Program and Book of Abstracts

State of the Science Workshop on Offshore Wind Energy, Wildlife, and Fisheries 2024

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

July 16-19, 2024

https://www.nyetwg.com/2024-workshop

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NEW YORK STATE | NYSERDA

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1:15-2:00 pm	**Sessions 1 Symposium** Auditorium
	Session 2 Symposium Ballroom B
2:00-2:15 pm	**Break**
2:15-3:00 pm	**Session 3 Symposium** Auditorium
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3:00-3:30 pm	**Break** Ballroom A
	Student Meet-up Outdoor Tent
3:30-5:00 pm	**Session 5 Symposium** Auditorium
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Wednesday, July 17

7:30-9:00 am	**Breakfast** Ballroom A
9:00-9:15 am	**Welcome** Auditorium
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5:00-6:45 pm	**Poster Session** Fishbowl Room, Outside Tent

Thursday, July 18

7:30-8:45 am	**Breakfast** Ballroom A
8:45-9:15 am	**Session 17 Plenary Speaker** Auditorium
9:15- 10:45 am	**Session 18 Oral Presentations** Auditorium
	Session 19 Symposium Ballroom B (ends at 10:30)
10:30-11:00 am	**Break** Ballroom A
11:00 am-12:30 pm	**Session 20 Oral Presentations** Auditorium
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12:30-1:30 pm	**Lunch** Ballroom A
1:30-5:30 pm	**Side Meetings and Workshops** Rooms 302-306, Ballroom B
3:15-3:45 pm	**Break** Ballroom A
5:30-8:00 pm	**RWSC/MTS Tech Cafe** Stony Brook Union

Friday, July 19

7:30-9:00 am	**Breakfast** Ballroom A
9:00-10:15 am	**Session 22 Oral Presentations** Auditorium (ends at 10:00)
	Session 23 Symposium Ballroom B
10:15-10:45 am	**Break** Ballroom A
10:45 am-12:30 pm	**Session 24 Oral Presentations** Auditorium
	Session 25 Symposium Ballroom B
	Session 26 Facilitated Discussion Ballroom B
12:30-12:45 pm	**Concluding Remarks** Auditorium

About the Workshop

Thank you for participating in the 2024 State of the Science Workshop on Offshore Wind Energy, Wildlife, and Fisheries! Workshop goals include:

- Engaging and informing interested stakeholders about the state of knowledge regarding wildlife, fisheries, 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
- Promoting collaboration through expert information exchange and discussion

The theme of the 2024 Workshop is "Taking an Ecosystem Approach: Integrating Offshore Wind, Wildlife, and Fisheries", including:

- The interface of science and policy: how science is applied to inform siting, design, permitting, monitoring, and mitigation of offshore wind farms
- Methods for monitoring and mitigation: technology development and integration
- Conservation opportunities relating to offshore wind: net positive impacts, conservation offsets, compensatory mitigation, and other mechanisms for offshore wind to have a positive impact on wildlife and fisheries
- Ecosystem interactions: ecosystem approaches to understanding offshore wind effects, including a focus on both physical and biological interactions and how offshore wind energy (and other stressors such as climate change) may change ecosystems across trophic levels
- Correlation vs. causation: determining causes of ecosystem change
- Updates on the latest approaches and findings from the U.S. and elsewhere around the world

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) and now the Fisheries Technical Working Group (F-TWG). 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; Grace Chang, Integral Consulting; Doug Christel, National Marine Fisheries Service; Julia Dombrowski, National, Offshore Wind Research & Development Committee, Liz Gowell, Orsted; Ursula Howson, Bureau of Ocean Energy Management; Juliet Lamb, The Nature Conservancy; Carl LoBue, The Nature Conservancy; Pamela Loring, US Fish and Wildlife Service; Laura Morse, Invenergy; Mike Pol, Responsible Offshore Science Alliance; Emily Rochon, Vineyard Offshore; Howard Rosenbaum, Wildlife Conservation Society.

Organizing Committee

Kate McClellan Press, NYSERDA (Committee Chair); Morgan Brunbauer, NYSERDA; Brian Dresser, TetraTech; Eleanor Eckel, BRI; Kelli Gormley, NYSERDA; Julia Gulka, BRI; Kelly Hammond, NYSERDA; Bethany Meys, NYSERDA; Kate Williams, BRI

About the E-TWG

The Environmental Technical Working Group (www.nyetwg.com) is an independent advisory body to the State of New York with a regional focus on offshore wind and wildlife issues in the eastern U.S. This team of stakeholders includes advisory member organizations, comprised of offshore wind developers and science-based non-governmental organizations, as well as observer organizations from state and federal agencies located from Maine to North Carolina. The group provides advice on how to advance offshore wind development in an environmentally responsible way and promotes regional coordination and collaboration. Since 2018, State of the Science events have been a key approach to support these goals.

About the F-TWG

The Fisheries Technical Working Group (https://nyftwg.com) is a group of commercial fisheries representatives and offshore wind energy developers who provide guidance and advice on how to responsibly implement New York State's efforts to advance offshore wind energy development. State and federal fisheries managers also are engaged in this group to provide technical experience and assist with coordination. Recognizing the complexity of the fishing industry in the New York Bight, F-TWG members come from a regional geography, with fishing community representatives from New England and the Mid-Atlantic.

Detailed Agenda

Tuesday, July 16

Time	Session
8:00-10:30 am	**Registration – Lobby**
10:30 am - 12:15 pm	**Welcome and Keynote Address –** Auditorium Welcome and Introductory Presentations (moderated by Kate McClellan Press) • Harry B. Wallace, Chief of the Unkechaug Indian Nation • Sandi Brewster-Walker, Executive Director & Government Affairs Officer of the Montaukett Indian Nation • Kate McClellan Press, State of the Science Organizing and Scientific Committees, NYSERDA • Gregory Lampman, Offshore Wind Director, NYSERDA • Doreen Harris, President and CEO, NYSERDA Keynote Presentation (moderated by Kate Williams) • *Climate Change and the Continental Shelf and Slope: Forcing, Ocean Processes, and Impacts* – Glen Gawarkiewicz, Woods Hole Oceanographic Institution
12:15-1:15 pm	**Lunch – Ballroom A**
1:15-2:00 pm	**Session 1 Symposium: Regional Wildlife Science Collaborative Science Plan Implementation in 2024 and Beyond** – Auditorium Organizers: Emily Shumchenia (moderator), Christian Laspada • *Introduction* – Emily Shumchenia • *Regional long term archival passive acoustic monitoring coordination and standardization* – Debbie Brill • *Urgent data collection needs for sea turtles* – Sue Barco • *Acoustic telemetry coordination among RWSC, ROSA, and ACT* – Jordan Katz • *Regional bird and bat monitoring coordination* – Samantha Coccia-Schillo • *Synthesizing oceanographic and seafloor habitat data to create a regional picture* – Nikelene Mclean

