). We monitored 346 female greater sage-grouse via telemetry from 2009 to 2014 within a control area and an area influenced by a wind energy development to estimate the potential impacts of wind energy infrastructure to greater sage-grouse habitat selection and demography. This study represents the only situation, in the U.S., where the habitat selection and demography responses of sage-grouse to the infrastructure associated with a wind energy development has been investigated. We did not detect a negative impact of the wind energy facility on nest site selection or nest survival during the study period. Greater sage-grouse rearing broods and selecting summer habitats generally avoided suitable habitats near the wind energy development; however, brood and female survival was not negatively influenced by the facility. The demography and spatial responses of greater sage-grouse in this study was similar to greater prairie-chicken responses to wind energy development. Future wind energy developments should consider the effects of wind energy development on sage-grouse habitat selection patterns and survival parameters. We recommend facilities similar in size that occupy similar habitats as our study be placed 1.20 km from any occupied sage-grouse nesting, brood-rearing, or summer habitats and consider the density of infrastructure.

**The USFWS Western Golden Eagle Team: An Overview** *(Poster)*

**Presenter:** Gary Williams (U.S. Fish and Wildlife Service)

**Authors:** Brian Woodbridge (U.S. Fish and Wildlife Service), Todd Lickfett (U.S. Fish and Wildlife Service), Geoffrey Bedrosian (U.S. Fish and Wildlife Service), Geoffrey Bedrosian (U.S. Fish and Wildlife Service)

**Abstract:** U.S. Fish and Wildlife Service Regions 1, 2, 6 and 8 established the Western Golden Eagle Team (WGET) in June 2013 to proactively address energy-related conservation needs of Golden Eagles (*Aquila chrysaetos*) by developing landscape-scale conservation strategies. Development of conservation strategies will be informed by: 1) spatially explicit predictive models of golden eagle distribution and habitat, including models of breeding, wintering, and movement/migration; 2) spatially explicit assessments of threats such as electrocution, lead poisoning, collisions, and other conservation concerns; and 3) information resources to support management of Golden Eagles and their prey. Together, these products will allow identification of important areas for, and risks to, Golden Eagles, as well as ways to improve their management. Completed or near-complete WGET projects/products...
include: 1) ecoregion-based models of breeding habitat throughout the West; 2) West-wide model of winter habitat; 3) West-wide analysis of golden eagle prey community composition and variability in space and time; 4) assessment of land management strategies for important prey species 5) Colorado/Wyoming-wide model of electrocution hazard; and 6) model to assess and rank electrocution risk of individual power poles. Projects in progress include, but are not limited to: 1) ecoregion-based conservation assessments and strategies for golden eagles in the Wyoming Basin and Northwestern Great Plains 2) electrocution hazard models for Montana, Great Basin, and Columbia Plateau; 3) telemetry-based models of movement/migration patterns; 4) reviews and field assessments of contaminant levels of and contaminant sources for Golden Eagles; 5) home-range, territory, and core area review; 6) population ecology review; 7) review and meta-analysis of productivity studies; 8) review and expert elicitation on disturbance effects and buffer distances; and 9) analysis of eagle mortalities at previously retrofitted power poles. Copies of selected WGET reports will be made available during the poster session.

**Turbine Integrated Mortality Reduction for Bats** (Oral Presentation)

**Presenter:** Christine Sutter (Normandeau Associates)

**Authors:** John Goodrich-Mahoney (EPRI), Sue Schumacher (We Energies),

**Abstract:** At the We Energies' Blue Sky Green Field wind facility near Fond du lac, Wisconsin we conducted an EPRI-funded study to determine if using real-time measures of bat activity could reduce bat fatalities and increase operational time. During the 2015 fall migratory season ten turbines operated normally and ten turbines operated under a model that curtailed turbines in response to real-time bat activity and weather conditions. The 20 turbines were searched daily for bat carcasses. The model-operated turbines showed an 83% reduction in overall bat fatalities and a 90% reduction in Myotis fatalities as compared to the normally operating turbines. The number of curtailed hours was slightly less (9%) under the model scenario than a 5.5 m/s cut-in speed scenario but was substantially less (35%) than if a 6.9m/s cut-in speed had been employed. The results of the survey also showed a strong correlation between bat activity and mortality, validating the use of activity data to inform mitigation. The successful implementation of allows wind energy facilities to maximize bat conservation while minimizing loss of energy and revenue.

