REWI Renewable Energy Wildlife Institute

14TH WIND WILDLIFE RESEARCH MEETING

Meeting Proceedings

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About REWI

The Renewable Energy Wildlife Institute (REWI, formerly the American Wind Wildlife Institute) is an independent, nonprofit 501(c)3 organization that advances scientific research and collaboration to better understand renewable energy's risks to wildlife and related natural resources and develop solutions. Built on a strong partnership of leaders, REWI works collaboratively with the wind and solar power industries, conservation and science organizations, and wildlife management agencies to accelerate responsible deployment of renewable energy to mitigate climate change and protect wildlife and ecosystems.

REWI plans to continue hosting biennial Wind Wildlife Research Meetings.

Abstract

The anticipated build-out of renewable energy development over the next 10 to 15 years is staggering, presenting both challenges and barriers in the path toward mitigating climate change through an energy transition that simultaneously facilitates wildlife conservation. Solving this immense challenge will require work across sectors to identify and evaluate solutions. These proceedings document current research pertaining to wind energy-related wildlife impacts from collision and displacement; the cumulative and potential population-level effects from both climate change and wind energy development; and technological advances to avoid, minimize, and offset these impacts. As the window of opportunity to prevent the most catastrophic consequences of climate change narrows, these proceedings reflect discussions among stakeholders – scientists, government wildlife agencies, wind energy developers, and conservation organizations – who are working to understand and develop solutions to mitigate risk to wildlife from wind, on and offshore, as we work to meet renewable energy targets to mitigate climate change.

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Abbreviations

Acoustic-activated Deterrent or Curtailment (AAC)
American Wind Wildlife Information Center (AWWIC)
Association of Fish and Wildlife Agencies (AFWA)
Alaska National Interest Lands Conservation Act (ANILCA)
Avian Power Line Interaction Committee (APLIC)
Bald and Golden Eagle Protection Act (BGEPA)
Bureau of Land Management (BLM)
Bureau of Ocean Energy Management (BOEM)
Coastal Virginia Offshore Wind (CVOW)
Construction and Operations Plan (COP)
Distinct Population Segment (DPS)
Endangered Species Act (ESA)
Environmental Impact Statement (EIS)
Environmental Protection Agency (EPA)
Generalized Estimator of Mortality (GenEst)
Gigawatt (GW)
Habitat Conservation Plan (HCP)
Inflation Reduction Act (IRA)
Megawatt (MW)
Memorandum of Understanding (MOU)
Migratory Bird Treaty Act (MBTA)
Motus Wildlife Tracking System (Motus)
National Environmental Protection Act (NEPA)
Non-governmental Organization (NGO)
National Renewable Energy Laboratory (NREL)
National Wind Coordinating Collaborative (NWCC)
Northern Long-eared Bat (NLEB)
Office of Energy Efficiency and Renewable Energy (EERE)
Outer Continental Shelf (OCS)
Post-construction fatality monitoring (PCM)
Renewables-Wildlife Solutions Initiative (RWSI)
Robust decision making (RDM)
Rotor-swept zone or area (RSZ)
Soil, Vegetation, and Wildlife Management Plan (SVWMP)
Special Purpose Utility (SPUT) permit
Turbine Integrated Mortality System (TIMR)
United States Department of Energy (DOE)
United States Department of Defense (DOD)
United States Department of Interior (DOI)
United States Department of Fish and Wildlife Service (USFWS or the Service)
United States Geological Survey (USGS)
Unmanned Aerial Vehicle (UAV) – aka, drone
Western Ecosystems Technology, Inc. (WEST)
White-noise Syndrome (WNS)
Wind Wildlife Research Meeting (WWRM)

Welcome Address
14th Wind Wildlife Research Meeting,
Winds of Change

Speakers:

- **Abby Arnold –** Executive Director, Renewable Energy Wildlife Institute
- **Brad Loveless –** Secretary of Wildlife and Parks, Kansas Department of Wildlife, Parks and Tourism
- **Jim Murphy –** Director, Legal Advocacy, National Wildlife Federation
- **Christi Calabrese –** Director, Permitting and Environmental Affairs, EDP Renewables North America LLC

Abby Arnold

Welcome to the 14th Wind Wildlife Research Meeting (WWRM) - "Winds of Change" Conference. Thank you to every one of you for your support for this meeting. As in the past 13 WWRM meetings, we have relied on the support of REWI's partners, sponsors, and planning committee members to host and develop the conference program. Also, thank you to the REWI staff instrumental in planning this event; Christina Marshall, Dr. Taber Allison, Dr. Shilo Felton, and Lauren Flinn.

In 1980, Congress passed landmark legislation, the Alaska National Interest Lands Conservation Act, (ANILCA). ANILCA protected over 100 million acres of national parks, wild and scenic rivers, and wildlife refuges for future generations. Recognizing Alaska Natives' dependence on centuries of subsistence hunting and fishing, ANILCA included a provision for Alaska Natives to continue to hunt and fish on these federally protected areas. Over 40 years ago, long before global recognition of climate change and its impact on wildlife, when I traveled to remote villages in Alaska's Interior, on the Yukon, Kuskokwim, and Koyukuk rivers, I participated in community meetings about land use and subsistence. I recall village elders sharing stories about the changes in animal behavior. (Changes in migration routes, calving grounds, fish abundance, water temperature…). Never in the fight to conserve these wildlands and wildlife did decision makers consider that over 40 years later, these wildlands would be threatened by climate change. Today, we look back on village elder observations and read scientific publications documenting dramatic changes in the Arctic resulting from climate change – loss of ice and the related impacts to ocean currents, weather patterns, and increasing species at risk – signs village elders warned us about. Today, all of us here, and communities across the globe, are feeling the impact. Awareness is catalyzed – climate change is real, and these issues now have national/international recognition.

In 2021, the White House announced its goal for net zero emissions economy-wide no later than 2050, with a 50% reduction of greenhouse gas emissions and 100% clean electricity by 2035. At the same time, the administration made a commitment to conserve, connect, and restore 30% of our lands and waters by 2030. The U.S. continues to face considerable challenges as it advances a clean energy transition, particularly as we balance the need for exponential growth in renewable energy development with conservation.

Over the past 28 years, through the Wind Wildlife Research Meeting and successful collaborations (e.g., the National Wind Coordinating Collaborative, with REWI and others), we have developed a collaborative model to tackle onshore wind and wildlife conservation that we can apply to offshore wind, solar, and other renewable energy technologies. Today, with the urgency to build out renewables to mitigate climate change, we need to implement what we're learning more rapidly, even in the face of substantial uncertainty, if we are to limit the greater risk of global extinctions from unmitigated climate change. The theme for this conference is "Winds of Change." We are facing these unprecedented challenges and often being asked to accept risks in ways we have never been asked to before. If we rise to these challenges and work collectively, we will find the solutions and accomplish our goals.

Brad Loveless

I am honored to be the Secretary of Wildlife and Parks in Kansas and on the Association of Fish and Wildlife Agencies' (AFWA's) Wind Energy and Wildlife Policy Committee, as well as a member of the REWI board. Kansas has the second highest wind potential in the U.S., second only to Texas. Kansas is approaching 50% of statewide energy production from wind, so it is no surprise that across state agencies we are engaged in conversations about wind energy and our wildlife resources. Against that backdrop, REWI has chosen the perfect venue to meet and to discuss wind and wildlife issues. Welcome to Kansas City.

Jim Murphy

We are witnessing stark changes across the landscape as a result of climate change. While progress in the development of renewable energy may have helped to avert the worst-case scenario for climate warming (5-6 degrees Celsius), there are still devastating impacts anticipated to human lives, vulnerable communities, and to wildlife. We need to continue to work toward solutions that reduce climate warming. However, we must balance those needs with reducing impacts to wildlife. There are risks and uncertainties and difficult choices ahead, but we need to remain focused on getting the science right as we advance the renewable energy transition.

We have seen unprecedented congressional action toward a renewable energy future, including the Inflation Reduction Act (IRA). These actions will help to promote policy goals and to speed renewables development and climate emissions reductions on the landscape. Additionally, the Recovering America's Wildlife Act[1] is nearing passage, which would grant millions to state wildlife agencies to invest in the type of research needed to support a responsible renewable energy build out.

Christi Calabrese

We have been challenged to substantially increase renewable energy deployment while doing so in a way that is protective of biodiversity. For this reason, many industry organizations engage with REWI to support the research needed to make informed decisions, to be part of the conversation around

[1] As of May 2023, the Recovering America's Wildlife Act has passed in the U.S. House of Representatives but has not been moved to a vote in the U.S. Senate. *See* https://www.congress.gov/bill/117th-congress/house-bill/2773/all-actions

wildlife-responsible development, and to find solutions to help facilitate development while protecting wildlife.

A Changing Policy Landscape

Moderator: Abby Arnold – Executive Director, Renewable Energy Wildlife Institute

Panelists:

- **Rachel London –** National Energy Coordinator, U.S. Fish and Wildlife Service
- **Jeremy Bluma –** Acting Division Chief, Bureau of Land Management
- **Wright Frank –** Chief, Renewable Energy Policy Group, Bureau of Ocean Energy Management
- **Brad Loveless –** Secretary of Wildlife and Parks, Kansas Department of Wildlife, Parks and Tourism
- **Jim Murphy –** Director, Legal Advocacy, National Wildlife Federation
- **Stu Webster –** Senior Director, Wildlife and Federal Lands, American Clean Power Association

Link to Recording: https://vimeo.com/user84144409/review/772133368/7b55f795b3

This session included a dynamic panel discussion on renewable energy policy, wind energy, and wildlife. Panelists discussed recent and anticipated changes in federal and state policy landscapes affecting how and where wind projects are built, and how energy is delivered to consumers. Leaders from state and federal agencies shared policy updates, highlighting unprecedented levels of interagency cooperation to address the pressing challenge of rapid deployment in the face of uncertainty and risk of impacts to wildlife.

Rachel London – U.S. Fish and Wildlife Service Policy

The mission of the U.S. Fish and Wildlife Service (USFWS) is to work with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. Climate change is having system-wide impacts, impacting the conservation work undertaken by the agency. The Ecological Services program has been working closely with the Science Applications Program on the development and implementation of the USFWS climate change action plan. In the past, this plan has been focused on minimizing carbon emissions across USFWS facilities and fleet, however, the program is evolving. Specifically, the climate action plan is being adapted to reform how renewable energy projects are reviewed, with a focus on getting projects on the landscape expeditiously, while conserving and protecting species. The USFWS is held by the Migratory Bird Treaty Act (MBTA), the Endangered Species Act (ESA), and the Bald and Golden Eagle Protection Act (BGEPA) to ensure that species are not further imperiled and continue to recover while supporting renewable energy development as a means to address climate change. The Service relies on and will continue to incorporate research and science in policy-making decisions and is working on improving external communications to promote renewable energy as a way to help meet its mission.

There are two rule-making proposals underway:

- In March 2022, a rule-change was proposed to reclassify the northern long-eared bat (NLEB) from threatened to endangered. This change is now under review following public comment.[2]
- In September 2022, the tri-colored bat was proposed to be classified as endangered, with no proposal to designate critical habitat. The public comment period has closed as of November 14, 2022. Public comments will be used to inform the final rule for the species.

There are four species with proposed rule changes on the Unified Agenda:

- Florida bonneted bat – The agency may reopen the comment period for a proposal to designate habitat initially proposed in 2020.
- Little brown bat – Proposed listing determination and critical habitat designation.
- Hawaiian hoary bat – Proposed reassessment of the species classification. Species may remain listed or may be down listed.
- Lesser prairie chicken – Rulemaking was proposed in 2021 to designate two distinct population segments (DPS). The final rulemaking proposal is included on the Unified Agenda for 2023, with the southern DPS proposed to be listed as endangered, and the northern DPS proposed for listing as threatened under the ESA.

An advanced notice was put forward in October 2021 of a proposed rulemaking to authorize take of migratory birds under the MBTA. The proposed rulemaking will go through the Office of Management and Budget for review and is anticipated to be published in winter of 2023. The public comment period for a proposed rulemaking regarding incidental take permits under the BGEPA ends in November 2022.

Jeremy Bluma – Bureau of Land Management

The Energy Act of 2020 provided that the Secretary of the Interior would establish the National Renewable Energy Coordination Office to support the coordination of renewable energy priorities as well as establish a national goal of 25 gigawatts (GW) of energy on federal lands by 2025. A big emphasis in the Energy Act was to enhance and improve coordination of renewable energy development on public lands. In 2022, a Memorandum of Understanding (MOU) was enacted across five key agencies in the renewable energy space, including the Department of Interior (DOI), Department of Defense (DOD), Department of Energy (DOE), Department of Agriculture, and Environmental Protection Agency (EPA) to improve coordination across the federal nexus. The MOU was a high-level agreement to work collaboratively with respect to renewable energy deployment across public lands, simultaneously addressing climate and conservation goals along the way. The Bureau of Land Management (BLM) is working on the following initiatives and will continue to engage with other federal agencies, state and local government, and additional interested stakeholders to update these plans:

- Increase staff capacity to support processing and robust environmental review for wind, solar, and geothermal energy development through strengthening partnerships and leveraging additional funding to create the best outcomes possible.

[2] On November 30, 2022, the USFWS published its final rule reclassifying the NLEB as endangered. The rule will be effective on March 31, 2023 (88 FR 4908).

- Build scientific and institutional knowledge to better mitigate impacts moving forward through collaboration with the United States Geological Survey (USGS), developing science to evaluate mortality relative to renewable development and better understand population effects.
- Land use planning updates to designate areas unsuitable for development and identify ideal areas with fewer resource conflicts and promote responsible development.

There are several proposed rulemakings and updates to policy and regulation for wind, solar, and geothermal development, including a ratemaking. The Secretary of Interior announced reduced rates and fees for rentals for wind and solar projects on public lands, helping us to incentivize and promote development of renewables on public lands.

We continue to give incredible attention to project review, both internally and in coordination with other agencies. There is substantial engagement being sought by stakeholders, and incredible support by leadership at all levels of government to invest time and resources into smart renewable deployment.

Wright Frank – Bureau of Ocean Energy Management

The authority of the Bureau of Ocean Energy Management (BOEM) is a stewardship role over the oceans from the boundary of state waters out to the Outer Continental Shelf (OCS), from three nautical miles for most states out to 100 miles offshore. BOEM oversees renewable energy, as well as oil and gas, and sand and gravel.

In addition to the 30x30 goal for conservation (30% of U.S. lands and waters conserved by 2030), there is a renewable energy goal of 30 GW by 2030 deployed in federal waters. BOEM has been focused on maintaining capacity to continue to support the build out of large projects, despite the legal and regulatory challenges to getting those projects permitted. BOEM continues to support permitting by completing the necessary due diligence as early as possible and maintaining a transparent process through public engagement and intergovernmental cooperation.

The permitting process begins with a feasibility investigation and data gathering of an area under consideration. The agency holds public meetings, engages with other federal and state agencies, implements studies, and reviews data to evaluate and understand the environmental impacts of offshore wind, all with the intent to avoid and minimize conflicts. At the point of a lease sale, much of the environmental due diligence of proposed lease areas has been done. To date, BOEM staff have found that, as they look further offshore, they see fewer bird conflicts and, though not as well-studied, it is presumed that bat impacts are lower in the offshore environment as well.

To date, the agency’s renewable energy program activities includes:

- Recent lease sale in the New York Bight with over $4.3 billion in bids.
- Leases in Carolina Long Bay.
- An anticipated lease offering of five leases across two areas off the coast of California.
- A number of call areas under investigation, though these have not moved to the lease phase.
- Two active research leases, including the only two turbines operating on the OCS.
- A total of 15 site assessment plans have been approved, including deployment of research buoys and other data gathering efforts.
- A total of 18 construction and operations plans (COPs) either under review or approved.

- Planned public meetings to support development of the full environmental impact statement (EIS) of 10 COPs under review.

Near-term activities include:

- Closely tracking policy initiatives in national marine sanctuary development as BOEM is not able to offer leases within the sanctuary areas.
- Proposed modernization rulemaking to analyze and update BOEM's regulations for the first time since they were promulgated in 2009.
- Proposed rule with a reorganization that would separate BOEM's regulations to give the Bureau of Safety and Environmental Enforcement authority in renewable energy that is similar to its existing authority over oil and gas activities, including engineering, safety inspections, and environmental compliance.

Brad Loveless – Kansas Department of Wildlife, Parks and Tourism; Association of Fish and Wildlife Agencies Executive Committee

Coordination with the states is best achieved through communication early and often. This is often difficult to do when projects are moving quickly but promotes the ability of the state to provide insight early enough to inform decisions and avoid conflicts as a project progresses. The USFWS Land-based Wind Energy Guidelines is the backbone guiding state-level siting and environmental review processes. Kansas has also been looking to the AFWA wind survey, which provides perspectives on what has and has not been working at the state level, citing communication as a key issue, to improve internal processes. Subsequently, the Kansas Department of Wildlife, Parks and Tourism has been engaging with the American Clean Power Association and REWI to learn more about their research and best practices around wind and wildlife so we can complement their efforts and work effectively together.

Well-sited renewables provide great "green" energy. However, there are projects in areas where the impacts to wildlife are so substantive, the energy produced there cannot be considered truly "green." As states, we must challenge energy developers to consider broadly all the impacts and all of the costs of a poorly sited development. For instance, there are proposed projects sited in areas of the last remaining habitat for lesser prairie chicken, where development will result in total displacement of the species. The habitat lost cannot be replaced, but projects can be built elsewhere to avoid these impacts. Our challenge to developers is to consider the financial tradeoffs of the upfront costs of siting right relative to the regulatory problems associated with siting in sensitive areas.

Local and state politics are changing. State legislatures are getting more involved based on feedback from constituents that their voices have not been heard. State legislators, however, are not equipped to make good decisions around wind power siting and regulations. Best outcomes come from inclusive engagement and in being transparent throughout the process to avoid involvement by those state legislators. Site-specific conversations with municipalities and states allow for state agency staff to engage and educate county-level officials and inform decision-making. We have to put more renewable energy on the landscape, and this can be done more efficiently and responsibly when in coordination with state agency staff.

Jim Murphy – National Wildlife Federation

At a high level, there is a great opportunity to capitalize on the need to advance renewable energy. Nationally, the goals include a 50% emissions reduction by 2050, 30 GW of offshore wind by 2030, and 15 GW of floating offshore wind by 2035. BLM has a goal to deploy an additional 25 GW of renewable energy on public lands by 2025, which is now only two and a half years away. All of this means that there will be a need for federal permitting that can be done quickly and efficiently. In terms of meeting climate goals, with 50% emissions reduction by 2050 paramount, renewable development is the only viable path to achieve that. Even with groundbreaking legislation from congress with the IRA, many of the initiatives proposed are likely not politically feasible. Given the current legislative climate, the primary tools we have are incentives to build out renewables and transmission the right way through effective research and permitting. The impetus is on getting renewable energy deployment right, and we need more legislative action from Congress similar to the IRA.

The IRA is a milestone for renewables, potentially providing $37 billion for renewables and clean cars, $135 billion in renewable tax credits, and $60 billion in investment in frontline communities. In addition to addressing wildlife impacts, these investments demonstrate a federal interest to ensure a just renewable energy transition, not only reducing further impacts to frontline communities but also increasing engagement in the political process for communities that have been adversely affected by climate change. One troubling area of the IRA requires that a certain amount of oil and gas leases be made available for offshore wind and leasing of public lands to move forward. From the perspective of renewables development, the legislation is a landmark, however, if there will be more oil and gas as a result, the climate mitigation aspects become dampened.

Collectively, we have ambitious goals for public lands and waters. As we move from developing renewable energy on private lands to public, permitting reform will be more at the forefront. In developing and modernizing permitting frameworks, there exists a real opportunity for the non-governmental organization (NGO) community and those in the renewable energy industry to work together to carve a path forward that protects our values and gives communities a strong voice, as well as addresses the need to build quickly and expeditiously with the level of uncertainty that we have to accept. Examples exist in the offshore wind space where the NGO community is pushing for programmatic reviews upfront that address primary siting decisions at the regional level. All of this initial work, however, is only beneficial to the renewable energy industry if the upfront work makes it easier on the back end. The National Wildlife Federation is currently reviewing the challenges under the MBTA and the BGEPA, reviewing vessel speed reduction in offshore wind, and looking at proposals like general permits that will hopefully make permitting easier, provide more certainty, and result in conservation wins that reduce climate change and protect wildlife as we move toward a cleaner energy future.

Stu Webster – American Clean Power Association

Wind energy has always been spatially explicit with only a handful of areas in the country that were the focal point for development. Now, with a multi-technology renewable industry (i.e., lower wind speed class turbines, photovoltaic solar, storage, offshore wind), we have opened up the entire country, creating a more diverse and more challenging conversation about siting and positive and negative effects of deploying renewable energy. The issues at the state level are more pronounced with solar than when it was just wind. The IRA has created an unprecedented level of conversation from the board room to the living room with responses ranging from exuberance to panic, depending on the perspective. Undoubtedly, the IRA represents an exciting affirmation of what our country believes in, that we need to transition from traditional energy to a less impactful energy generation strategy.

However, clean power installation in 2022 saw a decrease of 18% from previous years. The exponential growth curve over the past decade, including its benefits and penalties, does not appear to be continuing with the same historical trend. Multi-tech renewables emerged in 2011 and had obvious and significant benefits to the total renewable build out but have also introduced variability and the opportunity for companies to better hedge their risk. Most companies that have the capital to do so are deploying and operating all technologies across the board. Wind energy deployment in 2022 has seen a tremendous down-turn since this time last year (2021). In comparison, solar deployment only saw a slight decrease. Current economics are more favorable to solar in some regions of the country, in part due to the lower cost in energy storage; in other regions wind outcompetes solar. Storage has eliminated the intermittency argument with renewable energy critics, especially regarding solar, and will likely change the overall dynamic of the renewable energy industry.

The market reaction is evident, with solar accounting for 81% of the Power Purchase Agreement announcements and wind seeing its lowest third quarter since 2013. Also notable is the 85% decline in renewable energy development compared with this time last year. For a room full of professionals discussing renewable development and wildlife, it is important to ask why this is happening and realize that while we have very ambitious goals for renewable energy, deployment of renewable technologies is not on pace to meet them. In an environment where numerous barriers exist, particularly with respect to wildlife conservation, businesses are finding themselves more agile at investing in technologies and locales that pose the lowest development hurdle. This deserves reflection because it can change the dynamics of the discussion about wildlife habitat and environmental impacts of renewable energy.

We have high aspirations for renewable development (including 74 GW of offshore procurement planned), with significant government spending to lay the groundwork for the anticipated build out. Part of the funding available from the IRA includes $3.2 billion for transmission spending. To meet these goals, it will be critical to address the social, political, economic, and environmental issues associated with transmission. Otherwise, the anticipated wave of renewable energy development will not happen.

Audience Questions & Panelist Response/Discussion

Panelists responded to questions broadly addressing the following:

- Is net-zero achievable by 2050, and if so, what has to change to get there?
- How will any future Supreme Court decision regarding the MBTA affect USFWS' regulatory authority as it pertains to take?
- Given what is known about offshore fatalities, is extensive data collection expected?

(for USFWS) Is there additional information available regarding the decision not to designate critical habitat for tri-colored bats?

RACHEL LONDON: Generally, the USFWS made the decision that a critical habitat designation was not prudent for the conservation of the species, due in part to the reactions that can come from designating critical habitat and can sometimes be negative for the species. There are some specifics, but follow-up will be needed.

(for BOEM) Once an area is designated a call area, what steps occur that change its status to the point where a lease sale is initiated?

WRIGHT FRANK: The BOEM process would have the next step being wind energy area designation. The call area represents an attempt to procure as much information as possible. Following that comment gathering and analysis phase, BOEM will publish areas either as a draft first or as a final wind energy area and move to a proposed sale notice. There are cases where, for a number of reasons, the process slows or halts, for instance where conflicts with the DOD or other areas arise, the area has been deprioritized, or for political reasons at the state-level, and we generally don't move forward where there is opposition from the state. These are just some examples and not exhaustive.

(for BOEM) Someone remarked that bird impacts are expected to decrease the further a facility is offshore. Given this, what is the expectation for lessees to conduct extensive bird surveys in lease areas?

WRIGHT FRANK: BOEM's EIS will look at potential bird impacts and there is an avian and bat monitoring plan that the lessee must prepare as part of the COP. BOEM will review with the USFWS as a cooperating agency. There may be stipulations, but this is being considered.

Given what we know, can we get to net-zero by 2050, and what has to change to get there?

WRIGHT FRANK: This is a good goal, and it is ambitious. We need ambitious goals, but they come with challenges. I see two primary issues being the supply chain, broadly, and the Jones Act more specifically with offshore wind, which limits the use of certain vessels to transport the components to build offshore wind. If all goes right, this is attainable, but the supply chain issue is a preeminent challenge.

JEREMY BLUMA: There is no simple answer. There are very complex dynamics at play with environmental issues and supply chain. What is evident is the unprecedented levels of engagement and investment among federal agencies and other stakeholders. Things are moving in the right direction to advance toward net-zero, but whether this is attainable remains to be seen given the complex factors involved in energy transition.

BRAD LOVELESS: This is definitely attainable. Kansas is a private lands state, so here we have to work with landowners. We have to educate people and have conversations. We have examples of counties voting down projects because they have not been informed. In the west, I would encourage federal agencies, given the money and influence they have, to steer developers to optimal areas. No place is perfect or without impacts, but there are some areas that are better and have fewer conflicts. The federal agencies can use incentives and opportunities to direct developers to these places.

JIM MURPHY: We can absolutely do this. All of the things we are talking about in these panels are challenges we can solve together by 2050. The technology is there. The know-how is there. We can build this, and we can do it. The question is can we collectively get on the same page to define what sort of future we want for our grandkids and our great-grandkids. If we can't get on the same page, this will absolutely be the biggest challenge.

STU WEBSTER: I not only think it's possible, but I also think it is critically necessary. Anyone who thinks differently needs to pick a place in this world and look at the news. Climate change is here, it is now, and we need to transition. We need to be bullish, and we need to be less precautionary. That is not to say things need to be done in an unfettered way, but the transmission issue needs to be resolved and public lands need to be opened to renewable energy development. The industry is hindered by the fact that nearly all development is occurring on private land. This concentrates a massive amount of capital investment in spatially explicit locales, creating immense conflict. This conflict is blowing up at the local and state levels and making the federal issues secondary. We have limited capacity on private land alone and that strikes me as making it completely infeasible to accomplish not only the things we want to do but also the things we need to do.

RACHEL LONDON: The optimistic viewpoint is that we can get it done. USFWS is trying to expedite permitting while meeting conservation goals. We are staffing up, but we have suffered a loss of staff through administration changes in the past eight years with increased workloads and loss of institutional knowledge. We are in the process of building back up and although there are billions of dollars in funding, these funds are not directed at our agency in recognition of the environmental role we play in deployment of renewables. The interagency partnerships and other sources of funding have been vastly important in helping to support environmental reviews. We are looking internally to streamline and find improvements in our permitting processes, and we are looking for efficiencies in statute as well. We do have a role under the National Environmental Protection Act (NEPA): on public lands we have the ability to take programmatic approaches and we hope to use that approach to determine where projects should go on the landscape. However, we acknowledge the incredible amount of land necessary to meet this goal. I imagine there are rooms full of folks addressing these issues, including supply chain, similar to what we're doing here. Together we can make this happen.

Given the decision in West Virginia v. EPA and United States Supreme Court questioning Sackett v. EPA, how concerned is the Service that a proposed MBTA permit program could wind up under review by the Supreme Court and result in USFWS losing all incidental take authority?

JIM MURPHY: Speculating on the current Supreme Court is challenging. The statute says any and all takes, and that clearly includes incidental takes. It is worth noting that administrations from both parties have interpreted the regulation that way. It is also worth noting that in listening to the referenced arguments, there are some Supreme Court justices that have looked to past bi-partisan interpretations of the Clean Water Act as an indication of what wording means. It seems there is a strong basis for incidental take and that the Trump administration's take was wrong. That said, the MBTA is written differently than other statutes like NEPA and the ESA on how incidental take is described, and to the extent that any ruling on the MBTA that would go to the Supreme Court would only impact the Supreme Court. The administration is on strong footing with the current interpretation. A permitting program might assuage certain members of the Supreme Court who might have concerns about the fact that compliance with the MBTA incidental take permit was hard to come by without the certainty provided by a permitting program.

RACHEL LONDON: There has been a lot of back and forth in implementation within USFWS field offices. The MBTA is administered by the migratory bird program with field office staff interacting on project review at the field level. This back and forth in interpretation across administrations created uncertainty and challenges when determining how to implement the regulation. At the same time, language came out from the migratory bird program that, regardless of the status of the interpretation of the act, USFWS has a responsibility to protect and conserve migratory birds and will continue to do so in collaboration with any willing entity or agency. There are best management practices in place, and an incidental take permit program would help to codify those practices. With uncertainty over potential legal outcomes, we can continue to work in partnership with others to conserve migratory birds.

Wind Energy & Wildlife in the Context of Climate Change: Thinking globally, siting locally revisited 8 years later

Moderator: Shilo Felton – Senior Scientist, Renewable Energy Wildlife Institute

Panelists:

- **Taber Allison –** Director of Research, Renewable Energy Wildlife Institute
- **Cris Hein –** Senior Project Leader, National Renewable Energy Laboratory
- **Holly Goyert –** Sr. Wildlife Biologist, AECOM
- **Jay Diffendorfer –** Research Ecologist, Geosciences and Environmental Change Science Center, U.S. Geological Survey
- **Paul Rabie –** Senior Statistician, Western Ecosystems Technology, Inc.
- **Nihar Chhatiawala –** PhD Candidate/Assistant Policy Researcher, Pardee Rand Graduate School/RAND Corporation

Link to Recording: https://vimeo.com/user84144409/review/772143265/45f536305d

This panel was named for the 2014 paper by Allison et al., "Thinking globally and siting locally – renewable energy and biodiversity in a rapidly warming world." The panel discussion revisited the original concepts behind the paper through a "where are we now" lens and considered whether progress has been made over the past decade of research and deployment of renewable energy, focusing on wind energy. Discussions within this panel focused on identifying solutions for advancing wind energy as mitigation of climate change in an atmosphere of uncertainty with respect to risks and impacts to wildlife. Speakers highlighted that continued progress is reliant upon making decisions with deep uncertainty and in recognition of trade-offs between reducing overall risks to wildlife, species conservation, and climate mitigation.

Discussion focused on:

- Identifying the trade-offs between climate mitigation and species risk under variable or uncertain future scenarios;
- Evaluating strategies for rapid deployment and associated mitigation in the absence of data; and
- Applying widely used concepts to help develop decision-making pathways where deep uncertainty exists.

Taber Allison – Thinking globally, siting locally

In setting the stage for this session, we considered recent updates to the title paper originally given 10 years ago at the 2012 WWRM. The original paper posits the argument that rapid warming presents a global risk to biodiversity and the magnitude of that risk will vary depending on the rate of warming. The paper reviews what we need to do to limit these impacts – swift and deep reductions in emissions and rapidly increasing renewable energy production. The world has changed tremendously since the publication of this paper, at which time there were 60 GW of wind, no offshore wind, and no solar on the landscape. At the time, the projected need was 355-540 GW of wind power to combat rapid warming, a number that we now understand was well below the actual need. The current installed capacity at 140 GW creates an increasingly complex challenge when understanding and addressing impacts as we continue to progress toward meeting our energy generation needs. Over 14 WWRMs, we've presented and discussed research on how to reduce uncertainty around the impacts to wildlife from renewable energy, and how to mitigate those impacts; however, we likely won't eliminate that uncertainty. Therefore, we will continue to make decisions with some degree of uncertainty. The proposition in the paper was that we need to accept some and perhaps substantial risk of adverse impacts to wildlife from renewable energy to limit the far greater risks to biodiversity loss owing to climate change. The question then becomes, how much uncertainty in risk to wildlife are we willing to accept? The proposed approach is a value-based discussion leading to an agreement on outcomes, and what we need to know to achieve those outcomes.

Cris Hein – Are bats wind energy's Kobayashi Maru?