Time	Session
1:15-2:00 pm	**Session 2 Symposium: Offshore Wind Fisheries Monitoring Plan Development, Implementation, and Evolution Discussion Session** – Ballroom B (overflow in Rms. 302 & 306) Organizers: Reneé Reilly and Mike Pol (moderators) The Responsible Offshore Science Alliance (ROSA) has held a series of coordination sessions to discuss the development, implementation, and evolution of offshore wind fisheries monitoring plans to characterize challenges and solutions, and to understand what role ROSA could play to best serve the community as it develops regional monitoring strategies. This symposium will offer the opportunity for a discussion of the outcomes across sectors, including offshore wind developers, regulators, researchers, and fishing industry representatives.
2:00-2:15 pm	**Break**
2:15-3:00 pm	**Session 3 Symposium: Project WOW: Update on Project Results and Plans** – Auditorium Organizers: Douglas Nowacek (moderator), Kate Williams, Howard Rosenbaum, Xiaoqin Zang, Susan Parks • *Overview presentation – Douglas Nowacek* • *Q&A and panel discussion – all organizers*
2:15-3:00 pm	**Session 4 Plenary Presentation: Engaging the Fishing Community to Improve Marine Science –** Ballroom B (overflow in Rms. 302 & 306) Moderated by Ursula Howson *Engaging the Fishing Community to Improve Marine Science* - David Bethoney, Commercial Fisheries Research Foundation
3:00-3:30 pm	**Break – Ballroom A** **Student Meet-up – Outdoor Tent**

Time	Session
3:30-5:00 pm	**Session 5 Symposium: Lessons Learned from Collaborative Effects to Develop Fisheries and Benthic Monitoring Plans for Offshore Wind Farms** – Auditorium Organizers: Brian Gervelis and Jennifer Dupont (moderator) Addressing the challenges and realities of developing and executing Fisheries and Benthic Monitoring Plans that are aligned with the 2019 BOEM recommendations for renewable energy development. • *How survey designs influence study outcomes* – Dara Wilber • *Requirements and challenges when surveying benthic habitats and introduced hard structures* – Annie Murphy • *Challenges and recommendations for fisheries monitoring for offshore wind farms* – Sarah Borsetti • *Rhode Island state perspectives on fisheries and benthic monitoring* – Julia Livermore • *Challenges and solutions in executing monitoring plans* – Dave Bethoney • Panel Discussion
3:30-5:00 pm	**Session 6: Birds and Bats - Key Research Needs and Ongoing Activities** – Ballroom B (overflow in Rms. 302 & 306) Moderated by Kate Williams • *Synthetic analysis of post-construction displacement of marine birds from wind energy areas* – Juliet Lamb • *Interannual variation in bird species, abundance, and activity at offshore wind farms* – Greg Forcey • *GPS tracking of Maine's seabirds indicates varied exposure to forthcoming offshore wind development* – Dan Lyons • *Application of spatial models of marine bird distributions to inform offshore wind energy development* – Arliss Winship • *Regional assessment of offshore wind impacts on Aerofauna in Canada* – Paul Knaga
5:00-8:00 pm	**Poster Session and Dinner Reception with Heavy Hors d'oeuvres** – Fishbowl Room, Outdoor Tent

Wednesday, July 17

Time	Session
7:30-9:00 am	**Breakfast – Ballroom A**
9:00-9:15 am	**Welcome – Auditorium**
9:15-10:45 am	**Session 7: Hydrodynamics and Ecosystem Linkages** – Auditorium Moderated by Grace Chang • *From wind to whales: potential hydrodynamic impacts of offshore wind on Nantucket Shoals region ecosystems* – Kaustubha Raghukumar • *Ecosystem effects of large-scale implementation of offshore wind in the North Sea* – Luca van Duren • *Integrating offshore wind, wildlife, and fish: the "Predators and Prey Around Renewable Energy Developments (PrePARED) Projects* – Cormac Booth • *Streamlining integration and distribution of metocean data from offshore wind operations for marine stakeholders* – Tom Shyka • *Assessing the role of ocean currents on prey concentration from hourly to seasonal scales* – Jacquelyn Veatch
9:15-10:45 am	**Session 8 Symposium: The Continued Role of Acoustics in Marine Life Monitoring and Mitigation for the Offshore Wind Industry –** Ballroom B (overflow in Rms. 302 & 306) Organizers: Sharon Whitesell and Ariana Spawn (moderators). Examination of acoustic monitoring techniques and applications currently being used, with a discussion on successes and challenges to using these methods. • *ECO-Gliders: An autonomous oceanographic and ecological mission to inform offshore wind development* – Josh Kohut • *Active acoustic technologies for monitoring fish and zooplankton abundance, distribution, and behavior. What can fancy fish finders really do?* – Joe Warren • *Observations of the use of arrays for passive acoustic monitoring of vocalizing baleen whales* – Vince Premus • *Insight into the acoustic behavior of large whales: one acoustic tag at a time* – Susan Parks • Panel Discussion

Time	Session
10:45-11:00 am	**Break – Ballroom A**
11:00 am - 12:30 pm	**Session 9: Ecosystem Linkages and Forecasting –** Auditorium Moderated by Laura Morse • *Investigating prey fields near foraging right whales in and adjacent to the southern New England wind areas* – Christopher Orphanides • *Multi-decadal changes in seabird and forage fish distributions in the Northwest Atlantic* – Evan Adams • *Modeling distribution shifts of small odontocetes in the Northeast United States* – Nathan Hirtle • *Subseasonal forecasts as a powerful tool for dynamic mammal monitoring and management* – Julia Stepanuk • *Near real-time North Atlantic right whale density model* – Jason Roberts
11:00 am - 12:30 pm	**Session 10 Symposium: The Use of Acoustic Telemetry for Monitoring the Effects of Offshore Wind Development Along the U.S. East Coast –** Ballroom B (overflow in Rms. 302 & 306) Organizers: Chris Sarro and Greg DeCelles (moderators) This symposium will highlight how acoustic telemetry is being used to monitor changes in behavior, distribution and movement of marine fish and invertebrate species in response to offshore development. • *Session introduction with general overview of acoustic telemetry* – Chris Sarro/Greg DeCelles • *Evaluating space use of elasmobranchs before offshore wind farm infrastructure installation* – Bradley Peterson • *Utilization of acoustic telemetry as a regional non-extractive approach for monitoring protected, prohibited, and commercially/recreationally important fishes within Offshore Wind Lease Areas within the Mid-Atlantic Bight* – Keith Dunton • *Evaluating the performance of a fine-scale acoustic positioning system to monitor fish behavior along the Ørsted South Fork Wind Farm subsea cable route* – Michael Frisk • *Tracking the Fine-Scale Movements of Horseshoe Crab (Limulus polyphemus) and American Lobster (Homarus americanus) at a Wind Farm Export Cable Site with Acoustic Telemetry* – Matthew Sclafani • *Using acoustic telemetry to assess interactions between offshore wind development and cod spawning on Cox Ledge* – Ali Frey • *Go with the flow: Creating and maintaining a developer-funded acoustic telemetry monitoring framework in southern New England* – Connor Capizzano

