Book of Abstracts

State of the Science Workshop on Wildlife and Offshore Wind Energy 2022

Hosted by the New York State Energy Research & Development Authority (NYSERDA) on behalf of the Offshore Wind Environmental Technical Working Group (E-TWG)

July 26-28 and September 21, 2022

https://www.nyetwg.com/2022-workshop

NEW YORK STATE | NYSERDA

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9:00-10:30 am	**Welcome and Keynote Address** Grand Ballroom Salons 1-3
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Wednesday, September 21 (Virtual Session)

10:30 am-12:30 pm	**Session 12: Oral Presentations** Virtual session

About the Workshop

Thank you to everyone who participated in the 2022 State of the Science Workshop on Wildlife and Offshore Wind Energy! Workshop goals included:

- Engaging and informing interested stakeholders about the state of knowledge regarding wildlife and offshore wind energy development, including ongoing efforts to understand, minimize, and mitigate environmental impacts;
- Promoting regional coordination by sharing updates on research studies, guidelines development, and other efforts in the eastern U.S. and elsewhere; and
- Promoting collaboration through expert information exchange and discussion.

The theme of the 2022 Workshop was “Building on Existing Knowledge and Emerging Collaborations”. This included sessions focused on:

- Establishing a baseline: Understanding wildlife populations and distributions in the U.S.
- Risk assessments: Approaches and challenges
- Offshore wind development effects and species/ecosystem responses
- Minimization and mitigation approaches
- Cumulative impacts of offshore wind energy development
- Collaborative processes to improve development and conservation outcomes

Topics included the effects of both fixed-foundation and floating offshore wind energy development on wildlife including all vertebrates and invertebrates (including marine mammals, sea turtles, fishes, birds, bats, and benthos), oceanography, and the environment.

Workshop Organizers

State of the Science Workshops are hosted by the New York State Energy Research & Development Authority (NYSERDA) on behalf of the Offshore Wind Environmental Technical Working Group (E-TWG; www.nyetwg.com). This year's organizers include:

Scientific Planning Committee

Kate Williams, Biodiversity Research Institute (BRI; Committee Chair); Scott Ambrosia, Vineyard Wind; Bonnie Brady, Long Island Commercial Fishing Association; Shilo Felton, National Audubon Society; Liz Gowell, Ørsted; Juliet Lamb, TNC; Carl LoBue, TNC; Pamela Loring, US Fish and Wildlife Service; Liz Marsjanik, Vineyard Wind; Kate McClellan Press, NYSERDA; Howard Rosenbaum, Wildlife Conservation Society

Organizing Committee

Kate McClellan Press, NYSERDA (Committee Chair); Eleanor Eckel, BRI; Julia Gulka, BRI; Ed Jenkins, BRI; Kate Williams, BRI

NYSERDA Support Staff

Tricia King; Lana Mohamed; Kelli Gormley

Acknowledgements

Environmental Technical Working Group Members and Alternates (as of July 2022): Kate McClellan Press and Greg Lampman*, NYSERDA (Conveners/Chairs)* • Anthony Bevacqua and Kira Lawrence, *New Jersey Board of Public Utilities* • Lisa Bonacci, *New York State Department of Environmental Conservation*• Koen Broker, Louis Brzuzy, and Ruth Perry, *Shell New Energies* • Megan Brunatti, Colleen Brust, Kevin Hassell and Renee Riley, *New Jersey Dept. of Environmental Protection* • Zach Cockrum, *National Wildlife Federation* •Kimberly Cole and Kristi Lieske, *Delaware Dept. of Natural Resources and Environmental Control* • Jennifer Daniels, *EDF Renewables* • Jennifer Dupont and Scott Lundin, *Equinor* •Lisa Engler, *Massachusetts Dept. of Environmental Protection* • Michael Evans, Liz Gowell, and Melanie Gearon, *Ørsted* •Terra Haight, *New York Dept. of State* • Keith Hanson, Nick Sisson, Susan Tuxbury, and Alison Verkade, *NOAA* • Erin Healy, *Mayflower Wind* • Scott Johnston and Pam Loring, *U.S. Fish and Wildlife Service* • Shannon Kearney, *Connecticut Dept. of Energy and Environmental Protection* • Francine Kershaw, Ali Chase, and Nathanael Greene, *NRDC* • Atma Khalsa, *Avangrid Renewables* • Carl LoBue, *The Nature Conservancy* • Catherine McCall, *Maryland Dept. of Natural Resources* • Laura McKay, *Virginia Dept. of Environmental Quality* • Anne Marie McShea, *Ocean Wind* • Katherine Miller, *RWE Renewables* • Jennifer Mundt, *North Carolina Dept. of Environmental Quality* • Cynthia Pyc and Matthew Robertson, *Vineyard Wind* • Howard Rosenbaum, *WCS* • Brandi Sangunett, *BOEM* • Ally Sullivan and Paul Phifer, *Total Energies* • Fred Zalcman, *New York Offshore Wind Alliance*

Detailed Agenda

Tuesday, July 26

1:00-5:00 pm Side Meetings Room locations noted below

1-2:30 pm	Compensatory Mitigation for Birds: Opening a Dialog (hosted by the Atlantic Marine Bird Cooperative Marine Spatial Planning Workgroup). Discussion open to all workshop attendees with prior registration (Salon 3)
3-5 pm	Operating and Calibrating Offshore Motus Stations (hosted by the U.S. Fish and Wildlife Service and University of Rhode Island). Workshop open to all workshop attendees with prior registration (Salon 3)
1-5 pm	Non-Extractive Techniques for Resource Assessment (hosted by the Responsible Offshore Science Alliance). Open to workshop attendees with prior registration (Salon 1-2)
2-5 pm	Project WOW External Advisory Board (hosted by the Regional Wildlife Science Collaborative). Closed meeting (Salon 5)

5:00-7:00 pm Opening Reception Bistro Z Restaurant Terrace

Opening Reception – Open to all Workshop Attendees

Wednesday, July 27

8:00-9:00 am Continental Breakfast Grand Prefunction/Grand Terrace

9:00-10:30 am Welcome and Keynote Address Grand Ballroom

- Welcome from NYSERDA and workshop planning committees
- Keynote from Ivan Savitsky, Offshore Wind Manager at The Carbon Trust and manager of the Offshore Renewables Joint Industry Programme (ORJIP) for Offshore Wind

10:30-11:00 Break Grand Prefunction Room

11:00 am-12:30 pm Session 1 Grand Ballroom (Salons 1-3)

Session 1: Oral Presentations

- *Demersal trawl and ventless trap surveys at Block Island Wind Farm* – Dara Wilber
- *NOAA Fisheries and BOEM federal survey mitigation implementation strategy* – Northeast U.S Region – Andy Lipsky
- *Altered spatial distribution of a marine top predator under elevated ambient sound conditions* – Amber Fandel
- *Displacement of Red–throated Loon by offshore wind farms in the North Sea of Germany* – Georg Nehls
- *Piloting the operationalization of net positive impact on an offshore wind project* – Jennifer Dupont
- Question and Answer (Q&A) Period – all speakers

12:30-1:30 pm Lunch on the Grand Terrace

1:30-3:00 pm Sessions 2-3 Grand Ballroom (Salons 1-2 and 3)

Session 2: Oral Presentations – Grand Ballroom Salons 1-2

- *Sometimes seen, but often heard: Presence of dolphins and harbor porpoise in potential cable corridor areas* – Melinda Rekdahl/Sarah Trabue
- *Monitoring the health and movements of pinnipeds in the Northwest Atlantic Ocean* – Allison DePerte
- *SPACEWHALE: Surveying whales from space as an effective tool for baseline studies and respective monitoring* – Julika Voss
- *Extremely reliable locations and calling abundance via passive acoustic monitoring* – John Spiesburger
- *Automatic whale detection from vessels for real–time vessel–strike and noise impact mitigation – current developments and applicability* – Daniel Zitterbart
- Q&A Period – all speakers

Session 3: Symposium – Grand Ballroom Salon 3

Predatory–prey interactions with forage fish and seabirds: Building a foundation to understand indirect effects of offshore wind on marine ecosystems – Evan Adams. Examination of predator–prey relationships in the context of offshore wind development, focusing on seabirds and their prey. Presenters will describe forage fish trends and communities and the movements of the predators that rely on them, and discuss effects of offshore wind that can precipitate ecosystem changes.

- Forage fish occurrence and temporal changes in offshore wind energy areas on the U.S. Northeastern Continental Shelf – Kevin Friedland
- The influence of climate and wind energy development on seabird–forage fish trophic relationships in the Northeast U.S. – Michelle Staudinger
- Forage fish community and surface aggregation dynamics in the Northeast U.S. Continental Shelf Ecosystem – Chandra Goetsch
- Assessing individual movement, habitat use, and behavior of non–breeding marine birds in relation to planned offshore wind development in the eastern U.S. – Julia Gulka
- Filling knowledge gaps: What’s next for understanding changes to seabird–forage fish dynamics? – Evan Adams
- Panel Discussion – all speakers

3:00-3:30 pm Break Grand Prefunction Room

3:00-5:00 pm Sessions 4-5 Grand Ballroom (Salons 1-2 and 3)

Session 4: Oral Presentations – Grand Ballroom Salons 1-2

- *Regional habitat modeling results & establishing standard benthic data sharing workflows* – Marisa Guarinello
- *Modeling distributions of deep–sea corals offshore of the Southeastern United States to guide efficient discovery and protection of sensitive habitats* – Matthew Poti
- *Use of passive acoustic telemetry to monitor the presence and persistence of highly migratory species within Southern New England wind energy areas* – Brian Gervelis
- *Pre–construction evaluation of Atlantic cod spawning in Southern New England offshore wind areas* – Alison Frey
- *Establishing the Atlantic cod spatiotemporal spawning baseline in Southern New England to assess potential interactions with offshore wind energy* – Rebecca Van Hoeck
- Q&A Period – all speakers

Session 5: Symposium – Grand Ballroom Salon 3

New York, New York: Working together to establish marine mammal baselines in and around a wind energy lease area and associated cable corridors – Howard Rosenbaum. Introduction to a collaborative project focusing on collecting baseline information on cetacean presence in the New York Bight. Presentations discuss project objectives and results thus far and include discussion on collaboration between researchers and developers.

- Passive acoustic monitoring in near real–time and associated capabilities – Mark Baumgartner
- Using regional datasets to inform environmental impact assessment and mitigation measures: A developer's perspective – Jennifer Dupont
- North Atlantic right whale (NARW) presence and vocal activity: Implications for safe passage through the New York Bight – Anita Murray
- Temporal variability in fin whale vocal activity: Understanding occurrence, behavioral shifts, and population structure in the New York Bight – Carissa King
- Baleen whale sightings: Distribution, behavior, and overlap with anthropogenic activities – Emily Chou
- Panel Discussion – all speakers

5:00-5:30 pm Break

5:30-7:30 pm Poster Session Grand Terrace

Poster Session Grand Terrace

Thursday, July 28

8:00-9:00 am Continental Breakfast Grand Prefunction/Grand Terrace

9:00-10:30 am Session 6 Grand Ballroom (Salons 1-3)

Session 6: Oral Presentations

- *Modeling offshore wind infrastructure effects on upper ocean physical and biogeochemical processes and implications for higher trophic levels* – Hansong Tang
- *Effects of floating offshore wind farms on coastal upwelling in the California Current ecosystem* – Kaus Raghukumar
- *Comparing underwater noise measured during construction of the first two offshore wind farms in the U.S.* – Kristen Ampela
- *Characterizing the operational soundscape of floating offshore wind parks: Implications for environmental risk assessment and wildlife* – Jordan Carduner
- *The characterization of acoustic particle motion from loud impulsive and quiet sustained sources of sound* – Kaus Raghukumar
- Q&A Period – all speakers

10:30-11:00 Break Grand Prefunction Room

11:00 am -12:30 pm Sessions 7-8 Grand Ballroom (Salons 1-2 and 3)

Session 7: Oral Presentations – Grand Ballroom Salons 1-2

- *Environmental drivers of distribution of whales, seabirds, and turtles in the New York Bight* – Sarah Courbis
- *Modeling past and future spatial distributions of marine bird species in U.S. Atlantic waters* – Arliss Winship
- *Oceanic records of North American bats and implications for offshore wind energy development in the United States* – Christian Newman
- *Offshore bat activity patterns detected by vessel–based acoustic monitoring* – Nathan Schwab
- *Technology needs for scientifically robust wildlife monitoring and adaptive management of birds and marine mammals* – Sarah Courbis
- Q&A Period – all speakers

Session 8: Symposium – Grand Ballroom Salon 3

If we build it, who will come? Exploring artificial reef effects associated with offshore wind installations – Carl LoBue and Annie Murphy. Examination of the ecological implications of introducing novel structures such as turbine foundations and scour protection into the marine environment through offshore wind development. Presentations will discuss nature–inclusive designs, identifying knowledge gaps, outlining research methodologies, and associated US–specific socio–ecological aspects.

- The flyway concept and assessment of offshore wind impacts on migratory marine fauna – David Secor
- Turbines as artificial reefs, nature–based design options to enhance habitat – Christopher McGuire
- Epifaunal colonization on foundations in the U.S. and subsequent organic enrichment to the seafloor – Annie Murphy
- Overview of lessons learned from Europe – Steven Degraer
- Artificial reefs associated with southern California oil and gas platforms – Erin Meyer-Gutbrod
- Panel Discussion – all speakers

12:30-1:30 pm Lunch on the Grand Terrace

1:30-3:00 pm Sessions 9-10 Grand Ballroom (Salons 1-2 and 3)

Session 9: Symposium – Grand Ballroom Salons 1-2

Collaborative animal movement studies to improve conservation outcomes – Pamela Loring, U.S. Fish and Wildlife Service. Discussion of current efforts and next steps for coordination and analysis of wildlife telemetry data for offshore wind research, monitoring, and assessments in the Atlantic. Using birds as a case study, symposium speakers will focus on coordinated automated radio telemetry (Motus) and satellite telemetry (e.g., Argos and GPS).

- Development of a coordinated offshore Motus network for monitoring birds and bats at site specific to regional scales – Pamela Loring
- Evaluating the impact of offshore Motus study design choices on the presence and movements of birds in marine environments – Evan Adams
- SCRAM model for estimating offshore avian collision risk using avian movement data – Andrew Gilbert
- A framework to determine optimal sample sizes and transmitter distribution for individual tracking studies – Juliet Lamb
- Combining satellite telemetry data across studies for Sterna terns relative offshore wind energy in Brazil – Rafael Revorêdo
- Panel Discussion – all speakers

Session 10: Symposium – Grand Ballroom Salon 3

Autonomous solutions responding to the oceanographic and ecological monitoring needs of offshore wind development – Josh Kohut and Grace Saba. Panel discussion focused on the use of autonomous platforms such as underwater gliders in offshore wind-related ecological and environmental monitoring. An introductory presentation will highlight a recent successful example of replacing vessel-based surveys from Antarctica with autonomous survey platforms. Panel discussion will include federal, state, and private sector perspectives on autonomous monitoring and regulatory solutions.

- Autonomous monitoring for resource assessment in the Antarctic and California Current – Christian Reiss
- Panel Discussion: Josh Kohut, Grace Saba, Andy Lipsky, Kate McClellan Press, Kira Lawrence, Renee Riley, Greg DeCelles, Christian Reiss

3:00-3:30 pm Break Grand Prefunction Room

3:00–5:00 pm Session 11 Grand Ballroom (Salons 1–3)

Session 11: Symposium

Progress on RWSC Science Plan for wildlife, habitat, and offshore wind energy in the U.S. Atlantic – Emily Shumchenia. The Regional Wildlife Science Collaborative (RWSC) is focused on how offshore wind development will affect wildlife and ecosystems off the U.S. Atlantic coast. This symposium will provide an update on development of integrated science plans, and how they will inform future coordination of research activities and funding. Following presentations from each taxa-based subcommittee, a concluding discussion will address future expectations and considerations.