In Star Trek terms, the Kobayashi Maru is a no-win training simulation. Wind energy is a critical tool to address climate change but continues to have measured impacts on certain bat populations. The question becomes whether solving the climate challenges we face through wind energy development is in direct conflict with bat conservation. In other terms, do bats pose a no-win scenario for wind energy development?

The current installed capacity in the U.S. is 140 GW, or 6% of electric supply, and the national goal is to achieve 40% electricity from wind with a projected growth of an average of 66 GW/year over the next 10 years. It is both exciting to see the U.S. move towards more renewable energy, but also overwhelming to think about this rate of expansion and how this might impact bats across the landscape.

Climate change also impacts bats. Human-induced climate change can result in increased intensity of storm systems and fluctuating extremes in temperature, which have the potential to dramatically impact localized bat populations. Dozens of published research papers and examples document climate-related impacts to bats across the globe.

We have two challenges – the impacts of wind energy and the impacts of climate change. How do we balance meeting climate change targets while reducing impacts from wind energy development? In Star Trek terms, we essentially have a Kobayashi Maru scenario– no matter what we do, we're likely to have an impact on bats. Where does this leave us?

We have several potential scenarios to consider:

1. Rapid deployment of wind technology with limited curtailment maximizes reduction in carbon emissions and results in species conservation worldwide, but we're likely to drive at least one species of bat toward extinction. In essence, the needs of the many outweigh the needs of the few or one.
2. Rapid deployment with intensive curtailment reduces renewable production and hinders broader conservation of bat species globally but may prevent extinction for one or more species. In essence, the needs of the one or few outweigh the needs of the many.
3. Negotiating to achieve collective goals wherein both industry and the conservation community employ a conservative approach to promote continued deployment. For example, striving for

50% reduction in bat mortality now to allow time for development of improved minimization strategies while simultaneously reducing the burden of monitoring.

There needs to be a transition in our approach to achieve our energy production and conservation goals. We can no longer just focus on site-specific impacts. We need to be more forward-looking and assess the challenges and opportunities of future deployment scenarios. This will require difficult conversations to identify transformative approaches and achieve a balance. The collective involvement of all affected parties will make this possible.

Holly Goyert – Wildlife conservation and research priorities for offshore wind energy development

At the start of an economic downturn, the offshore wind energy sector is not only growing but exploding, taking many by surprise, with a renewed commitment at the federal level to advance offshore wind energy deployment to 30 GW by 2030. The first utility-scale projects will be operational in 2023 and BOEM is undertaking additional leases across the country. Stakeholders are concerned over compressed timelines for the NEPA process – requiring developers to submit development plans, biological resource evaluations and impact assessments in under five years. These assessments can only be as rigorous as the data on which they are based. Research activities for offshore wind energy are therefore prioritized based on urgency and need.

Predicting marine wildlife hotspots early in the permitting process is crucial to avoiding interactions between offshore wind energy and wildlife, but these models don't yet exist. We can estimate distribution, relative abundance, and movement of wildlife in the marine environment using rigorous spatiotemporal predictive modeling. However, risk assessments must also evaluate where and when encounters with wind energy infrastructure may occur to determine vulnerability of populations to collision and displacement.

As turbine sizes increase, collision risk increases, particularly for avian species. The turbines at Block Island Wind Farm, erected in 2016, have a rotor swept zone (RSZ) extending from approximately 50-300 meters (m). Results of tracking studies have suggested that endangered seabirds (e.g., roseate terns) fly mostly below 50 m and beneath this RSZ, while threatened shorebirds (e.g., piping plovers and red knots) are thought to fly above the 300 m RSZ during migration. However, newer turbines with larger nameplate capacity are now exceeding the 50–300 m range, expanding to twice the RSZ. Coupled with uncertainty around bird flight height estimates, this creates a lack of confidence in current risk collision models. Additionally, though new technologies are being developed to detect bird and bat collisions, fatality rates cannot be measured at offshore wind energy facilities the same way they are for land-based wind. Given the knowledge gaps around fatality rates and collision risk for birds at offshore wind energy facilities, further research will be necessary to implement mitigation strategies and measure their effectiveness, mitigation meaning avoidance through siting, minimization of impacts, and compensation to offset losses to wildlife and their habitats.

While avoiding and minimizing are priorities, these options pose challenges in the offshore environment once structures have already been installed and reinforce the need for early discussions around compensatory mitigation. Mitigation planning is important to establish a net positive impact of wind energy on birds, however this is inherently difficult to quantify as impacts are often very site-, species-, season-, or individual-specific. Efforts to identify wildlife and research priorities for offshore wind (for example, the Regional Wildlife Science Collaborative) have generally identified three top stressors: cumulative effects, avoidance, and attraction. Avoidance may reduce direct impacts but can lead to displacement or create a barrier effect. Conversely, offshore wind energy infrastructure may serve as artificial habitat and attract wildlife, but this can also potentially increase collision risk. Addressing these pressing research needs will require advanced modeling, long-term monitoring, and new technologies to fill gaps in deterrent and detection capabilities.

In the last year, BOEM, the National Oceanic and Atmospheric Association, and USFWS have prepared new guidance for offshore wind energy development, including mitigation, endangered species protections, and siting and collision risk modelling. As a result, we need to prepare for major shifts in research questions and approaches to post-construction monitoring with the aim of reducing uncertainties, addressing mitigation, and supporting adaptive management.

Jay Diffendorfer – Counterfactuals and their relationship to wind energy and climate mitigation

The concept of counterfactuals was discussed in a recent paper by Katzner et al. (2022) titled "Counterfactuals to assess effects to species and systems from renewable energy development." For these purposes, counterfactuals are defined as possible alternative system trajectories in the absence of an intervention. For example, in the wind-wildlife science arena, a number of studies assess population growth rates and sizes with and without wind fatalities. Katzner's work sought to build a more comprehensive counterfactual that would consider the benefits of wind energy to wildlife from climate mitigation, knowing that wind energy is critical to decarbonization.

For species that are more adversely impacted by climate change, wind energy may result in an overall net benefit. To add to the overall dialogue of renewable energy, the scope of counterfactuals should reflect the overlap of impacts from climate change and the benefits of renewable energy to social, economic, and human health sectors.

Climate mitigation scenarios influence our thinking around counterfactuals. The levels of future climate change we will experience depend on how rapidly countries decarbonize and how quickly renewable energy is adopted. There are hundreds of different scenarios across multiple sectors and strategies for decarbonization, and a lot of uncertainty around the results. Given that, how do we approach a reasonable counterfactual analysis?

One possibility uses climate modeling presented by the International Panel on Climate Change wherein wind and renewable carbon offsets could be estimated for each climate scenario to evaluate realistic impacts to wildlife. We are likely to exceed 1.5 degrees Celsius of warming. The U.S. has national goals for decarbonization and wind energy development, but carbon is global. Outcomes for many species may depend on global decarbonization rates, despite strong national contributions. Temporal trends in global decarbonization will be important to consider in a national scale counterfactual analysis.

Counterfactuals will be meaningful for the long-term view of tradeoffs between impacts and benefits of wind energy to wildlife, particularly as carbon offsets grow and we begin to see the climate benefits. An initial counterfactual analysis is possible using existing information and such an analysis will help to clarify impacts from decarbonization at national scales, show the benefits beyond wildlife, and contribute to the broader national conversation about renewables.

Paul Rabie – Indirect, climate-mediated effects of renewable energy production on species' extinction risk

See also corresponding presentation #45 [Indirect, climate-mediated effects of renewable energy production on species' extinction risk].

We have a good understanding of the negative impacts of renewable energy on wildlife – we know which species are vulnerable, the level of impacts, and the indirect effects, especially on birds and mammal migration. There are a handful of studies that demonstrate positive indirect effects of renewable energy on wildlife, but what we don't understand are the counterfactuals.

Counterfactuals are difficult in practice because population modeling is inherently difficult, and modeling populations with climate inputs is even more complicated. Considering counterfactuals on a global scale may be more manageable, particularly in the face of rapid extinction rates across the globe relative to the handful of species facing direct impacts from renewable development.

Work is being done to develop a conceptual model assessing carbon impacts from energy technology, from materials production through operation and decommissioning. This model considers the lifetime carbon balance of renewable energy sources, then subtracts the balance for traditional energy sources to determine a net change in carbon output per kilowatt hour for renewable energy. By changing the carbon dioxide inputs in the atmosphere we can change global temperatures and subsequently affect global species extinction risk.

In the impossible scenario of an instant transition to renewable energy, global temperatures would hypothetically increase less than 1 degree Celsius, with a rapid transition predicted to keep temperature increases below 1.5 degrees Celsius. In a business-as-usual scenario, temperatures are predicted to rise by more than 2.5 degrees Celsius. Comparing these estimates to prediction risk models, we can expect between 700 million and 1 billion species lost, depending on how rapidly we can achieve an energy transition.

Though this information does not provide guidance on management or mitigation to further reduce the extinction risks posed by renewable energy, accepting some level of uncertainty may help to advance the conversation around renewables and global counterfactual modeling.

Nihar Chhatiawala – Assessing risks of offshore wind energy to wildlife through a deep uncertainty lens

See also corresponding presentation #65 [Assessing Risks of Offshore Wind Energy to Wildlife through a Deep Uncertainty Lens].

The energy transition is a global shift in natural resource consumption that has the potential to impact ecosystems and their ability to function in the face of climate change. We currently lack the tools to fully understand and mitigate environmental impacts of this energy transition. The offshore wind energy rollout is happening as we speak, and many initial decisions will have to be made well before the research community has conclusive data.

Day-to-day decision-making often occurs with a small level of uncertainty. In higher levels of uncertainty with greater probability distribution, we practice risk assessment, planning, and reacting based on our knowledge of the risk. With deep uncertainty, we don't understand the sensitivities of the decisions that we make, limiting our ability to fully assess the risks and outcomes of those decisions. Where valid predictions are not possible, robust decision-making (RDM) allows us to consider possible scenarios and evaluate which policies and actions will perform well across the broadest range of possibilities. In practice, deep uncertainty in the tradeoffs between offshore wind energy development and wildlife conservation could be addressed through modeling using a RDM framework.

In RDM, we cannot predict the future, but we can consider possible scenarios and evaluate which policies and actions will perform well across the broadest range of possibilities. The process of RDM has been broadly applied in a range of fields including urban and water resource planning and decarbonization strategy development but is not widely used in environmental resource planning. In practice, we might want to test policies and options over a very large number of potential scenarios addressing deep uncertainty in the tradeoffs between offshore wind energy development and wildlife conservation. We don't know for certain how climate change may affect performance of wind energy generation, what energy consumption patterns will look like, and what alternative and/or complementary energy technologies may emerge. We also don't know what the effects of climate change will be on ecosystems or what we may discover about direct impacts to wildlife in the next 10, 20, or 50 years.

If we know what we don't know, how do we determine the policy actions that we need to test? If we attempted to model this question, we might address the tradeoffs between wind potential and interactions with landmark species, incorporating multiple objectives to evaluate how near-, mid-, and long-term decisions would affect outcomes. While we have a good understanding of how to measure benefits, we don't have consensus on how to measure outcomes. We need an integrated model that centers on both ecosystem impacts and societal benefits and considers the most useful metrics for both. Through such a model, we can better evaluate how different policies will fare in variable use cases under deep uncertainty to help inform site planning and design as well as environmental assessment guidelines that are proactive and adaptive.

Audience Questions & Panelist Response/Discussion

Panelists responded to questions broadly addressing the following:

- How do we balance tradeoffs between species conservation, renewable energy development, and climate change??
- What role does the wildlife research community play in ensuring renewable energy generation targets are met?

Given how little we know regarding species response to offshore wind energy and the efficacy of curtailment at mitigating impacts in this offshore environment, how does this permit viable offshore wind energy generation?

CHRIS HEIN: We have limited information on bat activity patterns in the offshore environment, but bat activity tends to mirror activity onshore with increases during summer and fall under similar conditions. With no operational examples, we do not have the means to measuring impacts, or the effectiveness of curtailment. There are tools being developed to investigate exposure of bats to offshore wind energy that may serve as an impact metric. Without sufficient understanding, it becomes difficult to evaluate the tradeoffs – do we enforce curtailment from the start, whether or not we know it is necessary? Without sufficient data to suggest an impact exists in the offshore environment, and that curtailment strategies implemented onshore will also be effective offshore, it may be better to focus on understanding the activity patterns and potential risk to bats from offshore wind energy.

TABER ALLISON: For marine birds, where the patterns are less clear, we could determine the cost of curtailment and redirect some of that funding to compensatory mitigation and creating habitat. For bats, funding could be directed to support curtailment at high-risk onshore sites, where the risks and benefits are known.

Is there a way to take the counterfactual concept and build it into the NEPA process? To date, focus has been on the negative effects of renewable deployment. Can counterfactuals be used to identify positive effects?

JAY DIFFENDORFER: The amount of information available to develop counterfactuals on an individual species level is lacking. However, working toward better decision-making in the face of climate change is critical, with dire consequences for the planet. Not moving forward because of an assumed impact without looking at the net benefit or net response is short-sighted. This is the right kind of decision-making to address these issues, but it is difficult work to do.

PAUL RABIE: The question is, “what are the cumulative impacts?” Looking at the global view simplifies this work and allows for progress in the interim, as detailed models are being developed. The science is not there yet, so we should look at how much we value our current climate scenario and determine how much take can be justified to remain within that envelope.

As we consider the costs and benefits of potentially losing species either impacted by renewables or climate change, is there a way to mitigate for the loss of ecosystem services from those species?

PAUL RABIE: Quantifying ecosystem services for the purposes of determining mitigation is complex, affecting numerous taxa performing a variety of services, and there are a great many impacts to these services that have not yet been identified. There is no one size fits all answer, rather mitigation must be determined on a case-by-case basis.

JAY DIFFENDORFER: In Mexican free-tailed bat populations, ecosystem services were found to be in decline, partially due to decreasing bat populations, but also due to adoption of genetically modified organisms (GMOs) that were killing pests. In essence, GMO technology is replacing the service provided by bats. So, in the same way we have resource equivalency, species play an equivalency role in ecosystem provisioning and there is a great deal about that we don’t understand.

NIHAR CHHATIAWALA: If we don’t have a comprehensive understanding of what the impacts to ecosystem services are, we can latch on to some factor and attach a value to that and factor it into overall cost-benefit analyses to guide siting, as is commonly done in the field of environmental economics. Some valuation is better than no valuation.

Does the wildlife research community have a role in ensuring that net-zero emissions and renewable energy goals are met?

TABER ALLISON: When we know the kind of world we want, the research community can help define what we need to know to achieve it and associated research priorities. They have a huge role as the arbiter of decision-making where defining research priorities is needed to fill knowledge gaps.

HOLLY GOYERT: The wildlife community plays a role in addressing uncertainty – the community is tasked with estimating uncertainty and using those estimates to inform future monitoring and data gaps, and quantify net positive effects.

Recommended Resources

- Allison et al., 2014. Thinking globally and siting locally – renewable energy and biodiversity in a rapidly warming world.
- Bull et al., 2021. Reconciling multiple counterfactuals when evaluating biodiversity conservation impact in social-ecological systems.
- Denholm et al., 2022. Examining supply-side options to achieve 100% clean electricity by 2035.
- Katzner et al., 2021. Counterfactuals to assess effects to species and systems from renewable energy development.
- Lopez et al., 2021. Land use and turbine technology influences on wind potential in the United States. Energy 223: 120044.

Keynote Address 14th Wind Wildlife Research Meeting, Winds of Change

Moderator: Abby Arnold – Executive Director, Renewable Energy Wildlife Institute

Speakers:

- **Alejandro Moreno –** Deputy Assistant Secretary for Renewable Power, U.S. Department of Energy
- **Courtney Fogwell –** Senior Advisor to Shannon Estenoz, Assistant Secretary for Fish, Wildlife, and Parks, U.S. Department of Interior

Link to Recording: https://vimeo.com/user84144409/review/772155560/9665f65bdb

The keynote address was given by two senior-level staff from the DOI and the DOE. Alejandro Moreno, Deputy Assistant Secretary for Renewable Power, Office of Energy Efficiency and Renewable Energy (EERE, DOE), and Courtney Fogwell, Senior Advisor, Assistant Secretary for Fish and Wildlife and Parks (DOI), shared how these two federal agencies are working together to advance the administration's clean energy and conservation goals. Panelists addressed the following questions:

- How do the DOE and DOI's missions relate to advancing clean energy and conservation of biodiversity?
- What work are these agencies undertaking to advance those goals and what are the drivers influencing innovation in meeting those goals?
- How are the DOE and DOI working to address perceived tradeoffs in advancing clean energy and protecting biodiversity simultaneously?

Alejandro Moreno

The DOE, specifically within the EERE, views the importance of resolving the broad potential conflicts in land use, wildlife, and public acceptance issues around the widespread development of renewables as one of the most important challenges in reaching the administration's goals of a fully decarbonized power sector by 2035. The DOE, in collaboration with colleagues across agencies, is prioritizing the funding of research that will be critical to ensuring projects can be sited and operated complementary to wildlife, habitat, and broader land use concerns.

The DOE is an agency of innovation, meaning we develop technologies and science that ultimately give people more options. There of course will be trade-offs when building new infrastructure, but we have the ability to minimize those trade-offs and to create infrastructure that can meet our clean energy goals while benefitting both people and the environment.

The goal of the DOE under this administration is decarbonizing the energy sector and getting to a fully decarbonized power sector by 2035. Importantly, a primary reason we all care about advancing climate goals is the protection of biodiversity and overall ecosystem health. And we know that the potential impacts on biodiversity of not meeting our climate goals are tremendous. But the flip side is also important: that is, if we are not prioritizing ecosystem protection in the build out of renewable energy generation, the benefits of the clean energy transition are diminished. We have to find solutions that allow us to build substantial new infrastructure in a way that is commensurate and aligned with our environmental values and is equitable for all Americans.

To fully decarbonize our energy sector involves extensive build-out of new infrastructure on the order of one to two terawatts of generation, thousands of miles of transmission and distribution lines, along with new large-scale and small-scale storage. The DOE is critically evaluating how to reduce the overall level of infrastructure needed to meet these conservation goals; for example, recent studies have shown that we might be able to reduce new infrastructure needs considerably through existing efficiency measures, including adding more storage and flexibility into the power system.

The DOE has conducted substantial work on the technology side to minimize impacts, through both hardware and software as well as a lot of work on the science side, collecting baseline information, monitoring impacts, and collecting and making that information accessible. Community engagement has been a focus, though the authority of the federal government is limited to projects that have a federal nexus. Our focus has been on areas where we can make a difference, for example, providing resources to states and local jurisdictions to combat potential misinformation around clean energy technologies that tends to hold these projects up in local permitting, and to guide best practices in decision-making. We continue to work closely with our federal partners to strengthen the level of alignment across agencies. Every organization has its own mission and its statutory responsibilities, but for the big picture goals we are more collaborative than ever, and that gives me a lot of hope for what we can accomplish.

Courtney Fogwell

Climate change necessitates a clean energy future, but so does conservation. The administration is taking a whole-of-government approach to addressing the challenges of a clean energy transition. There are several renewable energy goals guiding the work of the DOI, including achieving a carbon-free power sector by 2035; wind energy will comprise a large portion of that. The DOI is also committed to permitting 25 GW of renewable energy on public lands by 2025, and collectively the DOE, the DOI, and the Department of Commerce have a goal of deploying 30 GW of offshore wind energy by 2030.

The biodiversity crisis we currently face is being exacerbated by climate change. The DOI and the administration as a whole recognize that deploying clean energy at such an immense scale will likely have implications for vulnerable species and our conservation goals. The administration relies on science and innovation to guide our efforts with recognition that this is an all-hands-on-deck moment. These broad issues require that we bring together a diverse set of stakeholders – including those in the scientific research community, industry, and conservation sectors – to work collaboratively. Scientists both within the government and externally are moving toward solving the challenges we face in the energy transition. Coupling this with advancements and innovation in new technologies from industry and conservation sectors instills promise that we can achieve these important goals.

The DOI is responsible for protecting and managing the nation's natural resources and cultural heritage, providing scientific and other information about those resources, and honoring its trust responsibilities and commitments to American Indians, Alaskan Natives, and affiliated island communities. Central to the mission is protecting biodiversity and preserving intact ecosystems. Climate change poses a direct threat to those efforts, but it also threatens everything else that we're required to protect. The President has made it very clear that the DOI needs to be taking a leading role in advancing these priorities. With so many species on the brink of extinction, we need to consider both the short-term and the long-term view. To protect biodiversity, we need to think about protecting and preserving our national parks, our national wildlife refuges, our rivers and waterways, and all other natural and cultural resources because all of these are at risk due to climate change. These resources are critically important for the health of our communities, the health of our economy, and the health of our ecosystems. All of these issues are interconnected, requiring a collaborative effort, involving broad engagement and innovation. Within this regulatory framework, we have the tools to help preserve biodiversity, but also the flexibility to work with partners and stakeholders as well as with industry to achieve the build out of renewables at the necessary scale in the short timeframe that we have to work with.

We need to be deploying renewable energy at an immense speed and scale. The DOI does not view conserving species, preserving biodiversity, and supporting recovery of species as mutually exclusive with building out renewable energy. At the Department, we’re approaching this thoughtfully in a number of ways, such as working to increase efficiency in the permitting process, providing more certainty for all stakeholders involved, supporting the critical science that will help alleviate tension where it does exist. The DOI is working to increase staffing to expedite permitting and environmental reviews. Simultaneously, USFWS is working with the energy industry to build offshore wind energy through early communication and engagement. USFWS is also in the process of promulgating two rules with respect to birds, one for incidental take of eagles and one for incidental take of migratory birds. The intent with both proposed rule changes is to introduce more transparent processes to provide more certainty to stakeholders while still protecting birds.

Along with the coordination, the DOI continues to invest in the research and the science, where the most difficult challenges often lie. White-nose syndrome (WNS) provides a great example wherein we know that wind energy has impacts on the bat population, but not nearly the level of impact posed by WNS. Based on what we’ve learned, we can invest in and support the research of really promising technologies and treatments that have the potential to not only positively impact the bat population but be a huge victory for wind energy as well. We have the toolbox, and it is through the innovation and the ingenuity of the collective of individuals and entities in this room that we’ll be able to achieve these goals and secure a bright future.

Estimating direct impacts to birds and bats: State of the science and challenges to implementation

Moderator: Cris Hein – Senior Project Leader, National Renewable Energy Laboratory

Panelists:

- **Daniel Riser-Espinoza –** Consulting Statistician, Western Ecosystems Technology, Inc.
- **Brogan Morton –** Founder & CEO, Wildlife Imaging Systems
- **Jennifer Stucker –** Senior Research Biologist and Offshore Wind lead, Western Ecosystems Technology, Inc.
- **Roberto Albertani –** Professor, Oregon State University

Link to Recording: https://vimeo.com/user84144409/review/772136466/89ac13d33d

Discussions within this panel focused on technological solutions and on-the-ground methods for monitoring the direct impacts of wind energy on wildlife, as well as how collection methods influence fatality estimates.

Panelists provided preliminary findings of studies evaluating novel modeling approaches or emerging technologies for assessing and estimating direct impacts, including:

- Improving eagle take estimations through carcass persistence data and incidental detections;
- Ground-mounted camera technology to detect bat fatalities;
- Multi-sensor technologies for accurately measuring collisions and to improve understanding of the conditions under which collisions occur; and
- Validating comprehensive technology for detecting collisions in the offshore space where carcass monitoring is not feasible.

Daniel Riser-Espinoza – Game bird carcasses are less persistent than raptor carcasses but can predict persistence dynamics, and incidental eagle carcass detection can contribute to fatality estimation at operating wind facilities

See also corresponding presentation #20 Quantifying incidental eagle carcass detection at operating wind farms and #30 The importance of bird type in carcass persistence trials: raptors vs. game birds.

Estimating eagle fatalities considers three variables: the probability of detection or searcher efficiency, the probability of persistence, and the search area. We conducted two studies focused on eagle monitoring, driven by a need to estimate eagle fatalities more accurately for permitting and compliance. The first study evaluated variability in carcass persistence between game birds and large raptors. The second study examined incidental detections of eagles by operations staff at wind facilities.

The persistence study incorporated field-based data and a meta-analysis of over 100 studies across the country to characterize the differences between persistence of game bird carcasses and raptor carcasses, and how persistence varied between species groups by habitat, region, and/or season. In both the field trials and the meta-analysis, results showed that raptors were predicted to last considerably longer than game birds, indicating that game birds are a poor surrogate for estimating raptor persistence, and raptor persistence can be reliably predicted from game bird persistence. Models did indicate variability across regions and habitat. The consistently longer persistence times exhibited by raptors compared to game birds means studies focused on detecting raptors can afford greater time between searches and less effort overall while maintaining high detection probability. For post-construction fatality monitoring (PCM) efforts relying on game bird surrogates for persistence trials, this modeling effort allows biologists to better scale game bird persistence to raptor persistence estimates.

The second study examined incidental eagle carcass detections at operating wind energy facilities, which are typically not accounted for in fatality estimates. This study aimed to evaluate whether incidental data could be quantified and incorporated into fatality estimates to provide a more accurate estimate of potential take. Results indicated a detection probability ranging from ~30-70% detection across the sites. A consistent pattern emerged indicating higher detection probability at sites with a less complex viewshed (e.g., fewer visual obstructions from habitat and topography). Using these data to calculate an estimate of eagle take in an Evidence of Absence framework showed that with operations staff conducting routine activities, between 10 and 50% of eagles expected to occur incidentally will be detected.

Both studies suggest a possibility of creating powerful models that could incorporate all available data to improve eagle take estimates.

Brogan Morton – Validating a bat fatality detection system

See also corresponding presentation #12 Validating a Bat Mortality Detection System.

The purpose of this presentation is to present preliminary data from a study aimed at validating a newly developed ground-based bat fatality detection system. The system consists of three thermal cameras. Two cameras are ground mounted on opposite sides of the turbine, each 50-75 m from the tower and directed toward the base covering a 50x100-m rectangle beneath the RSZ to capture carcasses falling after a collision. One camera is located closer to the turbine base and pointed upward to monitor bat activity within the RSZ and ideally detect the activity occurring right before a fatality. The study was conducted at two wind turbines in Texas and involved collecting video data from a few hours before sunset to a few hours after, capturing 30 frames per second. Fatalities were detected using a combination of human review and quantitative analysis. Videos were processed and analyzed for fatalities, with the algorithm designed to highlight novel objects with a downward trajectory, indicating a falling object. All fatalities were human verified.

The results showed that there were 21 matching fatalities between the system and the daily carcass searches and seven unmatched fatalities with five detections by the system that were not found by the human searchers. The system detection rate was 87.5% when considering only the fatalities found by the human searchers and 108.3% when considering both the fatalities found by the system and the human searchers. The results indicate the system performs as well or better than a human searcher. The study also noted an anomaly in the airspace below the RSZ where there was relatively greater activity on some nights, which may require extending the area of risk. The next steps include finalizing the track classification model, calculating temporal bat activity metrics, and conducting a full validation test with more turbines in 2023.

Jennifer Stucker – A multi-sensor approach for measuring bird and bat collisions with (offshore) wind turbines

See also corresponding presentation #47 A Multi-Sensor Approach for Measuring Bird and Bat Collisions with Wind Turbines: Completed Validation Results.

Measuring bird and bat collision is difficult. From over 25 years of land-based PCM we have learned that we need to do it more frequently and do it better. On land, we only know when a collision has happened over night or at the timestep of a single day, but we lack resolution on exactly when and under what conditions fatalities occur. To move the needle on curtailment, we need to have higher resolution data and that need exists for both land-based and offshore wind generation.

The TNO WT-Bird system is a multi-sensor technology capturing both audio and continuous imagery of turbine blades to measure collision. Pilot testing performed in the Netherlands indicated that both on- and offshore the system could only reliably detect objects 250g. A proposal was put forth to advance the technology to detect 8g objects, roughly the size of a songbird or bat. Between 2020 and 2023, we tested the system's sensitivity to different object sizes, including 8g, 25g, 40g, and 250g projectiles made of gelatin reinforced with balsa wood. Projectiles were tested on both stationary blades in the TNO lab and on moving blades at National Renewable Energy Laboratory (NREL) facilities in Colorado. Two configurations were tested on moving blades, including a single blade with three sensors and two blades with two sensors. The system was found to outperform expectations with detection rates of 60-70% overall and 30% higher performance on the 8g objects than expected.

Complementary to these data, WEST collected over 300,000 images from 100 hours of monitoring. Initial findings show high precision (0.81-0.91) with identifying birds, and lower precision (0.71) for bats, though sample sizes were small. Classification by the system did not confuse large and small birds with bats. A land-based validation including concurrent ground-based carcass searches and estimated bird and bat fatality rates indicated the system successfully documented collisions with both thermal, regular spectral, and human validation. In summary, utilizing the WT-Bird system with WEST's Computer Vision camera system, we have a system that can reliably detect collision down to 8g objects, both birds and bats, operating both day and night. Next steps include deployment of blade sensors, spectral cameras, and thermal cameras for long duration deployment in the offshore space.

Roberto Albertani – Night vision and augmented wildlife-blade impact detection for offshore wind turbines

See also on demand presentation #53 Night-Vision and Augmented Wildlife-Blade Impact Detection for Off Shore Wind Turbines.

The system we evaluated was designed to reduce uncertainties around measuring the impacts of blades through video monitoring in the offshore space, where carcass monitoring is not possible. The system included blade-impact detection with high-resolution night vision camera sensors with views of the edge of the blade. The blade root module measures the position of the blade when an impact occurs to determine the flight height at the time of impact for both birds and bats. A video and microprocessor located at the nacelle provides continuous footage of the airspace around the turbine. A microphone installed on the turbine blades detects the impact events and triggers storage of a time-series of images before and after the event. The system can determine, with higher resolution, events that are abnormal or outside of the normal operation of the blade. We tested the system's sensitivity to blade-impacts from 2.5g objects traveling between 7-12m/s.

Preliminary results from 51 image recordings detected 23 collisions of 40g objects. When impacts are detected by the sensors, several images are saved. The twin camera setup provides maximum coverage of the area surrounding the blades even for very long blades, extending the area of view, and improves detection of the species or object colliding with the blade. We have observed between 50-95% of impacts depending on the signal-to-noise ratio. The system demonstrated automatic storage of images of impact. Impacts with projectiles of 2.5g, 10g, and 25g were detected on still, large blades, with impacts of 25g and 40g objects partially processed on operational blades. Warmed projectiles were detected by the on-blade infrared camera. Additional field testing is planned, including testing the night-vision camera during night-time operations as well as software improvements.

Audience Questions & Panelist Response/Discussion

Panelists responded to questions broadly addressing the following:

- How promising are these types of technologies in accurately detecting collisions or estimating risks in the operational environment?
- What are the challenges for validating these technologies and operationalizing them?

(for Daniel Riser-Espinoza) How will the carcass persistence study be used to improve conservation, management, and/or compliance monitoring at wind facilities?

One of the main things we get from this work is a more accurate estimate of how long we expect eagle carcasses to last. The largest raptor we used in the persistence study or in the meta-data set are considerably smaller than the average eagle. To the extent that the size of the carcass is an influential factor in persistence, we might expect that even these favorable raptor persistence results are a bit conservative with respect to what we might measure for eagles. There are studies to suggest that the size of a carcass directly influences its removal. For large-bodied raptors, we see long rates of persistence, with removals infrequent, and a longer time to degrade naturally. If we were able to do a true study with eagle carcasses, we would expect to see similar or longer rates of persistence than raptor carcasses.

Effectively this helps us get to more accurate estimates and helps to avoid overestimation that would certainly result from continuing to use game birds as surrogates.

(for Brogan Morton) Did the pilot camera detection system in Texas seem a promising method for finding small passerines that are active at night?

The species targeted by this work were bats, however anything that is as large as a bat or larger will be captured if they fall within the field of view. In fact, birds that are larger will be seen in much greater detail from a greater distance. There is nothing in the system that would differentiate between a bird and a bat. No nocturnal passerines were detected during the human searches, but there is nothing that would preclude that.

How do we work with turbine manufacturers to integrate new technology into the system? How might they be more involved in designing the systems, so they are compatible?