**U.S. Raptor Mortality Estimates from Wind Energy for the U.S.** (Oral Presentation)

**Presenter:** Wallace Erickson (Western EcoSystems Technology, Inc.)

**Authors:** Kimberly Bay (Western EcoSystems Technology, Inc.), Shay Howlin (Western EcoSystems Technology, Inc.)

**Abstract:** The effect of wind energy on raptors, especially eagles, is the focus of extensive management and research efforts. We compiled data from over 146 comparable studies on avian fatality at over 85 wind energy facilities that represented about 15% of all wind energy currently in operation in the United States (US). We used advanced statistical analyses to estimate the annual rate of raptor fatalities and provide an understanding of how wind energy directly effects raptor populations. For all studies
combined, we analyzed fatalities of 14 species of raptors. We broke the raptor estimates out into owls, vultures and all other raptors, because many studies that were included only reported standardized estimates for raptors after excluding owls and vultures. Owls comprised 1% of the carcass records, vultures 1.2%, and all other raptors 7.8%. However, the raw composition numbers likely overestimate actual fatality composition for raptors because raptors are more detectable than other smaller bird groups. After adjusting the observed fatality rates for sources of bias such as plot size, estimator type bias, carcass removal and searcher efficiency, we calculated the continent-wide rate of fatality as approximately 0.1 – 0.2 raptor fatalities per megawatt per year (excluding vultures and owls), or about 6,500 to 13,500 raptor deaths per year. 90% of the raptor mortality occurs in the western U.S. (west of the Mississippi) where 81% of the MW have been installed. We estimate approximately 1000 to 2000 owl fatalities per year and 900 to 1850 vultures per year, resulting in an all inclusive raptor estimate of 0.13 to 0.26 per MW per year. Three species are estimated to comprise 75% of the mortality (American kestrel: 3000 to 6500, red-tailed hawk: 2000 to 4200, and turkey vulture (850 to 1800) followed by sharp-shinned hawk (3% of total raptors), golden eagle (2%), Swainson’s hawk (2%), northern harrier (2%), cooper’s hawk (1%), rough-legged hawk (1%), and ferruginous hawk (<1%).

**Ultraviolet Illumination as a Means of Reducing Bat Activity at Wind Turbines** (Oral Presentation)

**Presenter:** Paul Cryan (U.S. Geological Survey, Fort Collins Science Center)

**Authors:** P. Marcos Gorresen (University of Hawai’i at Hilo, Hawai’i Cooperative Studies Unit), Dave Dalton (Bat Research and Consulting), Sandy Wolf (Bat Research and Consulting), Sandy Wolf (Bat Research and Consulting), Frank Bonaccorso (U.S. Geological Survey, Pacific Island Ecosystems Research Center)

**Abstract:** Tree-roosting bats die often at the blades of wind turbines, but reasons for this higher susceptibility of ‘tree bats’ remain unknown. One possibility is that bats might not be able to discriminate wind turbines from trees. Attraction from afar may be a chronic problem of bat fatalities at wind turbines, because distant attraction could act against or beyond the influence of many curtailment and deterrence strategies. Despite low visual acuity, bats navigate by vision and can see the silhouettes of trees from great distances in darkness, a plausible distant-attraction cue. Furthermore, bats see light in the ultraviolet (UV) spectrum. We integrated these concepts and are pursuing the possibility that dim UV light that is not visible to humans or birds can be used to visually enhance turbines so that bats perceive them differently from long distances. Decreasing visual resemblance between turbines and trees at night might keep bats from approaching and perishing at turbine blades. This talk will detail our ongoing, multi-year effort to assess the practicality of using dim UV light to keep tree bats from turbines. Our promising results thus far have us moving forward with this research and we are now planning a full efficacy trial on operating wind turbines.