- General RWSC introduction and recent progress, and Protected Fish Subcommittee update – Emily Shumchenia
- Bird & Bat Subcommittee update – Zara Dowling
- Marine Mammal Subcommittee update – Deborah Brill
- Sea Turtle Subcommittee update – Avalon Bristow
- Habitat & Ecosystem Subcommittee update – Marisa Guarinello
- Panel Discussion: Kyle Baker, Corrie Curtice, Carl LoBue, Stephanie Vail–Muse, Nick Napoli

5:00-5:30 pm Concluding Remarks Grand Ballroom (Salons 1-3)

Concluding Remarks

Wednesday, September 21 (Virtual Session)

10:30–12:30 pm Session 12 Virtual

Session 12: Oral Presentations

- *Investigating prey fields near foraging right whales in southern New England* – Harvey Walsh
- *Towards understanding the potential for offshore wind to impact bats* – Jeff Clerc
- *Method for defining appropriate Acceptable Levels of Impact on bird populations* – Astrid Potiek
- *Using remote monitoring to understand weather influences on bird activity in the offshore environment* – Greg Forcey
- *The use of LiDAR technology to measure site specific offshore avian flight heights* – Steph McGovern
- *Machine learning for automated detection and classification of seabirds, waterfowl, and other marine wildlife from digital aerial imagery* – Kyle Landolt
- *B–finder – automatic bat & bird collision monitoring for wind farms* – Michal Przybycin
- *Design, production, and validation of the biological and structural performance of an ecologically engineered concrete block mattress* – Heather Weitzner
- Q&A Period – all speakers

Oral Presentation Abstracts – In-Person Sessions

Listed alphabetically by last name of first author

Comparing underwater noise measured during construction of the first two offshore wind farms in the U.S.

Kristen Ampela[1*], James Miller[2], Gopu Potty[2], Ying-Tsong Lin[3], Jennifer Amaral[4], Adam Frankel[4], Tim Mason[5], Anwar Khan[1]
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1 HDR, Inc., 2 University of Rhode Island, 3 Woods Hole Oceanographic Institution, 4 Marine Acoustics, Inc., 5 Subacoustech Environmental Ltd.

The purpose of the BOEM-sponsored Real-time Opportunity for Development Environmental Observations (RODEO) Program is to gather real-time data during construction and operation of offshore wind farms (OWF) at various locations in the U.S. to help assess environmental impacts of current—and planned—OWF facilities. The RODEO Program provides an important framework to align and integrate results from environmental studies of OWFs in multiple regions, involving different design and construction approaches, in a variety of benthic habitats and sediment types. We compare results from underwater acoustic monitoring performed during construction pile driving at the first two OWFs to be constructed in the U.S.: Block Island Wind Farm (BIWF), a five-turbine, 30 MW facility located 4.5 km from Block Island, Rhode Island, and the Coastal Virginia Offshore Wind (CVOW) project, which consists of two 6-megawatt wind turbines located 43 km east of Virginia Beach, Virginia. The following underwater noise metrics were compared: peak sound pressure level (SPL), peak-to-peak SPL, and single-strike sound exposure level (SEL). Results are of interest due to the unique nature of these data; however, comparisons presented here should be interpreted with caution due to the key differences between the BIWF and CVOW sites, including pile size and orientation, foundation type, hammer energy, water temperature and depth, and the distance of the sensors from the pile. This exercise may also provide a framework and lessons learned for future data analyses involving multiple OWF facilities.

Characterizing the operational soundscape of floating offshore wind parks: Implications for environmental risk assessment and wildlife

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1 Equinor ASA

Floating wind parks will play an important role in the future helping the world to reach the ambitious goals within the transition from use of fossil fuel to renewable energy. Floating wind parks can be built in deeper waters than jacket or monopile structures that are currently used as foundations for wind turbine generators (WTGs). During the construction phase floating wind parks produce less underwater sound compared to pile driving required to install traditional offshore wind monopile and jacket foundations. Once the construction of the offshore wind park is completed, operational sounds can also be expected to be present, both for bottom-fixed and floating wind parks. Equinor has conducted a sound characterization study in the first commercial floating wind park, the Hywind Scotland wind park out of Peterhead, Scotland. The work was carried out by JASCO using an advanced 4-channel hydrophone array placed within the wind park. This allowed a detailed analysis of the sound characteristics emitted from the floating WTGs. Continuous sound components were found as well as sounds of more transient character associated with the mooring system. The general soundscape can be characterized as low frequency broadband noise with some distinctive tonal elements. In this presentation, we will present the detailed results of the sound characterization study and discuss potential implications for environmental risk assessment studies and potential wildlife impacts. We will provide insights into potential impacts to wildlife. This will be shown by providing examples of sound propagation modelling of hypothetical wind farms placed at different locations with variable bathymetry, sound speed profiles and alike and discussing the results in context of various species' presence and hearing ranges.

Technology needs for scientifically robust wildlife monitoring and adaptive management of birds and marine mammals

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1 Advisian Worley Group, 2 Biodiversity Research Institute

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 or operations, which can limit their effectiveness and increase costs. Development of technology for monitoring wildlife should be directed towards the gaps in technical capabilities that drive challenges in (1) obtaining data on priority taxa, (2) collecting sufficient data for statistically robust outcomes, and (3) integrating technology solutions into normal construction and operations procedures. At present, however, there is no comprehensive analysis that identifies the technology innovations needed to address these challenges of statistical power and integration into operations to lower risks and costs.

The National Offshore Wind Research & Development Consortium has funded a desktop research study and expert engagement effort to develop targeted recommendations for wildlife monitoring technology development to inform the direction of future R&D funding. The assessment will focus on the ability of current bird and marine mammal technologies to answer priority research/monitoring questions, produce statistically robust data to inform meaningful adaptive management, and integrate into equipment and operations for fixed and floating offshore wind energy development. Efforts will focus on U.S. Atlantic, Pacific, and Great Lakes geographies. Assessment of needs and technology gaps associated with monitoring impacts of offshore wind will be conducted through literature review and a series of expert workshops in 2022-2023 and will result in recommendations for technology development that can be targeted at reducing uncertainty and improving data for understanding, mitigating, and adaptively managing impacts of offshore wind on marine mammals and birds. The result of this study will be 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.

Monitoring the health and movements of pinnipeds in the Northwest Atlantic Ocean

Robert A. DiGiovanni, Jr[1*], Kimberly Durham[1], Allison DePerte[1]
*rdigiovanni@amseas.org

1 Atlantic Marine Conservation Society

The Northwest Atlantic Pinniped Health Assessment Project is a collaboration between Atlantic Marine Conservation Society, Marine Mammals of Maine, the Northeast Fisheries Science Center, Cummings School of Veterinary Medicine at Tufts University Runstadler Lab, the Nature Conservancy (Virginia), Naval Undersea Warfare Center, and Naval Facilities Engineering Systems Command Atlantic, Mystic Aquarium and Stony Brook University's Marine Science Station. These researchers have come together to conduct studies on wild harbor (*Phoca vitulina*) and gray (*Halichoerus grypus*) seals in the Northwest Atlantic Ocean (NWA) to document their population size, the movements of these animals through the region and better understand the role they play in the overall ecosystem. This multi-year study is documenting, sampling and satellite-tagging pinnipeds from Maine through Virginia. The team plans to deploy 10-20 satellite tags per year for the next four years. Satellite tag data is being analyzed to understand broadscale movements of pinnipeds throughout the region and how they respond to natural and anthropogenic changes. Preliminary data from pinnipeds tagged during the 2021 field season in NY show that some animals have stayed close to the haul-out sites they were tagged at, while others moved far distances in few days. Gray seals tagged in Southern New England have travelled to the Abyssal Plain and the Scotian Shelf. Data collected through this study will inform environmental managers of areas of potential conflict between pinniped populations and new ocean development.

Piloting the operationalization of net positive impacts on an offshore wind project

Jennifer Dupont[1*], David Hedgeland[2], Magnus Eriksen[1], Mark Johnston[2], Filip Magnussen Sarfi[1], Peter Marcus Kolderup Greve[1], Scott Lundin[1], Maarten Kuijper[2]
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1 Equinor ASA, 2 BP

Equinor and bp are partners in the development of the Empire Wind project, a commercial-scale offshore wind farm located approximately 20 miles south of Long Island, NY. Recognizing the importance of a well-functioning natural environment, each company has established a biodiversity position which includes implementing new processes aiming to demonstrate net positive impact (NPI) for new operated projects in areas of high biodiversity value (Equinor) or that have potential for significant direct impact on biodiversity (bp). NPI is a project goal to outweigh adverse biodiversity impacts by taking on additional measures to enhance it, leading to a net positive gain.

In this presentation, we will discuss the process and initial results from the first NPI pilot project focused on a commercial-scale offshore wind project. The collaborative approach brought together corporate sustainability professionals, technical biodiversity subject matter experts, regulatory specialists, and various project professionals. Experts worked together to test and adapt methodologies, identify potential refinements of biodiversity data inputs, align with existing impact assessment processes, document lessons learned, and ultimately to support development of company-specific guidance documents for use on future offshore wind projects, as well as other projects in future portfolios. While the current pilot project was limited to internal company expertise, it is recognized that external stakeholder engagement is a key part of the NPI process.

In this presentation, we will provide an overview of the various stages of NPI quantification methodology including scoping, baseline establishment of key biodiversity features, impact assessment (including mitigation hierarchy), residual impact calculations, and compensation actions. We will provide specific examples from the Empire Wind project's list of key biodiversity features, including a discussion on challenges and lessons learned during the operationalization of this approach. The role and importance of external stakeholder input, as well as the timing for that engagement, will be discussed as well.

This represents the first pilot testing and refinement of NPI methodology for an offshore wind project for both Equinor and bp. Given publicly stated ambitions to significantly grow each of their offshore wind portfolios, the companies will utilize the results and lessons learned to inform future offshore wind projects with which they are each involved. Understanding interfaces/interactions between regulatory processes (e.g., impact assessment) and the NPI process will be key to streamline and leverage information appropriately to meet project requirements and corporate aims.

Altered spatial distribution of a marine top predator under elevated ambient sound conditions

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Natural and anthropogenic sounds bombard the ocean. Acoustic disturbances from storms, vessel traffic, and construction activities such as offshore wind can cause physiological and behavioural changes to organisms that impact their fitness or survival. Understanding animals' responses to acoustic disturbances is paramount, especially for protected marine mammals that use sound as a primary sensory modality for communication and foraging. To investigate the behavioural responses of a top predator, the bottlenose dolphin (*Tursiops truncatus*), to a range of underwater sound levels, we applied a non-invasive method of localising dolphin pods from their whistles using a bottom-mounted hydrophone array. We fit a state-space movement model to triangulated positions which accounted for spatial uncertainty and estimated the most likely true locations and movement path. We investigated movement parameters (speed and path straightness) and the animals' spatial distribution in relation to broadband (10 – 7080 Hz) and mid-frequency (2820 – 7080 Hz) ambient sound levels. Dolphins utilised different areas under elevated broadband and mid-frequency ambient sound levels compared to intermediate and low sound levels. Travel speed and directness of dolphin pod movement paths did not vary significantly in relation to ambient sound levels. While coastal top predators are often exposed to vessel traffic, bottlenose dolphins in the Mid-Atlantic Bight were not habituated to elevated ambient sound levels, as evidenced by their altered habitat use in our study. Behavioural responses to changes in the acoustic environment could impact the health and vital rates of protected species or have top-down effects on ecosystems and thus are critical to understand for decision makers, especially when proposed actions, such as the development and operation of offshore wind facilities, will increase sound levels.

Use of passive acoustic telemetry to monitor the presence and persistence of highly migratory species within Southern New England wind energy areas

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1 INSPIRE Environmental, 2 Anderson Cabot Center for Ocean Life at the New England Aquarium

The offshore waters of southern New England serve as important feeding grounds and migratory corridors for numerous highly migratory pelagic fish species (HMS; sharks, tunas, billfish) that inhabit the U.S. east coast. In addition to containing Essential Fish Habitat for at least 14 HMS, this region also supports extensive recreational fisheries for HMS in which hundreds of active vessels participate each year. Much of that recreational fishing effort is also concentrated on popular fishing grounds that are within areas leased for offshore wind development. Despite this ecological and economic importance, little attention or effort has been paid to assessing baseline conditions or the potential impacts of offshore wind activity on HMS and recreational HMS fisheries in the region. To address these deficiencies, we conducted a two-year pilot study during the summers of 2020 and 2021 to demonstrate the utility of passive acoustic telemetry to directly monitor the presence, persistence, and movements of recreationally-important HMS in and around popular recreational fishing locations within the MA/RI Wind Energy Area. We focused acoustic transmitter deployments on commonly captured HMS and monitored their presence with a stationary array of acoustic receivers. A total of 60 individuals of five different species were tagged, 35 of which were detected within the receiver array periodically from June to November in each year. Eight individuals tagged in 2020 returned to the array in 2021. Additional results on the movements of individuals will be presented. The receiver array and acoustic tagging will be expanded in 2022 as part of a collaborative, developer-led effort to support the continued collection of baseline pre-construction data. The results of this study, along with the expanded effort starting in 2022, will be used to monitor and assess potential impacts across the baseline, construction, and operations phases of offshore wind development in southern New England.

Regional habitat modeling results & establishing standard benthic data sharing workflows

Marisa Guarinello[1*], Emily Shumchenia[2,3], Alex Rhoads[1], Jenn Croteau[1], Ben Taylor[1], Nick Napoli[3], Connor Capizzano[1], Drew Carey[1]
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With funding from the Massachusetts Clean Energy Center (MassCEC), the Bureau of Ocean Energy Management (BOEM), and the Rhode Island Department of Environmental Management (RIDEM), INSPIRE Environmental and the Northeast Regional Ocean Council (NROC) have been working together with NROC's Seafloor Habitat Data Work Group to integrate high-resolution data from wind energy areas (WEAs) in the Northeast U.S. into pilot regional scale seafloor habitat data products. At present, data on seafloor composition at a regional scale are available at coarse levels of resolution and have limited utility in assessing risks and cumulative impacts associated with offshore energy siting and development. We will present initial regional seafloor data products that incorporate publicly available data including data collected by offshore wind developers, using a modeling approach to map the likelihood of encountering various sediment types. To facilitate updates to these and potentially other types of regional scale habitat products, we are developing data standards and data sharing workflows for work group members and the analytical team to test and iterate. An improved, and regularly updated, understanding of the regional seafloor habitats can increase efficiencies in siting, agency review and result in risk reductions for the environment, as well as for project planning, development, and construction. The work begun under this pilot project will continue as part of the work of the Habitat & Ecosystem Subcommittee of the Regional Wildlife Science Collaborative (RWSC).

NOAA Fisheries and BOEM federal survey mitigation implementation strategy Northeast U.S region

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NOAA Fisheries and BOEM share a commitment to develop offshore wind energy, while protecting biodiversity and promoting ocean co-use. There are many elements to achieve these goals, including mitigation of the impact of offshore wind energy development on NOAA Fisheries surveys. Nationally, NOAA Fisheries assesses the status of approximately 450 fishery stocks, 200 marine mammal stocks, and 165 threatened and endangered species. These assessments rely on more than 50 long-term, standardized surveys, many of which have been ongoing for more than 30 years. Each survey uses different methods, platforms, and designs, with the goal of providing information on a subset of species to support sustainable management. For example, bottom trawl surveys provide information on bottom fishes, plankton surveys provide information on the early life stages of fishery species as well as ocean production (phytoplankton and zooplankton), and aircraft and vessel visual surveys provide information on the abundance and distribution of whales, dolphins, and seals. Owing to the precautionary approach, increased uncertainty in the data originating from these surveys typically results in more restrictive management. As a result, NOAA Fisheries has made extensive efforts to maintain consistency in surveys over time to reduce uncertainty and increase accuracy and precision. Sustaining surveys with consistent sampling designs/methods is an essential feature of their value, allowing understanding of the status and trends of managed species consistently through time. These surveys are essential for sustainably managing our nation's fisheries, promoting the protection and recovery of marine mammals and endangered and threatened species, conserving coastal and marine habitats; and are also critical to understanding the impacts of climate change on marine resources and marine ecosystems. During the environmental review of the first offshore wind energy project in federal waters, four impacts to NOAA Fisheries surveys were identified: 1.Preclusion of NOAA Fisheries sampling platforms from the wind development area due to operational and safety limitations; 2.Impacts on the random-stratified statistical design; 3.Alteration of benthic and pelagic habitats, and airspace, requiring new designs and methods to sample new habitats; and 4. Reduced sampling productivity through navigation impacts of wind energy infrastructure on aerial and vessel surveys. For this reason, in 2021 NOAA Fisheries and BOEM committed to developing a federal survey mitigation implementation strategy to mitigate the impacts of offshore wind energy on NOAA Fisheries surveys. In Spring 2022, the implementation strategy will be released. This presentation will provide an overview of the process of developing the strategy and outline key elements of the approach for developing, implementing, and adapting NOAA fisheries survey mitigation activities in response to the impacts of offshore wind development.