JENNIFER STUCKER: We have a bit of a disconnect to advance the technology to meet the need with the availability of turbines on which to test. We can ask questions of manufacturers and operators, but seldom get clear answers. The response has often been that such deployments would void warranty and thus indicate a reluctance to participate. To move these technologies forward, we need turbine operators to provide dedicated space for sensors. We are limited in options for deployment, particularly in the offshore space, where testing requires this type of technology to be installed on the turbine platform or on the nacelle. While we may be able to validate technology on the ground, we need the ability to test in operational environments. It would be helpful to have manufacturers who could identify operators who would be willing to provide opportunities to deploy these technologies on operational machines. Indications are that real benefits have to be demonstrated – if it is not clear from the operators that a certain technology needs to be considered, manufacturers have not been willing to engage in discussions to promote system compatibility. For these technologies to be available, they first need to be validated, which requires a willingness from the manufacturer to engage.

BROGAN MORTON: To date, there have been conversations with manufacturers and operators, some of which have been productive. There have been developments with how to improve the placement of this technology along blades. However, often the easiest course has been to place cameras not on the turbine structure.

How are data being retrieved from these systems?

BROGAN MORTON: Some systems have been tested using solar power and memory card or internal storage, others have pulled power from the turbine. The primary challenge has been consistent power to reduce downtime. To operationalize, these systems will likely require power to be pulled from the towers themselves. In the offshore space, getting data to and from the turbine is a challenge. There are options (satellite, fiber-optic cabling), but each present their own challenges from IT integration to costs.

JENNIFER STUCKER: Data segregation requires a separate fiber network to be installed at construction, which is a cost consideration, but it makes this type of data collection, whether for testing and validation or to operationalize once available, much easier. Ideally, systems will need to be only minimally integrated for efficiency, however, separating the system from the data network of the turbines comes with a cost and significant pre-planning with advocacy from the operators and developers. An additional consideration for any data storage or transfer solution is the capacity, with data pulls sometimes on the order of millions of images.

BROGAN MORTON: Siemens has achieved this through build out of a separate customer network, but at significant additional cost.

ROBERTO ALBERTANI: Solving integration issues may require a tiered approach that addresses the mechanical integration of the sensors on the blades, the power/connection of the system with or without the supervisory control and data acquisition or other system on the turbine, then thirdly the data flow from and to these systems. Perhaps we need to evaluate each tier of this integration separately to systematically solve for whole system challenges.

(for Brogan Morton) For detections that were identified by the ground-mounted camera system, but not validated by human searchers, how can we be confident that those were true positive fatalities?

The system was designed not only to look for detections, but the tracks of objects detected, with tracks being comprised of spatially and temporally correlated detections strung together. We looked at the size of detections, how far apart they were and how fast they were travelling to determine the object's trajectory. We used the machine learning model to determine probable tracks and then reviewed the raw video to determine the validity of the mortality as detected by the system.

(for Jennifer Stucker) How does the speed of projectiles used in testing compare with flight speeds of birds and bats?

The velocity of the projectile is likely less relevant. The most important consideration is getting the projectile to collide with the blade. Another important factor is the velocity of the blade, where closer to the root the velocity is nearly zero and increases toward the tip of the blade. The launch speed of the projectiles was measured at 70m/s, but the velocity slowed tremendously throughput the trajectory of the object. Getting the instantaneous velocity at the time of collision was nearly impossible – it would be even less feasible to detect the velocity at the time of collision for a warbler or a bat.

Measuring bird and bat behavior to hypothesize species collision risk

Moderator: Kimberly Peters – Principal Avian and Bat Biologist, Ørsted

Panelists:

- **Johnathon Rogers –** CEO, Persimia, and Professor of Aerospace Engineering, Georgia Tech
- **Greg Forcey –** Principal Scientist, Normandeau Associates
- **John Yarbrough –** Senior Research Scientist, National Renewable Energy Laboratory
- **Trevor Peterson –** Senior Wildlife Biologist, Stantec Consulting

Link to Recording: https://vimeo.com/user84144409/review/772612266/9044a4a383

Discussions within this panel focused on technological solutions and on-the-ground methods for monitoring the direct impacts of wind energy on wildlife, as well as how collection methods influence mortality estimates.

Johnathon Rogers – Probabilistic bat fatality modeling based on survey data

See also corresponding presentation #16 Probabilistic Bat Fatality Modeling Based on Survey Data.

We generally understand that bat fatalities are not the result of deterministic conditions but are also not likely to be purely random events. Presumably, fatalities are the result of a random process that has some correlation or dependence on external variables that affect bat behavior around wind turbines. We sought to create a probabilistic model that better predicted when fatalities occur.

To help us better understand the uncertainty around these events and to analyze potential outcomes, we developed and tested a probabilistic model of bat fatality based on maximum likelihood estimation which produces a probability of fatality as a function of some covariate. We tested the probability of a fatality occurring under three key variables known to influence bat activity: wind speed, temperature, and month. We turned each of these into categorical variables based on their influence on bat risk (a.k.a. "activity") around wind turbines. For example, periods with wind speeds of 3-5m/s were categorized as high activity wind, while wind speeds of 6-8m/s were categorized as low activity wind.

We built the model using fatality data from the Fowler Ridge Wind Farm in Indiana. We broke down the three months (August-October 2021) during which PCM surveys occurred into 10-minute intervals (from sunrise to sunset) and assigned each interval the correct value from each of the three categorical variables described above, based on meteorological data. We then determined the probability of a bat fatality occurring during each 10-minute interval, based on the observed fatalities for each night. We optimized the model by comparing a series of hypothesized probabilistic nightly fatality predictions to the observed fatalities, using a maximum likelihood estimation process, until we produced a model in which the simulated fatalities matched the observed fatalities as closely as possible. We used this model (based on PCM data from a single season in 2021) to "predict out" the number of fatalities/turbine from 2007-2012. Comparing the model estimates to actual fatality records during these years produced similar results, providing a proof of concept for this type of model estimation approach.

We then attempted to determine whether a good model fit at one location could reliably predict bat fatality risk at other sites around the country. We used the same model fit to the Fowler Ridge survey data and used it to estimate fatalities for a wind site in Oregon, using site-specific meteorological data. We found lower predicted fatalities from the model estimation, which aligned with the findings of post-construction surveys from the site. We then tested model fit at a regional scale, using the model parameters from the original model and sampling meteorological data across the state of Iowa to determine how well the model would predict probability distributions at several wind sites. Responses were variable, but generally we saw a correlation between the modeled environmental variables and fatality events.

There are a number of potential site-specific factors that this model doesn't take into account and could certainly impact the estimates, but generally, if these correlations hold true at national or regional scales, this type of modeling approach may help to reduce some level of uncertainty in predicting fatalities for the purposes of designing mitigation. This model provides a powerful solution for understanding and predicting bat fatalities, allowing for more informed decisions around project siting and mitigation.

Greg Forcey – Behavioral responses to offshore wind turbine infrastructure among bird and bat species groups

See also corresponding presentation #40 Behavioral responses to offshore wind turbine infrastructure among bird and bat species groups.

Environmental variables such as seasonality, habitat, and weather have a strong influence on animal behavior and timing of activity which can affect collision risk. These associations underscore the importance of understanding the bird and bat behaviors and weather relationships with activity that occur on offshore wind turbines. We characterized the bird and bat activity and behavior in the RSZ of turbines at the Coastal Virginia Offshore Wind (CVOW) pilot project to 1) understand the type of behaviors that occur there, and 2) understand how activity is affected by weather variables.

We installed one ATOM system on each of the two turbines at the CVOW pilot project with the goal of characterizing bird and bat activity within the RSZ. The systems were deployed during spring (April 1-June 15, 2021), fall (August 15-October 31, 2021), and winter (January 15-March 15, 2022) for the first year of monitoring. The ATOM system was originally designed as part of a BOEM research contract, and upgraded to include two thermal cameras, a visible light camera, a Motus[3] receiver and upgraded acoustic detectors. The system is mounted to a chassis, which is then mounted to the wind turbine platform. We used a combination of composite and artificial intelligence image review to extract targets from the video and manually reviewed each target to identify to species or lowest achievable taxonomic level. Acoustic data were analyzed using Kaleidoscope Pro software. For each observation, we assigned a level of confidence to the identification from possible, to probable, to definite. Motus data were processed through internal filtering on the Motus website to obtain species ID from the tag data. Overall, we observed 521 bat detections and 1,011 bird detections. We observed birds from a wide range of taxonomic groups, including shorebirds, passerines, skuas, swallows, corvids, gulls, and one tern. Bat identifications included three species: hoary bat, silver-haired bat, and eastern red bat. There

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[3] Motus Wildlife Tracking System

were 1,313 detections of unidentified low-frequency species, and 37 bats detected only in video that could not be ascribed to species.

Over 98% of detections occurred in fall. Patterns of movement differed between birds and bats. Of individuals detected in video, 55% of bats were recorded when the blades were moving while 73% of birds occurred when the blades were not moving. Bird observations were classified into behaviors from the video data including foraging activity, flight height in relation to the RSZ, attraction (flies into then away from turbine), and micro-avoidance (moves from one side of blades to other while blades are spinning). A high percentage of observations were associated with foraging, particularly for passerines (71% of observations). Activity patterns varied with weather, particularly wind speed. Bat activity declined at wind speeds higher than 6m/s, though activity was recorded at wind speeds up to 16m/s. Passerine activity declined sharply at 5m/s, but the effect of wind speed was less apparent for non-passerines. This information has implications for collision risk and minimization, given that cut in speeds typically range between 3-5m/s for these turbines. The project will continue with an additional two years of continuous monitoring and will continue to evaluate these relationships to examine any temporal variation that may occur.

John Yarbrough – An AI driven flight path classifier designed for studying bat behavior in and around wind turbines

See also corresponding presentation #61 An AI driven flight path classifier designed for studying bat behavior in and around wind turbines.

This work built on research by Paul Cryan that manually classified bird and bat behavior around wind turbines. We endeavored to utilize machine learning to expedite the process of analyzing data from thermal cameras. We built a machine learning algorithm to filter the movement of the blade and focus on tracking movements of biological objects in the field of view. We were able to develop a classifier within the algorithm to detect a bat, track its flight movements, and recognize previously identified objects that leave and return to the field of view. With this information, we can start to ask questions about real-time conditions occurring at the time of the bat activity, versus an average or associated value determined in post-processing. We can use machine learning to determine exact coordinates for an individual object's movement with exact timestamps and use that to calculate the velocity which can in turn be used to filter out non-target objects, like insects, based on known flight speed. Algorithms can be trained to focus in on anomalies, for instance when a bat spends an inordinate amount of time around a turbine. From that data we can investigate why that might be occurring, what behaviors were exhibited, what environmental factors might be at play.

To do this, we started with a simple build out of a convolution neural network to conduct image analysis that would detect and track an object and classify the track as a linear movement, non-linear movement, or interaction with turbines (i.e., hanging around, diverting away, etc.). We defined what each type of movement looked like using existing bat flight paths (n=900) and ran this training data set through the algorithm. This resulted in an 85% ability to characterize linear flight paths, 50% chance of identifying non-linear flight paths, and a 40% chance of accurately identifying interactions. To improve the system, we need more training data, specifically to help differentiate non-linear and interaction flight paths, and account for curvature in linear flight paths versus a true non-linear flight. The classifier is built on only XY coordinates of the flight path and does not rely on the raw video data. This allows us to incorporate secondary and tertiary data during processing to characterize the flight paths such as degree of curvature and whether the object is moving toward or away from the turbine. We can also integrate real-time environmental data like wind speed and temperature. We can use this information to start determining whether environmental changes are influencing bat behavior or if behaviors are random acts. Once complete, this is a tool that could be used to expedite research. With more data, we can improve the classifications and offer a real-time solution to collect and process data offsite and have it available for use almost immediately. The algorithm, which is being called a “binary biological tracker machine learning algorithm,” and associated 3D learning multiclass will be released on GitHub by the end of 2022, with hope to incorporate more data and release an updated model thereafter.

Trevor Peterson – EchoPitch: Using acoustics to measure and manage risk to bats at commercial wind energy facilities

See also corresponding presentation #69 EchoPitch: Using acoustics to measure and manage risk to bats at commercial wind energy facilities.

This presentation focused on the potential utility of acoustic data in helping to manage risks to bats at wind energy facilities, as well as ongoing research on capabilities of the EchoPitch framework. We have a reasonable understanding of when risk to bats is highest, based on season, time of day, and wind speed and a regional level. We do not yet understand all factors driving collisions at the site level. To date, project siting has been the primary method for evaluating potential risks to bats and other wildlife posed by wind energy development. However, this approach has only been successful at identifying siting issues after a project has been built, which does not enable us to identify and prevent risks to bats at individual projects.

We know that for a bat fatality to occur, the bat must be in the RSZ while the blades are moving; curtailment or shutting down the turbine will therefore remove the collision risk, but at a significant tradeoff to power generation. The fundamental challenge with curtailment is to determine how best to balance risk reduction and energy loss and focus the measure on periods with increased risk. We may begin to answer this question by identifying other potential factors that influence bat collision risk. We’ve begun to understand not only that landscape factors are important, but also the way turbines interact with airspace (e.g., nacelle height, rotor diameter) can have a profound effect on risk to bats. Taken together, this suggests that we need to supplement PCM with more and better metrics, and acoustic data may help address this gap.

Acoustic monitoring has been utilized to attempt to measure and predict risk, but pre-construction bat activity has not been a good predictor of fatality rates, which may be in part due to not differentiating bat activity that would or would not have been exposed to turbine operation. To further address this question, we conducted an acoustic monitoring study at an operational wind farm with the goal of better understanding interspecies differences, relationships between habitat variables, seasonal variables, spatial components, and factors that might affect risk to bats. We deployed 15 acoustic detectors at each of two wind facilities in Missouri. Detectors were mounted 20m above the ground just below the RSZ and on the top of the nacelle. Data were collected for 1.5 years. We found a seasonal pattern with exposure peaking in the late summer and early fall. We looked at the number of bat passes with exposure per night and compared that across turbines with and without curtailment. We noted that acoustic exposure was significantly lower at turbines curtailed at 5m/s when compared to uncurtailed turbines. There were 10 times more bat passes at mid-tower height, closer to the ground, than at nacelle height, however, the seasonal distribution of that activity and the exposure was nearly identical. We found that patterns in acoustic exposure data and number of carcasses found were highly correlated, suggesting acoustic exposure data can be a good indicator of collision risk. Findings were nearly identical across both sites.

Making this connection between acoustic exposure and fatalities allows us to begin to analyze exposure and risk on a variety of scales. We can evaluate risk on an individual detector based on specific wind speeds, tailoring curtailment strategies to maximize operations and optimize risk minimization on a much more temporally precise basis. This also helps us to better understand where and under what conditions risk is occurring and design more effective minimization strategies with a specific risk reduction goal in mind, providing more flexibility and control versus a largely uniform implementation strategy that cannot account for site-specific factors. The next steps in this work include deployment of thermal cameras at one of these sites, as well as a paired site in Maine to better understand how these technologies might complement one another. Specifically, we intend to look at patterns of echolocation, and spatial distribution of bats around turbines.

Audience Questions & Panelist Response/Discussion

Questions were generally directed at specific panelists regarding clarification on methods and results. General questions focused on:

- Insights regarding incentivizing smart curtailment; and
- Factors that influence avoidance with a focus on opportunities and challenges for implementing the methods presented.

Does the panel have any insights on how to provide incentives to implement smart curtailments or smart solutions over blanket curtailments and to improve the feasibility of required minimization measures?

JOHN ROGERS: Data show that there are possibly some low hanging fruits in terms of bat activity or fatality data. For example, there appear to be time periods during which temperatures are very much out of range of when bats are usually active. There are also simpler solutions and all sorts of optimizations that can be done.

JOHN YARBROUGH: The incentive is for us as a community to make this smart curtailment smarter. Even with smart curtailment, turbines must shut down, so we should be looking at ways to shorten that time or design very specific turbine shutdowns. There is concerted interest in trying to shift the technology to cheaper systems so it can be deployed on multiple turbines, both to better assess how bat activity is distributed across sites and to target shutdowns when we recognize areas and periods with a lot of bat activity. This will help to optimize curtailment that is turbine dependent, instead of wind farm dependent.

TREVOR PETERSON: We could also incentivize curtailment by designing it in terms of intended outcomes, versus blanket requirements. For example, if you're an agency, instead of saying you shall curtail below 5m/s or 6.9m/s, design those conditions as the intended reduction in exposure to produce a curtailment strategy that will reduce risk by 50% or 75% or 25%. This allows the industry to be strategic in how they achieve reductions and address site-specific variables to achieve that, as well as promotes innovation in evaluating and reducing exposure risk.

GREG FORCEY: This would of course also have to be economically feasible, so the cost of the system and the maintenance and the whole process needs to be worthwhile for the developer to implement it, being both cost effective and biologically effective in reducing mortality.

Can you envision a way to integrate fatality risk and probabilities with exposure to generated quantitative risk threshold to guide curtailment?

JOHN ROGERS: We've done some important groundwork using models to optimize a curtailment strategy where we can reduce fatalities by a certain percentage. These models can determine exposure risk for any 10-minute period and determine what additional risk/incremental risk is added by operating in that period and for any time of the year. This information can be used to create decision-making tools that can work in real time based on either probabilistic models or predictive models using acoustic data to eliminate a certain percentage of risk and optimize mitigation strategies.

TREVOR PETERSON: If you quantify the value on the energy generation side, it allows you to acknowledge that there's a certain cost to achieve certain levels of risk reduction and that cost starts to increase very quickly going from, say,s 75% risk reduction to 85 to 95%. If you think about the value that the energy is providing, there is an inflection point between where the added cost of additional curtailment starts to decline relative to the amount of risk you're avoiding. Determining where that inflection point is will be key to optimizing its curtailment. This does not help us figure out the margin of risk reduction needed to achieve population goals, but at least by quantifying it would provide the basis for that sort of framework.

Where we're seeing some evidence of bird and bat avoidance of the turbines, are there ways to encourage that avoidance?

GREG FORCEY: Stated simply, probably not. You could take steps to maximize visibility or minimize low visibility conditions, but there is a limit to how to accomplish that and how effective it will be. There has been a study evaluating painting turbines black, however that study needs more validation before it can be considered a reliable approach.

TREVOR PETERSON: There has been some compelling work with bats to determine if they are failing to detect the turbine based on its shininess or because it is a novel object in the landscape. Making the turbine more visible to bats would theoretically result in avoidance, however there is quite a bit of evidence indicating bats are attracted to turbines. So, making them more visible could be an attractant. At this point, the evidence is not strong enough either way. This is likely true in the offshore environment as well, with the possible effect of attraction potentially much greater. There is virtually nothing else in the landscape and no habitat features other than the turbine. Camera data will help us determine the ways that bats are interacting with turbines and help decide whether these types of minimization measures are effective.

What software are you using for avian acoustic analysis? How many turbines or what percent of a project would you recommend these different technologies be applied to in order to get the collision risk and actual flight paths, and what would the cost be?

GREG FORCEY: The ATOM system can be used for flight path data.

JOHN YARBROUGH: With our system we're using a less expensive camera, roughly $6,000 per camera. We use Python to produce a 2D output. It would realistically take an additional $6,000 to add the 3D data. We're really trying to make it economical to move away from high resolution cameras because it is so cost-prohibitive just to monitor even one turbine. From an acoustic detector perspective, the answer depends on what you're trying to do with the data. If your intention is to control all turbines with the same algorithm, then you don't necessarily need that much spatial coverage, and we have not seen a big difference in things like the seasonal trends in bat activity across a site.

TREVOR PETERSON: It's important to clarify the goal for the data in order to answer this question. Typically, the amount of bat activity might vary quite a bit, but the conditions under which it occurs tend to not be very different across projects. Regardless of project size, about 10 to 15 detectors gives you pretty good spatial coverage. This also adds redundancy which is necessary because inevitably you lose some data. There is a tradeoff between what you think you're going to do with the data and how much the additional equipment costs. Acoustic detectors are considerably less expensive than cameras, and the analysis time is relatively short.

(for John Rogers) How can these methodologies and models be applied to summer data when conflicts start to arise with maternity colonies? Did you look at any summer data?

We did not specifically evaluate summer data. The nice thing is that bats echolocate most of the time so you can define and measure any of these index-based activity metrics during any season with roughly equal accuracy. It's more how you define the seasons and how you analyze the data, but you could evaluate exposure or activity or behavior in those different seasons.

(for John Rogers) One of the big issues with using fatality data and trying to understand conditions that may have led to that collision is not knowing when that carcass was actually hit. Is it absolutely necessary to use daily search data for the models to work?

With maximum likelihood, the quality of the data matters. We did a study on this which I didn't show but there's a gradual degradation as your searches have longer intervals. For example, the data get a little worse if you do searches every two days, and then they get pretty bad if you do weekly searches. If you do searches every month, the data become basically worthless. The way you might be able to deal with that is more data. So, if our data quality is poor, we can sometimes compensate with more data. Statistically speaking, there are gold standard data, but that doesn't mean that you need nightly searches to do this. For predictive purposes, we will take the data at 10-minute intervals the night before and we'll assign probabilities for each of those 10-minute intervals. Each has a probability of fatality and then we'll accumulate it so at the end we can optimize all those probabilities to maximize the likelihood of an outcome. We don't do any averaging, rather we rely on the convergence of law of large numbers to mitigate the fact that we can't take measurements exactly when that fatality occurred.

(for John Rogers) Was the Fowler Ridge model overlaid over Iowa cross-checked with any post-construction data to validate the bat fatality rates?

This was done as the last step of the project, and we didn't have a chance to go back and validate. The big question mark that hangs over this work is how portable is it? Is it portable at a very local scale, at a regional scale? We did a few test points, but we really need to look at it in more depth. I think the thing we took away from that Iowa example was that it can be done using just meteorological data from NREL. If we have met data across the country, we could potentially make nationwide predictions just to look at the trends. In the Iowa example, in warmer regions of Iowa we saw that fatalities are predicted to be higher because that's what the model reflected. But in general, I think validating and testing the portability of the model is an important next step.

(for John Rogers) Did you track the probabilistic modeled high fatalities with large energy or peak demand times for utilities, temperature, and time of day?

No, but that could certainly be done. If we can call this probabilistic model and then somehow have scores of high power prices or so on, that's just one potential application for this model. Smart curtailment strategy could be a big use case of this kind of model.

(for Greg Forcey) What is the range of detection for the video camera and for the acoustic units?

Based on the drone calibration test that we did, we were able to detect its drone out to about 280m. Smaller size targets (tennis ball size) can be detected out to 144m. We tried to use some smaller size foam cutouts to simulate birds and had mixed results. We're exploring some other options to try to assess the detection range of smaller targets. With the video we did do a calibration study for the original system that we developed with BOEM. However, the calibration tests done with the original system are not entirely representative of the new system given all the upgrades.

(for Greg Forcey) Were there any observed relationships with wind direction?

Both birds and bats were most active when winds were out of the north, northeast, and northwest, however, this may be an artifact of seasonality as most of the detections were in the fall and a southerly flight would align with the dominant direction of travel during migration.

(for Greg Forcey) How were you able to determine behavior (e.g., foraging versus passing through) and which criteria did you use to categorize behavior?

Foraging behavior was determined by observing the bird capturing prey. There were thousands of insects that we observed around the turbines, ranging from butterflies to moths to dragonflies. Foraging was not something that we just inferred; it was usually easy to see that the bird was capturing an insect. If we didn't or couldn't observe foraging behavior, we assumed the individual was flying through.

(for Greg Forcey) Does the ATOM system observe collision events during monitoring?

We did not observe any collisions during the first year of monitoring. We did observe some instances of air displacement. Air currents generated as the blades are spinning did seem to disrupt a couple of flights where the bird or bat backed off and appeared frazzled, fell a little bit, and then picked up and took off. The system has the capability to detect collisions if they occur within the cameras' viewshed. We can't detect collisions on the far side of the blades opposite the cameras, nor can we detect collisions on the portions of the blades obscured by the monopole. We can only see collisions if they occur between ATOM and the blades without obstructions.

(for Greg Forcey) What were the background wind speeds at the Dominion CVOW site?

Most bird and bat detections occurred at a wind speed of less than 6m/s. We compared the observed wind regime to observed bird and bat activity in relation to wind speed to determine if this finding just reflected the wind speeds at the site. The distribution of wind speeds at the site did not match the distribution of bird and bat activity in relation to wind speed at the site. This suggests that the relationship is not simply a result of the frequency of wind speeds at the site.

(for Greg Forcey) Is there a way the ATOM system could be optimized to detect avoidance and improve collision risk models for birds by including parameters like flux rates of animal movement, and meso- and macro-avoidance factors?

The system can be used to provide some level of quantification for micro-avoidance. In order to get more or better input parameters you would also need to look at meso- and macro-avoidance as well. That's not a job for ATOM but that's a job for other technologies such as radar. You want to consider a multi-sensor type system or series of technologies to get as much data as possible to inform the parameters for those collision risk models.

(for John Yarbrough) Given the system capture bats and insects, did you compare bat activity to insect activity, and if so, was there any correlation between the two? Is there a way for the system to be used to study this relationship?

We have begun to plot that data and the system can be used to evaluate relationships between birds, bats, and insects. We did notice a correlation with wind speed and both insects and bats. The beauty of this system is that we have a wealth of data and that presents a lot of opportunity for asking questions. We can see these patterns in real time and can begin to parse out this data and work with biologists to develop experimental designs to begin to explore things like attraction, behavioral classification, and the effects of deterrents.

(for John Yarbrough) How does the system recognize whether a detection is multiple bats with one track, or one bat with multiple tracks?

We assume that once a bat leaves for a certain period of time, when a bat re-enters the space, it is a new bat. Our field of view is very small. If we were to expand the field of view by repositioning the cameras further from the turbine, we would have more certainty over whether we are seeing one bat or multiple bats. This assumption may not hold true in the offshore space given the limited amount of refugia relative to the terrestrial environment. From an exposure perspective, when just using acoustics, we can't make that determination but that may not matter because what we're interested in is exposure risk, not necessarily the number of bats that fly through. The exposure risk of an individual bat is influenced by the number of passes, and that accumulated probability of interaction with the turbine.

(for John Yarbrough) Would 3D technology help to address some of these questions?

Yes. With 3D comes the added Z component with XY. The system that we developed can be used to add the additional dimension on the turbine. Adding a 3D multiclass component coupled with the tracking mechanisms could help to improve accuracy in determining the numbers of bats.

(for Trevor Peterson) Have you seen the acoustic exposure-to-mortality rate relationship translate from facility to facility?

We haven't evaluated this relationship among sites to date, but we are currently completing a research project to address this question and will have better perspective after this field season. We're doing work supported by the DOE and Mid-American in which we're collecting paired acoustic exposure and fatality data at 13 different facilities across Iowa and that will give us the ability to look at this more at a facility-wide scale. Instead of just determining monthly exposure versus monthly number of carcasses, we will be able to explore that relationship at many different temporal and spatial scales.

Recommended Resources

- Peterson, T.S., B. McGill, C.D. Hein, and A. Rusk. 2021. Acoustic exposure to turbine operation quantifies risk to bats at commercial wind energy facilities.

Technological solutions to minimize impacts

Moderator: Pasha Feinberg – Wind and Wildlife Specialist, National Wildlife Federation

Panelists:

- **Juliet Nagel –** Normandeau Associates, Inc.
- **Victoria Zero –** Research Biologist, Western EcoSystems Technology, Inc.
- **Sarah Fritts –** Associate Professor, Texas State University
- **Hein Prinsen –** Senior Consultant, Waardenburg Ecology
- **Aleksandra Szurlej-Kielanska –** Senior Research Ornithologist, Bio Seco

Link to recording: https://vimeo.com/user84144409/review/772608280/e0631a2afa

Presenters discussed research on technological solutions under development to minimize direct impacts to birds and bats from operating wind turbines with a particular focus on questions that identify the limitations and the challenges involved in implementing the methods presented. Studies aimed to evaluate the efficacy of evolving approaches to minimize risk relative to current standard practices, with results highlighting the need for site-specific consideration of design and implementation to achieve optimal results. Ultimately, the presenters provided evidence for promising new approaches toward risk reduction while balancing the need to continue to produce commercial-scale wind energy.

Juliet Nagel – Evaluation of the turbine integrated mortality reduction (TIMR) technology as a refined curtailment approach

Wind energy development is critical to address climate impacts, and bats provide invaluable ecosystem services. However, wind energy remains a leading cause of mortality for some bat species. We need both wind energy and bats on the landscape, so how can we have both? Current industry practice is to minimize or mitigate bat fatalities through curtailment, and in practice we know this method to be effective, albeit imperfect. Curtailment is typically moderated by wind speed, however, just because wind speeds are low does not mean bats are present, resulting in potential loss of energy. Conversely, bats may still fly above cut-in speeds resulting in fatalities.

Rather than apply a blanket approach, we might consider curtailment as a continuum moderated by environmental factors (e.g., temperature) or bat activity. Normandeau has deployed a TIMR, which uses acoustic sensors to trigger curtailment based on bat activity. We are currently exploring how varying the number, configuration, and effective detection radius of sensors at each turbine will affect bat collision risk, using acoustic data to model the following scenarios:

- Common Control - deploying sensors on multiple turbines across a wind energy facility with overlapping effective detection radii and each sensor controlling all turbines across the site (i.e., any sensor triggered results in site-wide shutdown), achieving total site coverage but likely resulting in the lowest operation time and highest energy loss;

- Unsaturated - deploying multiple sensors with reduced effective detection radius, providing some overlap of coverage between turbines but not complete site coverage, and likely to create the highest operation time and the highest risk to bats; and
- Saturated - deploying to a saturated density with sensors on every turbine informing their own, as well as adjacent turbines, offering reduced control distance and more operating time, but less cost-effective.

What we've learned thus far is that site-specific data will be important for implementing and updating this system to inform an effective curtailment strategy that meets objectives for both energy generation and bat conservation.

Victoria Zero – Test of an acoustic-activated curtailment system for minimizing bat fatalities

See also corresponding presentation #44 [Test of an acoustic-activated curtailment system for minimizing bat fatalities](#).

This study evaluated the efficacy of Natural Power's EchoSense (formerly DARC[4]) acoustic-activated curtailment (AAC) system at a commercial-scale wind facility in the Midwest. The site consists of 60 turbines in a predominantly agricultural setting but with significant forest and wetland cover (28%) and potential for listed bats to occur. This facility is in a relatively low wind resource area, meaning if the facility were to curtail at USFWS-recommended levels, turbines would be curtailed frequently, providing an ideal site to test the AAC approach. The primary objectives were to:

- test the efficacy of AAC relative to traditional curtailment,
- evaluate energy losses under both strategies, and
- determine any variation in seasonal efficacy of curtailment.

The 60 turbines were split into three experimental groups evenly distributed throughout the site: control (feathered below 3m/s and >10 degrees Celsius), blanket (feathered below 5m/s and > 10 degrees C), and a test group equipped with AAC sensors wherein a single bat call at any of the nacelle-mounted sensors would trigger curtailment at all 20 acoustic activated turbines for 30 minutes per detection (applying the same wind and temperature thresholds as the blanket group). Fatality monitoring was conducted across the site in both summer and fall.

AAC was statistically as effective as blanket curtailment with respect to all-bat fatality rates (summer and fall) and both curtailment strategies performed better than the control, with 43% reduction in bat fatalities. From May-October, blanket curtailment resulted in a 3.2% loss in energy production compared to the control, where AAC lost only 1.8%. Curtailment was most effective at reducing the overall percentage of bat fatalities relative to the control during summer (relative reduction); however, curtailing turbines during fall avoided a greater number of fatalities (absolute reduction). With most studies of curtailment focused on migratory periods, this result has important implications for how we consider curtailment to protect bats during sensitive life stages in summer months.

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[4] https://www.naturalpower.com/us/news/news-post/natural-power-launches-darc-bat-curtailment-creating-harmony-between-wind-energy-and-bats

Overall, AAC provided an effective means to minimize risk to bats at this facility and resulted in higher energy production relative to blanket curtailment. We need to continue to evaluate how AAC can be designed to improve energy savings and how we explain seasonal differences in efficacy. It is important to have good baseline bat activity and weather data to inform an AAC approach, but designed well, AAC can provide a viable long-term risk reduction strategy.