**Use of External GSM-based Transmitters for Seabirds: Preliminary Results and Recommendations for Future Wind-power Studies** (Poster)

**Presenter:** Jonathan Fiely (USGS Patuxent Wildlife Research Center)
Authors: Charlotte Kilchenstein (USGS Patuxent Wildlife Research Center), Alicia Berlin (USGS Patuxent Wildlife Research Center), William Montevecchi (Memorial University of Newfoundland), William Montevecchi (Memorial University of Newfoundland), Caleb Spiegel (U.S. Fish and Wildlife Service),

Abstract: Researchers have tracked raptors and other bird taxa using GPS-based transmitters with success using tags attached by Teflon-coated ribbon harnesses. Unfortunately deployment of similarly styled harnesses on seabirds has been unsuccessful with the possible exception of some land-based gulls. Presumably this is due to harness and transmitter interference with foraging behavior (i.e. pursuit- and plunge-diving) via hydro- and aero-dynamic influences, plumage integrity (loss of waterproofing), and poor harness fit during migration when birds experience rapid changes in body mass. Consequently, researchers have had to deploy surgically implanted platform terminal transmitters (PTTs), which have lower precision and higher power requirements compared to solar-powered GPS transmitters and may contribute to mortality in some species. Although data from PTT transmitters can inform about broad-scale migration patterns, GPS-derived data have the necessary precision to capture fine-scale movement patterns, allowing researchers to better relate the influence of weather, resource availability, and hazardous conditions (e.g. structures, pollutants, etc.) which may predict conflict with offshore wind installations. To assess this level of data resolution with free-ranging marine birds we used a newly developed 32g solar-powered transmitter which logs hourly GPS locations (accurate to 3m) and transmits them to cellular towers. We tested new attachment techniques using custom-molded silicone harnesses and 3D printed transmitter adapters with the goal of eliminating the need for implanted transmitters. In April 2016, we deployed 10 of these devices on Northern Gannets (Morus bassanus) and 3 on Surf Scoters (Melanitta perspicillata) along the mid-Atlantic US coast to test the technology. Attachments and data captures were successful to date with high overall retention rates in both species. Long-term success is currently being assessed. Preliminary data have corroborated previous PTT tracking data from these species. Gannets spent 36% of their time offshore (>5.5km) flying at an average 13.3m (±18m) altitude. Four individuals traveled directly through Wind Energy Areas (WEAs) over the course of their migration north and one remained for several days within 3.7km of the WEA. Surf Scoters appeared largely restricted to areas close to shore, corroborating long-term PTT tracking data, with the exception of two individuals that traveled offshore between Cape Cod, MA and Bay of Fundy. This trip was completed within 6 hours and birds achieved a maximum estimated altitude of 330m. While this pilot work has shown promising results, improvements on transmitter design are needed to i) reduce aero- and hydro-dynamic influences, ii) improve attachment longevity, and iii) enhance altitudinal data accuracy with accelerometer sensors. These data will be instrumental in modeling habitat use, mortality risk, and the impact of weather on flight behavior for these species in the face of multiple proposed offshore wind-power facilities along the US Atlantic coast.