Displacement of Red-throated Loon by offshore wind farms in the North Sea of Germany

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The utilization of offshore wind energy leads to globally expanding human activities in marine habitats. While knowledge on the responses of marine wildlife to offshore wind farms and associated shipping traffic is accumulating now at a fast pace, it becomes important to assess the population impacts on species affected by those activities. In the North Sea, the protected Red-throated Loon (*Gavia stellata*) widely avoids offshore wind farms. Satellite telemetry and aerial surveys revealed avoidance responses of > 10 km. High-quality aerial survey data on the distribution and occurrence of divers in the German North Sea are now available over 18 years and represents one of the most extensive data set of seabird responses to offshore wind farms.

Despite far-reaching displacement, offshore wind farms only affect a moderate portion of induvial home ranges as revealed by satellite telemetry. To get a robust estimate of the diver population during the spring season between 2001 and 2018, we applied an explicit spatio-temporal hierarchical model, more specifically, a latent Gaussian model (LGM) with a flexible stochastic partial differential equation (SPDE) approach in INLA. Model results indicated that, despite the erection of 20 offshore wind farms (1,052 turbines) in the study area and marked responses of divers to wind farms, no population decline was found.

The northern part of the German North Sea includes a so-called main concentration area of divers as defined by German authorities as well as a Special Protection Area. It accounts for approx. 60% of the German North Sea population. Over the years, a significant shift in the distribution of divers within the main concentration area was apparent: After the construction of several wind farms in the area, birds concentrated relatively consistently in a central area of the main concentration area, with the furthest possible distance to all surrounding wind farms. Although avoidance behaviour due to wind farm development led to a more narrowly focused spatial distribution of birds, the results currently provide no indication of negative fitness consequences on these long-lived species.

Modeling distributions of deep-sea corals offshore of the southeastern United States to guide efficient discovery and protection of sensitive habitats

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Many deep-sea corals form three-dimensional structures that support diverse benthic communities by providing microhabitats that are used by other species such as fishes, crustaceans, and echinoderms. Deep-sea coral habitats are vulnerable to activities that disturb the seafloor and have been the focus of conservation and management efforts across the world. The Bureau of Ocean Energy Management identified a need for information about the spatial distribution of deep-sea coral habitats offshore of the southeastern United States to assess the potential impacts of activities related to the development of offshore energy and mineral resources and to develop mitigation measures to avoid or minimize these impacts.

A database of deep-sea coral occurrences (presence-absence data) with associated measures of sampling effort and bottom type was compiled from a review of available data collected by underwater visual surveys. Spatially-explicit hierarchical occupancy models were used to relate records of deep-sea coral occurrence to spatial environmental predictors characterizing the seafloor, oceanography, and geography of the study area in order to predict and map the estimated occurrence of 24 taxa of deep-sea corals. The models attempted to account for imperfect detection and thus standardize estimates of occurrence across taxa.

Effects of floating offshore wind farms on coastal upwelling in the California Current Ecosystem

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In California offshore waters, sustained northwesterly winds have been identified as a key energy resource which could contribute substantially to California's renewable energy mandate (Senate Bill 100). However, the development of large-scale offshore wind energy projects has the potential to reduce the wind stress at the sea surface, which could have local and/or regional implications on California wind-driven upwelling, nutrient delivery, and ecosystem dynamics. Reported here is progress in evaluating potential changes in California coastal upwelling from offshore wind project development over a variety of environmental conditions and wind farm configurations.

In this study, a one-way coupled atmosphere-ocean model is applied over the period spanning the years 1988-2012 to evaluate changes to upwelling following the introduction of wind farms at Humboldt, Morro Bay, and Diablo Canyon, all of which were part of the original set of call areas at the time this study commenced. Since then, the Diablo Canyon call area will likely not be considered for future wind farm development. Nevertheless, these results can be considered to represent an upper-bound on potential upwelling effects of offshore wind, and consistent with the project design envelope approach favored in drafting offshore wind construction and operation plans.

From the atmospheric modeling, modest changes to wind speeds were found in the lee of wind farms (approximately 5% reduction), with areal extents of the wake due to wind stress reductions extending 200 km south of the Morro Bay/Diablo Canyon call area. The resulting ocean circulation fields were then compared using operational upwelling metrics for volume transport and nutrient delivery. The presence of turbines was found to lead to an approximately 10-15% decrease in upwelled volume transport and resulting nutrient supply to the coastal zone in the vicinity of the Morro Bay and Diablo Canyon call areas. While changes to upwelling are also observed near the Humboldt call area, they were found to be substantially smaller than those seen near Morro Bay.

The characterization of acoustic particle motion from loud impulsive and quiet sustained sources of sound

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The current consensus among the scientific community is that the majority of fish and invertebrate species experience sound through the particle motion component rather than through pressure, to acquire information about their environment (an approaching predator, the presence of a potential mate), as well as for communication or navigation. Yet, to date, regulatory guidelines to assess the effects of sound on aquatic life largely describe hearing thresholds in terms of sound pressure. More comprehensive guidelines have recently been proposed that take into account current state-of-the-science to consider the effects of particle motion. A key step towards framing meaningful guidelines is an understanding of particle motion levels generated during offshore activities, such as pile-driving during offshore wind farm construction and routine wind turbine operation.

Here we present results from two studies whose sound source characteristics can be considered similar to noise from pile-driving (i.e. loud and impulsive), and operational sounds (not as loud but more sustained). The first study was conducted in summer 2021 during a 40-day geophysical seismic survey along the Cascadia Subduction Zone off Oregon and Washington. The second study was conducted over a 9-day period in fall 2021 near an operational wave energy converter that operated offshore of Scripps Research Pier in San Diego, California.

Measurements for each study were obtained using an acoustic vector sensor array, the NoiseSpotter®, which measures acoustic particle motion and pressure using three sensors mounted at 35 cm, 50 cm, and 75 cm above the seabed, in the frequency band 50 Hz to 3 kHz. The measurement at 35 cm above the seabed was used to characterize sound transmission along the seabed boundary and substrate while the other two sensors characterized in-water sound transmission affecting both demersal and semi-pelagic marine organisms. By taking direct measurements instead of relying on imprecise modeling techniques, the system allows for the joint characterization of sound pressure and particle motion.

Results show that particle motion signals measured during the seismic surveys consist of both the in-water component as well as interface waves that propagate along the seafloor. Received peak particle velocity levels during the seismic surveys exceeded 95 dB re 1 nm/s at a distance of 27.5 km from the NoiseSpotter®. In contrast, particle velocity levels at the wave energy converter (WEC) ranged from 15 to 25 dB re 1 nm/s at a distance of 100 m from the WEC, and typically within 5 dB re 1 nm/s of the ambient noise floor. These results confirm that while chronic sound levels from operational marine energy installations are unlikely to affect marine animals, acute sound levels generated during construction or survey activities need careful consideration in framing regulations.

Sometimes seen, but often heard: Presence of dolphins and harbor porpoise in potential cable corridor areas

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Offshore bat activity patterns detected by vessel-based acoustic monitoring

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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.

Oceanic records of North American bats and implications for offshore wind energy development in the United States

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Offshore wind energy is a growing industry in the United States, and renewable energy from offshore wind is estimated to double the country's total electricity generation. There is growing concern that land based wind development in North America is negatively impacting bat populations, primarily long-distance migrating bats, but the impacts to bats from offshore wind energy is unknown. Bats are associated with the terrestrial environment, but have been observed over the ocean. In this review, we synthesize historic and contemporary accounts of bats observed and acoustically recorded in the North American marine environment to ascertain the spatial and temporal distribution of bats flying offshore. We incorporate studies of offshore bats in Europe and of bat behavior at land-based wind energy studies to examine how offshore wind development could impact North American bat populations. We find that most offshore bat records are of long-distance migrating bats and records occur during autumn migration, the period of highest fatality rates for long-distance migrating bats at land-based wind facilities in North America. We summarize evidence that bats may be attracted to offshore turbines, potentially increasing their exposure to risk of collision. However, higher wind speeds offshore can potentially reduce the amount of time that bats are exposed to risk. We identify knowledge gaps and hypothesize that a combination of operational minimization strategies may be the most effective approach for reducing impacts to bats and maximizing offshore energy production.

Extremely reliable locations and calling abundance via passive acoustic monitoring

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New commercial technologies are available for deriving extremely-reliable 100% Confidence Intervals of Location (CIL) of calling mammals derived from measurements of their Time-Differences-Of-Arrival (TDOA) from sparse passive acoustic arrays. The 100% CIL eliminate 10 to 50 km errors inherent in perhaps all other 2D location models due to imperfect clock-synchronization, use of hyperbolas to estimate location, and the presence of newly-discovered 2D black holes. The extreme reliability of the 100% CIL was independently verified in near-real time by Naval Air using their active sonars to detect submarines using many tens of drifting receivers and active sources. In every case, the 100% CIL contained the location of a submarine derived with its inertial navigation system. The new technology offers data-verified means for synchronizing clocks using only the measured TDOA from the animals, thus eliminating the need to purchase expensive atomic clocks or introducing acoustic sources at known locations. The 100% CIL are used to derive a mathematically-guaranteed lower bound of calling abundance without any tunable parameters such as the rate of an animal's call or its volume. Many standard statistical methods for estimating population abundance are derived from the so-called "distance-sampling function". The 100% CIL yield a means to significantly improve its estimation. The location and abundance technologies will be further demonstrated in the WOW program funded by the DOE and BOEM (https://offshorewind.env.duke.edu/) and should be used to re-analyze historical recordings where the temporal and spatial distributions of calls were previously estimated. The technologies can be used to derive 100% CIL for calling mammals in near-real time. For further information, see https://www.scientificinnov.com/current-work.

Modeling offshore wind infrastructure effects on upper ocean physical and biogeochemical processes and implications for higher trophic levels

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The scale of planned offshore wind (OSW) energy development along the coasts of the United States is phenomenal, with plans for up to 30 GW by 2030, suggesting the installation of approximately 3000 foundation structures, each supporting a nominal 10MW turbine, in the next decade.

Structures are known to affect hydrodynamic and oceanographic properties important to ecological processes and ecosystems. The hydrodynamics of flow past monopole structures has been modeled, engineered, and studied in the field. Field studies confirm the ramifications on important biological oceanographic parameters. A rich physical and bio-optical dataset, collected from the research platform (R/P) FLIP, provides field observations of the potential effects of OSW infrastructure on upper-ocean mixing. R/P FLIP was found to break down stratification and increase chlorophyll-a concentration, a proxy for phytoplankton biomass, by more than a factor of two in the upper water column. Further, underwater visibility changed by over 50% as the result of mixing from the hull of R/P FLIP, which extended ~90 m below the water surface. These results suggest that OSW infrastructure has the potential to alter turbulence, increase mixing, and affect underwater visibility, nutrient delivery, primary productivity, potentially affecting higher trophic level processes.

Environmental drivers of distribution of whales, seabirds, and turtles in the New York Bight

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Research has shown that marine top predators such as birds and marine mammals move in response to environmental variables, such as currents and upwellings that act as cues to food availability. Obtaining information about these habitat drivers is thus seen as a prerequisite for effective marine spatial planning. In this study, we support NYSERDA's goal of advancing the development and operation of offshore wind in a cost-effective and environmentally responsible manner. This is achieved by applying diverse oceanographic (e.g., upwelling areas) and ecological (e.g., observation) datasets and a novel integrated ecological modeling approach to enable an analysis of the ability of available NY Bight area data to predict wildlife distribution and movement.

A multi-step project approach was taken, initially consisting of data collation and processing and hydrodynamic modeling. These formed the basis for subsequent modeling consisting of an integrated complex of Hydrodynamic-, Dynamic Habitat (DHM)- and Agent-Based models (ABM). The executed DHMs generated a habitat suitability index for each taxon via statistically establishing the relationship with optimum habitat predictors; whereas, the ABMs predict movement through parametrization of target taxa, or 'agents', movement decisions within a sensory sphere in the model domain.

We developed these models to predict distribution and use patterns for four taxa: the fin whale (*Balaenoptera physalus*), the red-throated loon (*Gavia stellata*), the northern gannet (*Morus bassanus*), and the loggerhead turtle (*Caretta caretta*). Based on these analyses, the study further identifies sensitive model variables and important data gaps. The Project successfully executed the key project phases, the key results of which are summarized as follows:

- collection and processing, and quality assessment, of secondary survey data (e.g., aerial surveys, telemetry studies) essential for execution of the ecological modeling
- establishment of a validated regional hydrodynamic model that sufficiently covers target taxa connectivity, as well as pertinent oceanic characteristics such as the 'cold pool'
- the creation of dynamic habitat models of all four target at acceptable levels of accuracy
- the establishment of ABM models i.e., with integrated Dynamic Habitat models results, that illustrate viability of this technique

The overall result of these concerted steps is the conclusion that existing NY Bight data and a novel modeling approach can both uncover, and use, habitat drivers (predictors) to predict the presence and movement of key species.

The related implications are that the approach presents a new viable technique for siting studies and cumulative environmental risk / impact assessment as well as the possibility of informing real-time mitigation for adaptive management. The findings also provide some insight into priorities for monitoring to better refine future modeling.

SPACEWHALE: Surveying whales from space as an effective tool for baseline studies and respective monitoring

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Monitoring whales using satellite imagery can overcome challenges of traditional survey methods. Ship-based and aerial surveys tend to cover relatively small areas and can be time-consuming and expensive in remote areas, while acoustic monitoring is difficult to convert into counts for most species. With satellite, the number and distribution of large whales can be determined quickly and over wide areas, yet at a similar cost to traditional surveys. The method uses very high-resolution (VHR) satellite imagery with a resolution of 31 cm per pixel. It takes a "snapshot" of the area of interest and has the capability to capture very large and remote areas almost instantaneously.

We have developed a semi-automated methodology for evaluating satellite images, which takes only a few days to a week. Collected satellite imagery is first analysed by an automated deep-learning algorithm which identifies whale-like objects throughout the study area. In the absence of an archive of VHR images with whales, we trained our algorithm with down-sampled digital aerial images of minke whales (7 to 10 m long), which came from monthly monitoring flights of offshore wind farms. We demonstrated that the algorithm trained in this way could subsequently recognise 23 m long fin whales and other whale species on satellite imagery. The automated process is highly effective and a study in collaboration with Stony Brook University in New York and HiDef Aerial Surveying Ltd from the UK showed that the algorithm correctly classified 100% of images containing whales and 94% of images containing only water (BOROWICZ et al. 2019). Once the automated process is complete, our large team of expert reviewers validates the results to ensure that all objects are correctly identified and that whales are not confused with inanimate objects (e.g. boats, rocks, waves, foam).

The SPACEWHALE service has been applied in several projects: in the Mediterranean Sea, the algorithm detected almost twice as many fin whales as a previous manual investigation. In the Bay of Biscay, the algorithm detected fin whales and smaller whale species. SPACEWHALE counted humpback whales off the Hawaiian Islands and Southern Right Whales off the Argentinian coasts and in New Zealand's offshore waters. SPACEWHALE enables large areas to be surveyed on the high seas, covering 100% of an area at once and providing statistics on the spatial distribution and minimum abundance of large whales. It can provide data for baseline studies and environmental impact assessments, usually conducted with ship-based or aerial surveys. Monitoring using satellite imagery provides meaningful information for offshore wind development when applied regularly and has the potential to give a more comprehensive picture when applied across projects on the East Coast of the US. Moreover, SPACEWHALE enables continued monitoring of whales when person-dependent surveys are restricted as has been experienced during the COVID-19 pandemic.