Time	Session
12:30-1:30	**Lunch – Ballroom A**
1:30 pm - 2:30 pm	**Session 11 Symposium: New York, New York: The Interface Between Science & Offshore Wind Policy in a Dynamic Ecosystem –** Auditorium Organizers: Howard Rosenbaum (moderator) and Jennifer Dupont. This symposium provides targeted project results for small and large cetaceans and includes a discussion on how collaboration between researched and developers has improved the use of our science. • *Setting the stage: An overview of our research and the interface of science with policy/best practices* – Howard Rosenbaum • *A deeper dive*: *Seasonal occurrence of four large whale species from 2016-2024 in the Empire Wind area; moving beyond detection of single cell types for large whales to increase detection probability* – Melinda Rekdahl, Carissa King-Nolan • *Evaluating the efficacy of real-time passive acoustic monitoring near offshore wind energy development activities to help mitigate risks to North Atlantic right whales* – Mark Baumgartner • *Tying it all together: What do these findings mean for policy and best practice around development activities?* – Jennifer Dupont • Panel Discussion
1:30-2:30 pm	**Session 12 Symposium: Bats and Offshore Wind: Addressing Three Critical Needs for Effective Management –** Ballroom B (overflow in Rms. 302 & 306) Organizers: Nate Fuller (moderator), Jeff Clerc, and Laura Dempsey This session will focus on three broad categories of critical research needs: natural history, anthropogenic effects, and minimization, with the goal to address the current state of the science for each category. Talks from: • Nate Fuller • Laura Dempsey • Michael Whitby Q&A and panel discussion will also include Cris Hein.
2:30-2:45 pm	**Break – Ballroom A**

Time	Session
2:45-3:45 pm	**Session 13: Lightning Talks –** Auditorium Moderated by Brian Dresser • *Ecological innovations in Dutch offshore wind farm projects: a case study of Shell's contributions* – Candice Cook-Ohryn • *Engineering offshore wind farms to promote nature development* – Remment ter Hofstede • *Evaluating potential commercial fishing impacts in Attentive Energy One's lease area* – Matthew Bingham • *Pre-construction monitoring of hydrography, copepods, other zooplankton, fish, and other nekton at the Sunrise Wind lease area* – Joe Warren • *Sampling offshore bat activity with an unscrewed surface vehicle* – Michael Whitby • *Modeling uncertainty in Great black-backed gull movement in order to accurately quantify risk to offshore wind* – Esther Nosazeogie
2:45-3:45 pm	**Session 14 Symposium: Perspectives on Collison Risk Models –** Ballroom B (overflow in Rms. 302 & 306) Organizers: Evan Adams (moderator), Aonghais Cook, Andrew Gilbert, Holly Goyert, Pamela Loring, Kate Williams This symposium will compare approaches for using Collision Risk Models (CRMs) in several jurisdictions (United States, United Kingdom, and Australia). • *Review of types of collision risk models currently in use around the world* – Aonghais Cook • *The regulatory context of collision model usage in the United Kingdom* – Julie Miller • *The United States regulatory use of collision risk models* – Stephanie Vail-Muse • *Using movement data to inform collision risk models for endangered species in the U.S. Atlantic* –Andrew Gilbert • *New types of collision risk models implemented in Australia* – Elizabeth Stark • Panel Discussion
3:45-4pm	**Break – Ballroom A**

Time	Session
4:00-5:15 pm	**Session 15: Lighting Talks –** Auditorium Moderated by Howard Rosenbaum • *Evaluating the environmental performance of a newly designed ecological scour protection unit* – Yaeli Rosenberg (full-length presentation) • *A framework for monitoring ecosystem effects and impacts to ocean users of floating offshore wind infrastructure* – Casey Yanos • *Application of hydrodynamic and agent-based modeling techniques in the New York Bight* – Sarah Courbis • *Enhancing precision in environmental impact assessments: a comparative analysis of LiDAR with alternative methods for assessing collision risk for offshore wind* – Cameron Bullen • *Collating acoustic and visual data for assessing humpback whale presence in the New York Bight: a case study* – Sarah Trabue • *Drone-based photogrammetry reveals differences in humpback whale body condition across North Atlantic foraging grounds* – Chelsi Napoli • *Evaluating drivers of recent large whale strandings on the US east coast* – Lesley Thorne
4:00-5:00 pm	**Session 16 Symposium: Implementing a Bird and Bat Tracking Research Framework with the Regional Wildlife Science Collaborative for Offshore Wind –** Ballroom B (overflow in Rms. 302 & 306) Organizer: Pam Loring (moderator) and Nate Fuller This symposium will provide a forum for information sharing and facilitated discussions of current progress and objectives. Talks from: • Pamela Loring • Nate Fuller • Autumn-Lynn Harrison • Patrick Roberts
5:00-6:45 pm	**Poster Session –** Fishbowl Room, Outdoor Tent

Thursday, July 18

Time	Session
7:30-8:45 am	**Breakfast – Ballroom A**
8:45-9:15 am	**Session 17 Plenary Speaker –** Auditorium Moderated by TBD *Best practices regarding Indigenous engagement within the offshore wind industry* - Lucas Shumaker and Kelsey Leonard
9:15-10:45 am	**Session 18: Wildlife Survey Design and Analysis –** Auditorium Moderated by Juliet Lamb • *A comparison of visual and image aerial surveys for marine mammals and sea turtles in the New York Offshore Planning Area* – Debra Palka • *A novel approach to account for availability bias when estimating porpoise abundance from digital video aerial surveys* – Kelly Macleod • *Application of a Bayesian hierarchical density surface model to estimate seasonal abundance of large whales in wind energy areas off the east coast* – Doug Sigourney • *Guidance for detecting changes in marine bird distributions and habitat use related to offshore wind development in the United States* – Kate Williams • *Assessing study design options for post-construction avian displacement in the New York Bight* – Julia Stepanuk