Sarah Fritts – Species-specific effectiveness of an ultrasonic acoustic deterrent using experimental trials in a flight cage

*See also corresponding presentation #*2 *Species-specific effectiveness of an ultrasonic acoustic deterrent using experimental trials in a flight cage*.

Acoustic deterrents have been shown to be effective in reducing bat fatalities by up to 78% for some species but ineffective at reducing fatalities for others. To address the cause of this interspecies variation, we tested changes in bat flight behavior and in echolocation behavior for various species, using an experimental flight cage.

We conducted flight cage trials, testing individual bat responses to three acoustic emission treatments selected to overlap the echolocation signatures of most North American bat species – low frequency (0-32Hz), high frequency (38-50Hz), and full frequency (0-50Hz). We used Wildlife Imaging Systems to visually track bat locations within the flight cage relative to the source of ultrasonic emissions across treatments. We also measured bat echolocation characteristics (e.g., frequency, call duration, number of calls).

Flight data showed a greater density of flight activity further away from the deterrents in all treatments relative to the control and no significant difference across the high, low, and full frequency treatment groups. However, the range of flight distances from the acoustic emitter within the flight cage did vary between high, low, and full frequency treatment groups.

Data suggested different responses in each treatment group based on both sex and species. In cave *myotis* species, we observed response to deterrents in all treatment groups, with differential responses by sex when deterrents emitted low frequency. Similarly for red bats, all treatments were effective, however, responses to high frequencies varied by sex, low frequency varied by both sex and season (i.e., males in spring showed greater response), and to the combined treatment by season (i.e., both males and females showed stronger response in spring). Bats also shifted their echolocation frequency higher in response to ultrasonic emissions, which may explain some of the variation observed in flight distance responses.

This research has the potential to identify in which cases (e.g., species and season) deterrents would be most effective (e.g., targeting deterrents when fatalities are highest for females, which contribute more to population growth rates). Future work will aim to further explain the observed variability through both adjusting experimental design and additional data analysis.

Hein Prinsen – Measuring flight behavior of cormorants with a dedicated 3D bird radar to develop shutdown decision rules

See also corresponding presentation #9 Measuring flight behavior of cormorants with a dedicated 3D bird radar to develop shutdown decision rules.

The study assessed the viability of a 3D radar system to detect and identify Great Cormorants within the vicinity of a proposed wind facility on an inland lake in the Netherlands. The proposed facility includes 24 offshore turbines located within a protected area hosting a large breeding colony for Great Cormorants, a federally protected species in the Netherlands. Numbers of Great Cormorants have declined steadily for the last 10 years, and the colony represents 20-30% of the local population within the protected area, posing concern over potential collision risk.

We deployed the 3D Robin radar system at eight proposed turbine locations proximate to the breeding colony to track flight height, movement, and speed of cormorants during the 2022 breeding season. The system has a >10km detection radius and can classify small, large, or flocks of birds but cannot identify species. We conducted weekly field visits to validate the system and identified 5,000 cormorant tracks and 1,0000 tracks of other species. Data were used to develop a machine-learning algorithm to classify cormorant tracks. The model achieved 81% accuracy in identifying bird tracks, 80% sensitivity in correctly identifying cormorants, and 88% specificity in correctly identifying which tracks were not cormorants, increasing the sample size from 5,000 field-verified to over 200,000 cormorant tracks.

Using the system, we identified flight speed, flux (number of cormorants/km/hr), and general activity patters of Great Cormorants within a 300m radius of each proposed turbine location as well as the area in between. Preliminary results indicated a seasonal increase in flux rate (number of cormorants/km/hr) through the turbine area in June and July. Flight activity peaked 1-5 hours after sunrise. We measured height distribution at each proposed turbine location, and while most individual birds were flying below the RSZ, the distribution across all tracks suggested potentially biologically significant overlap with the RSZ – even just 20-25% of individuals flying in the RSZ represents several thousands of birds throughout the breeding season. There was variation between turbine locations based on proximity to the colony, with higher flux rates observed at turbines closer to the cormorant breeding colony.

Our results demonstrate that 3D radar provides a promising approach to reducing collision risk. We can use radar to establish real-time bird activity and determine if a bird is on collision course, allowing for a targeted shutdown of individual turbines, rather than a blanket shutdown approach.

Aleksandra Szurlej-Kielanska – Bioseco BPS - way to protect birds against collision on onshore windfarms

See also corresponding presentation #41 BiosecoBPS - way to protect birds against collision on onshore wind farms.

The BiosecoBPS system is a fully autonomous stereovision system equipped with a daytime camera and AI-based software capable of monitoring a 360-degree area around a turbine. The system can detect a bird approaching the turbines and take predicted actions based on distance and flight path.

We evaluated the efficacy of the system to reduce risks to birds and validate a reduction in shutdown time at three operational wind farms in Poland, southwest Spain, and central Spain. At the facility in southwest Spain, the focus was on migratory birds and raptors. In central Spain, the study focus was on vultures, which experienced high collision risk year-round. In Poland, the study focus was on cranes, which use the facility as a flight route between foraging and staging areas – the facility is currently required to shut down all turbines for two hours at sunrise and sunset in August and September based on this daily activity.

All birds detected by the BPS system were classified to species or species group to calculate the number of detections (individuals or groups) that resulted in turbine shutdown. We further analyzed the videos from the system for behavioral responses of birds detected within the RSZ. This information was compared with fatality data from post-construction monitoring studies.

In central Spain, BPS detected over 39,000 birds, 10.8% of which were birds of prey. Less than 60% of detections of birds of prey met shutdown criteria (i.e., were detected within the RSZ). The facility in southwest Spain had lower numbers of birds (14,000) but a higher proportion were birds of prey (54%). Less than 73% of birds detected met shutdown criteria. No collisions were observed in the video analysis, and no fatalities were identified during post-construction monitoring, suggesting that for the detections that resulted in turbine shutdown, the shutdown was effective at preventing collision. Of these, 23% and 28% of detections resulting in shutdown in southwest and central Spain, respectively, were birds of prey, indicating the system is effective at providing protection for these species.

In Poland, BPS showed high detection efficiency for cranes up to 400m from the turbine, with about 60% of birds observed flying at collision height. However, 98% of these cranes were observed more than 100m from the turbine, never entering the RSZ. These data were used to determine how much the turbine shutdown time would decrease when using the BPS system. Total shutdown time under the current required regime is 244 hours per year. Using the BPS system to shut down the turbines only during sunrise and sunset when birds fly within 300m of the turbine resulted in 56 hours of total shutdown time. Shutting down turbines based on any bird activity from sunrise to sunset in efforts to protect not only cranes, but diurnal raptors resulted in 120 hours of shutdown which still represented a 50% reduction from the current regime.

Audience Questions & Panelist Response/Discussion

Panelists responded to questions broadly addressing the following:

- What are the limitations of these systems?
- How can systems be improved for broader applications (e.g., offshore, more species)?
- What are the barriers to implementation?

How are you forming partnerships with industry to get developer buy-in to these technologies?

VICTORIA ZERO: At USFWS, through the Habitat Conservation Plan (HCP) process we are trending toward exploring novel forms of mitigation, and in some cases using HCPs as a mechanism for conducting that research. Through that inherent interaction with USFWS on these topics, we are fostering mutual education and reflective learning.

HEIN PRINSEN: At least in Europe, there is a huge incentive in the wind industry to develop and invest in these kinds of studies through a competitive offtake process. There is an underlying driver to bring industry representatives, consultants, and ecologists to the table to help one another.

ALEKSANDRA SZURLEJ-KIELANSKA: We collectively need wind energy, and therefore we need to work together to collect more data and develop better systems for detection and to test their effectiveness.

(for Hein Prinsen) What technological improvements would we need to apply assisted shutdown technology further offshore?

We tested this technology for a bird species that has very predictable behaviors. To apply this offshore, you would need species identification capabilities, so knowing your focal species and how they can be distinguished from other species using only flight track. You also have to filter out radar noise from ocean waves and other "sea clutter." Additionally, the system cannot currently distinguish between a small flock or a large flock, making it difficult to quantify the total number of birds moving through the space.

(for Sarah Fritts) How much influence might the flight cage design and environment have over bat responses, and how would that vary from expected responses at the RSZ or nacelle height?

This was the first study of its kind, and we realize that we have a lot yet to learn. Currently, deterrents are installed near the top of turbines, but as other presenters here have shown, bats are flying below the RSZ more than initially thought. What we thought bats were experiencing and their reactions at the top of turbines may be completely different when flying closer to the land surface.

(for Victoria Zero) What were the drivers behind seasonal differences in response to acoustic-activated deterrents and what are the implications for design and the use of the system as a result of seasonal variability?

We defined summer as May 15-July 31 and fall as August 1-October 15, and there could be differences in the wind regime at this facility across those seasons which could influence efficacy. We could also be seeing species-specific responses or that behavioral responses from bats around turbines are changing seasonally. Some work has shown that tree bats will engage in riskier behaviors around turbines during the fall.

Is there any work that uses technology to target specific species (i.e., protected species)?

JULIET NAGEL: Acoustic-activated sensors detect bats by frequency, so if the interest is mainly to protect only federally protected bats, turbine curtailment can be based on the call characteristics of those species.

HEIN PRINSEN: It is important that a system be species-specific if you want to tailor shutdown time based on those species, and there is a lot of work being done to improve the technology in that direction. We've tested the radar system for additional species to develop shutdown rules for various gull species – however, the success of this is tied to how predictable a species is. We are also testing shutdown rules for migratory passerines, which will not require species specificity. Radar can detect at night so turbine shutdowns can be designed around night migration activity within the RSZ.

ALEKSANDRA SZURLEJ-KIELANSKA: With raptors and larger birds, we don't have enough information for species-specific curtailment and to protect these species we should continue to use a more conservative approach.

(for Hein Prinsen) Did you observe examples of turbine or facility avoidance associated with turbine operation?

There are several studies, particularly for offshore wind facilities, where numerous species (e.g., gannets, sea ducks, divers) exhibit coarse-scale avoidance behavior. What will be more interesting for shutdown development will be to understand micro-avoidance.

(for Hein Prinsen) What is the distance from turbines birds can be detected using radar and do the turbines create interference?

The turbines create tremendous interference for the radar and therefore this may not provide an effective means of detecting collisions or observing micro-avoidance in the RSZ, however, they may be useful in combination with cameras or other technologies. The effective distance varies due to sea clutter. However, generally, radar can detect out to 5km for large birds or flocks and possibly greater for birds flying at higher altitudes.

(for Victoria Zero) In the AAC study, why was curtailment limited to 30 minutes and what were the criteria for resuming operations?

The 30-minute period was a default of the system used. Generally, we have to assume that bats will require time to move through an area, and with curtailment we want to ensure there is sufficient shutdown time to allow for a bat to move away from the area of risk. In this study, the curtailment period was extended in 10-minute increments. If a bat call was detected in the last 10 minutes of the initial 30-minute period, turbines would remain inactive for an additional 10 minutes until no bats were detected within a 10-minute block.

What are the financial tradeoffs between blanket curtailment relative to deployment of the alternative technologies discussed here considering long-term operations and maintenance costs?

VICTORIA ZERO: This is inherently site-specific and requires good baseline data to answer. We can use these data points to inform financial modeling and determine where the optimization occurs when considering potential energy losses under a blanket curtailment regime. There is no one right approach, and there will be hidden costs, so it's important to talk with potential vendors and understand those factors up front.

SARAH FRITTS: Developing a workable approach hinges on defining your goals. Effective curtailment may benefit from a combined approach depending on the time of year, the species of concern, and site-specific factors. It is difficult to put a value on a species and important to recognize that there will not be a single solution. We also aren't currently accounting for climate change in our modeling. We need to know more about how bats are responding not just to wind energy but how they are changing their behaviors, migration patterns, and movement across the landscape in response to climate change.

HEIN PRINSEN: You need equipment to understand the system, and with that information, you can make better decisions about the measures you need to take. These systems require a large investment, particularly if implemented over the life of a project, but there can be an offset if it results in significantly less shutdown time than the traditional curtailment regime.

Are there any calls to action or barriers we should be addressing toward advancing technology that minimizes impacts?

JULIET NAGEL: There has been a recent push to create a central repository for bat samples, particularly for tissue. If we can start collectively contributing samples this will help us to answer some of the long-term questions about how bats are moving on the landscape.

VICTORIA ZERO: To those of you dealing with endangered species concerns, do not be afraid to do research on these technologies. We are seeing more support from USFWS for unconventional minimization approaches as part of habitat conservation planning. I would encourage you to take those proposals to USFWS and not assume that they will require 5.5m/s blanket curtailment or nothing.

SARAH FRITTS: There is not infinite money to do these studies. We know that curtailment works, and there is so much data available, but much of it remains private. Making data publicly accessible can help fill in the gaps and inform recommendations without the expense of additional data collection.

HEIN PRINSEN: We have to pursue international cooperation. A natural next step may be a combined meeting to bring all of this information together, as well as to emerging markets (e.g., Africa, Asia, Latin America) to save them from reinventing the wheel.

When should we start to worry?: Translating fatality events into population-level effects

Moderator: Nathan Fuller – State Bat Biologist, Texas Parks and Wildlife Department

Panelists:

- **Amanda Hale –** Senior Research Scientist, Western EcoSystems Technology, Inc.
- **Rafael Villegas-Patraca –** Principal Scientist, Normandeau Associates
- **Ryan Butryn –** Senior Information Science Manager, Renewable Energy Wildlife Institute
- **Todd Katzner –** Research Wildlife Biologist, U.S. Geological Survey

Link to Recording: https://vimeo.com/user84144409/review/772611143/3117a7f375

This session focused on research that capitalized on large datasets across broad geographies that contribute to our understanding of population-level impacts to wildlife from wind energy. Presenters discussed factors that contribute to heterogeneous mortality rates across wind projects and offered future research directions to understand cumulative impacts for species across landscapes and inform more effective minimization and mitigation strategies.

Amanda Hale – Site-specific conditions necessitate adaptable curtailment systems: the importance of explicit curtailment plans to reduce bat fatalities at wind energy facilities

See also corresponding presentation #28 One size does not fit all: species composition of wind turbine fatalities varies by region and with the spread of white-nose syndrome for three sensitive bat species.

WNS has led to significant declines in bat populations over the last 15 years, with some fatality estimates in the millions and colonies experiencing 90-100% mortality in some instances. Three species appear to be disproportionately impacted: NLEB, tri-colored bat, and little brown bat. A goal of this work was to better estimate fatalities from wind energy on those cave-roosting species. To do this, we capitalized on the Renew database, maintained by WEST, which contains hundreds of PCM reports collected over the past 10-20 years.

Using data from Renew, we evaluated changes in species composition in the number of fatalities in relation to the spread of WNS. We analyzed monitoring data from the several PCM studies at Mid-American wind energy facilities in Iowa over a seven-year period. Of all fatalities reported in the Renew database, the majority (78%) were from migratory, tree-roosting bats, with the three cave-roosting species representing less than 8% of reports. In our analysis focused in Iowa, we found that, over time, the number of carcasses of cave-dwelling bats declined regardless of level of effort, and not a single NLEB carcass was reported in the entire data set. Conversely, the numbers of tree-roosting species increased with increasing survey effort. This suggests that over this monitoring period, there were fewer cave-roosting bats on the landscapes and available to interact with turbines.

We followed this effort with a species composition assessment modeled after the USFWS species status assessment approach, evaluating collision mortality for cave-roosting bat species by determining changes in the proportion of fatalities reported for each species pre- and post-WNS. We included data by USFWS region where available, as well as data from Canada by province, using a 2-year lag time after WNS was detected for the post-infection data. We also eliminated data from wind energy facilities employing curtailment to focus on the effects of WNS alone. All three species experienced a reduction in fatalities post-WNS. Little brown bat fatalities decreased from 8% to 2.3% (70% reduction), tri-colored bats decreased from 2.4% to 0.15% (94% reduction), and NLEB from 0.19% to 0.02% of all fatalities (89% reduction). Species composition of carcasses varied regionally pre-WNS, and there were distinct regional differences in the change in species composition post-WNS. The Midwest region experienced the most significant decline in species composition of carcasses post-WNS, however, that change was not very significant in the Northeast. This suggests there are areas where bats are still occurring in larger numbers and perhaps the best opportunity to protect those populations is to target mitigation and minimization efforts in those areas.

Next steps include monitoring in areas where data gaps exist, particularly in the western US and in areas where WNS has not yet been established. This will be particularly important for little brown and tri-colored bats to understand what the impacts of WNS and wind energy expansion might mean for the viability of those populations, as well as to better target minimization efforts for the greatest effect.

Rafael Villegas-Patraca – Human infrastructure fatalities for soaring birds in central Mexico

See also corresponding presentation #71 Human Infrastructure Fatalities for Soaring Birds in Central Mexico.

This study was driven by a recent rule change in Mexico to limit wind energy development and to better understand bird interactions with associated infrastructure, particularly electrical power lines. At the time of the study there was an estimated 750,000km of electrical line in Mexico.

This work sought to quantify the number of collisions with power lines at three sites across Mexico with variable conditions. Surveys were conducted along 10km of secondary power lines in Guanajuato, Tamaulipas, and Oaxaca. Sites varied in vegetation and density of infrastructure, with the site in Oaxaca having the highest density of power lines and the most plant biodiversity. Carcasses were collected along the survey track and identified to species level. Over 600 carcasses from 65 species were collected in the last year. Species composition varied between the three sites, but overall results showed a wide diversity of families and species collided with power line infrastructure. Carcass abundance varied by site, with 66 carcasses of 15 species found in Tamaulipas, 42 carcasses of 11 species in Guanajuato, and 471 carcasses of 48 species in Oaxaca. White-winged dove, which had not been previously reported in mortality monitoring, made up a large proportion of the carcasses at Tamaulipas and Oaxaca (57% and 50%, respectively).

Notably, carcasses included three protected status species and 18 migratory species. Species included both very small passerines (e.g., chipping sparrow) and very large soaring birds (e.g., turkey vulture). Of the carcasses found, 59 had not been previously reported in mortality monitoring in Mexico. We also found variation in the most affected families by site, possibly attributable to different composition of bird communities across the regions.

We are going to continue this work, looking at other types of collisions with human infrastructure including roads and buildings, for both birds and bats. The intent of this work is to inform regulators of the importance of considering not only wind energy facilities when designing protection for birds, but the associated infrastructure, including power lines, which has a clear impact on fatality risk.

Ryan Butryn – Regional variations in bird and bat collision fatalities at wind energy facilities in North America, north of Mexico

See also corresponding presentation #63 Regional variations in bird and bat collision fatalities at wind energy facilities in North America, north of Mexico.

Why is calculating cumulative mortality across facilities useful? Looking at a region, or continent, or sub-region, we can combine data from wind energy facilities that are distributed across that space to start to ask a myriad of questions about what sort of impacts these combined facilities have on species distribution, evaluate how additional new construction might change those impacts, and determine whether we have sufficient data to have confidence in those assumptions. As we gain experience using these shared datasets, for instance the American Wind Wildlife Information Center (AWWIC) database, we're able to ask more targeted and specific research questions to help advance our certainty around mortality estimates and the factors that contribute to higher mortality.

The ultimate goal of this work was to produce an estimator that would promote seamless integration of new monitoring data even in the absence of standardized methods in order to better estimate cumulative fatalities across wind energy projects. Data were compiled from 255 PCM studies, representing about 30% of the installed capacity in the US, to evaluate the feasibility of using a Bayesian modeling framework to derive a cumulative impact estimate that better incorporates uncertainty by modeling the detection process and the ecological process simultaneously.

We started by re-establishing the baseline cumulative estimates using more recent data pooled across studies with variable methods. In all we pooled estimates from 92 studies across the US and Canada. We validated our model by comparing Generalized Estimator of Mortality- (GenEst) produced estimates with estimates produced from our Bayesian model. We found good agreement between estimates produced by our model and estimates produced by GenEst, suggesting this framework could be used to incorporate covariates in estimates, as well as produce a batch or cumulative estimate rather than produce estimates for every facility individually. However, we were limited in the inferences we could make because of the limited number of studies and the limited spatial scope where data existed. We intend to build on this work by adding data from an additional 63 PCM studies and incorporating important predictors of mortality such as season, bird conservation region, curtailment, landscape and habitat variables, as well as turbine size. We also hope to look at response variables like bird size or group (i.e., raptors vs. passerines).

We will need more data, particularly data that is collected using standard methods. It will be increasingly important that we collectively identify priority questions and that PCM studies are designed to address those questions in a standardized way.

Todd Katzner – Science to streamline renewable energy development: the Renewable-Wildlife Solutions Initiative

See also corresponding presentation #60 Science to streamline renewable energy development: the Renewables-Wildlife Solutions Initiative.

Often, we encounter conflicts at the intersection between initiatives to conserve biodiversity and to promote renewable energy. We have developed the Renewables-Wildlife Solutions Initiative (RWSI) to address barriers to the responsible development of renewable energy generation. One primary barrier is the lack of information on population-level and cumulative effects of renewable development on wildlife to inform regulatory decision-making. We currently have the tools to evaluate impacts to individuals but often fail to translate that data into meaningful information at the population level. Fundamentally, we need to understand at what level the number of fatalities will affect population viability across different species, and where those fatalities are occurring. The vision of RWSI is to serve as an online repository for biological samples of wildlife collected from renewable energy facilities that can be used to perform stable isotope analysis and identify where animals are coming from. The goal of this work is to identify the origins of every animal found at renewable energy facilities continent-wide and use that to assess population-level and cumulative impacts of renewable energy for high priority species.

This approach will provide key information to scientists and regulators to identify affected subpopulations, inform management decisions, and ultimately make the permitting process more transparent, simpler, and less expensive.

To that end, RWSI is developing a network of research institutes, called nodes. At present, we have nodes in Illinois, Texas, and Iowa that are collecting and submitting georeferenced biological samples of birds and bats killed at wind and solar energy facilities, receiving thousands of carcasses per year. RWSI has begun to use the data to generate model estimates of impacts to species in California. In one study, RWSI used isotope analysis to determine the origins of Golden Eagle carcasses found at facilities at Altamont Pass, CA. (Katzner et al., 2016). We found that 25% of the birds killed at Altamont were growing feathers far from the facility. Demographic models suggested that approximately 11% of eagles at Altamont should be 2-year-old birds, however, fatality data showed 30% of carcasses were in this age group, suggesting that the population at Altamont is sustained by 2–4-year-old birds immigrating from other populations. While we don't know the total size of the source population, we can begin to make inferences about the vulnerability of the source population posed by this facility based on other demographic indicators (e.g., nest data). In another study, we evaluated the population vulnerability for 23 species of birds collected at wind and solar energy facilities in California (Conkling et al., 2022). We found that 48% of the species would be vulnerable to additional take and that vulnerability extends to populations outside the study area. This will allow us to identify where mitigation may be most important and effective at addressing risks to these species.

RWSI continues to collect samples and build the database, as well as standardize procedures around data collection and reporting across nodes. We also plan to address issues with privacy and data sharing to ensure that effective data protection measures are in place to promote confidence in contributing to this database, while also continuing to make the data accessible. Additionally, RWSI is advancing research around using results to target mitigation. However, all of this work is contingent on continued partnerships from nodes, support from state and federal agencies, and funding.

Audience Questions & Panelist Response/Discussion

Questions addressed two key areas:

- What level of confidence or certainty can we have around population-level impacts derived or inferred from available data? What limitations exist?

- What tools or resources are available to facilitate contributing to these data and what is necessary to advance this type of work?

(for Amanda Hale) Do you think it's too late to capture the true population impacts to bats from wind energy, considering we don't have certainty on population estimates and nor the degree to which WNS has influenced current population sizes?

I'm optimistic that we can, with funding and support. The tools are there. The starting point is immaterial and we can implement modeling regardless of where we are in terms of population decline. Some publications out of Canada have indicated that year is a significant term in modeling around impacts, which does indicate some amount of missed opportunity. However, we should be able to key in on some population-level impacts at least in the US eventually, using genetics and bioinformatics.

This will take time – so we need to evaluate what we can do now to buy time. Thinking specifically about migratory tree bats, we can implement minimization to help provide science the time to catch-up and develop those mechanisms.

We need to join efforts across North America. There have been a few studies in Mexico around these issues, but we need to encourage more of an academic effort to look at this broadly, particularly over the next decade.

How safe is it to infer population declines from carcass surveys and could declines in carcasses represent positive curtailment results?

TODD KATZNER: As scientists, our inferences can only be as good as the quality of the data. The people doing carcass surveys are not necessarily prioritizing collecting the type of information necessary to make inferences about population-level impacts. We absolutely have to use the data available, but also have to understand the limitations of those data.

AMANDA HALE: For the study evaluating linkages between declines in carcass data and prevalence of WNS, we did not look at facilities that included curtailment. Curtailment and cut-in speed could be just one of many predictors in a model. Often, fatality monitoring happens immediately after construction, but curtailment doesn't start until after monitoring has ended, so we have data that was collected prior to implementation of curtailment, complicating our ability to determine linkages.

Where we have good evidence of declines in cave-roosting species from other survey data, it is validating to see that the numbers from carcass searches track the survey numbers because that is what you would expect. For migratory tree bats, on the other hand, that are interacting with turbines in a number of ways that are not fully understood, the element of attraction complicates our understanding of what carcass results mean and what we can infer. For example, if in a given region you are seeing changes or constancy in fatalities over time, you would need other information to put that in context and link it to a population of interest.

(for Amanda Hale) Data demonstrate that some species and sex classes and ages of bats are often misidentified. Is it still valuable to contribute data to or use data from AWWIC or other such

databases to evaluate impacts, or should we rely solely on data validated through molecular methods? What is the additional cost of implementing additional molecular methods?

Though the AWWIC database does include a column for sex, we have not elevated or published those summaries for exactly this reason. There is a study underway to look comprehensively at sex ratios for bats killed at wind energy generating facilities, funded through the Renewable Energy Wildlife Research Fund. Initial results suggest that sexing carcasses in the field more than a day old is unreliable, and probably should be excluded from data recording. When using sex to generate demographic models, the data should be validated using molecular methods and, in some cases, species ID should be as well (e.g., with yellow bats in Texas, where we have three species of yellow bats converging in the same areas). To really understand population-level impacts and identify populations of interest, we first have to get the species right. This level of confirmation may not be necessary for all species, but as wind energy development moves into new areas and species ranges shift due to climate change, this additional confirmation will be helpful to determine what the true impacts are.

If monitoring is occurring in a place where impacts to listed species are anticipated, companies may already be doing this through tissue sampling. Estimates for one-off sample analysis are in the range of $65/sample. If there is more interest in doing some sort of research, this cost can be greatly reduced by barcoding in bulk using a lab with infrastructure where salaries are already paid for – in the range of dollars or pennies per sample.

(for Rafael Villegas-Patraca) With Avian Power Line Interaction Committee (APLIC) updates coming out soon, are there other tools or opportunities to share what we're doing across borders? How do we work together and how might we use what has been learned in Mexico to inform the transmission build out that will be necessary to achieve clean energy goals in the US?

In Mexico, we are struggling to get support from regulatory agencies, despite having agreements with other countries regarding biodiversity and research priorities. We've made some headway with demonstrating the concerns and adopting regulations for wind energy development but have not been able to achieve that for other infrastructure. We continue to work to gain support for adopting guidelines like APLIC, but success will depend on continued cooperation across borders. Conversations and meetings like WWRM will help to facilitate that cooperation moving forward.

(for Todd Katzner) Are the existing nodes in the RWSI network associated with university research/museums that have infrastructure in place and in which regions do we need additional nodes?

The ultimate goal is to have real infrastructure to support the space needed to house carcasses. At our USGS location, we have invested a lot in freezers with a number of conventional deep-freeze units. We have a node at the Illinois Natural History Survey at the University of Illinois, associated with a conventional university museum. We are still working toward establishing something similar in Texas. We currently have gaps in the Northeast, Southeast, and Southwest. Most of our nodes are academic institutions. USGS does not have museum-level storage, and this information is best maintained in a public-private partnership, instead of being housed entirely in government institutions. There is also a need for more freezer capacity in the Midwest where more monitoring is occurring and more bats are being found. Transmission is another weak link in the node system, as this information will be key to understanding population-level impacts from renewable energy.

(for Todd Katzner) Are data from non-renewable energy sources acceptable for the RWSI database? What level of granularity is needed for location data?

We're talking about renewable energy because of the current attention it garners in the space around collisions, but this could be equally useful in considering additional sources of collisions, particularly where something is causing a large number of fatalities. This is of course constrained by funding, where for small numbers of fatalities across the landscape, there will be little return on investment.

(for Ryan Butryn) Does REWI or AWWIC have a resource that outlines important PCM considerations for compatibility with the AWWIC database?

There is a template with detailed instructions for rules and data formatting.

(for Todd Katzner) Given MBTA restrictions on processing birds, what can companies do to contribute tissue samples to RWSI?

If required to have a Special Purpose Utility (SPUT) permit, a scientific collectors permit will not replace the SPUT. However, if a company is not planning to get a SPUT, in many cases, USGS can help get coverage under a scientific collector's permit.

What should agencies consider in funding priorities over the next year to advance this work?

TODD KATZNER: Building out databases, funding more facilities to collect and host data samples, and ensuring that funding is in place for the next several years. We should also target funding to advance modeling that will help us to utilize data more thoroughly.

RYAN BUTRYN: Pooling all of the data we already have, figuring out where that data is currently housed, and reviewing that data to identify where gaps exist.

AMANDA HALE: Identifying bat behavior at turbines to better minimize impacts – specifically how and when they are interacting, what types of behavior is occurring, and where along turbines collisions are taking place.

RAFAEL VILLEGAS-PATRACA: In Mexico, most facilities are private and though federal funding is available, it is typically not for use on private facilities – so diversifying the sources of funding available to conduct this type of work regardless of geographic location to facilitate that collaboration across borders.

Recommended Resources

- Conklin et. al., 2022. Vulnerability of avian populations to renewable energy production.
- Katzner et. al., 2016. Golden Eagle fatalities and the continental-scale consequences of local wind-energy generation.

Compensatory mitigation and offsets: Ensuring a net gain for wildlife

Moderator: Dr. Holly Goyert – Senior Wildlife Biologist, AECOM

Panelists:

- **Troy Rahmig –** Endangered Species Program Manager, Tetra Tech
- **Ted Hartsig –** Senior Scientist, Olsson
- **Vince Slabe –** Research Wildlife Biologist, Conservation Science Global
- **John Goodell –** Principal Owner, Northwest Avian Resources
- **Aspen Ellis –** Ph.D. Student, University of California – Santa Cruz

Link to recording: https://vimeo.com/user84144409/review/777419100/6ee6a52db5

This session explores various conservation actions to offset potential losses from wind energy development and addresses the challenges involved in developing and implementing conservation programs for this purpose. Research presented during this session contributes to an understanding of the options available to ensure that wind energy development results in a net gain for populations of wildlife and for global biodiversity. Presenters address questions about the appropriate scale for mitigation to ensure that affected wildlife experience a net gain and reinforce the need for consensus, adaptability, and a regional approach.

Troy Rahmig – When does habitat loss result in take?

See also corresponding presentation #17 When does habitat loss result in harm under the Endangered Species Act and implications for listed bats.

Though wind energy infrastructure does not typically result in significant loss of habitat, habitat loss in general is a stressor, particularly on bats, therefore it is increasingly important that we evaluate population-level impacts of habitat loss from projected development. As renewable energy infrastructure accumulates on the landscape over the next 10-15 years, it will be important to understand when habitat loss constitutes “take” of listed species and to appropriately mitigate for those losses.

One mechanism for avoiding take on bats is to limit habitat clearing to winter months, when bats are not present. If we are able to achieve low to no mortality through this avoidance, then we must consider when habitat loss on its own results in a take that would require permitting under the ESA.[5] Harming an

[5] Take as defined under the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm includes any behavioral effects that result from significant habitat loss or modification. ”

individual includes significant modification to habitat that results in changes in behavior on the landscape, specifically *significant* alterations of habitat at an appropriate scale.