Establishing the Atlantic cod spatiotemporal spawning baseline in Southern New England to assess potential interactions with offshore wind energy

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The reproductive behavior of Atlantic cod, including high spawning aggregation site fidelity and acoustic communication during courtship rituals, make them potentially vulnerable to offshore wind energy disturbance. While many aspects of Atlantic cod biology are well-studied, little is known of the habitat use and spawning behavior of spawning components of the George's Bank stock in Southern New England waters. To establish baseline understanding prior to OWE development, we used a combination of fixed-station and glider-based passive acoustic monitoring methods to evaluate the spatiotemporal spawning dynamics of Atlantic cod in Southern New England. Generalized linear modeling was used to evaluate correlations between cod spawning associated grunt activity and multiple environmental cycles. Results from the Southern New England spawning grounds were compared to similar data of the geographically separated Massachusetts Bay winter-spawning subpopulation within the Western Gulf of Maine stock. Lastly, we assessed potential interactions with OWE in designated Wind Energy Areas in Southern New England waters. Fixed-station passive acoustic data from 2013 – 2015 captured the dynamics of a spawning aggregation within a Wind Energy Area while glider-based data captured occasional grunts throughout the Southern New England study area. Despite diel differences in the temporal dynamics of grunt activity between the two regions, the overall seasonality of inferred spawning was similar. Specifically, grunt activity was estimated to peak near the full moon during a three-week period from late November to early December in both regions. Under current OWE construction guidelines, our results suggest that Atlantic cod spawning in Southern New England will likely overlap with planned OWE construction in both time and space. This baseline understanding of cod spawning phenology in the Mid-Atlantic can be used in mitigating disturbance of spawning through limiting construction timelines and consideration of turbine or cable placement.

Pre-construction evaluation of Atlantic cod spawning in Southern New England offshore wind areas

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Atlantic Cod is an ecologically, economically, and culturally important groundfish species in the North Atlantic Ocean. This species has been historically overexploited, and New England stocks remain well below rebuilding targets due to overfishing, poor recruitment, and climate effects. Spawning dynamics and stock structure of cod is relatively uncertain in the southernmost extent of their range, Southern New England, where offshore wind development is planned on cod spawning grounds. Spawning aggregations have previously been shown to be highly sensitive to human disturbance, and cod may be impacted by offshore wind development through alteration of spawning habitat and disruption of spawning behavior. This study aims to map the spatiotemporal distribution of cod spawning in Southern New England while serving as a pre-construction baseline study for characterizing interactions of Southern New England cod with planned offshore wind development. Beginning in November 2019, in collaboration with commercial and recreational fishermen as well as offshore wind developers, we tagged spawning cod with acoustic transmitters and deployed an acoustic array with ten moored receivers, accompanied by a receiver reporting in real-time attached to an autonomous glider. Data from three subsequent seasons is being used to quantify residence, straying, arrival, departure, and fidelity to the Cox Ledge spawning ground (in Rhode Island Sound). Biological samples from fisheries and offshore wind area monitoring are also being used to characterize the spatiotemporal distribution of spawning. Results from the first two years of tagging and biological sampling suggest spawning occurs from November to March, with high residence in the Cox Ledge area, some regional spawning outside the Cox Ledge area, and some multi-year, annual spawning site fidelity. Results from this study will characterize spawning dynamics and habitat use and help to inform the stock structure and assessments of cod.

Demersal trawl and ventless trap surveys at Block Island Wind Farm

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The expanding offshore wind industry on the northeastern U.S. coast originated with Block Island Wind Farm (BIWF), which was built on a pilot scale of five, 6-MW wind turbine generators that became operational in 2016. Local commercial and recreational fishing interests and the scientific community collaborated to design a demersal trawl survey and a ventless trap survey to document potential impacts of BIWF construction and operation on demersal fish/invertebrates and lobsters/crabs, respectively. Each survey was conducted in the BIWF area and in reference locations over seven years that spanned baseline, construction, and operation time periods. Results of the demersal trawl survey indicate relative abundances of little skate, summer flounder, windowpane, winter flounder, winter skate, and longfin squid did not exhibit a detrimental effect from BIWF operation. Likewise, benthivore and piscivore assemblage composition did not exhibit an effect from operation. Relative abundances of structure-oriented species, such as black sea bass and Atlantic cod, increased in the wind farm following turbine installation. A post-hoc power analysis revealed an approximate 40% to 63% level of background variation in abundance between reference areas, therefore smaller effect sizes would not indicate a statistically significant wind farm impact. Stomach content analysis was conducted on flounder, gadids, and black sea bass, along with an examination of fish condition and stomach fullness. Prey accumulation curves indicated that diets were adequately characterized with sample sizes of approximately 40 stomachs for most time period by area combinations. Inclusion of mussels and mysids in fish diets following turbine installation indicate fish forage on the colonized turbines. For the ventless trap survey, lobster data were analyzed using a BACI design and dependent variables included catch rates, ovigery rates, shell disease, and cull status. Crab and black sea bass catch rates and size distributions were examined for spatial and temporal differences. Operation of the BIWF has occurred against a background of declining lobster harvests in southern New England and the decrease in lobster catches between the baseline and operation time periods was proportionally less at the reference site which was located on favored fishing grounds. Interannual variation in lobster catches was similar to that observed in Rhode Island and Massachusetts fishery-independent surveys. Although changes to the fish and invertebrates examined in these studies were not substantial, potential effects of larger wind farms should be examined as the US offshore wind industry expands.

Modeling past and future spatial distributions of marine bird species in US Atlantic waters

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Knowledge of animals' spatial distributions is fundamental to managing potential impacts of offshore wind energy development on marine wildlife. Habitat-based species distribution modeling of at-sea survey data is a common approach to characterizing marine wildlife distributions over large areas. Two recent studies applied that approach to describe the average seasonal distributions of marine bird species in US Atlantic and Pacific waters during the past several decades. However, the distributions of some marine bird species have changed over time and will potentially change in the future, for example as a result of climate change. The objective of this study was to extend the models for Atlantic marine bird species to allow for distributional changes over time and to project potential future distributional changes. At-sea counts of marine birds from boat-based and aerial surveys during the past 20-25 years were compiled, primarily from the Northwest Atlantic Seabird Catalog database. Environmental data from the same time period were acquired from a global ocean reanalysis (GLORYS12V1) and a global remotely sensed wind field product (CERSAT). Projected changes in the same environmental variables during the next 30 years were acquired from a simulation experiment that used a high-resolution global climate model (GFDL CM2.6). The retrospective and projected oceanographic data had a spatial resolution of approximately 10 km. A statistical modeling framework is being used to estimate the relationships between contemporaneous bird counts and environmental variables, and those relationships are then applied to project potential changes in bird distributions during the next several decades. We will report preliminary results of this modeling study. The final results will provide updated estimates of the current distributions of marine bird species in US Atlantic waters as well as projected changes in bird distributions under an idealized climate change scenario. This information can be used by managers to minimize potential impacts of current and future offshore wind energy development on marine wildlife.

Automatic whale detection from vessels for real-time vessel-strike and noise impact mitigation – current developments and applicability

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Ship-strikes are a serious threat to North Atlantic Right Whales. This became particularly clear in 2017, when 17 of the ~470 remaining North Atlantic right whales died. At least 6 of these deaths are believed to be due to vessel collisions. This event clearly showed the need for technologies that can help to mitigate ship-strikes. Ship-strike can be mitigated if the whale is detected from the vessel itself early enough to react (slow-down, change course). Currently, real-time marine mammal detection from vessels prone to ship-strike (e.g. crew transfer vessels, fast ferries) is mainly achieved by human marine mammal observers. Visual observations are only possible during daylight hours and require numerous observers to guarantee continuous observation; therefore, visual observers for mitigation purposes are rarely implemented on smaller vessels or ferries. As autonomous vessels will soon become larger and more numerous, increasing the need for technologies that allow for the detection and avoidance of large whales.

Thermal imaging systems have been increasingly tested during the last decade for their capability to detect and localize whales in real-time. For thermal imaging systems to be effective for ship-strike mitigation, automatic detection of the whale signatures in the video feed is crucial.

Here we present our results on the development and tests during the last five years of low-cost solutions for ship-strike and noise mitigation technologies using thermal imaging camera systems on the east and west coast of North America. The systems are designed to be used on any kind of ships without any expert supervision. To reduce the false alert rate to zero detection verification can be conducted on-board or remotely within seconds. We show that low-cost thermal imaging solutions provide sufficient detection range for effective ship-strike mitigation and noise mitigation.

Oral Presentation Abstracts – Virtual Session

Listed alphabetically by last name of first author

Towards understanding the potential for offshore wind to impact bats

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Bats have been observed offshore for over 100 hundred years. Historically considered anomalous, recent bat monitoring efforts throughout the Atlantic Offshore Continental Shelf (AOCS) suggest that eastern red bats, hoary bats, and silver-haired bats commonly travel offshore during the fall migratory period. With wind energy development throughout the AOCS expected to support nearly 30 GW of power production by 2030, there is growing concern that the species most common to the AOCS are those that regularly collide with terrestrial turbines. As we continue to investigate what might be driving offshore bat activity, it is equally critical to investigate how bats interact with novel anthropogenic structures once in the offshore environment. Here we present our findings of offshore bat monitoring comparing bat activity observed from buoys, boats, and turbine platforms. We further present results related to offshore prey abundance monitoring. We highlight novel metrics that in the offshore environment can be used to infer the magnitude of an interaction with different anthropogenic structures offshore. We then use our data to inform a brief working example that considers the potential for bats to experience sub-lethal energetic consequences as the number of offshore wind turbines in the AOCS grows. Our findings suggest that under certain scenarios as offshore wind energy development increases offshore, bats may experience increased energetic costs and mortality risk.

Using remote monitoring to understand weather influences on bird activity in the offshore environment

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Bird activity is influenced by various environmental conditions, including seasonality, habitat, and weather variables, including wind speed, direction, and visibility. Understanding how weather variables affect bird activity at offshore wind turbines can improve our understanding of activity patterns, predict those patterns, and reduce bird collision risks at offshore wind turbines. We performed a meta-analysis of existing acoustic, thermal, and visible-light light data on bird activity from buoys in the offshore environment, the Frying Pan Shoals Light Tower, and offshore wind turbines in the Atlantic Ocean. Bird and bat acoustic detectors were installed on buoys, while Acoustic and Thermographic Offshore Monitoring (ATOM) systems were installed on Frying Pan Shoals and the offshore turbines. We related bird detections from ATOM and buoy systems to wind speed, wind direction, and visibility variables to understand how bird activity was affected by these weather variables in the offshore environment. These findings can inform collision risk models, smart curtailment regimes, and prioritize species for future research.

Machine learning for automated detection and classification of seabirds, waterfowl, and other marine wildlife from digital aerial imagery

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Avian and marine wildlife surveys can inform environmental assessments to describe potential impacts of offshore energy development projects. While low-level, ocular surveys have been successful at providing useful information, they place agency personnel at risk of injury and survey results are prone to bias and misclassification. The U.S. Geological Survey (USGS), in collaboration with the Bureau of Ocean Energy Management (BOEM) and the U.S. Fish and Wildlife Service Division of Migratory Bird Management (USFWS-DMBM), is advancing the development of deep learning algorithms and tools to automate the detection, classification, and enumeration of seabirds, waterfowl, and other marine wildlife from digital aerial imagery. Imagery collected over the Atlantic Outer Continental Shelf and the Great Lakes will provide data for algorithm development. A customized version of the open-source annotation tool CVAT (Computer Vision Annotation Tool) is providing the framework for an interactive GUI, allowing wildlife experts to create annotations and support the annotation database development. To detect avian targets in the imagery, a Faster-RCNN model with a ResNet-50 FPN backbone has been trained on approximately 14,000 individual waterfowl and other avian species. To classify wildlife objects, a pseudo soft-fine label approach was created to automate the classification of a subset of hierarchical taxonomic values including scoter spp., black scoter, white-winged scoter, long-tailed duck, and non-target species. We found that by using a refined annotation, avian detection results had a mAP of 0.47 and a mean AR of 0.57. Additionally, the classification results performed with an average accuracy of 90.7% for the species provided during training. These results show that it is possible to both detect and classify avian targets in aerial imagery with some degree of accuracy given the relatively small amount of training data for machine learning applications. Future work will need to encompass larger training data with more wildlife targets of interest to improve model performance. Additionally, testing of high-performance computing infrastructure will be needed to provide confidence that a large-scale implementation of these computer vision methods will provide measurable results over huge amounts of image datasets.

The use of LiDAR technology to measure site specific offshore avian flight heights

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Collison is one of the main mortality factors for avian species caused by operational offshore windfarm (OWF) developments. Typically, this is assessed using collision risk models which require avian flight heights as an input. Historically, flight heights have been estimated from available literature, boat-based surveys, or size-based calculations from aerial digital still imagery. These methods are subject to variable error and subsequent bias within the calculations, which leads to uncertainty around the results, which can lead to overly precautious estimates of collision. This paper describes a new measurement methodology for collecting site-specific avian flight heights in the offshore environment.

LiDAR (Light Detection and Ranging) technology is an accurate survey method that measures distances using laser light. Traditionally this technology has been applied as a topographic mapping tool. APEM has developed an approach which utilises a custom-built system that captures both high-resolution digital still imagery and LiDAR positional data of avian species concurrently. Birds in flight are identified to species level from the imagery and the flight height is measured by “hits” from the LiDAR system. When the two data sets are combined, this methodology provides accurate avian flight heights which are site and species-specific. Proof of concept studies have produced confident matches between imagery and LiDAR data, with >95% of flying birds having flight height measurements within one metre accuracy. Preliminary data show that matching high-resolution images with the LiDAR, show a high rate of success even with birds flying close to the sea surface, with our results accurately depicting birds captured at all heights. Furthermore, species size does not appear to affect the results, with even small birds (<40 centimetres) achieving a mean LiDAR hit rate greater than one.

This technology will help to fill important knowledge gaps around site-specific avian flight heights. The simultaneous use of LiDAR and digital still imagery provides flight height measurements that can more accurately and precisely inform collision risk models than traditional methods, reducing the levels of precaution required around OWF developments. Although in its early stages, results from trials of this technology demonstrate that it is likely to become the most appropriate tool from which to generate site specific avian flight height data.

Method for defining appropriate Acceptable Levels of Impact on bird populations

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Cumulative effects of offshore wind farms on bird populations are in Europe currently assessed using relatively simple criteria and thresholds like the ORNIS 1% criterion and the Potential Biological Removal (PBR). These methods are easy to apply and understand but come with limitations. To gain more insight into the current expected population trajectory and the effect of additional mortality, population models have been created. Whether an expected impact is acceptable depends on different factors, and this decision can be subjective. However, so far, there was no threshold for assessing whether a certain outcome of the population model was acceptable.

For the Dutch government, we developed a novel method to determine thresholds for acceptable levels of impact (ALIs), which can be assessed using matrix population models. In our framework, the threshold ALI is formulated as: The probability of a population decline of X% or more, relative to an unimpacted population, 30 years after the onset of a continuous prolonged impact, cannot exceed Y. We present a framework for determining the species-specific values of X and Y.

We determine the maximum acceptable decline of X% over 30 years based on the IUCN Red List status. For each species, we base the value of X on the IUCN approach for the change in status from least concern to vulnerable. In addition, we include a stricter threshold, which can be used for species with an unfavourable status. This results in a threshold of 30% and 15% acceptable reduction over three generations or ten years, whichever is longer. Using the species-specific generation time, this relative reduction is scaled to a period of 30 years, in accordance with the ALI definition.

Even in the scenario without impact, the X threshold may be violated due to uncertainty in demographic rates. For that reason, the acceptable probability of violating the X threshold (Y) needs to be defined. Our approach considers the relative cause of violation of the X threshold: how often is the violation caused by the impact (rather than by uncertainty). Policymakers can decide on the level of causal certainty which is no longer acceptable. Our method calculates threshold values for Y as the species-specific thresholds associated with specific levels of acceptable causality (risk), taking into account the uncertainty in the unimpacted population trajectory.