Time	Session
9:15-10:30 am	**Session 19 Symposium: Building Sustainable Offshore Wind Futures Through Collaborative Research Programs –** Ballroom B (overflow in Rms. 302 & 306) Organizer: Olivia Burke (moderated by Ivan Savitsky). A panel of experts will explore the concept of collaborative programs in practice (case study presentations) and discuss how these programs are coordinating and collectively driving meaningful interactions between offshore developers and other co-uses of marine space. • *Introduction* – Ivan Savitsky • *Cross-border collaboration* – Ivan Savitsky • *Supporting the organized delivery of funding* – Emily Shumchenia • A *model to bring diverse ocean users and stakeholders, including communities, private and public sector together* – Katy Bland • *Expert support to build a strong and future-proof industry* – Julia Dombrowski • *Efficiently addressing community concerns* – Mike Pol
10:30-11:00 am	**Break – Ballroom A**
11:00-12:30	**Session 20: Changes to Fisheries and Ecosystems –** Auditorium Moderated by Brendan Runde • *Characterizing the offshore wind farm impacts on NOAA fisheries survey data quality for key Mid-Atlantic fisheries* – Ming Sun • *60 years of the Northeast Fisheries Science Center bottom trawl survey: maintaining a long-running series in the face of growing uncertainty* – Catherine Foley • *Evaluating potential recreational fishing impacts in Attentive Energy One's lease area* – Jason Kinnell • *Modeling interactions among commercial shellfish fishing in wind energy by using a stakeholder-informed agent-based approach* – Daphne Munroe • *Regional compensation for fisheries: a new approach to mitigation* – Kris Ohleth

Time	Session
11:00-12:30	**Session 21 Symposium: Progression Towards an Integrated Ecosystem-based Approach to Assessing Environmental Impacts of Offshore Energy Development –** Ballroom B (overflow in Rms. 302 & 306) Organizers: Jacob Levenson, Jennifer Bosyk, and Stephanie Webb (moderated by Kristen Strellec). A panel of experts from various institutions to share developments in the available modeling tools used in forecasting available environmental impacts. Talks from: • Jacob Levenson • Andrew Lipsky • Howard Townsend • Ethan Deyle • Beth Fulton
12:30-1:30 pm	**Lunch- Ballroom A**
1:30-5:30 pm	**Side Meetings/Workshops** – Rooms 302-306, Ballroom B ***Advance registration required.*** *Descriptions and registration links at* *www.nyetwg.com/workshop-side-meetings* • Untangling the Marine Food Web: Bridging Knowledge Gaps to Better Understand Forage Taxa in the Mid-Atlantic Bight – Rm 302, 1:30-3:30 pm • Floating Offshore Wind Technology, Fisheries Interactions, Limitations, and Opportunities for a Path Forward – Rm 303, 1:30-4:30 pm • Collison Risk Modelling Working Group – Rm 306, 1:30-5:30 pm • Offshore Wind and Wildlife Technology - Mini TechSurge – Ballroom B, 1:30-5:30 pm • Project WOW External Advisory Board Meeting (closed meeting) • Surfclam Stock Enhancement: Who, What, When, and Where Next? (closed meeting)
3:15-3:45 pm	**Break – Ballroom A**
5:30- 8:00 pm	**RWSC/MTS Tech Café** – Stony Brook Union

Friday, July 19

<table>
<tr><th>Time</th><th>Session</th></tr>
<tr><td>7:30-9:00 am</td><td>Breakfast – Ballroom A</td></tr>
<tr><td>9:00-10:00 am</td><td>Session 22: Mitigation Approaches for Wildlife and Fisheries – Auditorium

Moderated by Carl LoBue
Acoustic and environmental monitoring during turbine installation at South Fork Wind Farm – Arthur Newhall
Scale model testing of biodiversity enhancing scour protections for offshore wind foundations and cables – Stendert Laan
Designing offshore wind pile driving to minimize Level A take estimates – Cormac Booth</td></tr>
<tr><td>9:00-10:15 am</td><td>Session 23 Symposium: State of the Policy: Building an Enabling Environment to Support the Delivery of Biodiversity Positive Outcomes Requires the Interface of Science and Policy – Ballroom B (overflow in Rms. 302 & 306)

Organizer: Tricia Jedele (moderator)
A forum to synthesize net positive impact (NPI) related from other State of the Science symposia, to support the interface of science and policy by discussing how the policies that are unfolding support NPI objectives and discuss how spatial tools might be used to verify the identification of priority species and habitats. Brief presentations and panel discussion with:
Tricia Jedele
Shayna Steingard
Kate McClellan Press
Anthony Dvarskas
Joel Southall
Marta Ribera
Emily Shumchenia</td></tr>
<tr><td>10:15-10:45 am</td><td>Break – Ballroom A</td></tr>
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Time	Session
10:45-12:30	**Session 24: New Technologies –** Auditorium Moderated by Colleen Brust • *Using autonomous gliders to understand patterns and drivers of habitat use for baleen whales in the New York Bight* – Katherine Gallagher • *Integration of non-extractive environmental DNA in monitoring potential impacts of offshore wind development* – Jason Adolf • *Machine learning and high performance computing for the detection and classification of marine wildlife in digital aerial imagery* – Kyle Landolt • *Technology gaps for monitoring birds and marine mammals at offshore wind facilities* – Sarah Courbis • *Marine Observer: Empire Wind case study of long wave infrared camera vessel deployment to detect large whales* – Audrey Bard • *Exploring eDNA as a non-extractive technique for long-term monitoring of marine communities in offshore wind developments* – Carmen Bernett
10:45-12:00	**Session 25 Symposium: State of the Science: The Applications of Compensatory Mitigation and Voluntary Conservation Measures to Achieve No Net Loss or Net Gain to Birds Impacted by Offshore Wind Energy Projects –** Ballroom B (overflow in Rms. 302 & 306) Organizers*:* Holly Goyert (moderator), Kate Williams, Wing Goodale, Evan Adams, Kim Peters, Scott Johnston, and Caleb Spiegel. This symposium aims to identify existing research efforts that integrate impact assessment with compensatory mitigation and/or voluntary offsets. • *Introduction* – Holly Goyert • *USFWS approaches to compensatory mitigation, and considerations on net gain strategies* –Scott Johnston • *Conceptual overview of the methods available to quantify compensation* – Aspen Ellis • *Applications of identifying offsite offsets and acceptable levels of impact from collision with onshore wind energy in emerging markets* – Aonghais Cook (presenting for Dave Wilson) • *Habitat and resource equivalency analyses as potential approaches for net-positive biodiversity estimation* – Anthony Dvarskas • *Research to underpin policies designed to offset impacts from offshore wind and achieve net gain in the UK* – Kate Searle

Time	Session
12:00-12:30 pm	**Session 26 Discussion: Compensatory Mitigation & Biodiversity Positive Approaches in the Marine Environment** – Ballroom B (overflow in Rms. 302 & 306) Moderated by Holly Goyert and Tricia Jedele Facilitated panel discussion on the state of the science and policy on compensatory mitigation and biodiversity positive approaches in the marine environment (continuation of Sessions 23 and 25)
12:30-12:45 pm	**Concluding Remarks** – Auditorium