Using a Landscape Design Conservation Planning Process to Assess and Plan for Wind Energy Development in the Western Great Plains, USA (Oral Presentation)

Presenter: Anne Bartuszevige (Playa Lakes Joint Venture)

Authors: Kyle Taylor (Playa Lakes Joint Venture), Alex Daniels (Playa Lakes Joint Venture), Michael Carter (Playa Lakes Joint Venture), Michael Carter (Playa Lakes Joint Venture)
Abstract: Landscape design is a conservation planning process that integrates societal goals and values with biological goals, and uses sound science based in landscape ecology to describe future scenarios where specific and measurable biological goals can be attained. The Playa Lakes Joint Venture (PLJV)—a non-profit conservation organization dedicated to conserving the playas, prairies and landscapes of the western Great Plains for the benefit of birds, other wildlife and people—is using landscape design to help conservation partners in their conservation planning decision making. The U.S. Great Plains region has been referred to as the “breadbasket of America” because it provides a high proportion of the agricultural products grown in the U.S. Increasingly the region is being called on to provide a larger proportion of the energy needs of the U.S. as well. In addition to large oil and gas resources, the six states within the PLJV region, all have some of the highest wind energy potentials in the U.S; thus there is a high rate of wind energy development occurring in the region. Yet, this region also provides critical habitat for migrating wetland birds in the Central Flyway so conservation of grassland and playa wetlands in the region are of utmost importance for maintaining populations of these birds. We modeled wind energy development suitability using wind turbine locations from the FAA digital obstruction database and a suite of physiographic, anthropogenic and climate variables to populate the model. The output is a continuous, 30-meter resolution raster surface representing suitability for wind energy development on a 0 to 1 scale. We used similar methods to model risk of agricultural development. We used models developed by Burris and Skagen (2012) to understand playa loss due to climate change. We then evaluated risk of playa wetland loss based on various assumptions of wind, agricultural and climate change risk to determine conservation needs for migrating waterfowl in the region. The results of these models are being used by PLJV and its partners to understand risk of habitat loss on the landscape, how and where to mitigate that risk and to provide guidance to wind energy developers in the region about conservation concerns. Ultimately, the landscape design process allows us to understand the interactions between biological concerns and the economic needs of the region and develop conservation plans that acknowledge both.

Using Incidental Finds to Update Collision Risk Models at Wind Farms (Poster)

Presenter: Kevin Kritz (U.S. Fish and Wildlife Service)

Authors: Margaret Rheude (U.S. Fish and Wildlife Service), Leslie New (Washington State University)

Abstract: The US Fish and Wildlife Service has developed an eagle collision risk model for predicting fatalities at wind farms. This model combines eagle exposure to turbines with probability of collision with these turbines, with an expansion factor to determine the annual predicted fatalities at a wind facility. This model was developed from studies of eagle interactions with wind farms, using Golden Eagles and wind farms in the Western United States. Although 18 bald eagles (known) have been killed or injured at wind facilities to date, almost all of these have all been discovered through incidental finds, generally by Operations and Maintenance (O&M) personnel. Much of current post-construction monitoring consists of several years of mortality searches by trained biologists, but this effort is not sustained through the life of the project. We present a methodology for using existing personnel at wind facilities so that incidental finds can be used to update the collision probability model for bald eagles. We recommend wind developers determine eagle detection by unit effort by O&M staff. This can be conducted as part of a larger post-construction mortality monitoring plan, so that the probability of detecting dead or injured eagles can be can be calculated from everyday movements of O&M staff.
Wind developers must first determine the area visible by O&M staff (likely roads and pads). Trial carcasses can then be placed with variations in distances from road/pad, vegetation, and weather conditions. Once a detection probability is established, incidental finds of eagles can be used to inform fatality estimates. This in turn can be used to update the collision risk portion of the eagle fatality model. These calibrations can easily be done during trial periods of intensive mortality monitoring, and can then serve as a cost-effective measure of monitoring mortalities of large birds at wind facilities for the life of the project.

Utilization Probability Map for Migrating Bald Eagles in Northeastern North America: A Tool for Siting Wind Energy Facilities and Other Flight Hazards (Poster)

Presenter: Elizabeth Mojica (EDM International Inc.)