The choice of specific values for X and Y are made in the policy domain. We present a framework for policymakers to determine the species-specific choice of X and Y, based on a.o. species-specific information on ecology, population trends, IUCN Red List and other status assessments, threats and uncertainty and/or potential for compensation. This resulting ALI can be used for assessing the impact of wind farms, as well as the impact of other initiatives. We advise re-evaluations when new European status reports are published or other relevant new knowledge becomes available.

B-finder - automatic bat & bird collision monitoring for wind farms

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1 EMPEKO S.A. B-finder Team

This paper presents results of test of the prototype of B-finder system. B-finder system is breakthrough automation technology for wildlife post-construction monitoring based on sensors. B-finder technology enables automatic bats & birds fatality monitoring for onshore & offshore project. Results of 30-months tests of prototype are presented. Post-construction fatality of bat and bird on wind turbines onshore monitoring methods are based on searching on the ground. Such methods are not suitable for offshore wind farms. In this presentation breakthrough solution for automated counting and mapping of bat and bird collision in real time is described. B-finder system establish a global measurement standard in area of environmental monitoring for wind farms. B-finder system introduces automation, efficiency and transparency of bat and bird collision monitoring on wind farms.

Tests of B-finder prototype were performed between 11.11.2017 and 30.05.2020. During the test period the system was in operation day and night and in variable weather conditions. The prototype was installed on the onshore tower of wind turbine Enercon located in western Poland (temperate climate zone). The long tests in real conditions provided the information about the hardware endurance and gave the opportunity to perform series of tests, leading to further improvements of the software. Because of the limited number of real collision cases and fixed length of the wind turbine's blade, the main research was based on simulated collisions at different distances from the wind tower. This way, the results of the tests are universal and applicable to all turbine types with different blade dimensions. The real collision factor is random phenomena and the average number of collisions make difficult to tests the system based on the results of real fatality only. For the assessment of the efficiency in detection of collisions more than 1300 series of simulation-tests was performed. Freshly dead zebra finches *Taeniopygia guttata*, Barbary doves *Streptopelia risoria*, domestic pigeon *Columba livia* and swan goose *Anser cygnoides*, as well as plastic test tubes and bottles have been used as the objects for the simulation. Real animals used for the tests were direct equivalents of real collisions. To reduce the number of freshly dead animals, plastic equivalents were calibrated and used in the majority of simulations.

The B-finder system in the basic configuration enables: detection of all bats species up to 50 m from the wind tower (min. 95% efficiency); detection of smallest bird species up to 50 m from the wind tower (min. 95% efficiency); detection of all bigger bird species up to 100 m from the wind tower (min 95% efficiency).

Results of tests shows the readiness of B-finder system to be a new measurement standard for onshore and offshore wind power.

Investigating prey fields near foraging right whales in southern New England

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We are conducting multidisciplinary research to gain insight into the prey resources and oceanographic features related to the distribution of highly endangered North Atlantic right whales in the southern New England region. In recent years, up to 23 % of the right whale population has been sighted in the region from December to May. We have been sampling plankton near feeding right whales during winter months from 2020 to 2022 to better understand the prey field composition, abundance, and vertical distribution. Shipboard sampling of plankton and oceanography was conducted using a combination of plankton nets, acoustics, and a video plankton recorder to map vertical distribution patterns of zooplankton. Analysis of the prey community from February and March collections made in 2020 and 2021 showed that *Calanus finmarchicus* was one of the most abundant taxa collected. *C. finmarchicus* abundances were similar to long-term averages of the region. Other abundant taxa included barnacle larvae and the calanoid copepods *Pseudocalanus* spp., *Centropages* spp., and *Temora longicornis*. Preliminary analyses of the energy density of plankton collections estimated the lipid rich *C. finmarchicus* copepodite stage 5 averaged 27 kilojoules per gram dry weight. Bulk plankton, unsorted sub-samples, from the same collections averaged 17 kilojoules per gram dry weight. We hope that our paired physical and biological observations can be used to understand right whale prey in the region and better predict future right whale distribution for use in developing effective and efficient management measures.

Design, production, and validation of the biological and structural performance of an ecologically engineered concrete block mattress

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To evaluate the structural and biological performance of the Ecological Articulated Concrete Block Mattresses (ACBMs), a pilot project was deployed in April 2017 at Port Everglades, Florida, USA, and evaluated against controls of adjacent artificial structures and smooth-surface concrete blocks and monitored over a period of two years. Based on the results of this study, design alterations, including modifications of concrete composition, surface texture, and macro-design, have increased the richness and diversity of sessile assemblages compared to control blocks and adjacent artificial structures and supported a higher abundance of mobile species. This ecological improvement was achieved within the operational limitations of conventional manufacturing and installation technologies, while complying with strict structural requirements for standard concrete marine construction. The results supported the working hypothesis and demonstrated that design alterations have the potential to increase the ecological value of concrete-based coastal and marine infrastructure and promote a more sustainable and adaptive approach to coastal and marine development in an era of growing offshore wind development.

Symposia

Predatory-prey interactions with forage fish and seabirds: Building a foundation to understand indirect effects of offshore wind on marine ecosystems

Moderator: Evan Adams, Biodiversity Research Institute

The distribution and availability of food resources are key drivers of habitat use in marine species. Forage fish are key resources for a diverse range of predators and their availability to predators can change rapidly over space and time. Predator-prey interactions can be difficult to measure in situ due to difficulties in monitoring changes across species and the dynamic nature of marine ecosystems. Further, predator-prey relationships are two-way interactions that create complex feedback loops in ecosystems that can make inference challenging. The complexity and strength of these relationships have the potential to change marine community composition and merit further research to better forecast changes and aid conservation efforts.

Offshore wind development has the potential to be an agent of both direct and indirect effects in marine systems through its effects on ocean substrate, surface and subsurface currents, and ensuing behavioral changes to many species. Data are lacking on the effects of offshore wind on these interactions in North America, this symposium will address this gap using active research and monitoring programs to describe the current state of knowledge to relate these findings to anticipated effects of offshore wind development. The program will start with a description of forage fish status and trends on the Northeastern Continental Shelf, move to a discussion of temporal changes in forage fish and their connection to predator populations, describe forage fish communities and the processes that create surface aggregations, identify the movement behaviors of the predators that rely on them and how these behaviors are linked to current forage fish populations, then quantify spatiotemporal interactions between forage fish and seabirds over short and long time scales. Afterward, the presenters will meet as a panel to discuss potential approaches to understanding species interactions in the context of offshore wind and subsequent indirect effects from development that can precipitate ecosystem changes.

Presentations:

- **Forage fish occurrence and temporal changes in offshore wind energy areas on the U.S. Northeastern Continental Shelf**
  Kevin Friedland, NOAA Fisheries, kevin.friedland@noaa.gov
- **The influence of climate and wind energy development on seabird-forage fish trophic relationships in the Northeast U.S.**
  Michelle Staudinger, U.S. Geological Survey, mstaudinger@usgs.gov
- **Forage fish community and surface aggregation dynamics in the Northeast U.S. Continental Shelf Ecosystem**
  Chandra Goetsch, Biodiversity Research Institute, chandra.goetsch@briwildlife.org
- **Assessing individual movement, habitat use, and behavior of non-breeding marine birds in relation to planned offshore wind development in the eastern U.S.**
  Julia Gulka, Biodiversity Research Institute, julia.gulka@briwildlife.org

- **Filling knowledge gaps: What's next for understanding changes to seabird-forage fish dynamics?**
  Evan Adams, Biodiversity Research Institute, evan.adams@briwildlife.org

Discussion Panel: What do we need to know to understand the effect of offshore wind on species interactions – all speakers

New York, New York: Working together to establish marine mammal baselines in and around a wind energy lease area and associated cable corridors

Moderator: Howard Rosenbaum, Wildlife Conservation Society

Offshore wind (OSW) development in the New York Bight (NYB) has the potential to add pressure to an already heavily human-dominated region. Of particular concern is the lack of baseline data on cetacean species, some of which recently started to have a more extended presence in the NYB. In response to this need, WCS and Equinor established a project expanding upon the previous WCS-WHOI near real-time acoustic monitoring effort in Equinor Wind Lease 0512 area.

The project provides baseline information on cetacean presence, which is vital for informing effective mitigation during OSW energy development in the NYB. Near real-time acoustic monitoring and associated archival recordings provide unique opportunities to explore mitigation approaches and outreach. Implications of this project are far-reaching and include establishing a paradigm in the NYB that may guide additional monitoring and mitigation, and demonstrating the use of this approach as a model for other areas facing similar pressures.

The symposium provides an overview of our project objectives and results thus far (see Presentations) and includes discussion on how collaboration between researchers and developers improve the use of our science, monitoring and mitigation, best practices for OSW energy development, and links to wider regional efforts.

Presentations:

- **Passive acoustic monitoring in near real-time and associated capabilities**
  Mark Baumgartner, Woods Hole Oceanographic Institution, mbaumgartner@whoi.edu
- **Using regional datasets to inform environmental impact assessment and mitigation measures: A developer's perspective**
  Jennifer Dupont, Equinor, JDUP@equinor.com
- **North Atlantic right whale (NARW) presence and vocal activity: Implications for safe passage through the New York Bight**
  Anita Murray, Wildlife Conservation Society, amurray@wcs.org
- **Temporal variability in fin whale vocal activity: Understanding occurrence, behavioral shifts, and population structure in the New York Bight**
  Carissa King, Wildlife Conservation Society, cking@wcs.org
- **Baleen whale sightings: Distribution, behavior, and overlap with anthropogenic activities**
  Emily Chou, Wildlife Conservation Society, echou@wcs.org

If we build it, who will come? Exploring artificial reef effects associated with offshore wind installations

Moderators: Carl LoBue, The Nature Conservancy, and Kathy Vigness-Raposa, INSPIRE Environmental

As offshore wind rapidly develops along the US east coast, an understanding of the ecological responses to the novel structures positioned throughout the water column is critical to enable sustainable development. Novel surfaces associated with offshore wind, including turbine foundations and scour protection, will result in an increase in the standing stock biomass of basal trophic level organisms (e.g., filter feeders), which may facilitate the transfer of organic material from the water column to upper trophic levels (fish) and to the surrounding benthic environment. These novel structures will also serve as new refuge for fish species, which may also promote increased fish production through this refuge and supply of new food resources. This symposium will facilitate discussions on the ecological implications associated with introducing intertidal, novel substrata to the outer continental shelf through offshore wind development, including the concept of nature based or inclusive designs for scour protection and cable mattresses. The intended outcome is to develop a conceptual framework to guide the research needed to fully address the questions around the potential for offshore wind farms to serve as artificial reefs and the subsequent ecosystem-level shifts associated with offshore wind development, including identifying knowledge gaps, outlining research methodologies, and discussing US-specific socio-ecological aspects to this topic.

Presentations

- **The flyway concept and assessment of offshore wind impacts on migratory marine fauna**
  David Secor, University of Maryland Center for Environmental Science, secor@umces.edu
- **Turbines as artificial reefs, nature-based design options to enhance habitat**
  Christopher McGuire, The Nature Conservancy, cmcguire@tnc.org
- **Epifaunal colonization on foundations in the US and subsequent organic enrichment to the seafloor**
  Annie Murphy, INSPIRE Environmental, annie@INSPIREenvironmental.com
- **Overview of lessons learned from Europe**
  Steven Degraer, Belgian Institute of Natural Sciences, steven.degraer@naturalsciences.be
- **Artificial reefs associated with southern California oil and gas platforms**
  Erin Meyer-Gutbrod, University of South Carolina, emgutbrod@seoe.sc.edu

Collaborative animal movement studies to improve conservation outcomes

Moderator: Pam Loring, U.S. Fish and Wildlife Service

Studies that use electronic tags (including satellite and radio transmitters) to track animals provide important data on the movements of known individuals across time and space. The utility of telemetry data to provide population-level information and improve conservation outcomes increases with the sample size of tagged individuals. To help meet these information needs, we are working collaboratively to increase coordination of telemetry data collected by the research community by combining data across tagging efforts and taxa to better inform analyses and impact assessments of offshore wind at site specific to hemispheric scales. In addition, we are developing guidance, workflows, and tools for data collected using coordinated automated radio telemetry (Motus) and satellite telemetry (e.g., Argos and GPS technologies) in offshore environments. Through these efforts, we aim to develop a collaborative, multi-disciplinary approach to improve consistency, accessibility, efficiency, and transparency in collection, analysis, and management of wildlife telemetry data to address high-priority information needs for offshore wind energy. This symposium includes select presentations on current efforts and next steps for coordination and analysis of wildlife telemetry data for offshore wind research, monitoring, and assessments in the Atlantic. While this symposium will focus on birds as a case study, its guidance and conclusions will also provide a roadmap for coordinated tracking of other vertebrate species including fish, marine mammals, sea turtles, and bats.

Presentations:

- **Development of a coordinated offshore Motus network for monitoring birds and bats at site specific to regional scales**
  Pamela Loring, U.S. Fish and Wildlife Service, pamela_loring@fws.gov
- **Evaluating the impact of offshore Motus study design choices on the presence and movements of birds in marine environments**
  Evan Adams, Biodiversity Research Institute, evan.adams@briwildlife.org
- **SCRAM model for estimating offshore avian collision risk using avian movement data**
  Andrew Gilbert, Biodiversity Research Institute, andrew.gilbert@briwildlife.org
- **A framework to determine optimal sample sizes and transmitter distribution for individual tracking studies**
  Juliet Lamb, The Nature Conservancy, juliet.lamb@tnc.org
- **Combining satellite telemetry data across studies for Sterna terns relative offshore wind energy in Brazil**
  Rafael Revorêdo, CEMAM, rafael.revoredo@hotmail.com

Autonomous solutions responding to the oceanographic and ecological monitoring needs of offshore wind development

Moderators: Josh Kohut and Grace Saba, Rutgers University

Traditional ecological and environmental monitoring programs are increasingly at risk due to more limited resources to support costly ship time and event-based disruptions such as the recent COVID pandemic, limiting opportunities for vessel-based biological and environmental observing efforts (Reiss et al. 2021). Additionally, the placement of planned offshore wind platforms off the coast of the Mid-Atlantic overlays historic vessel-based fisheries surveys that may need to be modified, or augmented, once the platforms are built and in operation. Therefore, there is a need to test the potential for autonomous platforms, such as underwater gliders, to augment/replace current vessel-based efforts, including pelagic and trawl fish surveys. While significant progress has been made in using autonomous vehicles to monitor the physical environment, developing these tools for the quantitative assessment of zooplankton, fish, and marine mammal populations has lagged. However, newly developed active and passive acoustic sensors for autonomous platforms make addressing these technological gaps now possible. Recent successes have demonstrated the ability for these systems to augment and completely replace vessel-based surveys. One such success story highlights the complete replacement within a two-year time period of the Conservation of Antarctic Marine Living Resources [CCAMLR] vessel-based surveys for the Antarctic krill fishery by gliders equipped with AZFPs and operated by NOAA Southwest Fisheries Science Center (Reiss et al. 2021). Given recent federal, state and private sector investments in oceanographic and ecological monitoring and research focused on the introduction of offshore wind to the US east coast, this session will provide examples of and discussion on autonomous monitoring/regulatory solutions.

Presentations:

- **Autonomous monitoring for resource assessment in the Antarctic and California Current**
  Christian Reiss, NOAA National Marine Fisheries Service, christian.reiss@noaa.gov

Panelists:

- Josh Kohut, Rutgers University, kohut@marine.rutgers.edu
- Grace Saba, Rutgers University, saba@marine.rutgers.edu
- Andy Lipsky, NOAA Southwest Fisheries Science Center, andrew.lipsky@noaa.gov
- Kate McClellan Press, New York State Energy Research and Development Authority, kate.mcclellanpress@nyserda.ny.gov
- Kira Lawrence, New Jersey Board of Public Utilities, kira.lawrence@bpu.nj.gov
- Renee Riley, New Jersey Department of Environmental Protection, renee.reilly@dep.nj.gov
- Greg DeCelles, Ørsted, grede@orsted.com
- Christian Reiss, NOAA Southwest Fisheries Science Center, christian.reiss@noaa.gov

Progress on RWSC Science Plan for wildlife, habitat, and offshore wind energy in the U.S. Atlantic

Moderator: Emily Shumchenia, Regional Wildlife Science Collaborative

The Regional Wildlife Science Collaborative (RWSC) is focused on how offshore wind energy development off the U.S. Atlantic coast will affect wildlife and ecosystems. RWSC coordinates across four sectors (federal agencies, states, offshore wind companies, and environmental non-governmental organizations) to share information, standardize data collection and monitoring protocols, define key scientific research needs at project and regional scales, and amplify the results of existing and ongoing research.