Oral Presentation Abstracts

Listed alphabetically by last name of first author

Multi-decadal changes in seabird and forage fish distributions in the Northwest Atlantic

Evan Adams[1*], Julia Gulka[1], Chandra Goetsch[2], Kevin Friedland[2], Andrew Gilbert[1], Holly Goyert[1], Iain Stenhouse[1], Kate Williams[1]

1 Biodiversity Research Institute, 2 National Oceanic and Atmospheric Administration

Forage fish availability influences the demographic rates of seabird populations through breeding season productivity and year-round survival. Offshore wind development is expected to change forage fish distributions and productivity in the Northwest Atlantic, which could alter seabird behaviors and distributions in the region. Further, environmental conditions in the Northwest Atlantic are rapidly changing, and while forage fishes and seabirds are responding, it is unclear how these changes affect trophic connectivity. To understand how offshore wind development could affect seabird populations, recent distribution changes must be quantified and trophic interactions assessed. Using two long-term survey datasets, we explored the spatiotemporal changes in Northwest Atlantic forage fish and seabird populations and how these changes interrelate across groups. Joint species distribution modeling frameworks were used to predict seasonal spatiotemporal changes in occupancy and relative density for forage fishes and seabirds, respectively. Across the study area in the U.S. Atlantic, most seabird species decreased in relative density over the study period (2002–2019), while forage fish species exhibited more variable trends. Declining forage fishes, like northern sand lance, exhibited strong correlations with declining seabird densities across seasons. The centroids of seabird and forage fish distributions shifted over the study period, with more substantial range shifts among seabirds, though this pattern varied across seasons and species. These distribution shifts affected the spatial overlap between predator and prey distributions, especially for seabirds whose distributions tended towards nearshore areas during the non-breeding period. Our results suggest widespread regional relative density declines in the seabird community of the Northwest Atlantic, as well as declines in the occupancy of several forage fish species that are important prey for seabirds in the region (e.g., sand lance). Range shifts are occurring in both forage fishes and seabirds, albeit at different rates. These different rates of distribution change likely reflect species-level traits like mobility and strength of response to ecological change. These findings reinforce the importance of considering predator-prey dynamics for conservation planning and management, particularly for declining seabird populations.

Integration of non-extractive environmental DNA in monitoring potential impacts of offshore wind development

Jason Adolf[1*], Keith Dunton[1], Kiernan Bates[1], Erin Conlon[1], Shannon O'Leary[2]

1 Monmouth University, 2 St. Anselm College

Monitoring the potential impacts of offshore wind development on the marine ecosystem requires development of novel approaches that specifically address the challenges presented by this large-scale endeavor. Our group is integrating non-extractive environmental DNA (eDNA) and acoustic telemetry with capture surveys to advance the science of fisheries monitoring in the context of offshore wind development. Strengths of the eDNA approach to fisheries monitoring include its relative ease of deployment, including the ability to access new or difficult to navigate areas such as constructed wind farms, and scalability. Data from eDNA metabarcoding provides data on species presence, and presence- or relative abundance-based community composition. We are examining the relationship between eDNA metabarcoding results and capture surveys by pairing eDNA measurements with the NJ Ocean Trawl (five times per year), NJ Artificial Reef Survey (three times per year), NJ Raritan Inventory Project (five times per year) as part of a NJDEP RMI-funded project (2023-2025), the Orsted Ocean Wind 1 bottom trawl survey (with Rutgers University colleagues), and BRUV deployments with partners at Equinor in the Empire Wind development area. In addition to these paired eDNA-capture sampling campaigns, as part of the RMI project we are sampling eDNA in an experimental design that captures the cross-shelf (including the surf zone) and along shelf environmental gradients within which offshore wind development areas exist. A part of this campaign includes equipping and training community scientists to sample surf zone eDNA as a proof-of-concept toward further expansion of community-based fisheries monitoring that exploits the ease of sampling unique to eDNA. Environmental DNA has important roles to play in monitoring for potential impacts of offshore wind. Understanding and exploiting the strengths of eDNA is key to its further integration into fisheries monitoring plans as offshore wind development proceeds.

Designing offshore wind pile driving to minimize Level A take estimates

Michael Bellman[1], Patrick Remmers[1], Magda Chudzinska[2], Madalina Matei[2], Jason Wood[2], Cormac Booth[2*]

1 ITAP GmbH, 2 SMRU Consulting

Pile driving is considered to generate impulsive sounds – which are more damaging to the mammalian ear than exposure to non-impulsive sound. However, the signal of impulsive sound sources (e.g. pile-driving) loses its impulsive characteristics as a function of distance from the source (due to propagation effects) and could potentially be characterized as non-impulsive beyond a certain distance. Assuming signals are always impulsive can result in significant overestimation of Level A takes for marine mammals.

The Range Dependent Nature of Impulsive Noise (RaDIN) project explored the current state of knowledge on this issue how available data and model frameworks can plug this knowledge gap to support the design of and streamline the permitting decisions of offshore wind farms.

We also highlight the key future needs to further elucidate the issue of how impulsive noise could be better characterized (and how thresholds might be established to better characterize impulsiveness such that it impacts marine mammal hearing).

Using a real-world pile driving data and an animal simulation approach to calculate cumulative Sound Exposure Levels we investigate estimate the PTS ranges under different piling scenarios. We update the current state of the art and demonstrate some of the conservatisms in Level A take assessment and how the pattern of blows as the pile is installed was critical in determining the Level A take ranges. Our work suggests that real-world hammer logs generally result in lower Level A ranges when compared to a typical ES calculations.

Exploring eDNA as a non-extractive technique for long-term monitoring of marine communities in offshore wind developments

Carmen Bernett[1*]

1 Invenergy

As the global transition towards renewable energy intensifies, the marine environment faces increasing pressures from the construction and operation of offshore renewable energy. The renewable energy industry has both an environmental responsibility and a regulatory mandate to assess potential impacts to the marine ecosystem. However, existing guidance for environmental monitoring relies heavily on traditional approaches which have the potential to impact highly sensitive species and habitats. Non-extractive techniques, such as eDNA to characterize marine environment communities and species offer tremendous promise for reducing the environmental footprint of impact assessment and filling critical information gaps. This presentation will highlight the utility of eDNA as a non-extractive method relevant to offshore wind development and discuss preliminary results in characterizing marine communities and species. Invenergy is currently conducting eDNA studies of its lease area in tandem with regulatorily required surveys to develop a comprehensive set of baseline data over time. This effort will be crucial for understanding the temporal dynamics of marine communities and will inform a more integrated approach to mitigation and monitoring efforts throughout the lifecycle of the project. Moreover, the application of eDNA minimizes the ecological impact associated with traditional survey techniques. Conventional methods, such as trawling or dredging, can disturb marine habitats and inadvertently harm non-target species. In contrast, eDNA sampling is non-invasive and eliminates the need for physical interaction with the ecosystem, reducing the potential for ecological disruption. This makes eDNA a valuable tool for conducting ecologically sensitive assessments while still providing robust data for decision-making processes.

