Bat & Bird Interactions with Offshore Wind Energy Development

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NREL Transforming ENERGY

Pacific Northwest NATIONAL LABORATORY

Today's Agenda

Bat & Bird Interactions with Offshore Wind Energy Development

- Introduction
- Topic Overview
- Panel Discussion
- Q&A
- Closing Remarks

Photo by Cris Hein, NREL.

Introduction to SEER

At the direction of the U.S. Department of Energy's Office of Energy Efficiency & Renewable Energy Wind Energy Technologies Office, Pacific Northwest National Laboratory & National Renewable Energy Laboratory are jointly leading a multi-year collaborative effort to facilitate knowledge transfer for offshore wind (OSW) research.

Project Objectives

- Summarize the international understanding of environmental effects, monitoring tools, and mitigation strategies for OSW & how it applies to the U.S. Atlantic and Pacific Coasts.
- Examine which of the state-of-the-art methods & technologies are relevant to environmental issues specific to U.S. offshore wind development.
- Identify knowledge & research gaps based on the diversity of species, habitat uses, & stressors; U.S. environmental legal/regulatory structure; and technological innovations.
- Collaboratively develop outcomes together with existing science entities & regional working groups to fully leverage community expertise.

Introduction to SEER

Research Briefs
Review state of the knowledge on stressor/receptor interactions, monitoring methods & technologies, mitigation measures, & cumulative impacts.

Webinar Series
Disseminate findings presented in Research Briefs to the offshore wind industry & others who are interested.

Research Recommendations
Summarize information gaps, barriers, & current challenges for U.S. Atlantic and Pacific Coasts to inform or guide future development efforts.

For more information, visit: https://tethys.pnnl.gov/seer

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Introduction to SEER

Underwater Noise Effects on Marine Life

Bat and Bird Interactions with Offshore Wind Energy

Risk to Marine Life from Marine Debris & Floating Cable Systems

Benthic Disturbance from Foundations, Anchors, & Cables

Introduction of New Structures: Effects on Fish Ecology

Vessel Collision: Effects on Marine Life

Electromagnetic Field (EMF) Effects on Marine Life

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Topic Overview:

Bat & Bird Interactions with Offshore Wind Energy Development

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Bats, Birds, & Offshore Wind Energy

Offshore wind energy (OSW) may represent a new risk to bats and birds off the U.S. Atlantic & Pacific Coasts.

There is a potential risk of collision for certain species & behavioral effects, including avoidance & attraction, for other species.

Given the limited OSW deployments in the U.S., potential risk can be evaluated based on information from studies in Europe, known offshore movement patterns, & land-based wind farms.

Photo by Senu Sirnivas, NREL.

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Bats, Birds, & Offshore Wind Energy

Worldwide, studies at OSW farms have not reported any bat fatalities & only a handful of bird fatalities, but systematic studies have not been conducted.

The lack of data stems from the absence of a practical approach to measuring collision-related mortality offshore.

Across the U.S. & Canada, hundreds of thousands of bats & birds are killed by land-based wind turbines each year.

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Main Risks & Effects: Bats

Data from Europe & the U.S. suggest that bats, particularly migratory tree-roosting species, may approach & interact with land-based wind turbines, which increases collision risk.

Several hypotheses may explain why bats are attracted to wind turbines, including the:

- Influence of surrounding landscape/habitat,
- Distribution of prey near wind turbines,
- Environmental conditions,
- Physical presence of wind turbines, &
- Physiological phenomena.


Photo by Cris Hein, NREL.

Main Risks & Effects: Bats

Along the U.S. Atlantic Coast, at least seven species have been recorded offshore, including three migratory tree bats (hoary bats, eastern red bats, & silver-haired bats).

Limited data exist for bat occurrence along the Pacific Coast, but hoary bats are known to migrate offshore & use coastal islands near California as stopover locations.

Seasonal activity patterns observed at land-based & offshore studies suggest patterns of fatality may be similar.

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Main Risks & Effects: Birds

Hundreds of species of birds use the offshore environment, including shorebirds, wading birds, pelagic birds, & migratory songbirds.

Some bird species may adjust their behavior in response to wind farms, which could affect their survival & reproductive success.

Conditions such as weather, time of day, visibility, & farm configuration, may influence avoidance rates and extent of movement around the wind farm.

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Main Risks & Effects: Birds

Avoidance: An action taken by a bird to prevent interacting with the wind farm.

- **Macro Avoidance**: Response to the presence of the wind farm, resulting in a redistribution of birds outside of the wind farm perimeter.
- **Meso Avoidance**: Response to the presence of individual turbines or turbine strings, resulting in a redistribution of birds within the wind farm.
- **Micro Avoidance**: Response to the rotor-swept area or blades of a wind turbine, considered to be a last second action to avoid collision.