The RWSC Steering Committee is developing an integrated Science Plan for Wildlife, Habitat, and Offshore Wind Energy in the U.S. Atlantic ("Science Plan") that reflects the research priorities of the four RWSC Sectors with input from the research community through six taxa-based Subcommittees. The Science Plan will articulate the data collection and analysis activities that need to occur in the next 10 years to identify, assess, and avoid impacts to the distribution, abundance, and behavior of wildlife due to offshore wind development.

Presentations:

- **General RWSC introduction and recent progress, and Protected Fish Subcommittee update**
  Emily Shumchenia, Regional Wildlife Science Collaborative
- **Bird & Bat Subcommittee update**
  Zara Dowling, University of Massachusetts Amherst, zdowling@eco.umass.edu
  Marine Mammal Subcommittee update
  Deborah Brill, Duke University, deborah.brill@duke.edu
  Sea Turtle Subcommittee update
  Avalon Bristow, Mid-Atlantic Regional Council on the Ocean, avalonbristowmarco@gmail.com
  Habitat & Ecosystem Subcommittee update
  Marisa Guarinello, INSPIRE Environmental, marisa@INSPIREenvironmental.com

Panelists:

- Kyle Baker, Bureau of Ocean Energy Management, kyle.baker@boem.gov
- Corrie Curtice, Duke University, corrie.curtice@duke.edu
- Carl LoBue, The Nature Conservancy, clobue@tnc.org
- Stephanie Vail-Muse, U.S Fish and Wildlife Service, stephanie_vail-muse@fws.gov
- Nick Napoli, Northeast Regional Ocean Council, nicknapoli01@gmail.com

Poster Abstracts

Organized by workshop theme; within each theme, abstracts are listed alphabetically by last name of first author

Establishing a baseline: Understanding wildlife populations and distributions in the U.S.

BOEM environmental studies for protected species and offshore wind

Kyle Baker[1*], Mary Boatman[1], David Bigger[1]
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1 Bureau of Ocean Energy Management

Through the Bureau of Ocean Energy Management (BOEM) Environmental Studies Program, BOEM funds scientific research to inform decisions about offshore wind. BOEM has invested more than $80 million in collecting baseline information about the distribution and abundance of marine life, birds, and bats and potential impacts from development (seafloor disturbance, sound, electromagnetic fields [EMF]). The topics studied are informed through intergovernmental task forces, public meetings, formal information solicitations, and recommendations made in BOEM-funded studies. BOEM identifies priorities annually during the development of the studies plan. Selected completed and ongoing studies that provide information about offshore wind and protected species in the Atlantic are categorized. A complete list of studies that are in progress or completed is available on the BOEM website. BOEM also supports the Regional Wildlife Science Collaborative and regional data portals, such as the Northeast Ocean Data Portal, where data form study products are made available to the public.

Long-term trends in large whale ecology in the New York Bight and adjacent estuaries

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1Rutgers University 2Gotham Whale

Forthcoming offshore wind construction in the New York Bight (NYB) requires an understanding of current and historic trends in local whale ecology, which may be impacted by construction activities and subsequent increases in vessel traffic. Most formal scientific data from the NYB have been collected in the last 50 years, which creates a challenge in constructing a historical baseline. However, data from non-traditional sources can be useful for assessing long-term trends. We used three opportunistic sources to describe the ecology of large whales in the NYB and adjacent estuaries over the last 200 years. Prior to 1971, the North Atlantic Right Whale Consortium (NARWC), the American Offshore Whaling Logbook (AOWL), and historic newspaper records were comprised mainly of right (n=51.2%), fin (23.8%), and sperm whales (n=18.9%). However, from 1971-2020, records consisted of fin (54.9%), minke (16.9%), humpback (13.1%), and right whales (12.3%). All species were recorded in all seasons, but humpback, fin, minke, and sperm whale sightings were highest during the summer. Right whale sightings were highest during winter, but strandings were highest during the summer. A substantial number of humpback, fin, and minke whale sightings occurred in waters off Montauk, New York (NY), and fin and right whale sightings occurred closest to wind energy areas (WEAs). We found little evidence to suggest that humpback and minke whales were consistently present prior to the 1980s. Therefore, factors other than recovery from whaling may be driving their occurrence in the NYB and adjacent estuaries.

Marine mammal and sea turtle stranding response in the NY Bight: A baseline record of current threats in the Northwest Atlantic

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Marine mammal and sea turtle strandings have been documented in the New York Bight since the early 1980s. Stranding responses have evolved to incorporate increasing coastal wildlife populations and associated challenges with shared habitat utilization by humans and wildlife. These changes have required significant changes to the program over the years in response to challenging events. In just five years, from 2017 through 2021, Atlantic Marine Conservation Society (AMSEAS) responded to 1,049 marine mammal and sea turtle strandings, an average of 210 events per year. This includes 65 large whale strandings in the New York Bight, an average of 13 strandings per year. In addition to changes in large whale strandings, the frequency of deceased sea turtles that have evidence of human interaction contributing to the cause of death is increasing. Changes in pinniped populations have been observed as well, including increased numbers of gray seals (*H. grypus*) documented at eastern Long Island haul-out sites and extended residency through the summer months.

In response to these changes, AMSEAS is analyzing marine mammal and sea turtle stranding data from Massachusetts, Rhode Island, Connecticut, New York and New Jersey from 2017 through 2021 to answer the following questions. What is causing mortality in marine mammals and sea turtles in the New York Bight? How do these mortalities relate to wild populations? How can the causal factors for mortality be mitigated by the public? Data including species, sex, date of stranding, location of stranding, cause of stranding/ mortality and basic life history information will be examined in this study. The results of this study will establish a baseline understanding of the threats already challenging marine life in the New York Bight. As ocean development continues to increase, including establishing wind energy projects, these baseline data will inform environmental managers of changes occurring and enable mitigation measures to be established. AMSEAS will combine the results of this survey with active health assessment and monitoring projects to contribute to the overall picture of the health of marine mammals and sea turtles in the Northwest Atlantic Ocean.

Aligning the seasonal migrations of North Atlantic Right Whales with oceanic features

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For tens of millions of years, baleen whales have been migrating through our oceans. Despite this marvelous feat, they've been impacted by human activity with whaling, vessel collisions, and pollution. The North Atlantic Right Whale (NARW) population in particular has been in rapid decline with a slow to nonexistent rebound compared to other baleen whale species. To minimize human impacts on this critically endangered species, there has been a recent push in science and conservation to understand how the ocean environment influences the behaviors of whales. With this in mind, the purpose of this study is to see how oceanic features play a role in the pathways of North Atlantic Right Whales as they migrate off the coast of New Jersey. The study was performed in wind lease areas off the south coast of New Jersey as part of the ECO-PAM Project. ECO-PAM, funded by Ørsted OceanWind, is a collaboration between Rutgers University, Woods Hole Oceanographic Institution, and the University of Rhode Island. Autonomous vehicles equipped with oceanographic and ecological sensors simultaneously mapped whale detections in the context of physical ocean features. Slocum gliders, deployed in the late fall and winter (2021 and 2022), used DMON passive acoustic monitors to locate NARW relative to concurrent temperature, salinity, density, oxygen concentration, and chlorophyll observations. In addition to the glider data, satellite derived fronts based on MODIS Aqua 8-Day 1 km SST and ocean color composites were mapped relative to NARW observations. Preliminary analysis from the gliders, acoustics, and satellites highlights the potential for oceanic feature mapping to predict NARW migration pathways and conduct mitigation strategies. This research serves as an example of the new insight gained when integrating concurrent oceanic and ecological data. This analysis demonstrates how dynamic mapping through autonomous systems can support whale friendly activity in and around planned offshore wind lease areas in the Mid Atlantic Bight.

Distance sampling seabird surveys in the New York Bight

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Seabirds may be impacted by the presence and development of wind farms based on their behavior and spatial habitat use relative to wind energy areas (e.g. collision-risk or displacement). Upcoming wind farm development in the New York Bight (NYB) emphasizes the need to assess potential impacts on seabirds in this region. However, there are insufficient data with adequate spatiotemporal resolution in the NYB to assess seabird habitat use in detail. We are implementing shipboard line-transect surveys to provide information on the abundance, distribution and flight height of seabirds as part of a long-term monitoring program in the NYB. We designed a custom data collection template in Mysticetus software and integrated speech recognition functionality using Nuance Dragon NaturallySpeaking software and simple visual basic scripts. This allows observers to collect data hands-free and allows them to auto-populate critical fields with voice command in real-time while using other survey field tools to provide input for distance sampling (e.g. binoculars, pelorus). Oceanographic and fisheries acoustics surveys are also being conducted as part of this monitoring program, and integrative analyses of these interdisciplinary datasets will allow us to better understand drivers of seabird abundance and distribution and trophic interactions between mid and upper trophic levels.

Standardized data extraction from seabed imagery using machine learning

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Various types of high-resolution seabed imagery (towed video, plan view and sediment-profile imaging [SPI] drop cameras) are being used to map benthic habitat conditions at offshore wind farm sites and along potential export cable routes. Compared with traditional physical sampling conducted with grabs and cores, imaging techniques capture a detailed "picture" of baseline ecological conditions over more area and at a higher density. When high-resolution imagery is combined with and used to ground truth acoustic mosaic maps (e.g., multibeam ecosounder), highly detailed bottom substrate and habitat maps can be generated. Time series maps collected pre- and post-wind farm construction and operation should enable accurate assessment of changes in benthic conditions.

A significant challenge in the use of imagery for seafloor mapping is the large volume of "samples" (images) obtained and the need to efficiently extract high-quality quantitative data from the images. For SPI and plan view images, we have developed an in-house replicable approach for image analysis that employs machine learning to identify and measure key features in a repeatable and standardized way. For SPI images, the program automatically delineates the sediment-water interface, calculates penetration depth and boundary roughness, categorizes grain size major mode (phi units) throughout the image, and identifies biogenic structures and infauna organisms using varied machine learning techniques. In the plan view images, the program automatically detects the laser scalers, calculates the field of view, and identifies physical or biological features of interest once a training set is developed. The percent cover of various textures (e.g., 10% gravel, 90% sand) can also be accurately quantified in a supervised automated fashion.

Advanced algorithms for feature identification and image classification are continually being developed and refined in the wider data science community. By standardizing image analyses for seabed imagery, we are able to plug into and benefit from these algorithms to improve the accuracy and range of features we can identify using machine learning. Our long-term goal is to continually increase the efficiency and accuracy of data extraction from SPI and plan view imagery and to expand the use of these machine learning techniques to our imaging platforms, such as towed video records.

Tracking the habitat use of herring and great black-backed gulls in proposed offshore wind areas

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Upcoming development of offshore wind farms in the Northeast US (NEUS) portends the need to understand how wind turbines may impact the habitat use and behavior of seabirds. Gulls are thought to be particularly vulnerable to interactions with wind farms due to their flight heights and offshore feeding behavior. However, detailed information on gull habitat use is needed to better understand the potential for interaction between specific gull species and windfarms in this region. We deployed long-term solar powered GPS devices on 8 great black-backed gulls (*Larus marinus*) and 7 herring gulls (*Larus argentatus*) at two breeding colonies on Long Island in 2021 to assess the utility of these tags for understanding the breeding and post-breeding habitat use and movement patterns relative to offshore wind areas. We found that great black-backed gulls utilized offshore waters for foraging during both the breeding and non-breeding seasons to a much greater extent than herring gulls, which primarily utilized terrestrial and nearshore areas for foraging. Additionally, most (88%) great black-backed gulls migrated to more southern regions along the east coast of the US post-breeding while all herring gulls remained in the Long Island area. This data provides insight into the feasibility of using breeding colony-based tracking of seabirds to investigate potential interactions with offshore wind farm areas and highlights the importance of distinguishing between breeding and post-breeding movements and habitat uses.

Biosensors on metocean buoys provide long-term monitoring for diverse marine mammal species

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The minimization of impacts to wildlife during construction and operation of offshore wind projects is essential to their success. Buoy-mounted and accompanying seabed-mounted wildlife detection systems provide the means for baseline data collection on avian, bat, and marine mammal species richness. Seabed-mounted passive acoustic monitoring provides for reliable long-term data sets and the opportunity to ask questions probing temporal and spatial patterns of marine mammal activity and habitat use. Acoustic monitoring for birds and bats helps to determine migration abundance and seasonal passage through a wind resource area.

As part of wind resource assessment campaigns for NYSERDA, Ocean Tech Services, LLC, deployed metocean buoys with acoustic microphones to detect bird vocalizations and ultrasonic microphones for bat detection at two locations in the New York Bight over a period of two years. To capture marine mammal vocalizations without the impact of noise from a surface buoy, we deployed accompanying trawl-resistant bottom mounts (TRBMs) outfitted with hydrophone loggers. Recorded vocalizations for both buoy-mounted and seabed systems were analyzed by Normandeau Associates and identified to species or species group through a combination of automatic and manual vetting processes based on specific diagnostic acoustic features of the call sequences. Presented here are the results of the marine mammal acoustic analysis performed at both locations.

During 540 days of operation, 2,153 and 1,525 vocalization calls were recorded and analyzed from each of the two buoy locations, respectively. These calls were identified to totals of 9 and 12 species recorded at each buoy. The highest detection rates occurred during the period of August through mid-November, with the lowest detection rates recorded during the period of November through March. Additionally, one buoy recorded ~50% more detections per day on average than the other during the late summer and fall period. These results indicate both temporal and spatial influences on patterns of species richness and habitat use.

Long-term wildlife monitoring systems provide large marine mammal datasets with great potential for species-level identification. Buoy deployments with accompanying TRBMs are one way to acquire these robust datasets, which in turn allow for opportunities to ask questions related to temporal and spatial patterns of species diversity, activity, and habitat use. Paired with data collected on-site from the metocean buoys on environmental conditions above and below the ocean surface, similar surveys in the future hold strong potential for a better understanding of marine mammal behaviors and the external factors that influence them.

Digital aerial surveys and their use for establishing a baseline for site assessments

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Offshore windfarm (OWF) developments can have a range of impacts on marine wildlife. Therefore, it is imperative that detailed surveys are undertaken to provide a robust baseline on which to base assessments of impact during the permitting process. Marine wildlife surveying has rapidly evolved, from traditional boat-based surveys to digital aerial surveys. Many of the technological and methodological developments have been instigated to meet needs of the marine renewable energy industry through assessment of potential impacts, driven by the requirement for advancement in the knowledge base for both developers and conservation bodies. Recent developments include the simultaneous use of LiDAR and digital still imagery to measure site-specific avian flight heights that inform modelling to mitigate collision risk, which is a key mortality factor for avian species caused by OWF developments.

APEM have developed global best practices to marine wildlife surveying from projects in the UK, Europe, USA, Vietnam, and Australia which cover data acquisition, presentation, and interpretation. Moreover, APEM have extensively investigated the differences in survey designs and how these are employed in various situations, including wide area surveys, baseline studies to inform permitting, post-consent (pre-, during and post-construction) studies, as well as custom designs to answer specific questions on issues such as protected site connectivity, collision risk, avoidance and displacement, and colony counts.

Based on our extensive experience in marine wildlife surveying spanning the last 15 years, APEM will share the capabilities and the limitations of current techniques, best practices, and how these approaches can inform both baseline characterisation and assessment of the effects of developments on species responses.

Maximizing the potential of protected species observer data

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Protected Species Observers (PSOs) are deployed offshore on variety of industry as a regulatory requirement to implement monitoring and mitigation intended to minimize potential impacts to marine wildlife from exposure to sound. PSOs collect data including monitoring effort, survey and sound source operations, and detections of marine wildlife, including marine mammals as a regulatory requirement. However, PSO data has the potential to be valuable outside of achieving compliance with reporting requirements. The large volume of data that is collected across large areas make it a power analysis tool; for example, in the Gulf of Mexico where energy exploration has been active for over 20 years, more than 22,000 detections of protected species have been accumulated. Studies have been commissioned to analyse PSO data for general trends in species presence and to determine the potential effects of sound exposure on animal behaviour.