What constitutes a significant alternation remains subjective without proper context. We have to standardize the evaluation of habitat loss and the area within which habitat removal is assessed. If bats regularly use habitat within five miles (~50,000 acres) of a hibernacula or roost site, 100 acres of tree clearing may have significant impacts if the surrounding 50,000 acres is an agricultural setting and contains only 1,000 acres of forest mostly in riparian areas or hedgerows. However, if that surrounding landscape is 50% forested and contains 25,000 acres of habitat, the loss of 100 acres is relatively insignificant. Landscape context is important, and we should consider proportional habitat loss rather than a single number. Within the area of assessment, we could consider a threshold for permitting, which may create an incentive for avoidance (e.g., must remain under 1% or 5% to qualify for programmatic biological opinion). This concept can be scaled and easily integrated into existing decision-making tools (e.g., Information for Planning and Consultation tool, or IPaC), and remove subjectivity as to what constitutes a take under the ESA and reducing uncertainty in permitting.

Ted Hartsig – Soil, vegetation, and habitat restoration and management plans for improving wildlife in wind turbine fields

See also corresponding presentation #33 Soil, vegetation, and habitat restoration and management plans for improving wildlife in wind turbine fields.

Data from wind energy facilities suggest that each turbine on average impacts 3.5 acres of vegetation from linear corridors, building pads, laydown areas etc. This requires extensive restoration across multiple disparate areas with varying restoration needs. As such, Soil, Vegetation, and Wildlife Management Plans (SVWMPs) for renewable energy have evolved beyond soil stabilization, are increasingly becoming required for site permitting, and more frequently incorporate wildlife habitat objectives.

A SVWMP is a measured, strategic approach that establishes goals to meet both landowner and client objectives in promoting wildlife movement and habitat connectivity and restoring vegetation to baseline conditions. SVWMPs might include statutory requirements (e.g., Stormwater Pollution Prevention Plan, local conditions, vegetation management strategies to control invasive species), and these requirements must be balanced with client and landowner objectives as well as budget and schedule constraints, including minimizing long-term Operations and Management.

Given the impacts project construction can have to soil, vegetation, and wildlife, the scope of SVWMPs has expanded to restore vegetation with consideration to how wildlife might use an operational facility, targeting placement of habitat in strategic areas away from infrastructure to reduce the risk of interaction. Restoration requires several considerations, however. While there is no single solution that will address all challenges with vegetation restoration, SVWMPs can be a useful tool for ensuring long-term site stability, restoring soil conditions to promote regeneration, minimizing fragmentation, and providing habitat in strategic locations to minimize wildlife interactions, while meeting client and landowner objectives.

Vincent Slabe – Non-lead ammunition distribution programs to offset Golden Eagle mortalities in Wyoming

See also corresponding presentation #58 Non-lead ammunition distribution programs to offset Golden Eagle mortalities in Wyoming.

To account for impacts to Golden Eagles from wind energy development, USFWS requires compensatory mitigation and science-based evidence of no net loss of individuals as part of the permitting process for wind energy facilities. At present the only acceptable mitigation is power-pole retrofits, primarily because USFWS has established a resource equivalency for the number of retrofits that effectively mitigate for the loss of one eagle. Lead abatement has been discussed extensively as another possible mitigation option; however, no similar resource equivalency has been established.

The goal of this work was to test the efficacy of a non-lead ammunition distribution program to offset eagle fatalities, by answering the following questions:

- How many hunters would participate in a non-lead ammunition distribution program?
- How many would use provided non-lead ammunition?
- Would this use result in a reduction of eagle fatalities?

We implemented a non-lead ammunition distribution campaign in the Shirley Basin of Wyoming. Wyoming has extensive wind development and a high resident golden eagle population (as well as high numbers of winter migrants). The Shirley Basin has multiple hunt units, telemetry data indicating high eagle use, and represents an area of moderate risk for lead poisoning. Within the Shirley Basin, we targeted specific hunt units that issued harvest permits in the study year (2020).

Eligible hunters that had active harvest tags received information on impacts to eagles from lead ammunition and a voucher for free non-lead ammunition. Post-hunting season, voucher recipients received a survey to quantify the number of hunters that utilized the ammunition and the number of animals harvested with non-lead rounds.

In 2020, we mailed 1,374 postcards to eligible hunters in the Shirley Basin. Of these, 434 hunters signed up to participate in the program which accounted for 13% of all hunters in the target units. We emailed post-harvest surveys to all 434 participants, and we received a 67.9% response rate. Of the hunters that responded to the survey, 85% hunted with the non-lead ammo distributed by our program. Of those that hunted, 68% successfully harvested a big game animal representing 7.5% of total harvest within the Shirley Basin.

These estimates are based only on survey respondents and need to be adjusted based on the number of hunters that did not respond to the survey. Additional ammunition distributions occurred in 2022. Ultimately, the data will be analyzed using a theoretical model developed by REWI (Cochrane et al., 2015) to understand the amount of non-lead ammunition it takes to mitigate for one golden eagle.

John Goodell – "Dead-Birds Flying" rehabilitated raptors as offsets to anthropogenic mortality: a demographic analysis of North American birds

See also corresponding presentation #73 "Dead-birds flying" rehabilitated raptors as offsets to anthropogenic mortality: A demographic analysis of North American birds.

Biologists tend to think of rehabbed birds as losses from the wild population, given low presumed survival rates for released individuals. However, the scale of individuals released across facilities could have population-level effects if these birds are achieving survival rates comparable to wild populations.

We conducted a multi-species analysis at a continental scale for 17 species using data from 24 rehabilitation facilities and the USGS Bird Banding Lab. Over two million birds have been banded between 1974-2018, and of those over 120,000 individuals were rehabbed, banded, and released birds. We estimated and compared survival rates of rehabbed and released birds to wild birds and utilized mark-recovery demographic models to determine whether rehabbed individuals can have measurable population effects.

Across species evaluated, rehabbed birds attained wild survival rates after acclimation for 13 of 17 species analyzed, including bald and golden eagles. In red-tailed and red-shouldered hawks, banding data suggested survival rates among rehabbed birds are significantly lower than wild populations in the first year post-release. However, they dramatically increase for individuals that survive beyond the first year, though survival rates for red-tailed hawks never reached those for wild populations. For red-shouldered hawks, survival for rehabbed birds was comparable to or higher than survival for wild birds after the second year post-release.

Results of demographic modeling indicated that in populations where rehabbed bird survival does not equal wild populations, there are minimal additive contributions. When survival rates are equal, rehabbed individuals can have a measurable additive effect. In the example of golden eagles, a long-lived species, one released individual was estimated to produce 8-10 birds. The potential for rehabbed individuals to provide a mitigation offset for incidental take of wild birds varies by age of individual at time of release, with first-year birds mitigating for on average 1.4-1.8 wild birds, and after first-year individuals mitigating for 1.0-1.2 individuals.

Rehabilitation centers are required to record and report information on the number of admissions and releases from permitted facilities, but this data is relatively inaccessible to conservation biologists and USGS has not encouraged the banding of rehabbed birds. This work demonstrates that banding rehabbed birds provides intrinsic value to the development of population models and informing mitigation resource equivalency, and these data should be made publicly available through a centralized database.

Aspen Ellis – Considerations for effective compensatory mitigation planning for marine birds

See also corresponding presentation #74 Considerations for effective compensatory mitigation planning for marine birds.

Seabirds are a highly threatened group of species. Due to extremely broad non-breeding ranges and highly constrained breeding ranges, these species face an array of anthropogenic threats, including predation, climate change, and offshore wind energy development. Several of these species have significant spatial overlap with existing or proposed development and, based on behavioral factors (e.g., amount of time spent in RSZ), are at increased risk for displacement or collision. This is especially concerning considering the scale of proposed development from 35 GW of existing infrastructure up to 2,000 GW globally by 2050, and the difficulty in quantifying impacts in the offshore space.

A working group of international experts on seabird impacts of offshore wind energy organized by the National Center for Ecological Analysis and Synthesis developed an internationally applicable framework to establish best practices for monitoring, modeling, and mitigating collision and cumulative impacts to seabirds. There will be residual impacts after all feasible avoidance has been achieved and while impacts can be minimized through layout decisions, deterrent technologies, and curtailment, these approaches have not been validated in the offshore environment, their efficacy for seabirds is untested, and their feasibility is uncertain. There is however significant capacity for compensatory mitigation.

Compensatory mitigation may be particularly effective for seabirds – there are many well-established conservation measures known to boost seabird populations. These include translocating colonies to more biosecure areas; eradicating invasive species at breeding colonies; and altering fishing methods and/or gear to reduce bycatch. The University of Santa Cruz's Conservation Action Lab has developed a seabird metapopulation viability analysis tool to model and compare how variable compensatory mitigation strategies could impact populations, incorporating baseline data, collision risk estimates, and current population trajectories. The outputs of this model can be used to compare management scenarios against population objectives, assess the feasibility of various strategies, and prioritize measures across broad regions.

While this model indicates potential for these mitigation strategies, they will be most effective if funded by offshore wind energy on a regional scale, rather than on a voluntary, case-by-case basis, and these actions will likely have to occur in areas outside of the area of impact (i.e., in species breeding areas). Mitigation for oil and gas spills may prove a promising model for how this strategy could be broadly implemented across national boundaries and managed by an overarching agency in a regulatory framework.

Audience Questions & Panelist Response/Discussion

Panelists responded to questions broadly addressing the following:

- Cumulative impacts
- "Rules of Thumb"
- Quantifying compensation and resource equivalency
- Regional approaches and spatial outlooks

How do you integrate cumulative impacts into the area of assessment?

TROY RAHMIG: If we can improve the way that impacts are assessed at the project level, we will inherently improve the estimation and consideration of cumulative impacts. The more we can introduce standardization in assessing project-level impacts, the easier it will become to compare and estimate cumulative effects over time.

JOHN GOODELL: In the bigger paradigm of rehabilitation data and proposing an actual tool to offset incidental take, we need to provide funding to support reliable data collection and dissemination. We have an incomplete picture of anthropogenic impacts, but with more of that information in hand, we would be better equipped to evaluate and measure cumulative impacts to populations as opposed to measuring with project-level mortality estimates alone.

VINCE SLABE: In the instance of golden eagles, USFWS recently released a report stating that golden eagle populations are stable. However, we know from various sources that there are additive anthropogenic impacts occurring, resulting in a 1% reduction of population growth rates. This could be the difference between a stable population and a declining population. We need to have a better understanding of these impacts and where they are coming from (e.g., lead poisoning, car strikes, shootings) to ensure that these populations are not falling below numbers where recovery becomes infeasible.

(for Vince Slabe) How can we verify the projected decline in lead from the non-lead ammunition distribution programs and how can that be used to equate the number of eagles saved?

We are very focused on data collection at this stage. We plan to work closely with the quantitative team at REWI to fully understand the model and how the results should be interpreted. There also needs to be a resource equivalency analysis developed to quantify the compensatory mitigation ratio, and that has typically come from USFWS.

Is a five-mile area of assessment around a project a good rule-of-thumb?

TROY RAHMIG: We rely on rules of thumb more than we like to think. With something as nebulous as habitat loss, it essentially starts with an idea based on the scientific information we do have and how species use the landscape. The specific area doesn't really matter as much as arriving at a consensus on what seems appropriate. This is adaptable and can be adjusted as the science evolves. The key is consistency in applying the framework and conducting analyses across projects so we can achieve higher predictability in the outcomes and, therefore, promote better decision-making.

TED HARTSIG: In the world of habitat and ecological restoration, we have to look at the tangential impacts of restoration. Sometimes that occurs at the watershed scale, in others the immediate scale. This is typically determined by the type of environment within which we're working – the different types of media, the species, and the target populations. In essence, that appropriate scale is not a single number, rather an evolving idea rooted in the needs of the project, problem, or target population.

How much of an invasive species would need to be removed from a colony to consistently increase egg and chick survival and offset the loss of breeding adults considering natural stochasticity in most breeding seabird populations? How could compensatory mitigation be used to increase adult survival or recruitment of adults into the breeding population?

ASPEN ELLIS: Any eradication should ideally be a complete eradication. Maintaining a low population of invasive species is less cost-effective and less effective overall in the long term. Pooling resources and funding to promote complete eradication early on in a project life cycle is critical to maintaining and increasing seabird populations over time, versus building funds slowly and starting eradication efforts later in the lifespan of the project. Major eradications are likely to result in the highest increase in recruitment and egg and chick survival. However, all of these efforts have to be excessively precautionary considering the variability in populations and the lack of access to data. It will be essential to implement these measures on a regional scale to have a net positive benefit to populations and we will have to accept a level of uncertainty.

JOHN GOODELL: We see a similar pattern in raptors where younger individuals have lower survival. This pattern was consistent in rehabbed individuals and offsets should therefore be age dependent. In raptors this might be a division between hatch year and after hatch year but may be more refined in eagles where we quantify impacts and develop explicit mitigation offsets for age groups from first through third year and post-fourth-year birds. These estimates currently reflect what we know about birds in the wild with slightly different survival rates. And with more work we will continue to evaluate these ratios to better reflect what we're observing.

(for Ted Hartsig) How many studies have shown how soil structure recovers after decompaction from removal of access roads and crane turn paths? How might soil compaction across a site affect species when construction does not directly impact habitat?

Most of that information will come from reporting of practitioners and will depend heavily on the type of structure of the soils present. Depth of compaction will vary based on soil type and in some cases may be only a matter of inches. In these scenarios, habitat restoration is much easier. Where the compaction goes deeper, it becomes much more difficult, and the restoration time is longer. Essentially, we have to rebuild the soil structure to restore and rebuild the soil biome, which could require 3-10 years depending on the degree of compaction. Once the soils have returned to natural, native soil, the impacts are no longer present.

(for Vince Slabe) Have you spoken with rehabilitation facilities in the study area? Do they observe any difference in the number of raptors affected by lead poisoning before and after the implementation of non-lead ammunition distribution?

We are not currently working with rehabilitation facilities on a specific project. Doing a pre- and post-assessment in-vivo is inherently difficult. It is challenging to measure whether lead concentrations are being lowered because blood concentrations can be affected by both recent exposures and lead accumulation. It is going to be very difficult to capture and measure birds before and after to quantify short-term differences. However, long-term data may be useful in identifying inflection points where acute exposures in a localized area start to decrease.

(for John Goodell) Was there a disproportionate number of rehabilitation facilities represented from certain regions in your analysis that may have influenced the survival rate estimates for rehabbed birds?

This work was foundational, and a proof of concept to determine survival rates at a continental level. A next step in the work may be to evaluate those regional differences. We had good coverage across the continent, but more importantly we should evaluate these facilities based on their best practices (e.g., whole body radiographs, pre-release flight chambers, pre-release conditioning) and how those practices might affect survivability of released birds.

(for Vince Slabe) Can you discuss the risk map for lead: specifically what are the predictors, what is the accuracy, and is it applicable to a larger study area?

The risk map was developed by the Western Golden Eagle Team, and the model evaluated harvest rates from each state by hunting unit and eagle density. The more we look at harvest data, the more clearly we see patterns delineated by hunting units. We used data from hundreds of eagles telemetered in the western US, as well as previous nesting population demographic studies, to produce density estimates. This is not an overly complicated model, but it does provide a simple and effective means of identifying areas that would be ideal for a non-lead ammunition program.

(for Troy Rahmig) How should potential avoidance of turbines by forest bats be accounted for when considering habitat loss in forested areas?

Nothing that we think about can be considered in a vacuum. We need to contextualize habitat loss based on what is available. Bats are likely to behave differently in areas with large amounts of habitat on the landscape relative to areas with less habitat available, e.g., they may travel further when there is less habitat. In simplistic terms, with more habitat available, the landscape can tolerate greater habitat loss, and that probably holds true regardless of how bats are behaving around turbines.

(for Vince Slabe) When can you incentivize with free ammunition, how do you achieve buy-in from hunters, and what is the cost differential between lead and non-lead ammunition?

Getting buy-in is very simple – providing free ammunition is very effective. We currently have a suite of programs with different levels of funding, but offsetting the cost directly is our primary approach – whether that is the full cost of a box of ammunition or a discount (e.g., $20 off). There are other approaches including outreach and education that can be effective in incentivizing hunters. Overall, the cost of non-lead ammunition is higher, but comparable to prices for high-end lead ammunition. This differential has decreased over the past 15 years and is likely to continue decreasing as more consumers want to buy non-lead ammunition. At this stage, we are focusing on offering free ammunition and on hunters voluntarily accepting it. We find that generally all hunters are conservationists and are not intentionally walking away from a harvest knowing that anything left behind could potentially poison another animal. The hunting community generally may be less aware of the fragmentation rates of lead ammunition and the potential harm to non-target species such as eagles, so buy-in will come from clear and consistent communication around these issues.

Recommended Resources

- Cochrane et al., 2015. Modeling with uncertain science: estimating mitigation credits from abating lead poisoning in Golden Eagles.

Landscape-level planning—How do we meet our wind energy needs with minimal impact to wildlife?

Moderator: Meaghan Gade – Energy and Wildlife Program Manager, Association of Fish and Wildlife Agencies

Panelists:

- **Emma Kelsey –** Biologist, U.S. Geological Survey, Western Ecological Research Center
- **Gunnar Malek-Madani –** Project Scientist, Olsson
- **Quentin R. Hays –** Wildlife Program Director, GeoSystems Analysis, Inc.
- **Misti Sporer –** Environmental Development Director, Duke Energy Sustainable Solutions

Link to recording: https://vimeo.com/user84144409/review/772815647/2632862dbf

The focus of this session was on means and methods to incorporate landscape-level information in the initial siting and risk assessment of wind projects and associated infrastructure. Panelists presented information on stakeholder-driven processes, improved tools for landscape-level planning, and modeling of wildlife and habitat distributions. The presentations focused on high-level themes and challenges involved in simultaneously meeting renewable energy development targets and land conservation goals to both mitigate climate change and conserve biodiversity.

Emma Kelsey – Seabird distributions on land and at sea to inform offshore wind energy planning throughout the Pacific Outer Continental Shelf region

See also corresponding presentation #7 Seabird distributions on land and at sea to inform offshore wind energy planning throughout the Pacific Outer Continental Shelf region.

This presentation provided an overview of recent and ongoing studies to inform offshore wind energy planning in the Pacific OCS, including aerial surveys, predictive density modeling, and telemetry tracking to characterize seabird distribution, movements, and ecology.

Multi-year, multi-season aerial survey data collected along the Pacific coast of the U.S. were used in the development of species-specific predictive density models to understand seasonal seabird distribution. Results showed variation between species and seasons, which can be helpful to inform offshore wind energy development siting. We are currently analyzing aerial survey imagery data from a recent effort of the Southern California Bight (2018-2021). This dataset will provide updated species distribution data for this area, which can inform future species distribution models, and uses novel aerial photography methods.

Another method we are using to explore species distributions in the context of potential offshore wind energy development are fine-scale satellite telemetry tracking studies, which involved deploying telemetry tracking devices to evaluate movement and behaviors of individual birds. We tracked over 1,000 individuals of seven species from 19 colonies across six of the Hawaiian Islands from 2013-2016. This effort yielded substantial data and is valuable in understanding where and how birds may interact with offshore infrastructure. As one example, overlaying red-tailed tropicbird tracks with previously proposed BOEM offshore wind energy call areas showed that individual movements throughout the call areas varied based on which colony an individual bird was tagged from. Although these call areas are no longer under consideration, this is an example of how the potential effects of offshore wind energy development on seabirds in Hawaii may be disproportionate or localized. Fine-scale tracking data can also be used to estimate flight heights of species, which will continue to be important as turbine technology advances and will help to inform our understanding of potential interactions between seabirds and the RSZ.

Currently, we are working on a complementary database and atlas of breeding seabirds in the Main Hawaii Islands. This database will be valuable to land managers and conservation groups and can support future efforts to connect birds at sea to their breeding colonies. Such efforts help us understand colony-specific effects of changes to the marine environment, such as offshore wind energy development.

In addition to the studies of fine-scale seabird movements like in the Hawaiian Islands study, we are exploring how radio telemetry data collected through the Motus can be used to track movements of smaller birds and bats at a much coarser scale. Motus is being considered as a primary method of tracking aerial fauna through offshore wind energy areas off the Atlantic Coast. We are coordinating a preliminary effort to establish a Motus network on the Pacific Coast in the Southern California Bight. To date, there are not any active Motus tracking stations in coastal Southern California, and we are planning to deploy 25 stations along coastal promontories and offshore islands in this study.

Lastly, we are working on updates to vulnerability indices for seabird populations, incorporating newly published information and lessons learned since our initial publication in 2017. This updated vulnerability index can be applied to our predictive species distribution models to evaluate site-specific vulnerability to offshore wind energy development. It could also be used by researchers and resource managers interested in assessing and mitigating site-specific potential impacts to seabirds from offshore wind energy in the Pacific OCS.

Gunnar Malek-Madani – Using remote sensing to identify suitable species habitat in renewable energy siting decisions

See also corresponding presentation #14 Using Remote Sensing to Identify Suitable Species Habitat in Renewable Energy Siting Decisions.

Confirming the presence or absence of protected species or species of concern within or near a renewable energy project can be challenging, so federal conservation agencies generally recommend avoiding suitable habitat for ESA-listed species altogether. Through spatial analysis of remotely sensed data, we can determine where potential habitat occurs to inform renewable energy siting decisions. However, freely available land cover data is often too coarse-scale and outdated to develop spatially explicit models at the desired level of accuracy and precision.

Alternatively, multispectral remotely sensed data can be used to classify landscapes and tailor those classifiers to control parameters of analysis to fit project criteria. We can adjust spatial and temporal resolutions of datasets and choose specific dates to determine when habitats are more distinct from background vegetation, removing subjectivity from the process and ensuring repeatable and defensible results. This process can be used to create customized land cover data sets focusing on habitats of concern and to identify constraints early in the siting process.

We used this approach to conduct a habitat analysis for NLEB using Sentinel 2 imagery, which provides a 10x10-m resolution. We utilized a time series of data from the blue, green, red, and near-infrared bands from two dates within the growing season as inputs into a random forest model. Additionally, a normalized difference vegetation index dataset was created from the red and near-infrared bands and was included as a fifth input for the model. The output of the model was a 10x10-m resolution land cover dataset. From this custom dataset, we were able to evaluate smaller scale patches of more refined land cover classes and assess habitat connectivity that may have been missed when using coarse-scale data, and ultimately improve our determination of habitat suitability. We can get even higher resolution by using unmanned aerial vehicles (UAV) which offer greater flexibility in the spatial resolution and can more precisely categorize land cover classes (e.g., teasing out prairie grass versus turf grass).

We can also use these data to evaluate the effectiveness of restoration work. We have gathered multispectral imagery annually from a UAV over a wetland restoration project area and used these data to conduct a change detection analysis and monitored spatial changes over time. From the multispectral imagery we can calculate different vegetation indices, for instance green leaf area, to detect differences in wetland vegetation over time and space (i.e., variation in health from one year to the next or variation in health spatially across the wetland at one point in time). These analyses have several potential applications including construction damage assessment and habitat health monitoring, and in all instances provide the added benefit of being more flexible, scalable, and accurate relative to generalized landcover data.

Quentin Hays – De-risking renewable energy infrastructure: using collaborative science and stakeholder engagement to reduce risk to wildlife in the arid Southwest

See also corresponding presentation #34 De-risking Renewable Energy Infrastructure: Using Collaborative Science and Stakeholder Engagement to Reduce Risk to Wildlife in the Arid Southwest.

Wind energy development is increasing, particularly in New Mexico, but to bring the generated power to market there is a need for transmission. Permitting and constructing transmission infrastructure presents unique challenges, especially in the Southwest where linear infrastructure may traverse hundreds of miles across a landscape with clustered or focused biological resources such as river corridors that create concentrated use areas for large aggregations of (migratory) birds.

The SunZia Transmission Project in New Mexico and Arizona is proposed to traverse approximately 550 miles of different vegetation communities and (land) jurisdictions, presenting numerous potential wildlife issues. Specifically, the line is proposed to cross the Middle Rio Grande Valley in New Mexico, which serves as critical winter habitat for the Rocky Mountain subpopulation of sandhill cranes, a population which has experienced substantial fluctuations over the last 80 years. Stakeholders have voiced concern over potential impacts from the proposed SunZia Project to the species. We conducted a landscape-scale risk assessment to identify hotspots of use and potential exposure to collision with transmission infrastructure for sandhill cranes and provide recommendations to mitigate potential impacts. We used data from a collaborative telemetry study conducted with USFWS to examine resource selection, passage rates, and flight heights to assess exposure and collision risk. We established hypothetical transmission lines across the Middle Rio Grande Valley every 500 m and used passage rates and flight distributions from telemetry data to model potential exposure risk from the buildout of transmission infrastructure.

The model output estimated between 3000 and almost three million crane passes per winter, depending on the location of a hypothetical transmission line. We found considerable variation in exposure rates. The highest passage and exposure were concentrated around federal- and state-run wildlife areas. Other notable areas had very low exposed passes per winter, such as the city of Albuquerque where most documented flights occurred at high altitudes. The results demonstrated that areas managed for wildlife are hosting large aggregations of wintering cranes for roosting and foraging, with corresponding local movement patterns, and thus with higher estimated passage rates across hypothetical transmission lines relative to unmanaged areas.

While the telemetry data revealed significant local movement between roosting and foraging areas, very little movement across the Middle Rio Grande Valley between or among roosts or managed foraging sites was revealed; overall, exposure to collision appeared to be driven by local movements between roosting and foraging areas. The study provided a spatially explicit and quantitative landscape-scale assessment of collision exposure and helped to identify locations in the Middle Rio Grande Valley of New Mexico where transmission line infrastructure would pose relatively low collision risk to wintering sandhill cranes.

As part of this process, we were also able to identify opportunities for impact avoidance and minimization both within and outside the Middle Rio Grande Valley. For example, recently there has been work to mitigate crane collisions on the Platte River in Nebraska using bird flight diverters and contemporary ultraviolet (power line) illumination technology. In addition to a commitment to deploy this ultraviolet illumination technology at the Rio Grande crossing, by soliciting stakeholder and agency input in project design, SunZia identified approximately 45 miles of the project where bird flight diverters will be installed to minimize overall avian collision risk, often in areas where standard practice and management guidelines (e.g., APLIC) may not have called for diverter installation.

The results of this study and the procedures we used (e.g., conducting a collaborative study with a management agency, soliciting stakeholder input on project design) can be used to inform alternatives during the NEPA process, increase community buy-in, and promote collaboration with local and national environmental groups to address project impacts. This is particularly important for the continued buildout of the large transmission infrastructure needed across the country to bring alternative energy to market and help decarbonize the grid.

Misti Sporer – Power infrastructure design blind spots: Case studies to identify patterns and trends specific to substation and power line design relative to system reliability, regulatory compliance, and liability

See also corresponding presentation #23 Power infrastructure design - blind spots: Case studies to identify patterns and trends specific to substation and power line design relative to system reliability, regulatory compliance, and liability.

APLIC has been working for over 30 years to reduce avian interactions with power lines. APLIC member utility companies obtain special use permits under the MBTA, which allows them to collect data on dead birds found near the infrastructure. The data collected by members are reported to APLIC and analyzed to identify trends and develop strategies to reduce bird collisions and electrocutions.

APLIC data from 2018-2020 found that electrocution was the primary risk to birds in the distribution system and around substations. This presents obvious concerns to birds, but also to power companies from increased outages, liabilities, and the potential for cascading electrical and environmental effects (system failure, wildfires, etc.). Often the configuration of poles for the distribution and collector systems is an afterthought, however, the configuration and design of the distribution and collection systems are important considerations for mitigating these risks. How can we design infrastructure to better mitigate these risks? Through isolation and insulation.

Isolation involves expanding the distance between energized and grounded components, while insulation involves providing protective cover over component pieces to prevent face-to-face or face-to-ground contact. Certain components create elevated risks to birds because of the tight configurations and number of components – specifically riser poles and substations. Avian interactions with these components have real cost implications, with potential equipment losses in the millions. Adding to the challenge is that no two substations are designed the same, so understanding how to mitigate risks requires a custom review of their risk profile, evaluating three key factors: component spacing, potential attractants (i.e., nesting sites, perching locations), and the susceptibility of the target wildlife to interaction. Once we understand the specific risk profile of a substation, we can design and install protective equipment to reduce that risk.

Cover shields and protective materials (i.e., insulation) have the potential to not only reduce interactions but also provide cost savings, provided equipment is properly designed and installed. As an example, AltaLink in Alberta, CA, installed custom insulation across 33% of substations in the fleet. This resulted in both reduced avian interactions and reduced outages for their customers. The company saw a rate of return between 17-33% and recouped associated costs in as little as 7-3.5 years, depending on the size of the substation (Hask & Sutherland 2013). In an industry where we have made a lot of progress in developing technologies to minimize collision risk at turbines, this presents a relatively simple way to reduce bird fatalities within the footprint of a development.

Audience Questions & Panelist Response/Discussion

Panelists responded to questions broadly addressing the following:

- How can these landscape-level models and approaches be used to mitigate climate change while conserving wildlife, and what continued research should we prioritize?
- Are there key stakeholders or collaborators who can help to advance landscape-level planning efforts?
- How do the landscape-level assessment approaches compare with other methods for quantifying impacts and risk?

Are there relevant stakeholders or potentially important collaborators that are missing from the conversation around landscape-level planning and assessment?

EMMA KELSEY: The key challenge is to ensure that we identify and involve all stakeholders and recognize that there are many people conducting this type of work that could be beneficial to the process. It's important to do the research and ask questions that can help to identify potential missing stakeholders.

QUENTIN HAYS: We should focus on broadening engagement from not just agencies at the federal level but to include smaller and more localized environmental organizations, participating and neighboring landowners.

GUNNAR MALEK-MADANI: We also need to start conversations early and collaborate with agencies to address issues before they occur.

MISTI SPORER: Traditionally underserved communities or underrepresented groups, Tribal members. We should be mindful of traditional cultural properties that occur on lands held in public trust that may not be on a map or in a database. Ultimately, in order to be a good actor, it is crucial to consider the community in which we are developing.

Given the demand for rapid expansion of renewable energy to mitigate climate change, what research should be prioritized over the next five years to facilitate this growth while conserving wildlife?

MISTI SPORER: The primary focus over the past 20 years has been on collecting more data. It is really important that we now prioritize leveraging the existing data to fill data gaps and identify implementable solutions to address the key challenges facing wildlife (e.g., how to reduce mortality at wind farms, reduce uncertainty in deterrents and curtailment), rather than simply collecting more data. We should also be utilizing these data to assess the socioeconomic outcomes of renewable energy expansion and to understand the potential impacts to our communities if we don't transition to a more sustainable power supply.

QUENTIN HAYS: There have been tremendous advances in remote sensing technology. The availability of higher resolution imagery data can better answer outstanding landscape-scale questions regarding risks to wildlife, particularly for offshore wind energy development, where we do have substantial data gaps. It will be critically important to identify where these gaps exist and to develop monitoring to inform modeling approaches that will accurately estimate impacts and support decision-making.

(for Emma Kelsey) Is there a density threshold of marine birds over which a potential or proposed offshore wind area would be removed from further consideration for development?

There are a number of factors that are considered when BOEM evaluates proposed call areas, including military use, commercial fishing activity, and an environmental data set that would include data on avian use, and specifically include data on seabirds. The seabird data are being used to generate a relative scale of vulnerability (i.e., in which areas seabirds are more or less vulnerable to interaction), but how that information is factored into the overall determination of viability for development is uncertain. At this time, there is not a specific density threshold that will determine whether an offshore wind energy call area is advanced for lease.

(for Gunnar Malek-Madani) What is the typical cost to conduct a remote sensing analysis for a 20,000-acre wind site, and how does that compare with the cost for data collected in the field?

There are multiple open-source, freely available data sets that can be incorporated, including Sentinel 2 imagery data, etc., which makes the overall analysis relatively inexpensive. The primary cost comes with the processing and manipulation of these datasets to develop specific inputs for modeling. The cost increases when generating our own data (e.g., using UAVs), however this is still generally less expensive than field surveys. Once the methodologies for data processing are developed, tested, and validated, the analysis can be scaled as needed with repeatable and defensible results.

(for Misti Sporer) What proportion of bird electrocutions results in outages and wildfires? Is it possible that some of these outages and wildfires result from "recreational hunting" at power lines rather than from electrocutions from avian interactions with the electrical infrastructure?