Integrating offshore wind, wildlife and fish: the 'Predators and Prey Around Renewable Energy Developments' (PrePARED) project

Cormac Booth[1*], Antony Bicknell[2], Matthew Witt[2], Philippa Wright[3], Paul Thompson[4], Kate Searle[5], Thomas Regnier[6], Bill Turrell[6]

1 SMRU Consulting, 2 University of Exeter, 3 St Andrews University, 4 University of Aberdeen, 5 UK Centre for Ecology & Hydrology, 6 Marine Directorate - Scotland

The Predators and Prey Around Renewable Energy Developments (PrePARED) is a 4-year collaborative research project concurrently studying predator (seabird and marine mammals) and prey (fish) distribution and behavior in and around offshore wind farms in the United Kingdom. The project commenced in 2022 and has brought together expertise from government, academia, nature conservation agencies and industry, to address critical knowledge gaps that currently are barriers to sustainable offshore wind development. Some of these gaps relate to how seabirds and marine mammals and their prey respond to offshore wind development and the mechanisms underpinning these responses.

Using a range of techniques and datasets collected around 5 wind farms at different stages of development (from pre-application through to five years post-operation) in the UK, we are assessing how the distribution and behavior of seabirds, marine mammals and their prey are changing in response to offshore wind development. Data from Passive Acoustic Monitoring, telemetry, hydroacoustic surveys, baited remote underwater (stereo) video and bomb calorimetry are being used. We'll present initial results on how the presence of turbine affects the biomass of key fish species (and their energy content as prey for predators) and higher trophic level predators and outline plans for the remaining two years on the project as we integrated findings to improve cumulative assessment tools (and ensure translation of robust science into evidence to inform decision-making).

These outputs are designed to improve the evidence base to help evaluate the effects of offshore wind development on key receptors, de-risk the permitting process, where the evidence base supports this and to help Increase stakeholder confidence in magnitude of cumulative effects. We intend that the outputs of the PrePARED project will also help support improved marine spatial planning and co-location of industries (e.g., offshore wind, shipping, fisheries).

Technology gaps for monitoring birds and marine mammals at offshore wind facilities

Sarah Courbis[1*], Aude Pacini[1], Heidi Etter[1], Megan McManus[1], Fabiola Campoblanco[1], Julia E. Stepanuk[2,3], Kate Williams[3]

1 Worley Consulting, 2 SoMAS, Stony Brook University, 3 Biodiversity Research Institute

It can be difficult to study effects of OSW development on wildlife in a manner that is statistically robust and integrates into OSW facilities' typical operations and infrastructure. This study, funded by the National Offshore Wind Research and Development Consortium in collaboration with NYSERDA, was introduced in its early stages at the last State of the Science and was completed at the end of 2023. It identifies technology gaps and technological research and development (R&D) priorities for monitoring marine mammals and birds for fixed and floating OSW. Generally, the types of technologies and the key associated technological R&D needs are similar for birds and marine mammals. The main exception is that some types of bird technologies are more likely to require direct integration with OSW infrastructure, whereas marine mammal systems tend to operate independently. Priorities to advance wildlife monitoring include improved early communication, standardization of resources for monitoring systems on OSW structures, battery/power access improvements, remote data transfer improvements, and advancements in automated collection and analysis of data. The successful integration of wildlife monitoring systems into OSW infrastructure and operations is dependent on systems designed with remote access mechanisms for data collection, maintenance, and data transfer to minimize risks to worker safety in the offshore environment. Application of the results of this study to prioritize and fund technology R&D will help to support statistically robust data collection and practicable integration of monitoring systems into OSW operations and infrastructure. We propose to present our findings from this study at the 2024 State of the Science Workshop.

Scale model testing of biodiversity enhancing scour protections for offshore foundations and cables

Antonios Emmanouil[1*], Luca van Duren[1], Natalia Aleksandrova[1], Stendert Laan[1]

1 Deltares USA, Inc

Increasing attention is currently being paid to nature-inclusive design of offshore wind farms. Especially in the North Sea, ecological regulatory requirements are introduced that concern the design of scour protections which form hard substrate habitats in otherwise sandy environments where offshore wind farms are typically constructed. By providing space for hard substrate associated benthos, food and shelter for fish and by acting as hotspots for kickstarting reefs, scour protections present opportunities for biodiversity enhancement and restoration of reef-building species.

The dimensions and composition of the scour protections can be optimized to further increase their ecological value. For example, artificial reef structures can be integrated into scour protections to create shelter for gadoids, or chalk-rich shell material can be introduced near the surface to promote the settlement of oyster larvae in support of oyster reef restoration efforts. In principle it would also be possible to introduce e.g. spat on shell, although this would have to be added post-installation. The ecological effectiveness of such concepts is studied through offshore pilot projects.

A prime requirement for any Nature Inclusive Design concept is that it should not compromise the stability or the functioning of the energy infrastructure. To investigate the hydraulic performance of eco-friendly scour protections around monopiles and cables, physical model tests were set up on two scales. We conducted tests in the Deltares' Delta Flume on 1:1 scale, where the performance of eco-friendly scour protections was tested with minimal scale effects under waves. Then, a series of tests was conducted on 1:30 scale to test the performance of eco-friendly scour protections under a combination of waves, currents, and a mobile seabed.

In our presentation, we present different options for biodiversity enhancing scour protections. These will be discussed focusing on the hydraulic stability and overall performance of various nature-inclusive elements under tested offshore conditions. We finally elaborate on the risks introduced by the nature-inclusive elements for the surrounding infrastructure and for the integrity of the scour protection itself.

60 years of the Northeast Fisheries Science Center bottom trawl survey: Maintaining a long-running time series in the face of growing uncertainty

Catherine Foley[1*], Philip Politis[1], Paul Rago[2], Kathryn Ford[1]

1 National Oceanic and Atmospheric Administration, 2 NOAA Fisheries Northeast Fisheries Science Center

The NOAA Fisheries' Northeast Fisheries Science Center (NEFSC) has conducted a multispecies bottom trawl survey (BTS) of the northwest Atlantic continental shelf and upper continental slope since the autumn of 1963. This 60 year time series is among the longest fishery-independent survey time series in the world and provides data crucial for conducting over 50 stock assessments, understanding changes in community composition, and quantifying ecosystem-level changes of the marine environment. Since its inception, the BTS has employed a random, stratified sampling design, stratified primarily by depth and latitude, and follows standard protocols, ensuring consistency of the gear and methods, with calibration factors calculated for known changes to ensure comparability over years and areas sampled. In recent years, however, the existing survey design and execution has faced compounding challenges including offshore wind development, vessel operation and staffing, increased fixed gear, and shifting species distributions. In particular, the survey's current platform, the NOAA Ship Henry B. Bigelow, a 206 ft long fishery survey vessel, is unlikely to be able to sample inside of offshore wind farms where fixed turbines and seafloor cabling increase operational risk. Therefore, the NEFSC is evaluating potential impacts to survey data products due to lost sampling and options to mitigate these impacts. Additionally, we are actively assessing other options to modernize survey design and ensure resilience against compounding disruptions to survey operations. These survey modernization efforts will serve to preserve and extend the time series in a scientifically and quantitatively verified method while maintaining its internal validity and increasing its precision for multiple commercial stocks assessed in the region. This talk will present the status of these efforts and identify the links to related work.