Large whale distribution and density in the New York Bight from aerial surveys 2017-2020

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The New York Bight is an ecologically important area in the Northwest Atlantic for many marine species. It's also an area of high human use for many offshore activities including shipping, fishing, and recreation, and is the target for offshore wind energy development. Large whale species occurring in the Bight (sperm, blue, sei, fin, humpback, and North Atlantic right whales) are NYS Species of Greatest Conservation Need and most are endangered at both federal and state levels. Understanding how large whale species use New York waters is critical to evaluating exposure to threats and potential impacts from direct and indirect sources, as well as ensuring the most stringent mitigation methods are used for all applicable activities.

Three years of visual line-transect aerial surveys were funded by NYSDEC and completed by Tetra Tech. From March 2017 to February 2020, 36 surveys (one per month) were conducted along 15 transect lines (2,514 kilometers) from nearshore out to 120 nautical miles. A small, high-wing, twin-engine aircraft (Partenavia P68C) with bubble windows was flown at an altitude of 305 meters and a speed of 100-110 knots. Two observers, one on each side of the plane, looked for whales out to three kilometers when the Beaufort Sea State was 5 or lower. To estimate density and abundance, conventional distance sampling methods were used. (See Zoidis et al. 2021 for more details.)

For all large whales, a total of 318 sightings of 629 individuals were seen. Of those, 287 sightings (594 individuals) were identified to species. Most sightings occurred on the shelf and were highest during summer followed by spring. Humpback and fin whales were sighted most frequently, with at least one sighting of each species in every month. Right whales were present in all seasons except summer and were primarily on the shelf. Sperm whales were sighted in all months except May and November and occurred in the slope and plain. Blue whales were recorded in fall and winter and only offshore. Sei whales were sighted only in the month of April, on the shelf and slope. With species-specific corrections applied for availability bias, the Bight-wide density estimate of all large whales was 6.3 individuals /1,000 km2 and the average annual abundance was estimated to be 272 individuals.

These results provide valuable data on year-round occurrence of large whales and provide a baseline for management and conservation. Our results can be used to evaluate potential effects of activities like offshore wind, shipping, and fishing. Sightings occurred frequently within leased and proposed wind energy areas and may help define work windows and set the expectation of whale presence. Fin, humpback, and right whales were sighted within shipping lanes in each of the three years, which may indicate a need to adjust current mitigation measures. Nearshore humpback whale sightings overlap with available fishing effort data and may help managers gauge risk in the Bight.

Assessing the role of ocean currents on prey concentration from hourly to seasonal scales using lagrangian coherent structures

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In response to the introduction of offshore wind in the Mid-Atlantic Bight (MAB), the following study quantifies the coastal ocean's role in prey concentrating features. Consistent or seasonal prey concentrating features created by hydrodynamics could be essential to marine mammal migration and feeding around offshore wind lease areas. Knowledge of where and when prey concentrating features exist and persist could be valuable in understanding feeding habits, spatial distributions, and reliance on northeast shelf oceanography of fishes and marine mammals. Inhomogeneous, or "patchy" distribution of plankton is in part due to mesoscale and submesoscale oceanographic features transporting and locally concentrating plankton that can increase prey availability for intermediate and upper trophic levels. Recent advances in Lagrangian Coherent Structure (LCS) analyses aim to identify these concentrating physical features and quantify their strength and persistence. While LCSs have been applied to many pelagic regions, the use of these tools in coastal systems with much smaller more complex dynamic scales, has yet to be fully explored. The following study quantifies the relationship between concentrating mechanisms in coastal surface currents identified by LCS and the spatial ecology of plankton. Four popular LCS analyses will be used: Transient Attractive Profiles (TrAP), Relative Particle Density (RPD), Finite Size Lyapunov Exponents (FSLE) and Finite Time Lyapunov Exponents (FTLE). The analysis began in Palmer Deep, Antarctica, with a simple, tightly-coupled food web where relationships between concentrating features and bioactivity are easier to identify. LCS were derived from observed surface current velocity data provided by a three-site High Frequency Radar (HFR) network over known penguin foraging areas and compared to concurrent prey and predator distribution data. The LCS metrics most aligned with the marine ecology of the simpler system in Palmer Deep were then applied to a more complex migratory food web in the MAB. LCS calculations were derived from MARACOOS network of sixteen HFRs that have been providing hourly surface velocity measurements in this region for more than a decade. Preliminary results show that strong LCS concentrating features are related to an increase in satellite observed chlorophyll fluorescence, concentrating food resources and acting as "marine grocery stores". Future work will analyze these LCS metric over multiple years, looking for inter-annual and seasonal variability. Seasonal persistence of concentrating features will be quantified and compared to important life cycle stages of MAB species. Persistent seasonal LCS features may serve as reliable migratory pathways acting as "ocean highways". Results will provide a new quantitative methodology for assessing marine ecosystems and population dynamics, inform ecosystem models, and deepen understanding of the role of physical ocean features in structuring marine ecology.

Monitoring surveys of pelagic fish and zooplankton in the New York Bight

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Vessel-based surveys funded by the NY Department of Environmental Conservation have been conducted seasonally in the New York Bight since 2018. These surveys utilize multi-frequency scientific echosounders, trawls, net tows, and CTD casts to assess the spatial and temporal variation of pelagic organisms in this region and relevant environmental factors. While the COVID pandemic restricted some cruises and sampling operations, patterns in fish and zooplankton distribution are detectable. Challenges in establishing a baseline in this area include: a wide diversity of organisms present, patchy distributions, and a variety of bathymetric and environmental habitats. However, some taxonomic and species-level patterns have been found in the data collected so far.

The first marine mammal surveys in the lower Thames River, Connecticut

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Marine mammals are known to range into tidal rivers; understanding their usage patterns in estuarine waters can provide valuable information for the management of protected species. The Thames is a tidal river confluent with Long Island Sound. Three years (2017-2019) of monthly surveys were conducted in the Thames River near the Navy's Submarine Base New London (SUBASE NLON) to identify the occurrence, distribution, and abundance of marine mammals in the lower 7 nautical miles of the Thames River; this is the first survey of its kind for this river. SUBASE NLON is located within the towns of Groton and Ledyard in New London County, Connecticut. Shipboard, line-transect methodology was employed by systematically collecting and analyzing sighting data. A total of 16 seal groups – all single animals – were sighted during the 3 years of the study. This included 12 harbor seals (*Phoca vitulina*), 3 gray seals (*Halichoerus grypus*), and one seal unidentified to species. The density estimate was 0.190 seals per km2 (seals/km^2). Sightings occurred seasonally in autumn and winter. All seals were in the water and no haul-out areas were identified. There were no cetaceans (whales, dolphins, porpoises) observed during the study. These results indicate that the Thames River gets low usage by marine mammals. There are large winter haul-out aggregations of harbor and gray seals on Fishers Island and on eastern Long Island, distances of 8–20 nautical miles from the Thames River mouth. The seals seen in the Thames may be individuals based at these other locations that occasionally range into the river. Despite the influx of cetaceans into Long Island Sound in recent years, apparently none entered the Thames, based on this survey and anecdotal reports. These data represent new systematic baseline data that will be useful for environmental evaluations related to upcoming offshore wind energy projects in Connecticut. Connecticut currently has two active offshore wind projects in development; one of which, Revolution Wind, will have staging operations based out of New London. The study also has applicability for other offshore wind projects that might overlap with the Long Island Sound, since it is anticipated export cables may pass through the Sound.

Offshore wind development effects and species/ecosystem responses

Development of research priorities for offshore wind and marine resources in New Jersey

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New Jersey's Department of Environmental Protection is tasked with supporting offshore wind (OSW) development while continuing to manage our valuable marine resources. New Jersey currently has the second highest offshore wind targets in the US and four projects in development. Mitigation of impacts from OSW development requires identification of potential impacts, evaluation of mitigation strategies, and permitting coordination.

Steps were taken to prioritize our efforts toward providing scientifically sound information for decision making around OSW development. These include understanding how specific ocean areas off NJ are used, evaluating which offshore wind activities may affect marine resources, and determining which resources/fisheries are most vulnerable. Stakeholder input and regional collaboration are critical for understanding the issues and working together on solutions.

Vulnerability of resources is a function of their unique attributes and their economic, ecological, and social value. Fishery resources can be evaluated based on attributes such as socioeconomics, fishery dynamics, management, and stakeholder concerns. As an example, surfclam and ocean quahog have been identified as vulnerable to offshore wind because of the fishery's high economic value, changing distribution, and use of mobile bottom gear. This industry also is particularly well-informed and engaged in management and permitting.

Prioritizing research needs and identifying information gaps related to OSW and marine resources facilitated development of the NJ Research and Monitoring Initiative. With a strong scientific foundation, we can effectively advocate for our resources in high-stakes decision making. There are many challenges and unknowns in OSW, such as diversity in responsibilities and limitations in cooperating agencies, interstate variation in permitting and power purchase mechanisms, and the rapid pace of development. A focus on building good relationships with stakeholders and science-based decision making are solid strategies for moving forward.

A multi-sensor approach for measuring bird and bat collisions with wind turbines: Completed validation results

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Offshore wind energy is well-established in Europe and Asia and is poised for rapid growth in waters of the Americas. Understanding the potential magnitude of bird and bat collisions at offshore wind farms is challenging given the harsh offshore conditions and the inability to conduct standardized carcass searches similar to land-based turbines. Development of an automated collision monitoring technologies to document collision is needed to benefit offshore and land-based wind energy. To support this need, WEST is leading a collaboration with the Netherlands Organisation for Applied Scientific Research (TNO) to advance an automated, multi-sensor system for detecting and quantifying bird and bat collisions at wind turbines. The primary objective of the DOE-funded project is to advance the WT-Bird® system to detect large, medium, small birds, and bat collisions during both daytime and nighttime hours. The system is composed of sensors installed inside of the turbine blades to detect collision impacts and cameras installed at the base of the turbine also document independently the same collisions. During 2021, the updated WT-Bird sensors (collision and photographic) were installed at the U.S. National Renewable Energy Laboratory (NREL). For the collision tests, the NREL engineers developed a pneumatic launching system and biodegradable gelatin and balsa wood projectiles capable of simulating different sized wildlife during collision. Projectiles ranged from 8 gram to 250 grams. Results indicate collision detection of all objects exceeded 64.7% with sensors mounted between the hub and blade mid-span. Detection rates increased with size of projectile, with zero false positives during the collision trials. The camera sensors mounted at the base of the turbine were capable of capturing the smallest projectiles in mid-flight. To develop the image recognition system, WEST collected imagery of birds and bats from two locations in Minnesota and at an offshore island in Maine. More than 300,000 images were evaluated manually to develop image recognition models for bats, small birds, medium birds, and large birds. Results varied between birds and bats as a consequence of limited bat imagery, but had an average precision of 0.71 for bats, and between 0.81-0.91 among the three bird categories; cross classification was not a serious concern. Major technological advancements resulting from the project include: 1) improving the sensitivity of acceleration sensors and algorithms to identify collisions of small birds and bats, 2) integrating machine learning algorithms to process imagery data collected by the cameras to automatically classify birds and bats and verify collision, 3) development of projectiles and launcher suitable for testing a collision detection system. Studies will continue with validation of estimates derived from turbine-based collision compared to standard fatality monitoring approaches during 2022, and at an offshore turbine trial during 2023.

Risk assessments: Approaches and challenges

New York offshore wind cable corridor constraints assessment

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WSP USA is supporting the New York State Energy Research and Development Authority (NYSERDA) in assessing what constrains offshore wind (OSW) cables and how to address constraints in order to achieve 9 GW of OSW by 2035. The Assessment involves evaluating and ranking onshore and offshore resource constraints, identifying minimization and mitigation strategies, and integrating agency and stakeholder input to help identify options to maximize benefits of renewable OSW energy and avoid, minimize, and mitigate conflicts and impacts. The Assessment seeks to advance NYSERDA's coordination and planning efforts by building on existing work, previous studies, and work in progress, including NYSERDA's Power Grid Study, Offshore Wind Master Plan, and Port Uses and Navigational Assessment. This Assessment will also coordinate the analysis and evaluation of potential corridors to support future decision-making and policy development to achieve New York State's goals and mandates and allow for commercial innovation. The draft assessment report is scheduled for public release in summer 2022, at which time NYSERDA will issue a request for information inviting comment on the draft report. As part of the information gathering process for the assessment, VHB is supporting the ongoing and earnest collaboration with New York State agencies, including the Department of Environmental Conservation (NYSDEC), Department of State (NYDOS), Department of Transportation (NYDOT), Office of General Services, Department of Public Service (NYDPS), and interested stakeholders.

Long-range offshore wake losses: Validation and practical impacts on offshore wind energy development

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A new method, using a relatively new technical capability, is presented for the evaluation of long-range wake losses. The method is applied to the NY Bight lease areas and very significant long-range wakes are found, to a distance over over 100 km. The practical implications for offshore turbine array design, net energy production, required improvements to current engineering wake loss (or wind farm-atmosphere interaction, WFAI) models, and the design of future leases are significant.

It is known that atmospheric stability is a critical parameter in the assessment of velocity deficit recovery in wakes behind operating wind turbines. And yet, common, long-established, atmospheric science stability parameters such as Richardson Number are not able to be fully measured using FLIDAR, because doing so requires an assessment of the change in temperature with height, which FLIDAR do not measure.

This being the case, a new method is validated onshore and applied offshore, using the Weather Research and Forecasting numerical weather prediction model, with its associated Wind Farm Parameterization (WRF-WFP).

Onshore validation confirms that the WRF-WFP simulates energy losses to within 20% of actual energy loss, based on a comparison of before-and-after production at a wind farm 50 rotor diameters (RD) downwind from another. Significant wake velocity deficits extend 400 RD down wind in certain conditions. By comparison, current engineering wake loss models are shown to result in wake loss estimates that are 1/3 to 1/4 of the actual wake loss (a large underprediction).

The WRF-WFP model is applied to 3/4 nm by 1 nm arrays designed for the NY Bight lease areas and prevailing southwesterly wind flow cases are investigated, for all four seasons. The IEA 15-MW reference offshore turbine is used within the subject turbine arrays. Turbine arrays are designed with 10 km of spacing between arrays, for each of the three southwestern-most NY Bight lease areas.

Atmospherically stable conditions for over cold ocean waters when warmer air overlays cooler ocean water, resulting in wakes that travel far longer than current industry models or experience would inform. The stable air prevents stronger winds aloft (above the upper blade tips) from mixing down as efficiently as would be the case in less stable conditions, extending the distance downwind that velocity deficits (wakes) are retained.

The recently leased NY Bight lease areas are oriented southwest-to-northeast, subjecting each successive lease area to the northeast to very significant wakes. The wakes are found to contain material velocity deficits of over 10% at times, at distances greater than 90 km (> 400 RD). It is confirmed that, similar to the validation cases, current engineering wake/WFAI models calculate wake losses that are 1/3 of the WRF WFP modeled wakes.

Implications of these results and recommendations for further study are provided.

Minimization and mitigation approaches

Measuring the effectiveness of a double bubble curtain during impact pile driving for the Coastal Virginia Offshore Wind (CVOW) Project

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As part of the BOEM-sponsored Real-time Opportunity for Development Environmental Observations (RODEO) Program, underwater noise was measured during installation of two 6-megawatt wind turbine generators (WTGs) located 43 km east of Virginia Beach, Virginia. The WTGs were installed on 7.8-m diameter monopile foundations in May 2020. RODEO Program monitoring included placement of acoustic sensors both at short-range from the turbines (within 3 km) and at long-range (7.5 to 30 km). A noise mitigation system (double bubble curtain, DBBC) was employed during installation of one of the piles, and recorded sound levels were compared to measure the efficacy of the system in reducing underwater noise during piling. The use of the DBBC resulted in a reduction of peak pressure ranging from 4.2 to 23.1 dB. DBBC efficacy varied with sound frequency, depth and distance from piling, and sensor orientation (azimuth). Results from all sensor types indicated that the DBBC was most effective at attenuating sound frequencies above 200 Hz, and less effective at lower frequencies.