Displacement: Limiting the normal use of an area within or adjacent to a wind farm, as resting, roosting, or foraging habitat.

Barrier Effect: Occurs where a wind farm alters the flight behavior of a bird & prevents it from accessing an area, resulting in the bird taking an alternate route.

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Main Risks & Effects: Birds

Calculations for displacement vulnerability suggest that species groups, including loons, sea ducks, grebes, and alcids, may exhibit avoidance behaviors.

Attraction may be associated with roosting or perching opportunities, or the creation of new favorable foraging habitat (often called the reef effect). Examples of attraction have been observed in Great Cormorants and Northern Gannets.

Seabirds with potential risk for collision include, gulls, cormorants, jaegars, & skuas, among others.

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Monitoring, Modeling & Mitigation Methods

Collecting data before, during, & after construction is necessary to understand changes to normal behavior, distribution, & movement patterns of bats & birds.

Carcass searches & the associated statistical tools used to estimate mortality at land-based wind farms are not possible at OSW farms.

Monitoring bat & bird interactions with OSW turbines will require a combination of approaches to determine species composition, assess behavioral changes, & detect collisions.


Photo by Cris Hein, NREL


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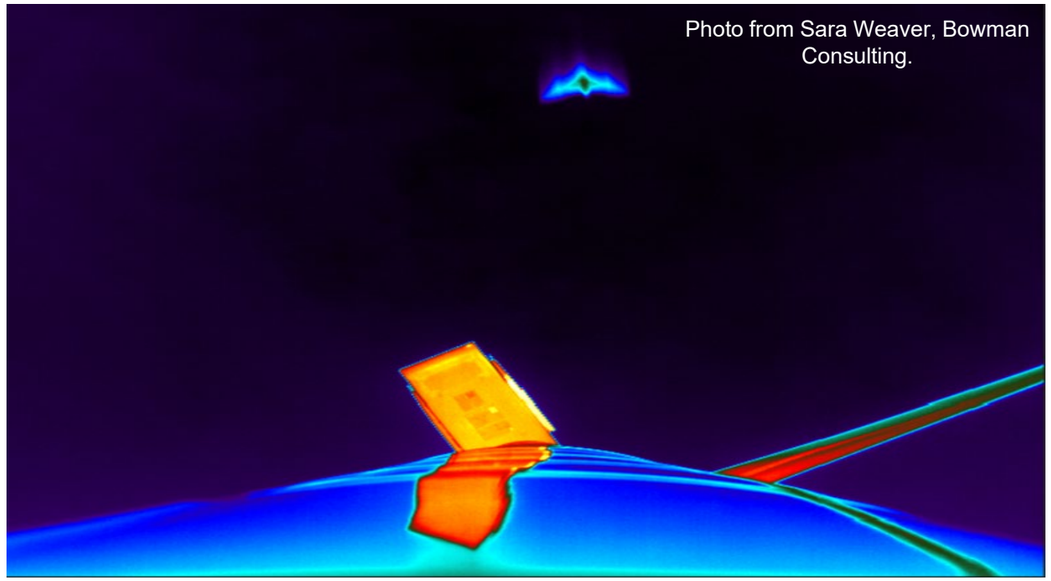
Photo from Sara Weaver, Bowman Consulting.

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Monitoring, Modeling & Mitigation Methods

Monitoring Technologies

- **Acoustic detectors** record vocalizations of bats within 40 m and birds within 100 m.
- **High-resolution digital aerial surveys** collect imagery from fixed-wing aircraft surveys over large distances.
- **Cameras** record visual or thermal observations of bats & birds near wind turbines.
- **Radar** tracks moving objects within a few kilometers to 250 km.
- **Strike indicators** record collision events using sensors installed along each blade.
- **Telemetry** provides information on movement patterns of tagged animals.

ThermalTracker camera system for monitoring bats and birds at wind farms. Photo from PNNL.