Interannual variation in bird species, abundance, and activity at offshore wind turbines

Greg Forcey[1*], Julia Robinson Willmott[1]

1 Normandeau Associates Inc

Species composition, abundance, timing of activity, and behavior in the offshore environment can affect species-specific exposure to turbine blades, collision risk, and displacement risk. Further, the physical location of offshore turbines in relation to staging areas in the USA, the Caribbean, and Central and South America can influence the bird species and densities that encounter those turbines. To date, limited data has been available on offshore bird interactions with wind turbines in the offshore environment, and even fewer studies examining interannual variation between years. Little knowledge in this space limits us from making informed recommendations about reducing risks to birds offshore. To fill knowledge gaps, we installed thermal cameras, a visible-light camera, acoustic detectors, and a VHF receiver for detecting Motus-tagged birds at the Dominion Energy Coastal Virginia Offshore Wind Pilot Project. Bird species composition, abundance, temporal variation, and behavior were evaluated and compared between years. Some species represented birds that remain within the USA year-round, while others represented trans-Atlantic migrants that winter in the Caribbean and northern South America, including Amazonia, and are presumed to migrate mostly across the northwestern North Atlantic. Peaks in activity during fall migration differed between years, and we observed variations in the number of behaviors among different species. Foraging behaviors were most common with passerines, while non-foraging behaviors were most common with other species groups. These results suggest that exposure, collision, and displacement risks vary over the years for birds in the offshore environment, and additional years of offshore bird data will allow us to quantify this variability. In the interim, risk assessments should consider the impacts of abundance and behavioral interannual variation when predicting the impacts of collisions and displacement from offshore wind turbines.

Using autonomous gliders to understand patterns and drivers of habitat use for baleen whales in the New York Bight

Katherine Gallagher[1*], Lesley Thorne[1], Jack McSweeney[1], Charles Flagg[1], Joe Warren[1], Josh Kohut[2], Travis Miles[2], Julianne Wilder[3], Mark Baumgartner[4]

1 Stony Brook University, 2 Rutgers University, 3 National Oceanic and Atmospheric Administration, 4 Woods Hole Oceanographic Institution

Passive acoustic monitoring (PAM) is a key tool for assessing long-term trends in cetacean populations globally. The use of PAM on autonomous ocean gliders along with multiple oceanographic sensors presents the opportunity to gather data on cetaceans and their habitats concurrently in times and places that are difficult to survey using traditional survey methods. The New York Bight (NYB) is a heavily urbanized region in the Northeast US which has high densities of vessel traffic and fishing vessels and has historically had limited marine mammal survey effort. There is particular interest in understanding marine mammal habitat in this region due to recent changes in the distribution of large whales, and due to upcoming offshore wind development in the region. PAM studies suggest that critically endangered North Atlantic right whales (NARW) are using waters of the Southern New England region, where the NYB is located, more frequently in recent years during winter months. Further, there has been a notable increase in sightings of humpback whales in the NYB since 2010. As part of a long-term monitoring program in the NYB, we are using autonomous underwater gliders equipped with digital acoustic monitoring (DMON) instruments and a suite of oceanographic sensors, including the NYSERDA funded GLIDE project. The short-term goal of this work is to examine the occurrence of large whales in the NYB, while long-term goals include quantifying changes to baleen whale habitat use over the next decade and developing predictive habitat models for baleen whales using glider data. Over 200 deployment days with DMON instruments were recorded in 2023. Fin and humpback whales were detected most frequently. Fin whales were detected nearly constantly from late summer to early spring. Humpback whales were detected in migratory pulses in the spring and fall. Sei whales and NARW were only detected during deployments in early spring, on less than 20% of deployment days. Different baleen whales are utilizing different portions of the NYB, including different sides of the Hudson River Valley seasonally. We will explore different oceanographic variables, such as the extent of the cold pool and frontal features on both sides of the Hudson River Valley. Preliminary results suggest that humpbacks favor the New York side of the Hudson River Valley during the spring migration, where more horizontal chlorophyll fronts are present in the same time frame. Future investigations will include the oceanographic conditions on each side of the Hudson River Valley, including possible upwelling and front formation as a result of the subsurface canyon. This work highlights the importance of consistent long-term monitoring in order to assess changes in baleen whale habitat use in association with anthropogenic change, and to identify times and regions of high risk for anthropogenic impacts on baleen whales.

Guidance for detecting changes in marine bird distributions and habitat use related to offshore wind development in the United States

Julia Gulka[1], Holly Goyert[1], Iain Stenhouse[1], Edward Jenkins[1], Kate Press[2], Caleb Spiegel[3], Timothy White[4], Kate Williams[1]

1 Biodiversity Research Institute, 2 New York State Energy Research and Development Authority, 3 U.S. Fish and Wildlife Service, 4 Bureau of Ocean Energy Management

Offshore wind (OSW) development is rapidly increasing in the U.S., necessitating guidance on how to measure the range of potential effects to seabirds. Among the most observed effects are behavioral changes that lead to avoidance from, or attraction to, OSW facilities. To ensure research into these responses is consistent and well-designed, a committee of subject matter experts developed recommendations for studies of changes in bird distributions and habitat use at OSW facilities. Under the auspices of New York's Offshore Wind Environmental Technical Working Group (E-TWG) and chaired by federal regulatory agencies, the committee included subject matter experts from the U.S., Canada, and the UK. Participants developed guidance informed by a literature review of existing studies, power analyses, and informal expert elicitation. The guidance document identifies key research questions and provides an overall process for the selection of research questions, focal taxa, and data collection methods. It describes how to design studies that provide adequate statistical power to detect effects, details the strengths and limitations of study methods, and recommends how best to achieve data consistency and transparency. The document also includes detailed recommendations for conducting observational surveys (boat-based and digital aerial), which are primary methods used around the world to detect changes in the distributions and habitat use of marine birds. These detailed recommendations focus on topics such as the use of before-after gradient (BAG) survey designs, the importance of power analysis to inform study design choices, recommended buffer areas to survey around wind facility footprints (4-20 km), and the number of years of pre- and post-construction surveys to be conducted (at least 2 years pre-construction and three years post-construction). The guidance developed by the committee is intended to improve the quality of site-specific monitoring efforts and reporting, which in turn will help to inform meta-analyses, cumulative impact assessments, and other large-scale assessments of OSW effects on seabird populations.