It is important to recognize that there are multiple operators, facilities, municipalities etc. operating on the grid and they vary in how each can detect outages on their respective systems. The variability in technology (e.g., self-healing grid systems) may mean that a bird interaction creates a very minimal disruption or no outage at all, whereas in other instances, an interaction may create an outage with larger impacts. On average, the available data show 40-60% of electrocutions result in an outage. Very few records exist of a flaming bird falling to the ground and starting a wildfire. More often, what results is a pole top fire that creates catastrophic damage within a small radius around the pole.

The issue of recreational hunting was first identified in Idaho where Idaho Power was observing abnormal patterns in the numbers of electrocutions and subsequently found that several fatalities attributed to electrocution were actually birds that had been shot. There are others looking at APLIC fatalities more broadly and they are finding staggering numbers of fatalities from small caliber rifles at the bottom of electrical poles on publicly accessible roads. There are publications forthcoming on this issue that hopefully address some of these questions.

(for Quentin Hays) What factors might influence the decision to bury a power line rather than install aboveground infrastructure?

There is a balance between accounting for environmental risk and determining what is feasible from an engineering and economic perspective. In assessing collision risk from overhead transmission lines, part of the intent has been to highlight where aboveground infrastructure poses a relatively higher risk and where shifting to underground transmission would provide a simple solution. However, there are numerous additional considerations, primarily whether underground transmission is feasible from an engineering perspective. If we look at the example from the Middle Rio Grande, nowhere else in the world are there lines of similar voltage to that proposed in the Middle Rio Grande running for similarly long distances underground. There were several areas, however, identified in the Middle Rio Grande where overhead transmission lines would pose relatively low risk to cranes.

(for Quentin Hays) Is the Middle Rio Grande projected to provide continuing habitat value for greater sandhill cranes, specifically with respect to fluctuating water levels resulting from climate change?

There are certainly challenges with water in the Rio Grande and more broadly across the southwest region. Cranes generally prefer to roost in areas that are flooded and forage in nearby crop fields. Traditionally there has been enough water for these areas to experience seasonal flooding. With careful management and oversight, and through a collaborative approach, these areas will continue to provide essential wintering habitat for the species.

On-demand Presentation and Posters

3 Reproducibility of a geographical study on the effects of wind turbines on bat fatalities in the Northeast United States

9:00 AM - 9:10 AM, Nov 14

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts ... **On-Demand**

Authors: Madeleine Tango, Middlebury College

With the expansion of wind energy as an alternative to fossil fuel use, it is important that we have the tools necessary to analyze ecological impacts. While geographic information systems (GIS) have many tools for this analysis, the lack of reproducibility in the field will lead to both decreased accuracy of results and slow down knowledge gain during a time in which research speed could prevent extinctions. In this integrative geography and biology thesis for the Environmental Studies department at Middlebury College, I study the reproducibility of a geographical analysis to better understand barriers to its reproduction. The study, conducted by consulting group DNV GL for the Wind Wildlife Research Fund, analyzes the relationship between tree-roosting bat fatalities and landscape features at on-shore wind farms in the northeast United States (Peters et al. 2020). I improve its future reproducibility by analyzing the ways in which both the bat fatality studies used to provide data for the Peters et al. (2020) study and the study itself could have been reported better for clarity and transparency with regards to methods, data, and sources of uncertainty. I also improve its future reproducibility by creating models and R scripts that reproduce the methods of this study to the fullest degree reasonably possible. The models and R scripts can be applied at various spatial scales to calculate landscape metrics (i.e., connectivity, percent area of land cover type, forest core area, etc.) and determine which are most correlated with hoary bat, eastern red bat, and silver-haired bat fatalities in a particular region. Methods, models, and R scripts are publicly available and could be applied to other species and land cover type contexts.

Reproduced paper ("Landscape factors associated with fatalities of migratory tree-roosting bats at wind energy facilities: an initial assessment", Peters et al. 2020) can be found at: https://awwi.org/wp-content/uploads/2020/04/WWRF-Landscape-Factors-and-Migratory-Tree-Bats.pdf. Thesis paper and materials can be found at: https://mtango99.github.io/thesis/thesis.html.

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Speaker

Madeleine Tango
Middlebury College

5 Abundance in 3D: Assessing collision vulnerability of seabirds and floating offshore wind in the California Current

9:10 AM - 9:20 AM, Nov 14

Direct and Indirect Effects on Wildlife and Their Habitats

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife **On-Demand**

Authors: Stephanie Schneider, H. T. Harvey & Associates; Sophie Bernstein, H.T. Harvey & Associates; Glenn Ford, R. G. Ford Consulting; Janet Casey, R. G. Ford Consulting; Jarrod Santora, National Oceanic Atmospheric Administration & U. C. Santa Cruz; Lisa Ballance, Oregon State University; Scott Terrill, H.T. Harvey & Associates; David Ainley, H.T. Harvey & Associates;

The California Current System (CCS) is the most intensely surveyed marine region in the world, with decades of ship and aerial surveys targeting seabirds since the late 1970s. These surveys have been essential for developing two-dimensional (2D) patterns of occurrence for single and multiple species relevant to the management of trophic resources. Such 2D analyses provide insights into the location of diversity 'hotspots' where food availability is highest. However, current proposals relevant to another resource, wind, to construct floating offshore wind facilities (FOSW) necessitate more explicit consideration of vertical (3D) use of space by seabirds and the extent of overlap with rotor swept zones to better assess collision vulnerability in offshore environments. Seabird flight heights and style vary as a function of wind speed and, for gliding and dynamically soaring species, flight heights increase rapidly with increasing wind speed. In response to the persistent, strong winds typical of the CCS, these dynamic soarers dominate the outer continental shelf, particularly during spring and summer months as they migrate into the area from elsewhere (e.g., Hawaii, New Zealand) and then leave the area in winter. Other species that nest in Alaska may be present only in winter. Here, we present a 3D view of seabird abundance in the CCS as a function of location, season, and wind speed. Additional covariates used to help predict abundance included distance to shelf break, distance to seamounts and canyons, distance to the sea floor, distance to nearest breeding colony, and sea surface temperature. This 3D framework demonstrates how, in areas of the CCS with a rich wind resource capable of supporting FOSW, the avifauna composition and abundance, as depicted by traditional 2D analyses, is quite distinct from what is predicted to occur at the height of rotor swept zones owing to species-specific flight styles, specifically heights achieved in relation to wind speed. Improving understanding of these differences in the composition and abundance of seabirds as a function of vertical distribution is essential for understanding seabird vulnerability to collision with future FOSW facilities across the CCS and elsewhere in the Pacific.

Speaker

Stephanie Schneider
Ecologist
H. T. Harvey & Associates

10 A heuristic agent-based model for simulating golden eagle flightpaths and mapping potential collision risk

9:20 AM - 9:30 AM, Nov 14

Application of Research Results towards Practicable Solutions

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand

Authors: David Brandes, Lafayette College, NREL; Eliot Quon, National Renewable Energy Laboratory; Rimple Sandhu, National Renewable Energy Laboratory; Charles Tripp, National Renewable Energy Laboratory; Regis Thedin, National Renewable Energy Laboratory; Tricia Miller, Conservation Science Global; Melissa Braham, Conservation Science Global; CHRISTOPHER FARMER, WEST, Inc.; Todd Katzner, U.S. Geological Survey

High-resolution telemetry data collected over the past two decades has greatly increased knowledge of raptor movements, flight behaviors and altitudes, and mechanisms by which raptors sustain flight. These data provide a basis for development of spatially explicit simulation models that can be used to map high-use areas as a function of varying atmospheric conditions, and thereby identify regions of potential collision risk with wind turbines. Here we demonstrate a heuristic agent-based model that is available as part of our Stochastic Soaring Raptor Simulator (SSRS) framework that simulates both directed migration movements and non-directed or local movements of golden eagles (Aquila chrysaetos), a species known to collide with wind turbines. The model is predicated on the idea that the distribution of atmospheric updrafts (i.e., the energy landscape) is a primary driver of the movement choices of large soaring birds, and thus is based first on simulating the orographic and thermal uplift velocity fields at a chosen grid spacing. The model ruleset consists of both deterministic and stochastic movements that are applied iteratively as the agent (an eagle) moves through the modeled domain, resulting in a movement track from each user-selected starting point. The simulated movements include gliding in orographic updrafts, soaring in thermal updrafts and then gliding, directed random walks, and fully random walks. Each movement is assigned a weighting factor reflecting the likely altitude of the eagle engaged in that type of flight. By running many tracks through multiple realizations of the simulated updraft velocity fields we generate a density map showing likely regions of low-altitude flight that could potentially expose eagles to collision risk. We include several preliminary case studies of simulations with comparison to telemetry data collected from golden eagles in the USA to demonstrate the practical utility of the model.

Speaker

David Brandes
Professor
Lafayette College

13 Decoding golden eagle movement behavior from high resolution, variable rate telemetry data through Bayesian filtering

9:30 AM - 9:40 AM, Nov 14

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts ... | On-Demand

Authors: Rimple Sandhu, National Renewable Energy Laboratory; Charles Tripp, National Renewable Energy Laboratory; Eliot Quon, National Renewable Energy Laboratory; David Brandes, Lafayette College; Regis Thedin, National Renewable Energy Laboratory; CHRISTOPHER FARMER, WEST, Inc. ; Adam Duerr, Conservation Science Global; Melissa Braham, Conservation Science Global; Todd Katzner, U.S. Geological Survey

The recent advances in animal tracking technology have enabled the collection of a vast amount of in situ data regarding the movement of wildlife at high spatiotemporal resolution. These data are usually available at variable time resolutions and contains noise (error) originating from GPS fixes. Decoding movement characteristics, particularly of flying animals, from telemetry data while handling these factors is a challenging yet important task for conservation purposes. Typically, this task is broken into two subtasks: resampling, and model calibration. The resampling subtask converts the variable rate positional data into a constant time interval data, while the model calibration subtask uses the resampled data to tune time-invariant parameters of the proposed models. For telemetry data at high temporal resolutions (order of 1 second), it is very challenging to decouple noise from actual movements using interpolation-based resampling techniques. Any errors introduced during resampling can significantly alter the the calibration and prediction attributes of the movement model. We address this problem through a unified Bayesian state-space framework that can handle both the resampling and calibration tasks in a single step. In addition, we use the speed and heading of the bird from telemetry data to regularize the position information of the bird. We use a Kalman filtering approach to include these nonlinearly related motion parameters within the state space framework. We cross-validated to quantify how this inclusion affects the model performance in estimating true bird movements. The relationship between the true state of the bird and environmental and topographical covariates is then represented parametrically. These parameters are then tuned using stochastic sampling strategies like Markov Chain Monte Carlo (MCMC). We use the telemetry data collected from golden eagles in the western USA to demonstrate the applicability of this approach to build a predictive, probabilistic movement model. Our preliminary results show that this approach provides improved predictive performance in terms of capturing higher-order motion parameters such as angular and horizontal accelerations, which may have simpler and more direct relationships with environmental covariates than corresponding speeds. In this talk, we will demonstrate how this state-space approach benefits the prediction capabilities of a movement model in simulating golden eagle paths through a wind power plant in Wyoming given certain atmospheric conditions. The model outcomes are aimed at informing mitigation strategies that can minimize the potential for collisions of golden eagles with wind turbines.

Speaker

Rimple Sandhu
Computational Scientist
National Renewable Energy Laboratory

14 Using Remote Sensing to Identify Suitable Species Habitat in Renewable Energy Siting Decisions

10:20 AM - 10:30 AM, Nov 14

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand | Poster

Authors: Chris Jorgensen, Olsson; Gunnar Malek-Madani, Olsson

Confirming the presence or absence of protected species or species of conservation concern within or near a renewable energy project can be challenging, especially when many of these species are rare or elusive. Robust survey methods and long-term monitoring strategies can result in financial and temporal burdens. State and federal conservation agencies often recommend avoidance of any suitable habitats for protected species or species of concern all together to minimize any potential adverse impacts, but this avoidance strategy is challenging and burdensome for large projects. Remote sensing techniques are increasingly used to identify or predict where land cover types, specific habitat characteristics, or even entire species' communities may occur. To explore the efficacy of using remote sensing to identify environmental constraints early in the siting process, we tested methods at a theoretical project location. Using publicly available satellite data as well as drone imagery collected using a multispectral sensor, we classified and explored various habitat and land cover types at our test site. Results from the two imagery platforms were evaluated and assessed for accuracy. We discuss the benefits and limitations of using various remote sensing platforms in evaluating potentially suitable habitat at a landscape scale, and ways remote sensing can be integrated into early-stage siting decisions to avoid and minimize impacts to listed species or species of conservation concern.

Speaker

Chris Jorgensen

Technical Leader
Olsson

15 Low-impact wind siting in the southeastern United States

10:30 AM - 10:40 AM, Nov 14

Couching Wind Energy Development within Landscape-level Conservation... | On-Demand

Authors: Liz Kalies, The Nature Conservancy; Dalia Patino-Echeverri, Duke University; Xueying Feng, Shenzhen Qianhai PricewaterhouseCoopers Business Consulting Services Co. Limited; Shawn Li, GreenStruxture

Although installed wind power generation capacity in the United States reached 100 gigawatts (GW) in 2019, quadruple the capacity in 2008, a noticeable void exists in the Southeast. Scant wind power development in this region is due to relatively poorer wind resources, other competitive energy sources, and political opposition. However, the dramatic increases in wind turbine hub height, which allow harvesting the faster wind resources that occur farther from the ground, combined with a growing sense of urgency to develop renewable energy, point to a near future with significant wind development everywhere, including the Southeast. Nevertheless, the enthusiasm for replacing fossil fuels with renewable sources is tempered by fears that the vast land requirements of utility-scale wind farms may disrupt valuable ecosystems. In this paper, we identify the areas where installed wind power capacity is least likely to disrupt wildlife and sensitive natural areas in the southeastern United States. We then describe and make available the resulting geospatial database. The generated maps exclude geographic areas unsuitable for wind power development due to environmental concerns or technical considerations corresponding to five categories. The results suggest that even after removing sizable areas from consideration, there is significant land for wind development to meet the energy and climate needs of the Southeast, particularly in North Carolina and Kentucky. Assuming wind power land requirements of 29-69 acres/MW, an estimate of the onshore wind power capacity that could be installed in the Southeast is 356-1,300 GW, which could generate 470-2,715 TWh. For context, 980 TWh equals the total electric power generated in the Southeast in 2018 and 1,700 times more than current wind power generation.

Speaker

Liz Kalies

Lead Renewable Energy Scientist, North America region
The Nature Conservancy

16 Probabilistic Bat Fatality Modeling Based on Survey Data

10:40 AM - 10:50 AM, Nov 14

Application of Research Results towards Practicable Solutions

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand | Poster

Authors: Jonathan Rogers, Persimia; Christian Newman, Electric Power Research Institute; Donald Solick, Electric Power Research Institute

Growing concern over bat fatalities at wind farms has led to the development of so-called smart curtailment approaches throughout the wind energy community. Some smart curtailment approaches rely on models that predict bat fatality risk as a function of temporal and meteorological variables. While models have been developed to fit prior data, they routinely exhibit poor predictive accuracy and thus are often of limited use in project siting and smart curtailment. This presentation describes a new probabilistic approach to modeling bat fatalities at wind farms on a local and regional scale. Unlike prior deterministic models, the proposed modeling method assumes that bat fatalities occur randomly according to a probability distribution. This probability distribution is a function of meteorological and temporal variables, and may be fit to historical fatality data using a statistical maximum likelihood approach. During the fitting process, fatality survey data is used to estimate the number of fatalities per night (or during regular time intervals). Probabilistic model parameters are then optimized such that the expected model-predicted fatalities matches the observed fatalities as closely as possible in a least-squares sense. Portions of fatality survey data for a given site (say, over multiple years) may be used separately for model training and validation. A primary benefit of the probabilistic modeling process is that it treats bat fatalities as a random process, where the probability of fatality depends on underlying meteorological, temporal, and geographical variables. Because the model is probabilistic in nature, it may be used to generate histograms of yearly fatality predictions with only a few years of meteorological data. Monte Carlo simulations can therefore be performed to predict not only mean fatalities for a given facility, but also standard deviation, percentiles, and other statistics of interest. Furthermore, once a model is fit to fatality survey data for a particular site (or a nearby site) and its accuracy can be verified, it may potentially be used in future years as a substitute for post-construction fatality monitoring.

The presentation will cover the modeling methodology including a description of the mathematical form of the model, the required fatality survey data, and the maximum likelihood model fitting process. Example results will then be provided showing a probabilistic model fit to fatality survey data for the Fowler Ridge wind farm in Indiana. This model is then used to predict regional bat fatalities across the state of Iowa as well as for a wind project in Oregon. In each case, the model is used to produce histograms of predicted bat fatalities from which a variety of statistical quantities may be extracted. The results demonstrate the utility of the probabilistic approach in accounting for the random nature of fatality events, particularly when compared to deterministic modeling approaches.

Speaker

Jonathan Rogers
CEO
Persimia, LLC

18 Attraction of bats to a high-intensity light installation at Flight 93 National Memorial

10:50 AM - 11:00 AM, Nov 14

Application of Research Results towards Practicable Solutions **Evaluating Minimization and Compensatory Efforts** **On-Demand** **Poster**

Authors: Donald Solick, Vesper Bat Detection Services; Matthew Clement, Arizona Game and Fish Department; Nicholas Solick, Vesper Bat Detection Services; Brenda Wasler, National Parks of Western Pennsylvania; Joe Lyon, National Parks of Western Pennsylvania

Artificial light can potentially affect nocturnally active animals, particularly those engaged in migration such as birds and bats. On September 10 - 11, 2021, the Tribute in Light installation of 40 high-intensity spotlights was illuminated at the Flight 93 National Memorial (FLNI) in southwest Pennsylvania to commemorate victims of the 2001 terrorist attacks. We monitored bat echolocation calls and feeding buzzes using bat detectors at FLNI and two other parks in the region for four weeks before and after the ceremony. During the ceremony, the lights were turned off at various intervals to reduce impacts to migrating birds, allowing us to compare bat activity during periods of illumination and darkness. We hypothesized that bats would be attracted to the light display to forage on insects, and predicted echolocation calls and feeding buzzes would be greater during the periods the lights were illuminated. We found that bat activity and feeding buzzes were similar during light and dark periods during the ceremony at FLNI, but were up to 20 times greater than at other parks during the ceremony, and at all parks before and after the ceremony. High levels of feeding activity at FLNI also continued during the hours after the ceremony, particularly for eastern red bats, Lasiurus borealis. These results suggest that bats were attracted to the lights for foraging, remaining in the area when the lights were turned off to feed on the many insects initially attracted to the lights. As such, the Tribute in Light ceremony may benefit bats during fall migration. We suggest that high-intensity spotlights, when managed to minimize impacts to birds, could be a potential mitigation tool for migratory bat species.

Speaker

Donald Solick
Owner
Vesper Bat Detection Services LLC

21 Contextualizing Regulatory Take Assessment Requirements for Wind Energy Facilities in Hawaii: A Case Study Using the Hawaiian Hoary Bat.

11:00 AM - 11:10 AM, Nov 14

Application of Research Results towards Practicable Solutions | On-Demand | Poster

Authors: Jenny Taylor, Tetra Tech, Inc.; Tom Snetsinger, Tetra Tech, Inc.

The U.S. Fish and Wildlife Service and Hawaii Department of Land and Natural Resources require that estimated take in support of an incidental take permit at individual wind projects in Hawaii be quantified using the 80 percent upper credible limit (UCL) using Evidence of Absence software, and that post-construction mortality monitoring occur for the life of the project. Thus, individual projects are required to perform intensive fatality monitoring programs, typically including weekly searches by canine teams and scavenger control efforts, as well as mitigate for impacts that are likely over estimated. Because regulators currently review Hawaii wind projects individually, an understanding of the combined effect of the application of the 80 UCL standard has not been explored, and regulators typically sum the 80 percent UCL values as a shortcut to evaluate the overall scale of wind energy development impacts on individual threatened and endangered species, particularly the Hawaiian hoary bat. We use a dataset developed over the operational period (2 - 16 years; 60 project-years) for six Hawaii wind projects with approved Habitat Conservation Plans (HCPs) and associated incidental take permits to analyze the overall estimated take of the Hawaiian hoary bat from these projects. We use the multiclass and multiyear modules of the EoA software for meta-analysis, and contextualize the results in the framework of the applied regulatory standard at individual projects. Preliminary results using operational periods of 2 - 15 years (54 project-years) and some simplifying assumptions suggest:

- Estimated take from the sum of individual project estimates is approximately 7.7 percent higher than the results of a meta-analysis combining the datasets.
- The application of the 80 percent UCL at individual projects provides a 96.5 percent probability that overall combined take is below the combined take estimate developed by summing the individual take estimates.
- If the regulatory standard were shifted to a 65 percent UCL, this would provide 80 percent confidence that combined take was below the summed values from individual projects.

While it is clear the Hawaiian hoary bat is impacted by wind energy development, we believe such impacts should be measured and mitigated for at their median estimated levels. We suggest that current regulatory standards (using the 80 UCL), which likely over-estimate impacts, discourage development of a key renewable energy resource and continue to promulgate the idea that wind energy is the or at least_a key threat to the Hawaiian hoary bat. We believe collaborative approaches that would allow for adequate, but not onerous, post-construction mortality monitoring and impact assessments would allow for potential to address threats to the Hawaiian hoary bat as well as continued improvements in minimization measures without disincentivizing development.

Speaker

Jenny Taylor
Senior Biologist/Project Manager
Tetra Tech, Inc.

22 Balancing Bat Conservation and Wind Energy Production with EchoSense

11:10 AM - 11:20 AM, Nov 14

Application of Research Results towards Practicable Solutions | Evaluating Minimization and Compensatory Efforts | Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand

Authors: Roger Rodriguez, Natural Power; Gillian Vallejo, Natural Power; Devin Saywers, Natural; Jared Quillen, Natural Power

Curtailment of wind turbines during low wind speeds has been a leading solution in the reduction of bat fatalities caused by collision with turbines. This method, often referred to as blanket curtailment, has been documented to significantly reduce fatalities at local projects and on average across projects throughout North America. During periods when bats are most active, a threshold wind speed is established below which bat activity is likely to be highest and turbines are not allowed to operate. However, this can translate to a considerable loss of revenue. More recently, smart systems are being developed in which additional data are used to determine when bats are present during these periods, to curtail at these times accordingly, and to provide comparable conservation benefits to blanket curtailment with lower energy losses. One such system is the EchoSense system, which combines wind speed data with bat acoustic activity data measured in real-time on site to decide whether to curtail the turbines. Here, we present the results of a two-year case-study comparing the EchoSense system with a blanket curtailment approach in terms of both the financial benefits and the fatality rates associated with each. In the first year, a control treatment was also included in which no additional curtailment was used. We did not find a statistically significant difference in carcasses detected among any of the treatment groups in either year. In the first year this was likely due to a lack of statistical power, since turbine operational issues resulted in reduced sample sizes. In the second year, comparable numbers of carcasses were detected for both EchoSense and blanket curtailed turbines and no significant effect was found between treatments, suggesting that the EchoSense system performs similarly to blanket curtailment in terms of bat fatalities at the study site. The reduction in energy loss associated with EchoSense curtailment compared to blanket curtailment was 41% in the first year and 56% in the second year. Use of the EchoSense smart curtailment system in place of blanket curtailment at this site would therefore be expected to translate into a considerable increase in annual revenue, similar in magnitude to the addition of another turbine to the site, while simultaneously resulting in comparable fatality rates to blanket curtailment.

Speaker

Roger Rodriguez
Bat Biologist/Principal Consultant
Natural Power

24 Whooping crane inland winter habitat selection

11:20 AM - 11:30 AM, Nov 14

Direct and Indirect Effects on Wildlife and Their Habitats | On-Demand | Poster

Authors: Brandi Welch-Acosta, Western EcoSystems Technology, Inc. (WEST); Karen Tyrell, Western EcoSystems Technology, Inc. (WEST); Thomas Prebyl, Western EcoSystems Technology, Inc. (WEST); Rosa Palmer, Western EcoSystems Technology, Inc. (WEST); Wade Harrell, US Fish and Wildlife Service; Aaron Pearse, US Geological Survey

The Aransas/Wood Buffalo population (AWBP) of the whooping crane (Grus americana) winters along the Texas coast at the Aransas National Wildlife Refuge and surrounding areas. Previous studies have determined wintering habitat use is heavily concentrated in coastal marshes; however, infrequent use of inland wetland habitats and cropland has also been documented. Given projections of continued population growth and observations that some individual whooping cranes currently utilize inland habitat during the wintering season, it is anticipated inland habitat use will increase in the future. WEST, in coordination with the USFWS and USGS, developed resource utilization functions (RUF) to model whooping crane winter habitat relationships and predict space use of inland winter habitat based on habitat covariates.

We compiled a set of environmental spatial data layers for habitat characteristics considered to be important for whooping crane use, to include as covariates the RUF model. We used 'random forests' to model whooping crane use as a function of the environmental covariates. Random forest models are a machine learning technique that inherently account for non-linear habitat relationships and covariate interactions. Among the 17 covariates evaluated, those identified as having the highest importance in predicting inland winter habitat use included distance to cropland, proportion of cropland within 1200 m, and measures of urban development. Additionally, covariates describing the amount of grassland cover, proportion of wetlands, and measures of wetness or standing water had moderate importance values. Overall, the model estimated that 50% of use was contained with an area of approximately 38,000 acres (50% use contour), whereas the 75% and 95% of use was encompassed by 136,000 and 710,000 acres, respectively. Predicted areas of concentrated use occurred in Wharton and Colorado counties and, to a lesser degree, in portions of eastern Brazoria and southern Galveston counties.

This model, while presently limited by a small sample size of existing observations at inland wintering areas, could be used during the project assessment process to evaluate potential impacts to whooping cranes related to inland habitat use in close proximity to anthropogenic land use. Additional inland winter habitat use data collected in the future could be incorporated into the model to increase sample size and reduce model uncertainty. As the whooping crane population increases and winter habitat use could expand, the potential for habitat loss and fragmentation, behavioral impacts related to disturbance, and collision risk could also increase. This RUF model should be helpful in determining where impacts to whooping cranes are likely, as well as provide a tool for development of conservation measures.

Speaker

Brandi Acosta
ESA Compliance Specialist
Western EcoSystems Technology (WEST)

25 The emerging role of autonomous recording technology in pre- and post-construction bird monitoring at utility-scale energy developments

11:30 AM - 11:40 AM, Nov 14

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand | Poster

Authors: Aaron Boone, Environmental Consulting & Technology, Inc.; Matthew Ihnken, ECT, Inc; Brian Ortman, ECT, Inc.

Acoustic recording devices are increasingly being used in place of traditional manned surveys to monitor avian species richness, detect rare species of heightened conservation interest, and explore unknown behavioral strategies like phenological variation in vocalization repertoires. Deployment of autonomous recording units (ARUs) can contribute to effective bird conservation during pre- and post-construction development and operations phases at energy facilities. The significant development footprints of renewable energy facilities have the potential to permanently alter or remove habitat or present barriers for sensitive bird species. Additionally, a wide range of bird species experiences varying levels of collision mortality at renewable energy facilities. Passive recording technology and acoustic data analysis techniques have improved appreciably in recent years. ARUs aid efficiency when assessing an area's overall bird community or attempting to detect rare vocalizing birds, mainly when seasonal or daily variation of vocalization frequency is uncertain. In this presentation, we discuss ARU technology's capabilities in the ornithology field and explain emerging data analysis techniques that will support bird monitoring objectives or the exploration of other research hypotheses. The ARU is an important and cost-effective part of the modern bird and wildlife conservation tool kit.

Speaker

Aaron Boone
Senior Scientist
Environmental Consulting & Technology, Inc.

27 WREN, Tethys, and the Wind Energy Monitoring & Mitigation Technologies Tool

11:40 AM - 11:50 AM, Nov 14

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand | Poster | Significance of Wind Energy Development and Energy Choices to Wildlife

Authors: Jonathan Whiting, Pacific Northwest National Laboratory; Zara Miles, Pacific Northwest National Laboratory; Hayley Farr, Pacific Northwest National Laboratory; Cris Hein, National Renewable Energy Laboratory; Samantha Rooney, National Renewable Energy Laboratory; Emika Brown, National Renewable Energy Laboratory

Reducing the impacts of wind energy development on wildlife requires scientifically based monitoring and mitigation strategies to inform decision-makers, developers, and the research community on sustainable siting, construction, operations, and decommissioning. As part of its mission to support the global deployment of wind energy through a better understanding of environmental issues, Working Together to Resolve Environmental Effects of Wind Energy (WREN) has established an online tool to serve as a reference of available technologies for monitoring and mitigating the environmental effects of both land-based and offshore wind energy development. The new Wind Energy Monitoring & Mitigation Technologies Tool (https://tethys.pnnl.gov/wind-energy-monitoring-mitigation-technologies-tool), provides information on a variety of monitoring and mitigating technologies (e.g., camera systems, radio tags, deterrents), including a description for each technology, its application, and its current research status (i.e., whether the technology has been tested in a laboratory study, pilot field study, small-scale field study, and/or large-scale field study). WREN will continuously maintain and update the research status of technologies included in the Tool to ensure the international community has access to current information on monitoring and mitigation solutions, their state of development, and research validating their use and effectiveness. Leveraging its connection to Tethys, the Tool also links each entry to relevant publications in the Tethys

Knowledge Base that have conducted validation studies for the technology. Tethys

is a free, online database that supports WREN by facilitating the knowledge sharing needed to advance land-based and offshore wind energy development in an environmentally responsible manner. The primary feature of Tethys is the Knowledge Base, which contains over 5,300 documents on wind-wildlife research. These documents can be searched by environmental stressors and receptors, such as collision risk for bats and birds or underwater noise effects on marine mammals. Additional resources include a bi-weekly newsletter, an international events calendar, archived webinars, educational summaries, and lists of researchers and organizations involved in wind-wildlife research. This presentation will provide an overview of the recently launched Wind Energy Monitoring & Mitigation Technologies Tool and highlight some of these additional resources available on Tethys. Members of the international wind energy community are encouraged to submit relevant wind-wildlife monitoring and mitigation technologies for inclusion in the Tool, as well as relevant wind-wildlife publications for inclusion in the Tethys Knowledge Base, by emailing tethys@pnnl.gov.

Speakers

Hayley Farr
Environmental Scientist
Pacific Northwest National Laboratory

Zara Miles
Technical Intern - Marine/Wind Energy and Environmental Effects
Pacific Northwest National Laboratory

Jonathan Whiting
Environmental Engineer
Pacific Northwest National Laboratory

29 Environmental Regulation of Energy Generation: From Steam Turbines to Wind Turbines

11:50 AM - 12:00 PM, Nov 14

Direct and Indirect Effects on Wildlife and Their Habitats

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife

On-Demand

Authors: John Young, ASA Analysis & Communication, Inc.

In the 20th century, electricity was generated primarily by steam turbines which require water as a heat sink to condense the steam. Initially most steam turbine facilities used once-through cooling systems which drew water from nearby rivers, lakes, or oceans, then discharged the heated water back to the source. The environmental effects of these withdrawals and discharges were regulated by §316 of the 1972 Clean Water Act Amendments. §316(a) required that the heated discharge maintain a balanced indigenous community in the water body, and §316(b) required that the design, location, capacity, and construction of the intake structure use best technology available to minimize adverse environmental impact. The impacts of highest interest were entrainment, passage through the cooling system by small aquatic organisms, and impingement, entrapment of larger organism on debris screens. The USEPA provided guidance documents for both sections in 1977 which were challenged in court, withdrawn by the agency, and then used by default for decades as the basis for quantifying and regulating the impacts on a site-specific basis. The guidance documents supported a view that impact was to be considered on the level of populations and communities rather than on individual organisms. In the 1990s, USEPA began a decade-long effort to formalize uniform regulations for §316(b). The new rules did not define adverse environmental impact, but used a framework designed to reduce deaths of aquatic organisms by a large percentage from what could occur under baseline conditions, i.e., no features to save fish. After 3 years, the new rule was again withdrawn after challenge by environmental advocacy groups, and finally replaced by a rule which steered toward technological solutions, with less reliance on strict numerical reduction targets. At present, thermal discharges are still regulated using the guidance document from the 1970s. Wind turbine regulation is primarily through the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, the Endangered Species Act, and the National Environmental Policy Act. At the turn of the 21st century, determining the "biological significance" of wind turbine impacts on populations and communities was still a regulatory goal however, similar to "adverse environmental impact" there was no fixed definition of the concept and data requirements would be onerous. The USFWS issued interim voluntary guidelines in 2003, and revised guidelines in 2012 that provide methods for site-specific evaluation of potential and actual impacts on wildlife, without the need for extensive off-site data collection. The guidelines provide recommendations for technology and operational practices to minimize losses of wildlife. There are many parallels in evolution of regulation of steam turbines and of wind turbines. Although both initially allowed for broader ecological characteristics in regulatory decisions (population growth rates, stability, density-dependence) the difficulty of adequately defining the concepts and collecting the data to evaluate them forced a turn toward ways to minimize the loss of individual organisms. The shift in focus allows for quicker regulatory decisions, and more expedient incorporation of technology to reduce fish and wildlife losses from energy production.