An agent-based model to assess the effectiveness of surface-based detection methods for vessel strike mitigation of large mammals

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The surge in marine traffic due to increasing commercial and recreational use of the world's ocean leads to growing concerns on vessel and marine mammals encounters. For endangered species, like the North Atlantic right whale, vessel strikes can be responsible for the majority of the recorded deaths. Reducing the number of vessel strikes is key to increase North Atlantic right whale protection and a number of mitigation methods have been proposed and implemented. We developed an agent-based model to assess the effectiveness of vessel-based surface whale detection methods, such as thermal imaging systems and marine mammal observers, for different vessel and animal characteristics.

Our study showed that under the right vessel's speed and maneuverability, vessel-based whale detection systems can be very effective and could lead to a significant decrease in vessel strikes when deployed at a large-scale. In particular, in speed restricted areas (10kn) any form of on-board detection system that can detect at least 1km in the distance will greatly (90+%) enhance animal protection. For faster ships, such as cruise-ships, a detection system that detects at least 3km in the distance leads to good results (~85%). Finally, fast vessels with low maneuverability, such as supertankers, cannot directly benefit from having such a system on-board but the information obtained and shared from other vessels equipped with such a system, could help estimate a near real-time distribution of whales in critical areas and improve the large-scale dynamic management efforts.

AI for whales: Towards real-time, automated detections in thermal imagery

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The global biodiversity and climate crises are coincident and deeply interwoven, and their responses and solutions must be, too. The development of offshore wind energy comes with heightened risk to marine mammals, with a need for pile driving and other activities that can produce dangerously loud noise in an underwater environment. Current methods for mitigating this risk are effective, but do not allow for work to continue after dark or in other conditions of lowered visibility. Here we provide a roadmap for leveraging the power of deep learning and thermal imaging to augment existing mitigation protocols and provide real-time detection of endangered and threatened whale species, and we discuss what a future of such monitoring might promise. In particular, we highlight how the state-of-the-art in deep learning and other AI approaches is already well-suited to the task of detecting whales in real-time thermal imagery, and how such a system, combined with passive acoustic monitoring at night, and visual observations during the day, can minimize the risk to species, providing a more robust landscape of detections, and counteracts some of the limitations of these common methods.

Offshore wind farms – modelling tools for nature inclusive design in a dynamic sand wave area

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This poster highlights current R&D on measurements and modeling tools for Nature Inclusive Design (NID) as part of this ECOFRIEND collaboration.

Due to demands of the Paris Agreement, there is rapid investment in renewable energy across the European Union. Energy generation from offshore wind is especially taking off in the shallow North Sea due to consistent winds and the limitation of new wind developments sites on land. Since monetary subsidies for offshore wind are no longer required to make wind farms economical, ecological optimization (limiting environmental impacts and goals to enhance biodiversity or ecological function) through NID is increasingly important. For example, the most recent tender for an offshore wind area in the Dutch North Sea (Hollandse Kust West) was the first where ecological factors were the main deciding factor for winning the tender.

Several reef-building species such as the European flat oyster (Ostrea edulis) and the Ross worm (Sabellaria spinulosa) are functionally extinct or in poor state of conservation – mainly due to the extensive level of bottom trawling for flat fish in the North Sea. Offshore wind farms are potentially suitable locations for such species as bottom-trawling gear is not allowed in wind farms, however, not all areas are equally suitable for reef-building species. For example, migration of sand waves on the bed, which can exceed 10 m height in some sections of the North Sea, can lead to habitat smothering, while high bed shear stresses over these bedforms can also increase the likelihood of dislodgement of shellfish species (e.g., oysters). Scour protection can be modified to create shelter for juvenile fish and invertebrates and to expand feeding habitat for species feeding on hard substrate. However, the complex dynamics of sand waves and other bedform features can also reduce effectiveness of scour protection mitigations.

Optimizing NID design for offshore wind energy farms increasingly requires the consideration of these various biotic and abiotic interactions which can evolve at time scales of seconds (e.g., sediment transport) to decades (e.g., re-establishment of species populations). Knowledge is required, on the hydrodynamic and sediment dynamics in these sites, to assess which NID options are sensible for specific siting locations. In the public-private partnership ECOFRIEND we develop a number of numerical and physical modelling tools that can be used to design site specific solutions and assist in optimal design and timing of measures. Advancement and validation of these tools is essential for both regulators (setting tender criteria) and developers to tailor NID requirements and solutions to local conditions, to ensure optimal ecological benefits without wasting efforts on measures that nature renders ineffective in a few years' time.

Best practices for mitigation of offshore wind energy impacts on pacific seabirds

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Offshore wind power will be crucial to reach sustainable energy goals and is rapidly expanding, with new developments planned for the US West Coast's Pacific Outer Continental Shelf. Seabirds are at risk of population impact from offshore wind energy infrastructure via displacement and collision and are already the most endangered marine animals. In 2021, a group of international experts convened via a National Center for Ecological Analysis and Synthesis working group to develop global best practices framework for identification, quantification, and mitigation of offshore wind impacts on seabirds, with a focus on application for the California Current Ecosystem. In this talk we summarize the framework, including:

1. Consideration of seabird impacts due to wind turbine displacement, habitat alteration, and collision;
2. Approaches to model population level consequences of wind energy impacts; and,
3. Best practices to minimize and mitigate offshore wind development impacts on seabirds.

As development of wind energy on the Pacific Coast of the US continues to be evaluated, we stress the need to evaluate the cumulative impact of full infrastructure buildout throughout a region and consider conservation banking to better address the impacts of buildout on broad-ranging waterbird species. Finally, we emphasize the importance of compensatory mitigation as a means to counter mortality associated with wind energy infrastructure that cannot be minimized via alterations to turbine placement or design.

Facilitating digital communication between offshore wind farms and marine stakeholders mitigates impact on fisheries and the environment

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U.S. government researchers estimate that offshore wind projects could disrupt and/or displace some commercial fisheries by as much as a quarter. Commercial fishing fleets have opposed offshore wind projects, labeling them a significant threat to catches of crucial stocks by interfering with navigation and altering ecosystems. That opposition contributes to delays in permitting and is among the reasons the U.S. has lagged Europe in offshore wind development. The National Environmental Policy Act requires projects on federal property to avoid, minimize or compensate for their impacts.

Our customer discovery research has indicated that the parties suffer from lack of communication, lack of planning, unclear on who is accountable, and finally a relationship poor on trust. We found that 1) There is no streamlined way to share information between fisheries and offshore wind developers 2) Fisheries need to know activities of offshore wind vessels beforehand to take optimal waterfront decisions 3) Fisheries will not share information willingly, they will only react to information provided to them. Currently, communication between offshore wind projects and fisheries are conducted via email notifications (which usually go unread). Data exchange is very limited, and is not harvested or used to avoid, minimize, or even assess the level of compensation for any impact on the fisheries.

We have built a proprietary digital solution, WATERFRONT, that seeks to alleviate this issue by providing a platform through which developers and the fishing industry can communicate dynamically with one another. Waterfront, disseminates information from the offshore wind project to the fishing community and vice versa, in an efficient, timely, and secure manner

We have conducted an extensive Beta Testing campaign with an offshore wind developer based off of New Bedford, MA from September 2021 – June 2022. We have found that by enabling direct streamlined digital interactions, communication, and data exchange between offshore wind projects and their marine stakeholders we can mitigate marine spatial conflicts, avoid fishing gear loss and damage, empower fisheries to engage and address project marine activities/plans, facilitate site specific data exchange, and create an effective streamlined claims workflow for fisheries. Further, we will present how a multifunctional mobile app that can quickly log and display spatial, temporal, thematic, and other relevant ecological data with ease will help to increase the amount and frequency of scientific data available to better document, characterize, and mitigate offshore wind development impact on fish, marine mammals, and habitats.

Collaborative processes to improve development and conservation outcomes

Effective stakeholder engagement in offshore wind energy development: New York State's Environmental and Fisheries Technical Working Groups

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The offshore wind energy industry is rapidly developing in the United States. New federal mandates require at least 30 GW of offshore wind by 2030. With the largest goal in the US, New York seeks to advance offshore wind in a way that is both environmentally and socially responsible, as well as being cost-effective. To achieve this, New York developed technical working groups (TWGs) on critical topics including fisheries (F-TWG) and the environment (E-TWG). The TWGs are composed of offshore wind developers, fishing industry (F-TWG) and environmental non-governmental organizations (E-TWG), and regional state and federal representatives, to advise the State on offshore wind issues by emphasizing the use of science and technical expertise to inform decision making. The objectives of the TWGs include improving understanding of, and the ability to manage for, potential impacts to the environment and fisheries; developing transparent, collaborative processes for identifying priority research needs and mitigation methods; and reducing permitting risk and uncertainty for developers by improving clarity and transparency in expectations and processes. Examples of successful TWG collaborations have included the NY Bight Transit Lane Workshop sponsored with RODA and which was later used by the Bureau of Ocean Energy Management (BOEM) in their decision making for their 2022 Final Sales Notice for the NY Bight and the development of recommendations for best management practices for wildlife by E-TWG specialist committees, which were incorporated into New York's required Environmental Management Plans. The effectiveness of these collaborations is due to the regional, rather than state-specific, scale of interest, which creates the ability to develop guidance at an appropriate geographic scale and promote regional collaboration and communication. This is essential to minimize impacts to these key stakeholder groups while also building trust as the offshore wind industry progresses.

Wildlife and Offshore Wind (WOW): A systems approach to research and risk assessment for offshore wind development from Maine to North Carolina

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WOW is a multi-institution consortium that brings together PIs in the areas of statistical and ecological modeling, geospatial data analysis and modeling, marine megafauna research, bioacoustics, behavioral ecology, and biological oceanography. Our goal is to provide a long-term, adaptive roadmap for efficient and effective assessment of potential effects of offshore wind on marine mammals, from siting through operation. We will create and refine a suite of frameworks for risk assessment; we will use these to identify data gaps, prioritize research, and design integrated research programs. The frameworks will allow for integration of new technologies and innovation into assessments of effects and for active evaluation at multiple temporal and spatial scales, including cumulative impacts. Intended outcomes are to increase efficiency of risk and impact assessments, enhance communication and collaboration across broad stakeholder groups, facilitate innovation, and directly inform the responsible and timely development of offshore wind energy. Project deliverables include: i) creation of tools to evaluate baselines, ii) recommendations of consistent methodologies, iii) harmonization of data and metrics necessary for monitoring, iv) robust design agenda for targeted research, v) species distribution models and behavioral assessments for marine mammals, and vi) the development and maintenance of an open source blueprint for risk assessment frameworks that can be applied to future decision making.

Tethys: Facilitating knowledge sharing for offshore wind-wildlife research around the world

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Tethys is a free, online database that facilitates the knowledge sharing needed to advance offshore wind energy development in an environmentally responsible manner. After twelve years of operation, Tethys is an internationally recognized and trusted broker of information and resources. The primary feature of Tethys is the Knowledge Base, which contains over 5,300 documents on the environmental effects of wind energy. These documents can be easily filtered, searched, and sorted to find content relevant to specific topics, such as underwater noise effects on marine life. Additional resources include an online newsletter, an events calendar, archived webinars, educational summaries, and lists of researchers and organizations involved in wind-wildlife research. Tethys also serves as a collaborative space and dissemination platform for several ongoing U.S. and international research efforts. The U.S. Offshore Wind Synthesis of Environmental Effects Research (SEER) effort synthesizes key wind-wildlife issues and disseminates all its project deliverables, including educational research briefs and webinar recordings, through Tethys. Similarly, Working Together to Resolve Environmental Effects of Wind Energy (WREN), a task established by the International Energy Agency, uses Tethys to facilitate international collaboration, coordinate member activities, and advance global understanding of the environmental effects of wind energy. To further support the wind energy community around the world, WREN and the Tethys team are now working to develop a new tool that will provide information on the technologies available for offshore wind environmental monitoring and mitigation. Once made publicly available on Tethys, the tool will be continuously maintained and updated to ensure the international community has access to current information on monitoring and mitigation solutions, their state of development, and related research on their effectiveness. This poster will provide an overview of the resources available on Tethys, highlight products developed through the SEER and WREN efforts, and discuss progress on the development of the new wind energy monitoring and mitigation tool.

Wildlife data standardization and sharing: Guidance for environmental data transparency for offshore wind energy

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The New York State Energy Research and Development Authority (NYSERDA) funded a study to facilitate transparency and sharing of non-proprietary environmental data for offshore wind energy development. This study reviewed databases that (1) focus on wildlife (including fishes, birds, bats, marine mammals, sea turtles, marine invertebrates, and benthic communities), (2) host types of data expected to be collected by offshore wind energy developers, (3) have geographic relevance to the eastern U.S., and (4) accept raw data produced by other parties, and share these data publicly. A second set of more detailed criteria were used to identify a subset of databases most appropriate for meeting the State's data transparency goals. These criteria included factors such as availability of a public interface, QA/QC processes, and inclusion of effort and metadata (where appropriate).

15 databases were recommended as primary or secondary repositories for different types of raw data generated by offshore wind energy developers and their contractors. While most taxa and data type combinations discussed in this report have clear database options, there are some gaps. For example, benthos, zooplankton, and fish data are poorly served by extant databases, either because relevant databases do not exist, they do not accept private data, or do not permit public access to those data. Data originators are encouraged to make such data available to the public directly (for example, on a project website) and to consider potential support for the development of appropriate public databases. Regardless of the database(s) chosen to host data, it is recommended offshore wind energy data contributors:

- Follow relevant federal and regional guidelines and recommendations for the submission of wildlife data
- Develop data sharing plans and communicate them to all relevant parties prior to data collection
- Consider effort data (where relevant) as essential information
- Co-collect and report appropriate abiotic environmental data for interpretation of wildlife information.
- Devote resources to developing comprehensive, standardized metadata for all data types
- Disseminate raw data to the most appropriate database(s) as soon as feasible following internal quality assurance processes (within two years is strongly recommended)
- Submit project metadata to the environmental metadata base in the Tethys Knowledge Base
- Share derived data products (e.g., model outputs, summary maps) as well as raw data

As the offshore wind energy industry continues to develop in the U.S., and increasing resources are channeled into environmental monitoring, well-considered data collection, coordination, and dissemination are becoming increasingly important. Focused efforts on the above fronts will make these data accessible, create future efficiencies, and ensure decision-makers have the best information available to manage this growing industry.

Turbine reefs: Nature-based design of scour protection as a potential net-positive enhancement tool

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As ambitious plans for offshore wind development on the east coast of the US continue to grow, and the first commercial-scale projects in the US begin construction, some European nations and global development companies are now aiming for "net-positive biodiversity impacts" from new projects commissioned after 2030. While many questions remain about what this means and how it could be applicable in the context of offshore wind development in the US, it is probable that expanded fish and invertebrate abundance and species richness around the base of underwater foundations and associated scour protection could be a place where those goals are achieved. The recent report by The Nature Conservancy and INSPIRE Environmental explores the potential effects of incorporating ecological principles and preferred habitat characteristics of target marine species into the design of scour protection and cable mattresses used in offshore wind build-out on the east coast of the US. While the efficacy of approaches for intentionally attempting to increase habitat value provided by scour protection layers requires further exploration, concepts and materials used in similar "nature-based design" approaches for dual-purpose coastal and estuarine construction projects (living shorelines, oyster reefs etc.) provide a solid foundation for exploring this avenue at offshore wind structures. If considered early in the design process, we believe it may be possible to incorporate nature-based designs with little appreciable project costs. The potential for scour protection and other underwater structure associated with offshore wind development to enhance production of valuable species and support diverse communities is an area that is ripe for further exploration in the US, with potential outcomes of shifting public perception of projects, enhancing certain fisheries and marine communities, and ultimately influencing guidance on decommissioning. Our report titled Turbine Reefs: Nature-Based Designs for Augmenting Offshore Wind Structures in the US also includes tables of species groups that could potentially benefit throughout the geographic range of wind development on the east coast, and a catalog of US vendors that could provide scour protection construction materials.