Authors: Bryan Watts (College of William and Mary), Courtney Turrin (College of William and Mary)

Abstract: Collisions with anthropogenic structures are a significant and well documented source of mortality for avian species worldwide. The Bald Eagle (Haliaeetus leucocephalus) is known to be vulnerable to collision with wind turbines and federal wind energy guidelines include an eagle risk assessment for new projects. To address the need for risk assessment, in this study, we 1) identified areas of northeastern North America utilized by migrating Bald Eagles, and 2) compared these with high wind-potential areas to identify potential risk of Bald Eagle collision with wind turbines. We captured and marked 17 resident and migrant Bald Eagles in the northern Chesapeake Bay between August 2007 and May 2009. We produced utilization distribution (UD) surfaces for 132 individual migration tracks using a dynamic Brownian bridge movement model and combined these to create a population wide UD surface with a 1 km cell size. We found eagle migration movements were concentrated within two main corridors along the Appalachian Mountains and the Atlantic Coast. Of the 3,123 wind turbines >100 m in height in the study area, 38% were located in UD 20, and 31% in UD 40. In the United States portion of the study area, commercially viable wind power classes overlapped with only 2% of the UD category 20 (i.e., the areas of highest use by migrating eagles) and 4% of UD category 40. This is encouraging because it suggests that wind energy development can still occur in the study area at sites that are most viable from a wind power perspective and are unlikely to cause significant mortality of migrating eagles. In siting new turbines, wind energy developers should avoid the high-use migration corridors (UD categories 20 & 40) and focus new wind energy projects on lower-risk areas (UD categories 60-100).

Vindval, 10 Years of Experience from the Swedish Research Programme on the Environmental Impact of Wind Energy (Poster)

Presenter: Åsa Elmqvist (Vindval)

Authors: Annika Nilsson (Swedish Energy Agency)

Abstract: Vindval is an applied research programme that has a unique setup in Sweden. It's aim is to facilitate the processes around planning and permitting for wind energy plants. It is run a s a cooperation between the Swedish Energy agency and the Environmental protection agency.
The main idea was to gather knowledge from the early parks that were granted construction subsidies at that time. The organisation includes close cooperation with stakeholders such as people working in the permitting processes or preparing material for it. In addition to the effects on wildlife, the programme also looks into the effects on humans and the interests of people.

From the start, very little was known about environmental impact of wind and the common belief was that expansion would be large offshore. Therefore projects were initiated in order to study marine environments.

Some years later it had turned out that onland sites were of greater interests than offshore and focus for studies changed to forests and mountains. It also became clearer that there is already a great portion of knowledge but it could be contradictory and difficult to put it in a context. By that time the solution was to identify expert panels and put together synthesis reports on the topics wind energy and land living mammals, wind energy and the effects on birds and bats, Wind energy and the effects on marine life, Wind energy and the effects on people’s interests.

In the third period it was concluded that we know enough to say that we can continue the expansion of wind power without putting the environment at a great risk if we apply the available knowledge. Studies are conducted to make use of available data from monitoring programs and focus is updating and completing previous work. A new area is how to measure societal benefit from wind projects.

As the program has been running for 10 years now, there is a substantial amount of knowledge collected and communicated. There are also interesting experiences gained on how to run an applied research programme for specific purposes in a complex context of numerous different interests.

Vultures as Surrogates for Eagles and Other Large Birds in Bias Trials for Wind Farm Fatality Monitoring (Poster)

Presenter: Chris Farmer (DNV GL Energy)

Authors: Thomas Snetsinger (Tetra Tech, Inc), Dave Phillips (Apex Clean Energy, Inc)