Speaker

John Young
Vice President
ASA Analysis & Communication, Inc.

32 Curtailment: From blanket curtailment through smart curtailment and beyond

12:00 PM - 12:10 PM, Nov 14

Evaluating Minimization and Compensatory Efforts | On-Demand

Authors: Lauren Hoskovec, Western EcoSystems Technology, Inc. (WEST); Paul Rabie, Western EcoSystems Technology, Inc. (WEST); Michael True, Western EcoSystems Technology, Inc. (WEST); Andrew Tredennick, Western EcoSystems Technology, Inc. (WEST)

Curtailment of operations, in some form at wind facilities, is perhaps the oldest and most effective method used to minimize bat fatalities. Yet, "curtailment" can mean many things, and the advent of acoustic-triggered and smart curtailment algorithms has ushered in a new era of sophisticated curtailment regime options. These new options offer many conservation and economic benefits over traditional blanket curtailment. In this talk, we will give a historical overview of curtailment, highlighting milestones along the way to the present, such as: the effectiveness of blanket curtailment, acoustic-triggered curtailment, and smart curtailment defined by environmental cues. We will then discuss the current state of curtailment, including a presentation of a new Bayesian decision tree algorithm for smart curtailment that explicitly incorporates the cost of curtailment in the model fitting itself. Last, we will look to the future. The future holds the promise of even more refined methods, such as: 1) dual scale curtailment algorithms that use regional signals to activate local smart curtailment algorithms; 2) opportunities to incorporate uncertainty in risk to bats and impacts to power production losses by considering the implications of wind shear for wind speeds at different heights in the rotor swept zone; 3) species-specific models and algorithms; and 4) the possibility of deploying self-learning curtailment algorithms that update in real-time.

Speaker

Dr. Lauren Hoskovec
Western EcoSystems Technology, Inc. (WEST)

33 Soil, Vegetation and Habitat Restoration and Management Plans for Improving Wildlife in Wind Turbine Fields

12:10 PM - 12:20 PM, Nov 14

Couching Wind Energy Development within Landscape-level Conservation Efforts

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand | Poster

Authors: ted hartsig, Olsson, Inc.; James Hartsig, Invenergy, LLC; Susan Opperman, Olsson, Inc.

Effective wildlife habitat restoration recognizes the inherent variability of soil and vegetation in wind turbine fields. Soil, Vegetation, and Wildlife Management Plans (SVWMPs) focus management activities to accomplish vegetation and wildlife habitat objectives, minimize expenses, and restore wind turbine fields for wildlife and other natural resources. The SVWMPs are simple guides for how, when, and where to implement vegetation and habitat restoration practices.

The SVWMP guides soil and vegetation restoration to create and improve wildlife habitat. Effective habitat includes all facets of the soil, plant, and water environment. Therefore, a successful and effective plan must begin with these essential elements. In addition to providing a plan for restoring soil and vegetation, these plans provide the basis for monitoring wildlife populations that support continued development and operations of wind turbine facilities.

The implementation of SVWPs are an essential tool to support siting and permitting of wind turbine facilities, gain and provide public support, guide construction and habitat restoration, monitor the success and establishment of wildlife populations, and make successful and adaptive management as necessary. This presentation covers how SVWMPs can be efficiently and effectively developed and implemented to provide initial site planning, construction site guidance and restoration, long-term site management, and wildlife monitoring for wind turbine field operations. This presentation includes case studies of soil and vegetation management plan development for renewable energy facilities, including procedures, challenges, and implementation in this growing industry.

Speaker

Ted Hartsig
Olsson, Inc.

34 De-risking Renewable Energy Infrastructure: Using Collaborative Science and Stakeholder Engagement to Reduce Risk to Wildlife in the Arid Southwest

12:20 PM - 12:30 PM, Nov 14

Application of Research Results towards Practicable Solutions

Direct and Indirect Effects on Wildlife and Their Habitats | On-Demand

Authors: Quentin Hays, GeoSystems Analysis, Inc.; Adam Cernea Clark, Pattern Energy Group LP

Many areas in the Southwestern United States suitable for utility-scale wind and solar energy development currently lack the infrastructure needed to bring power to market. Because of the arid nature of the Southwest, riverine and riparian corridors such as the Pecos River, Rio Grande, and San Pedro River serve as crucial resources for wildlife, and renewable energy facilities in this region must deliver power utilizing transmission infrastructure that cross one or more of these vital wildlife areas. The Middle Rio Grande Valley of New Mexico serves as critical wintering habitat for tens of thousands of sandhill cranes (Antigone canadensis) and white geese (snow goose [Anser caerulescens], Ross's goose [Anser rossii]), and multiple high-voltage transmission lines that deliver power from wind energy facilities in central New Mexico cross or are planned to cross the Rio Grande, potentially impacting populations of these species. Wintering sandhill cranes in the Rio Grande are also a significant socio-economic resource, and local opposition to renewable energy and associated infrastructure in this area is often based on perceived impacts to this species.

To better understand the risk to wintering sandhill cranes posed by the SunZia Southwest Transmission Project, which is proposed to cross the Rio Grande to deliver power to market from large wind energy installations in central New Mexico, we engaged in a collaborative study with the United States Fish and Wildlife Service utilizing data derived from a long-term telemetry-based monitoring program. We used approximately 160,000 in-flight locations to determine flight heights and calculate passage rates, then used spline regression modeling to develop a landscape-level map identifying hotspots of risk to sandhill cranes posed by the Project. We showed that in many areas, the likelihood of population level impacts is extremely low. We also engaged stakeholders from local environmental non-governmental organizations, many of whom were historically opposed to the Project, to share the results of our study and better understand continued concerns. This engagement led to proposed minimization measures for the Project that exceed industry standards, and when informed by the results of our study can serve to effectively "de-risk" the portion of the Project that crosses the Rio Grande. We demonstrate that a collaborative approach, grounded in strong science and supported by stakeholder engagement, can facilitate development of the critical infrastructure needed to support the continued growth of renewable energy in the Southwest.

Speaker

Quentin R. Hays
Wildlife Program Director / Senior Wildlife Ecologist
GeoSystems Analysis, Inc.

36 Greater sage-grouse population trends relative to wind energy infrastructure in Wyoming

12:30 PM - 12:40 PM, Nov 14

Direct and Indirect Effects on Wildlife and Their Habitats | On-Demand

Authors: Kurt Smith, Western EcoSystems Technology, Inc. (WEST); Chad LeBeau, Western EcoSystems Technology, Inc. (WEST); Jeffrey Beck, Department of Ecosystem Science and Management, College of Agriculture and Natural Resources, University of Wyoming

Increasing pressure to develop wind energy highlights considerations for the conservation of wildlife inhabiting areas with high wind potential. The current approach to managing greater sage-grouse (Centrocercus urophasianus; hereafter, 'sage-grouse') with respect to wind energy facilities is to restrict development in priority habitats. This management approach will likely see intense scrutiny as political and public pressure to increase renewable energy output rises. Research is thus needed to guide wind development in sagebrush (Artemisia spp.) habitats in a manner that minimize impacts to sage-grouse and other sagebrush-occurring wildlife that inhabit these sensitive landscapes. Currently, the effects of wind energy development on sage-grouse has only been evaluated at one site in Wyoming. We evaluated population-level responses of sage-grouse to nine wind energy facilities (7-Mile Hill, Campbell Hill, Evanston, Foote Creek Rim, Glenrock, Mountain Wind, Pioneer, Rock River, and Top of the World) that occur in central and southwest Wyoming using maximum male lek count data from the Wyoming Game and Fish Department Sage-Grouse Lek database from 1980 to 2020. We evaluated the association between effect of wind turbines on male lek counts by implementing a Before-After Control-Impact study design, where we considered treatment leks (i.e., those exposed to turbines) if they occurred within 5.0 kilometers (km) of a turbine. Leks were assigned as controls if they were greater than 5.0 km from a turbine and less than 15.0 km from a turbine. Trends in counts of males attending treatment and control leks were evaluated over a 6-year period following development to capture any potential time lags in the effects of wind energy development. We detected no difference in lek count trends among control and treatment leks between pre- and post-development periods. Our findings corroborate another study that suggests male sage-grouse attending leks near wind energy development may respond differently than males attending leks in proximity to other forms of energy development. Findings from this research will provide key information for managers tasked with evaluating future wind energy development in sage-grouse range by providing information on placement and configuration of turbines in proximity to leks and sage-grouse habitat.

Speaker

Kurt Smith

Western EcoSystems Technology, Inc. (WEST)

38 Vulnerability of common nighthawk populations to fatalities at wind energy facilities

12:40 PM - 12:50 PM, Nov 14

Direct and Indirect Effects on Wildlife and Their Habitats

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand

Significance of Wind Energy Development and Energy Choices to Wildlife

Authors: Tara Conkling, US Geological Survey; Hannah Vander Zanden, University of Florida, Department of Biology; David Nelson, University of Maryland Center for Environmental Science, Appalachian Laboratory,; Adam Duerr, Conservation Science Global; Todd Katzner, U.S. Geological Survey

As renewable energy production expands across North America, regulatory guidelines call for estimates of population level impacts of renewable energy-derived fatalities on wildlife species. An integral part of this assessment is defining the geographic origin of highly motile species killed at wind facilities, and many previous studies have used stable hydrogen isotopes (8^{2}H) for this purpose. However, the uncertainty associated with 8 ^{2}H-based estimates of geographic origin is typically large, making it difficult to use this approach to identify the origin of a given individual for species (e.g., Caprimulgiformes) with molt patterns that can occur across multiple stages of the annual life cycle. We used a multi-isotope approach to geolocation, considering both d^{2}H and carbon stable isotopes (8^{13}C) to evaluate population of origin for Common Nighthawks found dead at wind energy facilities in Wyoming. Preliminary data suggest that the multi-isotope assignment process resulted in substantially improved estimates of population of origin than with either isotope alone. Data on population of origin were then used together with Bayesian demographic models to identify vulnerable subpopulations of Common Nighthawks to fatalities from wind energy development. Our approach illustrates the relevance of multi-element isoscapes to further classify population of origin or identify subpopulations of interest, and how those origin data can then be used to assess vulnerability of species potentially affected by wind energy development.

Speaker

Tara Conkling

Wildlife Biologist

U.S. Geological Survey

39 Predicting hoary bat fatalities using the passage of regional weather systems

12:50 PM - 1:00 PM, Nov 14

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand | Poster

Renewable Energy Wildlife Research Fund Project

Authors: Julie Bushey, Western EcoSystems Technology, Inc. (WEST); Andrew Tredennick, Western EcoSystems Technology, Inc. (WEST); Rhett Good, CWB®, Western EcoSystems Technology, Inc. (WEST); Paul Rabie, Western EcoSystems Technology, Inc. (WEST)

Hoary bats are common fatalities at wind energy facilities in the U.S., and researchers have expressed concern over the potential impact of wind energy to hoary bat populations. Many wind energy companies utilize an effective strategy called blanket curtailment to reduce impacts to bats over a pre-determined time frame (typically the late summer and fall) when most bat fatalities occur. Because hoary bat fatalities do not occur on every night, tools that predict the risk to hoary bats may allow wind energy facilities to regain lost energy production on nights when curtailment offers little to no conservation benefit to hoary bats. Many wind energy facilities in the Midwest lack significant forest cover near turbines, and bats must migrate or fly long distances before encountering turbines. Efforts to predict hoary bat mortality using on-site weather variables suggest that hoary bats in the Midwest could be making decisions to initiate flight or migration based on cues occurring several miles to tens of miles from wind turbines. We utilized eight years of existing post-construction fatality monitoring data from three different wind energy facilities in Illinois and Indiana to determine if hoary bat mortality could be predicted by the passage of regional weather systems. The specific objectives of this study were to: (1) assess whether regional weather covariates related to the passage of late summer and fall weather systems can predict hoary bat mortality at the regional scale; (2) identify influential patterns in the model that may indicate important cause-and-effect relationships between the passage of regional weather fronts and hoary bat mortality; and (3) compare the utility of the predictive model as a trigger for curtailment. We developed models to predict bat mortality based on weather variables measured at airports within 150 miles of two wind energy facilities, one in northeast Illinois (Pilot Hill) and one in northwest Indiana (Fowler Ridge). The efficacy of the models was tested at a third, anonymous wind energy facility located in northeast Illinois. All three facilities are located within approximately 20-40 miles of each other, have less than 0.5% of forest cover near turbines, and have available post-construction monitoring data during the late summer and fall. We used regularized logistic regression to predict the probability of nights with at least one hoary bat fatality. The optimal model predicted that curtailment could be eliminated on 42% of nights during the study period, while remaining 79% as effective as season-long blanket curtailment. Our results suggest hoary bats in Illinois and Indiana may decide to fly or migrate based on the passage of regional weather systems during the late summer and fall, and mortality is predictable based on this relationship. Incorporating regional models such as this one into existing smart curtailment programs has the potential to increase renewable energy production with little loss to the conservation of hoary bats. This research was funded by the Renewable Energy Wildlife Institute's Wind and Wildlife Research Fund.

Speaker

Julie Bushey

Associate Statistician
Western Ecosystems Technology, Inc.

41 Bioseco BPS - easy way to protect birds against collision on onshore windfarms

1:10 PM - 1:20 PM, Nov 14

Direct and Indirect Effects on Wildlife and Their Habitats **Evaluating Minimization and Compensatory Efforts** **International Wind-Wildlife Studies** **On-Demand** **Significance of Wind Energy Development and Energy Choices to Wildlife**

Authors: Aleksadra Szurlej Kielanska, University of Gdansk, TACTUS; Lucyna Pilacka, Pracownia Przyrodnicza Pilacka; Dariusz Gorecki, TACTUS; Magdalena Wybraniec, Bioseco; Damian Dziak, Bioseco

The dynamic development of wind energy requires the simultaneous implementation of effective systems minimizing the risk of collisions between birds and wind turbines.
More and more countries and organizations are defining guidelines for the necessary functionality of such systems. The minimum bird detection distance, trajectory tracking, and shutdown time are key factors in eliminating collisions.Since 2020 we continued survey on the validation of the subsequent version of the BPS detecion and reaction system. BPS is a fully automatic camera system which allows to estimate the distance of the bird to the turbine, classify its size and autonomously undertake various actions depending on the bird distance and flight path. Together with the integrated strobe and audio deterrent system and turbine shutdown module it is a tool to avoid potential collisions and reduce bird's mortality.The first tests of the system - Standard Plus version carried out in Germany in 2018, showed 80% efficiency in the detection of red kites at a distance of up to 320 m.Validation of BPS Premium (the second version) carried out in Poland in 2021 and 2022 showed 80% efficiency in detecting the same species from a distance of up to 400 m.
Tests of the new version of the system - BPS Long Range carried out at a wind farm in Germany in 2022 showed 96% efficiency at a distance of up to 500 m and 82 % efficiency in detecting this species at a distance of up to 700 m from the turbines.However, studies carried out at a wind farm in Spain showed that BPS Standard Plus detected all birds of prey with a wingspan of more than 1.1 m at a distance of up to 400 m in good weather conditions in the studied area.
In addition, data collected by 3 BPS systems installed in Spain showed that 60% of the detections of all birds of prey were from individuals approaching the turbine and these detections meet the turbine shutdown criteria. Less than 40% of the detections of birds of prey took place at wind speeds below 2 m / s, while the turbines were not working.
As shown by the analysis of the data collected by the system over 12 months, the system classified the improved size of birds with a wingspan of more than 1.1 m in 90% and the size of birds with a wingspan of 0.7 - 1 m in 80% of cases.
The collected data also allow the conclusion that some species keep a certain distance from the turbines at the wind speed over 8 m/s (Aquila sp., Buteo sp., Gyps sp.) but Gyps sp. and Milvus sp. remained active at this wind speed on the tested area (more than 10% of all detected birds of these species. The data collected so far indicate that BPS is effective in detecting and stopping wind turbines in response to the presence of birds of prey with a wingspan of more than 1 m.

Speaker

Aleksandra Szurlej-Kielanska
University of Gdansk, TACTUS

42 Bat diets and the potential role of crop-pest emergence as a contributor to bat mortality at wind facilities: a literature review and model exploration

1:20 PM - 1:30 PM, Nov 14

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand | Poster | Renewable Energy Wildlife Research Fund Project

Authors: Cecily Foo, Western EcoSystems Technology, Inc. (WEST); Amanda Hale, Western EcoSystems Technology, Inc. (WEST); Jennifer Stucker, Western EcoSystems Technology, Inc. (WEST)

Although the ultimate drivers of bat fatalities at wind turbines are still not well understood, foraging behavior of insectivorous bats puts them at increased risk of collision with rotating blades. Wind energy facilities are commonly located in agriculture fields where bats have the opportunity to exploit periodic superabundant insect emergence events in the late summer and early autumn. Thermal imaging, acoustic monitoring, and bat carcass stomach content analyses show bats prey upon insects on and near wind turbine towers. Studies have shown a positive association between insect abundance and bat activity, including in agricultural systems. To our knowledge, however, the hypothesis that superabundant insect emergences near wind turbines increase bat fatalities by creating efficient foraging conditions for bats has not been explicitly tested. We conducted a systematic review of bat diets for four common bat species in the Midwest and northern Great Plains to synthesize existing knowledge across species, assess the extent to which these bat focal species consume crops pests, and evaluate the potential for crop pest emergence models to predict temporal and spatial patterns of bat fatalities in this region. The studies we reviewed indicated big brown bats and eastern red bats consume a variety of crop pests including some for which emergence models may be available. In contrast, there were few studies for hoary bats or silver-haired bats, and the dietary evidence available in the literature is insufficient taxonomic resolution to definitely conclude that crop pests were consumed. To augment existing data and illuminate relationships, we recommend that genetic diet analyses for bats, specifically hoary and silver-haired, be conducted in the late summer and fall in this region. The results of these studies may provide additional candidate insect models to evaluate for predicting bat fatalities at wind turbines and clarify if the superabundant insect emergence hypothesis warrants further investigation.

Speaker

Amanda Hale
Senior Research Biologist
Western EcoSystems Technology (WEST)

45 Indirect, climate-mediated effects of renewable energy production on species' extinction risk

1:30 PM - 1:40 PM, Nov 14

Direct and Indirect Effects on Wildlife and Their Habitats | On-Demand

Authors: Paul Rabie, Western EcoSystems Technology, Inc. (WEST); Taber Allison, Renewable Energy Wildlife Institute; Clayton Derby, Western EcoSystems Technology, Inc. (WEST); Everett Noakes, Western EcoSystems Technology, Inc. (WEST)

The direct, negative impacts of wind and solar energy on wildlife are well documented, and are dominated by bird and bat collisions with energy production infrastructure, particularly wind turbines. Indirect negative effects are also documented, and include habitat loss and degradation, but very little work has been done that examines the potential positive indirect effects of renewable energy on wildlife as mediated through reduced climate forcing associated with renewable energy.

Climate change-mediated effects on individual species would require a detailed understanding of the effects of climate change on the population demography of those species. Such information is lacking for all but a handful of well-studied species. We used information from the peer-reviewed and grey literature to develop a simple conceptual model that relates life cycle carbon balance of renewable and non-renewable energy sources to atmospheric carbon and global temperature. Global temperature, in turn, has been modeled to drive the extinction risk (percent of species likely to become extinct) across the planet.

Preliminary calculations indicated that, depending on the scale of transition from fossil fuels to renewable energy usage over the next 100 years, global mean temperatures will rise between 1.4 and 3.9 C, and the risk to all taxa under those conditions ranges from 8.6 to 13.1% of species (0.7 to 1.1 million species) likely to become extinct. In our model, complete, immediate conversion from fossil fuels to renewable energy results in a 34% reduction in species extinction risk, globally. These estimates all assume that the climate system does not reach a "tipping point," beyond which the sensitivity of global climate to energy-related carbon emissions is reduced.

Our preliminary analysis relied on a broad but incomplete review of the available literature, and did not include any analysis of uncertainty around the estimates. Future work will include a more complete review of available information and the development of statistical models to characterize the uncertainty in the estimates. Nevertheless, work to date suggests that the relationship between renewable energy production and global extinction risk has the potential to inform policy decisions around the development of renewable energy infrastructure, and around our response to renewable energy impacts on wildlife.

Speaker

Paul Rabie

Biometrician
Western EcoSystems Technology, Inc.

46 Combining acoustic deterrents with curtailment further reduces bat mortality for some species

1:40 PM - 1:50 PM, Nov 14

Application of Research Results towards Practicable Solutio **On-Demand**

Authors: Rhett Good, CWB®, Western EcoSystems Technology, Inc. (WEST); Elise Anderson, EDF Renewables

The impacts of wind energy on bat populations is a growing concern because wind turbine blades can strike and kill bats, and wind turbine development is increasing. New approaches may be needed to reduce bat mortality in the future. We tested the effectiveness of two management actions at two wind energy facilities in reducing bat fatalities: curtailing turbine operation when wind speeds were <5.0 meters/second and combining curtailment with an acoustic bat deterrent developed by NRG Systems. Turbines were located at two adjacent wind energy facilities in northeast Illinois, USA, and studied during fall migration (1 Aug-15 Oct) in 2018. Curtailment alone was tested at one facility, while curtailment and simultaneous operation of acoustic deterrents was tested at the second facility. Management actions were compared to turbines that operated at manufacturer cut-in speed at each facility. Curtailment alone reduced overall bat mortality by 42.5% compared to turbines that operated at manufacturer cut-in speed, but did not reduce silver-haired bat (Lasionycteris noctivagans) mortality. Overall bat fatality rates were 66.9% lower at curtailed turbines with acoustic deterrents compared to turbines that operated at manufacturer cut-in speed. Curtailment and the deterrent had varying effects on mortality reduction between species, ranging from 58.1% for eastern red bats (Lasiurus borealis) to 94.4% for big brown bats (Eptesicus fuscus). Hoary (Lasiurus cinereus) and silver-haired bat mortality was reduced by 71.4% and 71.6%, respectively. Acoustic deterrents resulted in 31.6%, 17.4%, and 66.7% additional reductions of bat mortality compared to curtailment alone for eastern red bat, hoary bat, and silver-haired bat, respectively.

Wind energy operators and regulatory agencies should consider species-specific effects and conservation targets when identifying management actions and recommendations for reducing bat mortality. Curtailment is an effective strategy for reducing eastern red and hoary bat mortality but does not consistently reduce silver-haired bat mortality. Using acoustic deterrents in addition to curtailment results in additional benefit for silver-haired bats but may not benefit hoary bats because curtailment was highly effective for hoary bats. Our study, and previous studies of acoustic deterrents, were completed at wind facilities with rotor diameters < 110 meters. The effectiveness of acoustic deterrents for reducing any bat species mortality at turbines with rotor diameters >110 meters is uncertain because of the short distances that high frequency sound travels. Acoustic deterrents and lost revenue from curtailment result in significant costs to wind facilities. Regulators and wind energy facility managers should consider cost in terms of lost energy production, hardware purchase, and installation when recommending methods for reducing bat mortality at wind energy projects. Acoustic deterrents are a potentially effective tool for reducing bat mortality for some bat species but require significant investment in hardware, installation, and maintenance costs. The NRG Systems acoustic deterrent we tested included acoustic deterrents mounted on towers, which require additional installation costs and could be inconsistent with turbine warranties that prevent alteration to turbine structures.

Speaker

Rhett Good

Senior Biologist and Bat Practice Group Lead
Western EcoSystems Technology, Inc. (WEST)

49 Understanding interspecific differences in collision fatality of male and female bats to inform minimization strategies

1:50 PM - 2:00 PM, Nov 14

Application of Research Results towards Practicable Solutions

Direct and Indirect Effects on Wildlife and Their Habitats | On-Demand | Poster

Renewable Energy Wildlife Research Fund Project

Authors: Sara Weaver, Bowman Consulting Group; Sarah LiCari, Texas Christian University; Sarah Fritts, Texas State University; Amanda Hale, Western EcoSystems Technology, Inc. (WEST); Todd Katzner, U.S. Geological Survey; David Nelson, University of Maryland Center for Environmental Science, Appalachian Laboratory

While much progress has been made in describing patterns of wind-turbine related bat fatality, recent results from post-construction monitoring and research studies suggest the need to revisit patterns previously thought to be well established. For example, it has been shown that when genetic methods were used for sex determination of bat carcasses, morphology-based sex determinations of those same carcasses were inaccurate and often significantly overestimated the relative abundance of males. For bats, females are a key limiting factor for population stability and growth and too few females can cause drastic population declines. Therefore, activities that reduce the relative abundance of females, as opposed to that of males, are likely to lead to more severe population declines. Minimization strategies that target females, such as focusing smart-curtailment during periods of high risk to female bats, may be more cost-effective while simultaneously providing similar or even better population-level benefits compared to more generalized strategies. We assessed species-specific temporal (bi-monthly to monthly) and geographic variation in molecularly determined sex ratios of carcasses of seven bat species impacted by wind energy development across North America. To date there are four species with large enough samples sizes for statistical analysis, including Brazilian free-tailed bats (Tadarida brasiliensis, n = 395), eastern red bats (Lasiurus borealis, n = 1,042), hoary bats (Lasiurus cinereus, n = 616), and northern yellow bats (Dasypterus intermedius, n = 193). Generalized linear mixed models with a binomial distribution suggested sex-biased patterns in month-to-month fatality ratios for eastern red and hoary bats but not for Brazilian free-tailed and northern yellow bats. For eastern red bats, results indicate female fatalities were significantly higher in April, May, and August, and were significantly lower in July, September, and October. For hoary bats, female fatalities were significantly lower in September and October. Analyses are ongoing and these results are considered preliminary but suggest there are months of higher susceptibility to fatality for female eastern red and hoary bats. If these sex differences in the timing of fatality persist in the final analysis, then these results could immediately be used to inform minimization strategies to protect female bats.

Speaker

Sara Weaver

Bowman Consulting Group

50 Response of lesser prairie-chicken to a wind energy development located in a fragmented landscape

2:00 PM - 2:10 PM, Nov 14

Direct and Indirect Effects on Wildlife and Their Habitats | On-Demand

Renewable Energy Wildlife Research Fund Project

Authors: Chad LeBeau, Western EcoSystems Technology, Inc. (WEST); Kurt Smith, Western EcoSystems Technology, Inc. (WEST); Karl Kosciuch, Western EcoSystems Technology, Inc. (WEST)

The overlap of renewable wind energy with the range of lesser prairie-chickens (Tympanuchus pallidicinctus) raises concern given population declines and loss of habitat. Lesser prairie-chickens are adversely affected by landscape change; however, it is unclear how this species may respond to wind energy development. Therefore, managers and wind energy developers are currently tasked with making management or siting recommendations of future wind energy facilities based on lesser prairie-chicken behavioral responses to other anthropogenic development or other grouse species' responses to wind energy development. The current strategy of siting wind turbines in cultivated cropland within the range of lesser prairie-chickens has not been evaluated for its effectiveness at minimizing potential adverse impacts. We evaluated potential displacement effects, barriers to movement, and demographic consequences of a lesser prairie-chicken population in southern Kansas, USA, in proximity to a wind energy facility that was sited in cultivated croplands. We captured 60 female and 66 male lesser prairie-chicken from leks located along a gradient from wind turbines from 2017-2021. Over the study period, we collected lesser prairie-chicken location data and demographic information to evaluate resource selection, movements, and demography relative to environmental predictors and metrics associated with the wind energy facility. Lesser prairie-chickens continued to use habitats in close proximity to wind turbines, provided that turbine density was low within a 0.46 km area, and avoidance associated with cultivated cropland appeared to be more predictive than the presence of wind turbines. We observed movement between turbines suggesting that wind turbines did not act as a barrier to local movements; however, long-distance movements were not observed through the wind energy facility, which was largely cultivated cropland. We did not detect an influence of wind turbines on nest success or survival during breeding or non-breeding periods, a relationship that is consistent among multiple grouse species using habitats near wind energy infrastructure. Additional research is necessary to evaluate impacts associated with wind energy development in intact lesser prairie-chicken habitats, but placing wind turbines in cultivated croplands or other fragmented landscapes appears to be an important siting measure when considering development of a wind energy facility across the lesser prairie-chicken range.

Speaker

Chad LeBeau

Western EcoSystems Technology, Inc. (WEST)

51 Activity and foraging behavior of bats offshore on Lake Erie

2:10 PM - 2:20 PM, Nov 14

Direct and Indirect Effects on Wildlife and Their Habitats | On-Demand | Poster

Authors: Michael True, Western EcoSystems Technology, Inc. (WEST); Ashley Reed, Apex Clean Energy, Inc.

The development of wind energy facilities has raised conservation concerns for bats in North America, particularly for migratory tree bats, who comprise a majority of wind turbine collision fatalities. This group of bat species is known to fly offshore and bat activity relating to multiple factors over the Atlantic Ocean has been well researched. However in the Great Lakes, where offshore wind energy facilities are being proposed, data are lacking. Therefore, patterns of bat activity over these large waterbodies correlated with season, atmospheric conditions, timing, and behavior remain largely unknown, leaving a limited extent of informed management strategies. We attempted to fill this data gap by monitoring bat activity using acoustic detectors off the coast of Cleveland, Ohio, on Lake Erie in and near the proposed Icebreaker Wind Project. We produced an exploratory analysis consisting of summary statistics, graphical visualizations, and simple modeling exercises to describe general patterns of bat activity (i.e., counts of "bat passes") and any foraging behavior at these sites. The vast majority of bat activity could be attributed (from most to least) to eastern red, hoary, silver-haired, and big brown bats, which peaked seasonally in spring (for silver-haired bats), summer (for big brown bats), and fall (for eastern red and hoary bats). Bat activity was observed to decrease with increasing wind speed and increased with increasing temperature and pressure and was associated with tailwinds during migration periods. Activity peaked around two hours after sunset and decreased throughout the night. While activity was lower at more distant detectors from the shoreline, the foraging rate (i.e., the detector-specific proportion of foraging passes to total passes) was higher at these locations (compared to others), particularly during the insect-rich period of June to September, a period with an abundance of burrowing mayflies over Lake Erie. Our results indicate that offshore activity may be driven by migration across over-water pathways as the shortest and therefore least cost path, during atmospheric conditions and timing associated with lower energetic costs, and for foraging opportunities. These results are consistent with other studies evaluating bat activity offshore, although our study is the first to note considerable foraging activity. This study provides the foundation to equip the wind industry and wildlife managers on Lake Erie and possibly the Great Lakes more broadly with knowledge of the factors driving activity of bats offshore as to make informed decisions concerning possible management or minimization.

Speaker

Michael True

Associate Statistician

Western EcoSystems Technology (WEST)

52 Offshore bat activity patterns detected by vessel-based acoustic monitoring

2:20 PM - 2:30 PM, Nov 14

Direct and Indirect Effects on Wildlife and Their Habitats | On-Demand

Authors: Nathan Schwab, Tetra Tech; Katelin Craven, Tetra Tech; Derek Hengstenberg, Tetra Tech

Current understanding of offshore bat activity and behavior is limited. Tetra Tech conducted bat acoustic monitoring within Bureau of Ocean Energy Management's Renewable Energy Lease Areas along the eastern United States. Bat detectors mounted at the top of roving offshore research vessels confirmed presence of four bat species (eastern red bat, silver-haired bat, hoary bat, and big brown bat) during the active season (April - October) from 2018 - 2021. The results among the different lease areas were highly variable, although detection rates for all species were highest in early August through early November, consistent with migration periods for migratory tree bats. Regression analyses were completed for temperature, wind speed, and date to investigate correlations for the number of bat passes per night with weather data collected from the National Oceanic and Atmospheric Administration's National Data Buoy Center. The regressions for similar previous studies have yielded nonsignificant positive correlations of temperature with the number of bat passes per night and a significant negative correlation of wind speed and number of bat passes per night. This survey indicates that the Lease Areas are used by non-migratory bat species (big brown bats), as well as long-distance migrants (eastern red bat and silver-haired bat) with the highest detection rates during the fall of the study. Migratory tree bats represented the majority of the total bat passes recorded, with detections spread across the Lease Areas. Although the understanding of offshore bat activity and behavior is limited; migratory tree bats have been the most common species observed offshore, which is consistent with the results of this study.