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Monitoring, Modeling & Mitigation Methods

Single-sensor Technologies

- **VARS**: near-infrared cameras
- **DTBird**: visual or thermal cameras
- **DTBat:** thermal cameras or acoustic detectors
- **ID-Stat**: acoustic impact sensor
- **ACAMS**: stereo-optic visual cameras with fisheye lenses
- **B-finder**: thermal camera
- **ThermalTracker**: near-infrared cameras

Multi-sensor Technologies

- **WT-Bird**: accelerometer impact sensors and near-infrared cameras
- **ATOM**: thermal cameras, visual cameras, acoustic microphones
- **Wind Turbine Sensor Unit**: accelerometers and contact microphone impact sensors, visual and infrared cameras, & acoustic microphones
- **MUSE**: horizontal radar and thermal or visual cameras
- **TSVA**: stereo thermal cameras, acoustic microphones

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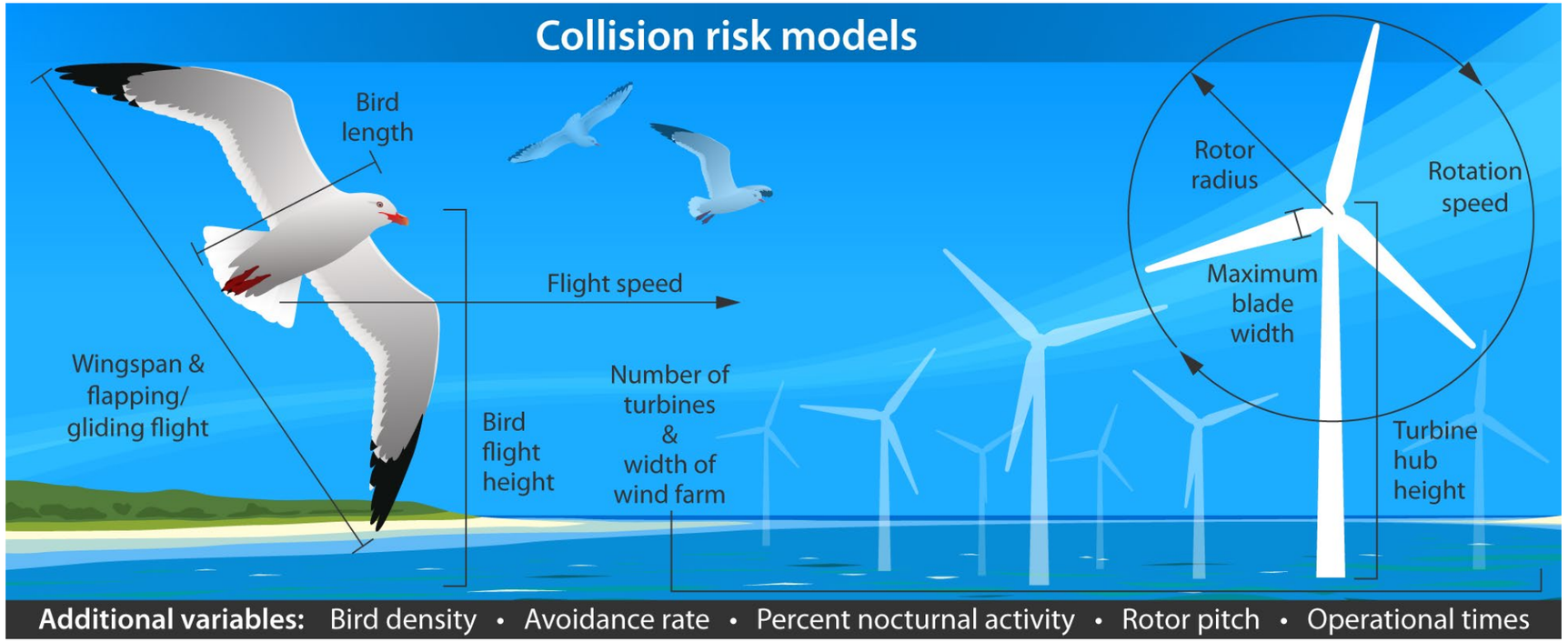
Monitoring, Modeling & Mitigation Methods

Monitoring data, combined with information on OSW farm layout and specifications, can be used to develop collision risk models (CRMs), which inform potential risk.



Parameters used in CRMs. Illustration modified from **Cook and Masden 2019**, NREL.

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Monitoring, Modeling & Mitigation Methods

CRMs are sensitive & can vary dramatically with small changes in the bird survey methods, input data (e.g., avoidance rates), & other assumptions.

Site-specific & species-specific information is necessary to achieve the best results, but the accuracy of model assumptions is difficult to evaluate.

With further development, sensor-based technologies may provide a means to calibrate & improve CRMs.

Photo by Dennis Schroeder, NREL.

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Monitoring, Modeling & Mitigation Methods

Developing cost-effective approaches to mitigate impacts will be necessary if OSW farms present significant risks.

Data on species' presence, use patterns, and behavioral interactions with wind turbines are essential in making informed siting decisions that maximize avoidance.

Factors that may result in avoidance or attraction, such as prey availability, perches, lighting, & proximity to high use areas should be considered.