Abstract: In post-construction fatality monitoring (PCFM) of wind projects, the amount of time a bald (Haliaeetus leucocephalus) or golden (Aquila chrysaetos) eagle carcass remains detectable (carcass persistence), can influence the ability to detect fatalities of these species, as well as influence the accuracy and reliability of the fatality estimates. Due to their protected status under the Bald and Golden Eagle Protection Act, it is difficult to accurately estimate carcass persistence for eagles using traditional bias trials, which rely on placing carcasses of monitored species to estimate their persistence. Consequently, limited research is available to reliably determine carcass persistence for eagles. As a result, sampling intervals for eagle monitoring are often more reflective of surrogate persistence than eagle persistence. Typically, surrogate species such as domestic pheasants (Phasianus colchicus) are used in carcass persistence estimation for eagles; however, it is probable that these persist for different durations than eagles. Black vultures (Coragyps atratus) are closer in size and plumage to eagles than typical surrogates, and both of these factors may influence carcass persistence. Therefore, to more accurately estimate eagle carcass persistence, we placed and monitored carcasses of black vultures within a proposed wind farm to estimate their persistence. Carcasses were monitored for 60 days in
each of three seasons, and we measured their mean seasonal persistence time and also derived bootstrapped estimates of mean persistence based on survival models fitted to the data. Our results indicate that carcasses of large raptors such as vultures and eagles persist in detectable form up to four months after deposition. Thus it is appropriate to consider this long persistence time in determining sample intervals for PCFM designed to monitor for eagle fatalities. Doing so will improve accuracy of facility-wide fatality estimates, and could provide for dramatic cost savings compared with sampling schemes that assume lower persistence times for eagles.

Wildlife Monitoring and Reporting System using Operations Personnel: 5-year Assessment (Oral Presentation)

Presenter: Jerry Roppe (AVANGRID, Inc.)

Authors: Paul Rabie (Western EcoSystems Technology, Inc.), Wallace Erickson (Western EcoSystems Technology, Inc.), Amy Parsons (AVANGRID, Inc.), Amy Parsons (AVANGRID, Inc.)

Abstract: As part of Avangrid Renewables, LLC (AR) Wildlife Protection Program, a Wildlife Monitoring and Reporting System (WMRS) is utilized to monitor and internally report wildlife injury and fatalities discovered during operations at its North American wind energy facilities. This is completed through voluntary, long-term operational monitoring conducted by operations and maintenance (O&M) personnel. These O&M personnel monitor and record wildlife injuries and fatalities to assess potential long-term operational impacts (trends) of a Project, or collectively, fleet-wide. There are three components to operational monitoring: 1) Environmental Coordinator (EC) inspections (standardized searches in the fall and spring) along access roads and pads, 2) monthly turbine checks (conducted with Spill Prevention, Control, and Countermeasure (SPCC) inspections at turbine pads), and 3) incidental observations for the entire plant. A key factor on validity of the methods is testing the ability of O&M personnel to detect bird or bat carcasses and subsequently assess the application to long-term monitoring. To address this factor, detection testing (searcher efficiency trials) was conducted to evaluate the efficacy of O&M personnel to detect fatalities during EC inspections at 4 study sites located across the U.S. The ECs found 105 of 139 carcasses resulting in detection level of 76% for all carcasses. This reinforced the use of operations personnel for long-term monitoring of bird and bat fatalities to provide a potential cost-effective approach to monitoring project impacts. Operational monitoring conducted since 2011 at up to 48 operating projects have been a part of WMRS and approximately 15,000 data points (inspections, checks, and observations) for wildlife monitoring have occurred. This data was evaluated for 3 areas or parameters (species composition, carcass index/detection rates, and detection rates vs estimated fatality rates) of operational monitoring that may provide valid measure or indexes of impact. Species composition data were compared to species composition from over 200 post-construction fatality studies at 139 North American wind farms. Species composition in the monitoring data was broadly similar to species composition from these wind plants. Detection rates from operations monitoring were weakly correlated with published fatality rates for bats and large birds suggesting that detection rates for operations monitoring may be useful as a broad index to overall fatality rates for those groups of taxa or as detecting large anomalous fatality events. There was little evidence for trends in detection rates through time, and no evidence for increasing trends in detection rates (impacts). Taken together, the current assessment demonstrates that operations monitoring using trained on-site O&M personnel provides a general indicator of the level of wildlife impacts, presents a
level of sensitivity necessary to trigger responses, and acts as valid approach for understanding impacts levels at operating assets.