Speaker

Nathan Schwab

Senior Biologist
Tetra Tech

53 Night-Vision and Augmented Wildlife-Blade Impact Detection for Off Shore Wind Turbines

2:30 PM - 2:40 PM, Nov 14

Application of Research Results towards Practicable Solutions

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife

On-Demand

Renewable Energy Wildlife Research Fund Project

Authors: Roberto Albertani, Oregon State University; Kyle Clocker, Oregon State University; Cassandra Davis, Oregon State University; Nicholas Drachnik, Oregon State University; Hristo Ivanov, National Renewable Energy Laboratory; Matthew Johnston, Oregon State University; Calder Wilson, Oregon State University

Wildlife deterrent systems, curtailing strategies, site permitting and other wildlife management protocols require reliable data for validation. Field data collection, applying current standard methods can present challenges and high costs on land-based wind turbines. Moreover, those methods, are simply not feasible in off shore environment. Reliable field data on wildlife mortality will assess wildlife presence and risks in both land-based and offshore wind turbines, as well as improve current statistical models. Progress of a project funded by the US Department of Energy Office of Energy Efficiency & Renewable Energy (EERE) on an advanced collision detection system for avian and bat species specific to offshore wind energy, including field-tests results, will be presented.

The project, developed by the Oregon State University team, is based on four tasks: 1) Collision detection of extremely low energy blade impacts, 2) Visual confirmation of events in low-visibility and nighttime conditions, 3) Event imaging over a long blade length and 4) General visual and acoustic surveillance capabilities. In previous developed system, impacts on blades are detected by sensing vibrations and structure-born noise at the blade-root. Limitations for the detection of extremely low-energy impacts, typically from bats or small birds, can be experienced due to the relatively low signal-to-noise ratio experienced on blades during regular operations.

With the hypothesis of addressing the low-energy impacts by local sensing, new arrays of sensors, contact microphones, were installed at multiple locations along and outside the blades, retaining the traditional sensors at the blade root including dual micro-cameras for event documentation in large blades. Potential losses of aerodynamic efficiency of the rotor, due to the application of the external sensors, can be mitigated by an appropriate location of the sensors along the airfoil section and by the application of a low-profile, minimum drag, aerodynamic fairing. The problem will be completely avoided by installing the sensors inside the blades, a relatively easy operation that can be performed during blade manufacturing or in-situ during regular maintenance. Night time blade-event documentation is provided by a high-resolution infrared camera installed at the root the blades. A day time visual and audio recorder with 360 degrees field of sensing, installed on the top of the nacelle, provides images and audio recordings for general monitoring of wildlife aerial activity around the turbine. The system can be installed on any turbine at any time of its operational life. The complete array of sensors was field-tested at the National Renewable Energy Laboratory (NREL) National Wind Technology Center (NWTC) applying the custom NWTC artificial impacts generator. Results showed the effectiveness of the on-blade infrared camera as well as the improvement in impact detection by placing sensors along the blade. This project represents a significant improvement for wildlife and wind energy interaction minimization strategies, supporting further safe development of the wind energy market.

Speaker

Roberto Albertani

Professor
Oregon State University

55 Seminole bats at Midwest wind facilities – evidence of fall northward movement and an update to the fall species range map

2:40 PM - 2:50 PM, Nov 14

Direct and Indirect Effects on Wildlife and Their Habitats

On-Demand

Poster

Authors: Michael True, Western EcoSystems Technology, Inc. (WEST); Julia Wilson, Western EcoSystems Technology, Inc. (WEST); Caitlin Campbell, Department of Biology, University of Florida; Ashley Reed, Apex Clean Energy, Inc.

The tree-foliage roosting Seminole bat (Lasiurus seminolus) has extended its geographic range more than 500 kilometers northward since the 1970's with climate change thought to be a major driver. The species range is restricted generally to the Southeastern United States, whereas the summer and fall ranges at their northernmost boundary extend to southern Missouri, Illinois, Indiana, and western Kentucky. However, from 2019 to 2021, during mortality monitoring studies at wind energy facilities during late summer and fall, we recorded 46 Seminole bat carcasses north of the currently defined summer and fall range boundaries with some carcasses as far north as Michigan. Seminole bats can be misidentified as eastern red bats (Lasiurus borealis), so we first evaluated trained bat biologists' ability to identify the species by using DNA confirmation of a sample (n = 12) of in-hand identified Seminole bats. All individuals in the sample were confirmed via DNA as Seminole bats, so we assumed the same 100% accuracy for all other in-hand identifications of the species. The abundance of Seminole bats far outside the summer and fall range boundaries may necessitate the reevaluation of these ranges, which may now encompass large areas of the Midwest. However, because most of the Seminole bat carcasses were found during what could be considered the migration season, they may have spent the mid-summer maternity season elsewhere-even within the currently defined summer range. To test this, we analyzed hydrogen isotope compositions of pelage from a sample of the Seminole bat carcasses (n = 21). Our analysis suggested that, between mid-summer and the death date (mostly during fall), nearly all bats traveled a considerable distance northward with origins likely near or within the currently defined summer range boundary. Therefore, we believe that the summer range map remains mostly accurate. However, due to Seminole bat carcasses being found north of the current fall range boundary, we present an updated fall range boundary based on the data we collected. Due to these newly discovered seasonal movement dynamics during a continuing range expansion, careful attention to correctly identifying Seminole versus eastern red bats at wind energy facilities in the Midwest will be particularly important to appropriately monitor the species as impacts from turbine collisions in the future are unknown.

Speaker

Michael True
Associate Statistician
Western EcoSystems Technology (WEST)

56 Progress towards a predictive eagle behavior and risk modeling framework: Overview and recent validation efforts

2:50 PM - 3:00 PM, Nov 14

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts - | On-Demand

Authors: Eliot Quon, National Renewable Energy Laboratory; Rimple Sandhu, National Renewable Energy Laboratory; Regis Thedin, National Renewable Energy Laboratory; Tara Conkling, US Geological Survey; Melissa Braham, Conservation Science Global; Heather Beeler, U.S. Fish and Wildlife Service; Charles Tripp, National Renewable Energy Laboratory; David Brandes, Lafayette College, NREL; Tricia Miller, Conservation Science Global

This presentation summarizes progress to date of the U.S. Department of Energy project, "Development of a computational framework for modeling golden eagles (Aquila chrysaetos) near wind farms," which focuses on stochastic behavioral modeling of soaring raptors across landscape, facility, and turbine spatiotemporal scales. This publicly available, open-source modeling framework includes behavioral models based on three different underlying principles: energy minimization at landscape scale, behavioral heuristics at landscape-facility scale, and data-driven behaviors at the facility-micro-scale. We will briefly overview the key advancements in the behavioral modeling state of the art, which leverages multiple high-resolution telemetry data sources combined with high-fidelity atmospheric flow modeling insights. We then present preliminary results from a validation study in Altamont, California. This new study involves a novel application of the Stochastic Soaring Raptor Simulator (SSRS), in a new geographic locale, to understand facility scale eagle movement patterns over time scales representative of a wind project's lifetime. For this desktop analysis (that does not depend on any high-performance computing resources), SSRS simultaneously considers a variety of wind conditions and eagle approach vectors toward a project site of interest. This work demonstrates the integration of publicly available landscape-scale atmospheric datasets, our recently improved engineering updraft models (see presentation from Thedin et al.), and our energy minimization behavioral models within the SSRS framework. While we only present results from a single behavioral model, the integration of these three modeling components forms the foundation for our more sophisticated behavioral models (see presentations from Brandes et al., Sandhu et al.) that are under active development. Results are presented in the form of presence maps, which may be applied to estimate risk to wildlife, augment ground survey data, inform wind-plant operations, or incorporated into wind-plant designs.

Speaker

Eliot Quon

Senior Researcher
National Renewable Energy Laboratory

57 Engineering models for orographic and thermal updrafts for movement simulators of eagles at risk of collision with wind turbines

3:00 PM - 3:10 PM, Nov 14

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts . On-Demand

Authors: Regis Thedin, National Renewable Energy Laboratory; Eliot Quon, National Renewable Energy Laboratory; David Brandes, Lafayette College; Rimple Sandhu, National Renewable Energy Laboratory; Charles Tripp, National Renewable Energy Laboratory; Tricia Miller, Conservation Science Global; Adam Duerr, Conservation Science Global; CHRISTOPHER FARMER, WEST, Inc.; Todd Katzner, U.S. Geological Survey

Reducing risk from wind turbines to eagles often requires an understanding of how the birds fly across the landscape. Simulation models describing movements of soaring eagles rely on a representation of the local conditions at the site of interest as an input for movement decision algorithms. Descriptions of local terrain features and spatio-temporal atmospheric conditions are necessary to represent the wind field. In particular, an accurate representation of the vertical component of the wind, accounting for both orographically and thermally induced updrafts is critical. In this work, as a first step to estimating collision risk, we use the Stochastic Soaring Raptor Simulator (SSRS) framework to demonstrate sensitivity of the resulting presence maps of golden eagles (Aquila chrysaetos) to the updraft modeling approach. First, we showcase the differences observed in a simplified model of the orographic updraft field compared to an improved model recently developed by the team. Improvements are validated against data from an atmospheric field campaign. The differences are assessed in terms of presence maps of golden eagles subject to the effects of the modeled updrafts induced by a moderately complex terrain and compared with GPS track data of golden eagles obtained in the same region. Next, we focus on thermal updrafts modeling. While thermal updrafts are dynamic and less predictable than orographic updrafts, we can use atmospheric conditions to drive some characteristics of thermals. We use mesoscale information from the high-resolution rapid refresh (HRRR) database to inform atmospheric conditions at the site and time of interest and determine the convective velocity field. We then use landscape albedo and solar incidence angle on the sloping land surface to weight the probable locations and strength of idealized convective thermal plumes within the model domain, generating a possible realization of the convective field. When considering convective conditions, an ensemble of presence maps obtained from multiple realizations is computed. We demonstrate some options in modeling thermal updrafts and show the sensitivity of presence maps to the different modeling parameters. These sensitivities of predicted eagle presence to updraft modeling choices have exposed the possibility of new regions of high presence density-and consequently, risk-that may have been overlooked by legacy models.

Speaker

Regis Thedin

Researcher
National Renewable Energy Laboratory

58 Non-lead Ammunition Distribution Programs to Offset Golden Eagle Mortalities in Wyoming

3:10 PM - 3:20 PM, Nov 14

Evaluating Minimization and Compensatory Efforts

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife On-Demand

Authors: Vincent Slabe, Conservation Science Global, Inc.; Ross Crandall, Conservation Science Global, Inc.; Tricia Miller, Conservation Science Global; Adam Duerr, Conservation Science Global; Melissa Braham, Conservation Science Global, Inc.; James Anderson, Clemson University

Wind energy has expanded greatly over the past two decades resulting in increased take of golden eagles (Aquila chrysaetos). The United States Fish and Wildlife Service developed requirements for specific conservation actions designed to mitigate eagle deaths resulting from wind energy development. To test the use of non-lead ammunition as a viable mitigation tool, we implemented a non-lead ammunition distribution program in southeast Wyoming, an area with high risk of lead toxicity and high golden eagle use. During the 2020 hunting season, we purchased non-lead ammunition for 434 big game hunters with limited-quota tags in the study area. Following the 2020 hunting season, we surveyed all program participants to assess use of the distributed non-lead ammunition and whether hunters were successful in harvesting game. Preliminary analysis suggests that of the 434 program participants, 80% used the ammunition to hunt and these efforts resulted in >215 lead-free gut piles. The relative reduction in eagle deaths based on the use of non-lead ammunition was quantified using a multi-faceted compensatory mitigation model. Preliminary results suggest that the use of non-lead ammunition provided to hunters through a formal distribution program is an effective method to offset golden eagle mortalities from wind development.

Speaker

Vincent Slabe

Research Wildlife Biologist
Conservation Science Global

59 UAS-based Line Transect Surveys to Measure Bat Occupancy, Abundance, and Species Composition at Wind Energy Facilities

3:20 PM - 3:30 PM, Nov 14

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts | On-Demand

Authors: Leigh Ann Starcevich, Western EcoSystems Technology, Inc. (WEST); Michael Gerringer, Western EcoSystems Technology, Inc. (WEST); Kimberly Bay, Western EcoSystems Technology, Inc. (WEST); Ben Sharp, Western EcoSystems Technology, Inc. (WEST); Lauren Hoskovec, Western EcoSystems Technology, Inc. (WEST)

The population size of most bat species is unknown, which presents a major conservation and management challenge because population trends and impacts of fatalities at operational wind energy facilities are unknown. Passive acoustic detection methods are commonly used to measure bat activity rates and species occupancy but cannot be used to calculate bat density or abundance because the number of unique individuals cannot be determined from acoustic detections. The objective of this study was to develop survey methodology to estimate bat occupancy and abundance by and across species using an Uncrewed Aircraft System (UAS) equipped with an onboard thermal camera and modified SM4BAT detector to simultaneously record bat calls and thermal videos to be able to detect individual bats. In 2021, we collected data along 1-km transects at a Midwestern wind energy facility during the fall migratory season, which is considered the period of highest bat activity at wind energy facilities. UAS flight speeds were set to exceed bat flight speeds to reduce double counting of individual bats. Each transect was surveyed seven times during the survey period. We deployed a grid of 16 passive detectors across the study area to compare and validate UAS data. We conducted transect surveys at two flight heights (20m and 40m) and recorded wind speed and temperature at the time of each UAS flight. Statistical methods were used to model bat occupancy, abundance, and detection processes. Trends in occupancy and species-level abundance were estimated to quantify population changes occurring during the fall migratory season. The detection probability of UAS thermal cameras to detect any bat at occupied transects ranged from 0.22 to 0.59 areas across the seven visits, the estimated occupancy rate declined from 0.59 to 0.23, estimated bat density declined from 119 to 14 bats per km^2, and estimated abundance declined from 21,390 bats to 2,471 bats. Decreasing trends in passive acoustic activity corroborated the trend in UAS detections. Unlike vehicular sampling, our approach surveys airspace in the rotor-swept zone of wind turbines, increases spatial coverage, and can detect non-echolocating bats. Passive acoustic detectors provided useful species composition estimates for a study area where windy conditions may have affected UAS acoustic detection rates. Future work includes improving UAS acoustic detection rates so that this survey methodology may be implemented independently of passive acoustic detector arrays.

Speaker

Leigh Ann Starcevich

Senior statistician
Western EcoSystems Technology, Inc. (WEST)

68 Technology Needs for Scientifically Robust Wildlife Monitoring and Adaptive

Management of Birds and Marine Mammals in Relation to Offshore Wind Energy Development

4:00 PM - 4:10 PM, Nov 14

Application of Research Results towards Practicable Solutions

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand

Authors: Kate Williams, Biodiversity Research Institute; Sarah Courbis, Advisian Worley Group; Aude Pacini, Advisian Worley Group

It can be difficult to study the effects of offshore wind energy development on wildlife in a statistically robust way that meaningfully informs mitigation and adaptive management. Currently available monitoring technologies are often limited in their ability to collect the necessary types and amount of data required, and furthermore are seldom well-integrated into offshore wind infrastructure and operational procedures, which can limit their effectiveness and increase costs. The National Offshore Wind Research & Development Consortium has funded a desktop research study and expert engagement effort to assess the ability of current bird and marine mammal monitoring technologies to 1) answer priority research/monitoring questions, including questions focused on priority taxa, 2) produce statistically robust data to inform meaningful adaptive management, and 3) integrate into normal equipment and operations for fixed and floating offshore wind energy development, in order to produce targeted recommendations for wildlife monitoring technology development to inform the direction of future R&D funding. This study's efforts are focused on U.S. Atlantic, Pacific, and Great Lakes geographies. Assessment of needs and technology gaps associated with monitoring impacts of offshore wind is being conducted through the following activities:

- Identification of questions, study design factors, and technology operational parameters needed to achieve robust statistical outcomes from monitoring
- Review of existing monitoring technologies to assess their capabilities, technology readiness levels, technical specifications, and operational parameters
- Identification of limitations for operational integration of existing technologies with offshore wind energy facilities, given hardware and software requirements, maintenance schedules, and other parameters
- Identification of gaps in capabilities of existing technologies to practically answer wildlife conflict questions and to be integrated into the equipment and operations of offshore wind farms
- Development of targeted recommendations for areas where resources should be directed to best support the offshore wind industry as it develops in the U.S.

This study, to be completed in mid-2023, will result in the identification of key priorities for technology innovation that will improve our ability to safely and effectively monitor birds and marine mammals in relation to offshore wind energy development.

Speaker

Kate Williams

Director of the Center for Research on Offshore Wind and the Environment
Biodiversity Research Institute

70 A Miniature Radio-Frequency Transmitter and 3D tracking Algorithm for Studying Bats and Birds Around Wind Turbines

4:10 PM - 4:20 PM, Nov 14

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts ... | On-Demand

Authors: Daniel Deng, Pacific Northwest National Laboratory; Jun Lu, Pacific Northwest National Laboratory; Corey Duberstein, Pacific Northwest National Laboratory; Hayden Whitbread, Pacific Northwest National Laboratory; Jayson Martinez, Pacific Northwest National Laboratory; Bingbin Wu, Pacific Northwest National Laboratory , ; Tao Fu, Pacific Northwest National Laboratory; Mitchell Myjak, Pacific Northwest National Laboratory; Xinya Li, Pacific Northwest National Laboratory

Radio-Frequency (RF) telemetry has been successfully used to track bats. However, use of RF telemetry in animal tracking has been limited by the relatively large transmitter sizes that could negatively affect the behavior of the animals to which they are attached, and the relatively short service life. The weight of the transmitter is a major constraint and as a result the smallest transmitters typically last less than two weeks. A more powerful battery will enable researchers to extend the life of the RF tags so that more fine-scale movement data can be collected before having to catch another bat. To study small animals and minimize the resulting bias introduced by the tag burden, biologists have been continually seeking smaller transmitters to obtain as-unbiased-as-possible data to support decision-making

We advanced the state-of-the-art of radio-frequency (RF) transmitters by developing three options of a new RF transmitter that can address the research needs for the key bat species to understand wind turbine impacts: 1) Minimized the transmitter size and weight (0.16 gram; 8 km range) to study bats that could be too small to use commercially available RF transmitters; this option targets as the endangered species of Myotis. 2) Prioritized service life (0.40 gram; one year tag life at 15 second ping rate; 16 km range) over the transmitter size, weight and detection range; This option targets the tracking applications for studying the migratory behavior of hoary, eastern red and silver-haired bats, while still staying under the 5% tag-burden guideline. 3) Prioritized detection range (0.57 gram; 35 km range) while keeping the transmitter size and weight reasonable; This option is designed for studying the potential landscape scale attraction of bats to wind turbines and their fine-scale movements across one or more wind farms. We also develop a 3D localization algorithm for these transmitters that can provide high-resolution behavioral information of the tagged bats. The detection range of three RF transmitter designs and the accuracy and efficiency of the 3D tracking algorithm were validated in an operational wind farm.

Speaker

Daniel Deng
Lab Fellow
Pacific Northwest National Laboratory

72 Assessment of Spatial, Temporal, and Meteorological Variation in Bat Activity at Two Operational Wind Facilities

4:30 PM - 4:40 PM, Nov 14

Application of Research Results towards Practicable Solutions

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand | Poster

Renewable Energy Wildlife Research Fund Project

Authors: Adam Rusk, Stantec Consulting Services; Trevor Peterson, Stantec Consulting Services Inc.

The magnitude of bat fatalities at wind projects across North America has yielded a need to better understand how bats are using wind facilities during operation. Absent this information, choosing to not operate turbines below varying cut-in speeds has reduced bat fatality rates. However, to sustain operations at intended levels we need a better understanding of how bats are using the airspace inside of a wind facility. The data we present here are from the first year (fall 2021 - summer 2022) of a multi-year study facilitated by the Renewable Energy and Wildlife Institute, the U.S. Fish and Wildlife Service, and Missouri Department of Conservation. We will discuss preliminary results of bat detectors placed on the masts (20 meters; 5 turbines/project) and nacelles (120 meters; 15 turbines/project) of turbines at two wind facilities in southwest Missouri and evaluate patterns of activity as it varies spatially, temporally, meteorologically, and by species. Results of fall 2021 indicated bat activity occurs at lower altitudes even when windspeeds at hub-height are high and that there is substantially more activity at lower altitudes than at higher. Additionally, turbines with the highest activity at lower altitudes do not necessarily have the highest activity at higher altitudes. These early results will feed into further data collection and more thorough comparisons of activity to time, space, and weather.

Speaker

Adam Rusk
Wildlife Biologist
Stantec Consulting Services Inc.

73 "Dead-Birds Flying" Rehabilitated Raptors as Offsets to Anthropogenic Mortality: A Demographic Analysis of North American Birds.

4:40 PM - 4:50 PM, Nov 14

Application of Research Results towards Practicable Solutions | Evaluating Minimization and Compensatory Efforts | Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand

Authors: Christian Hagen, Oregon State University, Dept. of Fisheries, Wildlife, and Conservation Sciences; John Goodell, Northwest Avian Resources; Guthrie Zimmerman, US Fish & Wildlife Service, Division of Migratory Bird Management; Brian Millsap, US Fish & Wildlife Service, Division of Migratory Bird Management

Conservation professionals agree on the need to develop alternative compensatory mitigation options to address take of Golden Eagles (Aquila chrysaetos) and other federally protected birds of prey by industry sectors. Several options have been proposed including raptor rehabilitation; however, its role as a viable conservation tool is untested and often received with skepticism. Rehabilitated raptors are considered "dead-birds flying" because it is assumed they contribute little if anything to the wild populations. The U.S. raptor rehabilitation sector is increasingly adopting best practices in diagnostics, treatment, and pre-release conditioning, and most facilities are experiencing growing annual admission rates. Currently no peer-reviewed demographic analyses or population modeling exists in North America using post-release data from rehabilitated raptors to evaluate its effectiveness at continental scales. Our objectives were to estimate annual survival probabilities of rehabilitated and wild raptors, impute those estimates into demographic models to assess what potential effects there were for individual additivity and on populations. We hypothesized that rehabilitated raptors would survive similarly to their wild counterparts after an acclimation period. The acclimation period we anticipated to vary according to life-history with shorter-lived species that have higher fecundity (r-selected) acclimatizing more quickly than longer-lived slow-reproducing species (K-selected). Alternatively, we hypothesized larger effects for additivity to individuals or populations for K-selected species. We used USGS Bird Banding Lab band-recovery data (1974 - 2018) from 20 birds of prey species for modeling survival of rehabilitated individuals (n = 125,740) in comparison to their wild counterparts (n = 1,913,352). We compared band-recovery models that explicitly estimated the potential acute effects of post-release acclimation to those without. Results from 17 species with adequate recovery data indicated that 4 species -1 wild survival, 4 species had uncertain estimates, and 9 species :: wild survival by years 2 and 3 post-release. In addition, to our survival estimates, our demographic models required estimates of fecundity, numbers of rehabilitated raptors released back into the wild, and an initial abundance per species. We drew estimates of fecundity from the literature. We sought admissions and release data (2012-2021) from 44 professional rehabilitation centers across the conterminous US, and received data from 24 facilities. Those facilities reported 69,707 admitted and 25,740 released, and an increasing trend over time. We estimated initial population sizes using the online Partners in Flight database, and multiplied those estimates by the proportion of each Bird Conservation Region covered by the 150-km radius (70,000 km^2) Service Area around each facility. Our stochastic demographic models quantified the extent to which "dead-birds flying" may contribute to broader conservation efforts, especially in the context of individual take. All species, but barn owl, had measurable numbers of individuals added to the population regardless of the number of releases. The general pattern was for K-selected species to yield larger benefits from rehab supplementation to the population. Combined these results provide evidence that rehabilitation may serve as mitigation tool to offset incidental take. We discuss potential calculations for estimating mitigation ratios from our results and broader implications for this important conservation challenge.

Speaker

Christian Hagen

Senior Research Faculty

Oregon State University, Dept. of Fisheries, Wildlife, and Conservation Sciences

75 Mitigating avian collisions with power lines through illumination with ultraviolet light

4:50 PM - 5:00 PM, Nov 14

Application of Research Results towards Practicable Solutions | Evaluating Minimization and Compensatory Efforts | On-Demand | Poster

Authors: James Dwyer, EDM International, Inc.; David Baasch, The Crane Trust; Amanda Hegg, National Audubon Society; Andrew Caven, The Crane Trust; Bill Taddicken, National Audubon Society; Catherine Worley, National Audubon Society; Cody Wagner, National Audubon Society; Phoebe Dunbar, University of Nebraska-Kearney; Nicole Mittman, University of Nebraska-Kearney

Bird collisions with power lines, wind turbines, windows, and other anthropogenic structures are a growing global conservation concern. Increasing the visibility of these structures to birds may reduce collisions but may only be accepted by human residents if increased visibility does not create visual disturbance. Illuminating structures with ultra-violet (UV) light may offer a win-win solution because UV light is visible to many bird species and species groups but is nearly imperceptible to humans. To evaluate this, we tested the effectiveness of two UV (390-400 nm) Avian Collision Avoidance Systems (ACAS) at reducing collisions with two 260-m spans of marked power lines. The two spans crossed the Platte River approximately 2 km apart. We conducted our assessment from February to April of 2021 at the Iain Nicolson Audubon Center at Rowe Sanctuary (Rowe), an important migratory stopover location for Sandhill Cranes (Antigone canadensis) in Nebraska. We collected data via live observations with night vision equipment to document flights past and collisions with the power lines we studied. We used a randomized design and a tiered model selection approach employing generalized linear models and Akaike Information Criterion to assess the effectiveness of ACAS considering environmental (e.g., precipitation) and detection probability (e.g., migration chronology) variables. We found focal (assessed power line) and distal (neighboring power line) ACAS status and environmental variables were important predictors of avian collisions. Our top model indicated the focal ACAS being on reduced collisions by 88% on the focal line, and reduced collisions by 39% at the distal line when the ACAS at the distal line was off. So, illumination of one power line reduced collisions not only with that line, but appears to have also reduced collisions with the other line 2 km away on the river, suggesting a positive "neighbor effect" of power line illumination. Our findings were consistent with a prior study of a single ACAS at Rowe and with two additional studies at the Monte Vista National Wildlife Refuge in southern Colorado where multiple power lines spans were monitored, and similar neighbor effects were found. Based on these findings we suggest illuminating wind turbines, wind energy gen-ties, guy wires, towers, and other anthropogenic structures with UV illumination will likely lower collision risks for birds while increasing human acceptance of mitigation measures in urban areas. For more detail, see Baasch, D.M., A.M. Hegg, J.F. Dwyer, A.J. Caven, W.E. Taddicken, C.A. Worley, A.H. Medaries, C.G. Wagner, P.G. Dunbar, and N.D. Mittman. 2022. Mitigating avian collisions with power lines through illumination with ultraviolet light. Avian Conservation and Ecology 17:9. https://doi.org/10.5751/ACE-02217-170209.

Speaker

James Dwyer
Research Scientist
EDM International, Inc.

76 A study to understand the effect of painting wind turbine blades on fatality rates of flying animals

5:00 PM - 5:10 PM, Nov 14

Evaluating Minimization and Compensatory Efforts

Evaluating Novel Approaches to Avoiding and Assessing Wind Energy's Impacts on Wildlife | On-Demand | Poster

Since the emergence of utility-scale wind energy production, efforts to reduce collision risk between flying animals and turbines have been challenged by the biological and technological complexities of the problem. Birds vary widely in their habits and flight behavior, and animal monitoring and identification systems designed to detect and curtail such impacts are complex, expensive, require ongoing maintenance, and may interfere with energy production. Nonetheless, federal and state regulatory agencies are mandated to respond to legal protections for flying animals. The need to identify ways for birds to safely coexist with cost effective wind energy production will only grow more acute.

Recently, researchers in Norway published a paper[1] documenting a nearly 72% decline in turbine blade-related bird mortality associated with a simple manipulation, painting one turbine blade black. The method generated considerable interest as it appears to thread a very fine needle; reducing impacts to bird populations using a simple, durable, inexpensive, low maintenance solution that does not interfere with energy production. Painting blades is thought to visually disrupt what otherwise may appear to the bird as a uniform airspace, making the turbine more visible, and eliciting avoidance behavior. However promising and well executed, the Norway study was at a single unique location and included just four of 68 turbines with painted blades. As such, there are widespread calls to generalize the result by replicating this study in other locations with other species.

In response, PacifiCorp is partnering with state and federal agencies, environmental non-profit organizations, universities, and utility companies to expand and validate this approach in the US. PacifiCorp, a regional power provider serving customers in six western states, has a strong interest in mitigating fatalities of birds, especially golden eagles, and is the developer and operator of the Glenrock I & II/Rolling Hills wind facility, a 237-megawatt utility-scale wind facility in central Wyoming well suited to such a study. Several years of avian fatality data already exist and would serve as reference observations for comparison with turbines having painted blades. PacifiCorp has been given authorization from the Federal Aviation Administration to change the color of up to 36 wind turbine blades for the proposed study.

The proposed study would run several years and complement existing research by increasing the number of painted turbines, generalize across more species and geographic areas, and provide the opportunity to evaluate changes in behavioral response to painted turbines. Although lab studies suggest that fields of view may be manipulated to increase turbine visibility to birds, much remains unknown about the science of avian perception and how it may be influenced to reduce collisions. The potential benefits of this turbine manipulation likely accrue primarily to species engaged in daytime movement. Nonetheless, if proven effective, this simple, low-cost modification may substantially reduce bird mortality at a time when wind energy plays an increasingly prominent role in meeting federally and state-mandated targets for renewable energy production.

Speaker

Shawn Childs

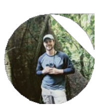
Senior Permitting and Compliance Analyst
PacifiCorp Wind Operations

77 Seasonal patterns of bird and bat collision fatalities at wind turbines

5:00 PM - 5:10 PM, Nov 14

On-Demand | Poster

Speaker



Ryan Butryn

Information Science Manager
Renewable Energy Wildlife Institute (REWI)

Information on when birds and bats die from collisions with wind turbines can help refine efforts to minimize fatalities via curtailment of energy productions and can offer insight into the risk factors associated with collision fatalities. Using data pooled from 114 post-construction monitoring studies conducted at wind facilities across the United States, we described seasonal patterns of fatalities among birds and bats. Bat fatalities peaked in the fall. Silver-haired bat (Lasionycteris noctivagans), a long-distance migrant, and Mexican free-tailed bat (Tadarida brasiliensis) both showed maximum fatality counts later in the year-October and November, respectively-than any other bat species. The other common species in our sample-hoary bat (Aeorestes cinereus), Eastern red bat (Lasiurus borealis), and big brown bat (Eptesicus fuscus)-showed broadly overlapping peaks of fatality counts in August. Fatalities of silver-haired bat showed a smaller spring peak in some ecoregions; no other bat species exhibited this pattern. Seasonal patterns of bird fatalities varied among guilds. Woodland birds, many of which were long-distance migrants, showed two peaks in fatalities corresponding to spring and fall migration. Grassland birds and soaring birds, most of which were resident or short-distance migrants, did not exhibit strong seasonal peaks in fatalities. Species in these guilds tend to inhabit regions with extensive wind-energy development year-round, which may explain the more consistent numbers of fatalities that we observed. Our results highlight the value of pooling data to develop science-based solutions to reduce conflicts between wind-energy development and wildlife but also emphasize the need for more extensive data and standardization of post-construction monitoring to support more robust inferences regarding wind-wildlife interactions and collision risk