Photo by Gary Norton, DOE/NREL.

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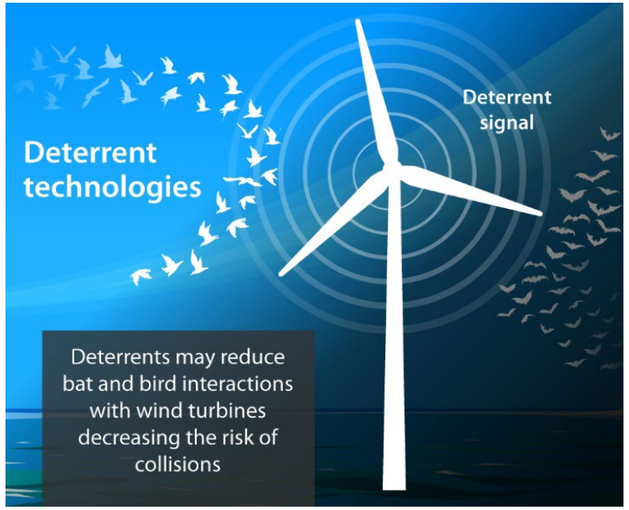
Monitoring, Modeling & Mitigation Methods

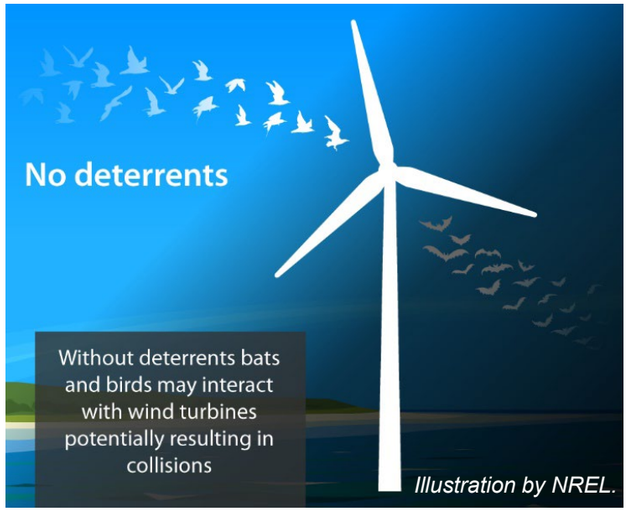
Curtailment

- Involves adjusting the angle of turbine blades (feathering) and increasing the cut-in speed at which blades begin to spin to prevent rotors from spinning during periods of risk.
- Proven effective for bats at low wind conditions but may not be necessary at higher wind speeds (when risk is low).
- One challenge is the loss of energy production, but there are ongoing efforts to make curtailment more cost-effective.

Deterrents

- Generate sound or visual cues that disrupts animals' normal behavior or flight path near a wind turbine.
- Existing technologies are installed on the nacelle or tower, but blade-mounted deterrents are under development.





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Monitoring, Modeling & Mitigation Methods

Compensatory measures offset potential impacts by creating or restoring habitats for species affected by wind farms, such as breeding, nesting, or foraging grounds.

Compensation may also be achieved by addressing other natural or anthropogenic effects on populations. This may include:

- Expanding protected areas,
- Reducing predation,
- Enhancing prey availability, or
- Removing invasive species.

Photo by Dennis Schroeder, NREL

Knowledge Gaps & Research Needs

Given the lack of OSW deployments across the U.S. Atlantic & Pacific Coasts, sharing lessons learned from national and international projects will improve technologies & methodologies for collecting baseline data, improving CRMs, and monitoring risks at OSW farms.

Primary Research Needs

- Collect baseline data (e.g., offshore abundance, distribution, movements, flight height, and flight speeds) to estimate potential exposure and decrease uncertainty for CRMs.
- Assess attraction or avoidance behaviors & understand the underlying mechanisms. Also determine whether there are fitness implications.
- Quantify collision risk and validate CRMs.
- Develop and validate potential mitigation options to reduce risk.

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Panel Discussion

Panelists:

Dr. Pamela Loring
US Fish and Wildlife Service

Kate Williams
Biodiversity Research Institute

Dr. Trevor Peterson
Stantec

Robin Brabant
Royal Belgian Institute of Natural Sciences

For more information on the literature reviewed to develop the Research Brief, visit:
https://tethys.pnnl.gov/summaries/bat-bird-interactions-offshore-wind-energy-development

Acknowledgements

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Members of the SEER Science and Technical Advisory Committee

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Upcoming Webinar

Electromagnetic Fields & Vessel Collision:

Effects on Marine Life

February 24, 2022, 8:00-9:30 AM PST