**Wildlife Rehabilitation and Wind Energy – Building a Partnership (Poster)**

**Presenter:** Jerry Roppe (AVANGRID, Inc.)

**Authors:** Amy Parsons (AVANGRID, Inc.), Julie Ponder (Minnesota Raptor Center), Michelle Hawkins (California Raptor Center), Michelle Hawkins (California Raptor Center)

**Abstract:** Injured wildlife (bird or bats) discoveries at operating wind plants, although rare, do occur and are often taken to wildlife rehabilitation centers for treatment and release. This relationship between the wind industry and wildlife rehabilitation provides an opportunity for understanding and support between these two groups. Avangrid Renewables, LLC has fostered relationships with wildlife rehabilitation centers throughout the country, some of whom manage hundreds of animals annually (Minn. Raptor Center >100 eagles, Calif. Raptor Center 300-350 raptors/year). Many of these centers also provide hands-on interpretive and education programs to the general public. Avangrid Renewables has partnered with these organizations to provide on-site training programs to the wind plant employees using educational birds. This has proven to be successful at raising the environmental awareness of the plant staff. Similarly, these interactions allow the wildlife rehabilitation community to understand how wind plants operate and work at minimizing environmental risk. On occasion, misunderstandings of these values and impacts of renewable energy development and operation present a challenge when establishing a working relationship with wildlife rehabilitators, but continued discussions between parties typically clarified those misunderstandings and successful partnerships were forged. This presentation will further describe the rehabilitation benefits and the process to develop a common understanding of mutual benefits and steps to establishing a successful partnership between the wildlife rehabilitation community and renewable energy industry.

**Wind Energy Habitat Conservation Plans: Overview of Species, Monitoring Requirements, Mitigation, and Take Estimation Methods (Poster)**

**Presenter:** Alicia Oller (Tetra Tech, Inc)

**Authors:** Thomas Snetsinger (Tetra Tech), Brita Woeck (Tetra Tech, Inc)

**Abstract:** Wind energy development is growing and will continue for the next several years due to the extension of the energy production tax credits. Wind energy projects may need the coverage of an incidental take permit (ITP) to limit their risk under the Endangered Species Act (ESA) for activities associated with construction or operation. With the potential listing of additional bird, bat, and other wildlife species and the development of wind energy projects in locations where impacts on listed species are possible, more project developers may be pursuing incidental take coverage. To obtain an ITP under Section 10 of the ESA, a Habitat Conservation Plan (HCP) must be developed that describes the 1) covered species, 2) avoidance and minimization measures, 3) methods for assessing estimated take, 4) mitigation to compensate for anticipated impacts on each covered species, 5) adaptive
management, and 6) monitoring requirements. Additionally, several states such as Hawaii also have state ESA laws which require incidental take coverage in addition to the federal ESA.

A number of HCPs have been prepared or approved for wind projects over the past 10 years with several individual and programmatic HCPs currently under development. The requested incidental take, monitoring methods and requirements, and associated mitigation have evolved as new data have become available and interpretation of HCP requirements have changed. Some HCPs are also including eagles which will then need to address the eagle incidental take permit guidelines.

We present a summary of the approved wind energy HCPs and publicly available draft wind energy HCPs to provide a summary of approaches to HCP development and discuss current trends in wind energy development and HCP implementation that may need to be considered by project developers. For example, current trends suggest that more Hawaiian hoary bat fatalities are occurring in Hawaii than previously anticipated, and additional bat species may need to be considered for incidental coverage as white-nosed syndrome continues to spread across the continental U.S. and impact bat populations. Some developers must also decide whether to include eagles in the HCP or apply for incidental take coverage separately. Furthermore, developers may need to assess how take limits and triggers for mitigation or adaptive management may also be affected by current and evolving fatality estimators. By understanding the similarities, differences, and interactions of these wind HCPs, both developers and operators can evaluate their existing or proposed projects to determine how to apply lessons learned and approaches from existing and proposed HCPs.