Modeling distribution shifts of small Odontocetes in the northeast United States

Nathan Hirtle[1*], Lesley Thorne[1], Jason Roberts[2], Patrick Halpin[2], Meghan Rickard[3,4], Ann Zoidis[5], Kate Lomac-MacNair[3,6], Debra Palka[7], Lance Garrison[7], Susan Barco[8], Jessica Redfern[9]

1 Stony Brook University, 2 Duke University, 3 New York State Department of Environmental Conservation 4 New York Natural Heritage Program, 5 Tetra Tech, 6 Owl Ridge Natural Resource Consultants, 7 National Oceanic and Atmospheric Administration, 8 Virginia Aquarium and Marine Science Center, 9 New England Aquarium

Climate change is causing significant changes in marine ecosystems globally, with oceanic warming being a primary driver. In particular, marine waters in the Northeast United States (NEUS) are warming rapidly compared to other large marine ecosystems. Little is known about the impacts of ocean warming on small odontocete species, many of which have broad distributions that span the waters of the Eastern United States. While previous studies have suggested poleward shifts in some odontocete species in this region, an assessment of distributional changes has not yet been confirmed by a robust, spatially-explicit analysis over a multi-decadal time scale. Potential distribution shifts could result in some odontocete species occupying new habitats, including shifts into offshore wind development areas. Thus, it is essential to quantify any shifts to anticipate future human-wildlife interactions. This research quantifies the magnitude and direction of potential distribution shifts in small odontocete species along the Eastern seaboard of the US (1.27 million km2) and identifies oceanographic drivers of observed shifts. We used over three million kilometers of boat and aerial line transect survey data from 1997 to 2020 to build species distribution models for six species of odontocetes: four warm-water limited species (*Tursiops truncatus, Stenella frontalis, Grampus griseus*, and *Delphinus delphis*) and two cool-water limited species (*Lagenorhynchus acutus* and *Phocoena phocoena*). Generalized additive models were used to generate spatially-explicit predictive maps of odontocete density over the 24-year study period. We found poleward distributional shifts in the density-weighted centroids of all species in at least one season. However, distributional changes are not symmetric around the centroid, with the core habitat's leading (poleward) and trailing (equatorward) edges moving poleward at different rates than the centroids. Our results suggest marked changes to small odontocete habitats in Eastern United States marine waters in association with warming in the NEUS. We discuss the implications of these changes for management relative to static offshore wind development areas throughout the NEUS.

Evaluating potential recreational fishing impacts in Attentive Energy One's lease area

Jason Kinnel[1*], Matthew Bingham[1]

1 Veritas Economics

Attentive Energy is currently developing the Construction and Operations Plan (COP) for its Attentive Energy One (AE1) Project. This presentation provides an overview of the commercial fishing evaluation that Attentive Energy is undertaking to evaluate the potential commercial fishing impacts associated with AE1. Commercial fishing occurs within a highly variable system of interconnected environmental, ecological, regulatory, market, and operational conditions. From a vessel captain's perspective, trip outcomes of catch, revenue, and profit can only be approximated, and from the modeling viewpoint, it is only possible to identify probabilities of different behaviors and outcomes. Quantitative economic modeling of commercial fishing requires an approach that accurately incorporates the complexities of uncertain trip outcomes and considers the probabilistic nature of modeling captain behaviors. Attentive Energy is employing a probabilistic modeling approach to evaluate AE1's potential impacts to the surfclam and scallop fisheries—the two commercial fisheries that have accounted for approximately 94 percent of the commercial fishing activity in AE1 over the last 14 years. The model's probabilistic structure explicitly incorporates the uncertain nature of fishing and fishing decisions while providing a robust and feasible way to characterize the multifaceted aspects of commercial fishing. The approach, referred to as a sequential choice simulation model, employs a mathematical representation of the following sequence of decisions involved in scallop and surfclam fishing trips:

1. whether to fish on a particular choice occasion,
2. which fishing area to choose,
3. which route to take to an area,
4. where to fish within an area,
5. when to return to port, and
6. what return route to take.

The presentation discusses both the modeling approach and its application to evaluate potential fishery impacts within AE1's Lease Area.

Regional assessment of offshore wind impacts on aerofauna in Canada

Paul Knaga[1*], Katrien Kingdon[2], Sylvain Christin[2], Christine Gilroy[2], Stephanie Avery-Gomm[3], Kate Williams[4], Iain Stenhouse[4], Megan Ferguson[4], Julia Gulka[4], Evan Adams[4], Wing Goodale[4]

1 Environment and Climate Change Canada, 2 Canadian Wildlife Service, 3 Environment and Climate Change Canada, Science and Technology Branch, 4 Biodiversity Research Institute

Recently, the Canadian government has signed agreements to conduct regional assessments of offshore wind power development along the Atlantic coast. Impacts on avifauna (migratory birds, species at risk) are a potential concern in Canadian waters as some species are known to be particularly vulnerable to offshore wind turbines. This presentation reviews the current state of offshore wind development in Canada and how Canada is approaching the regional assessment of potential impacts on aerofauna, specifically migratory birds, bats, and species at risk. We draw upon Canada's regulatory mechanisms, existing literature, and ongoing research to identify critical areas of concern and gaps in knowledge. We aim to provide a comprehensive overview of how Canada is assessing potential impacts of offshore wind development on migratory birds, bats, and species at risk and informing decision-making around the sustainable development of this emerging industry.

Synthetic analysis of post-construction displacement of marine birds from wind energy areas

Juliet Lamb[1*], Julia Gulka[2], Evan Adams[2], Kate Williams[2], Aonghais Cook[3]

1 The Nature Conservancy, 2, Biodiversity Research Institute, 3 The Biodiversity Consultancy

Displacement of marine birds from at-sea foraging, resting, and migratory habitat is frequently observed following construction of offshore wind energy installations. However, effects have varied widely among monitoring methods, locations, and species. The drivers of this variation are unclear but likely include a combination of study design parameters, differences in the magnitude of responses among species and seasons, and differences in wind farm locations and layouts. An understanding of the underlying factors driving both occurrence and detection of displacement effects is required to inform wind farm design and develop best practices for monitoring. We conducted a synthetic meta-analysis of existing literature to assess the state of knowledge on displacement effects. Drawing from 37 studies and reports on displacement of marine birds by wind energy infrastructure, we extracted the likelihood of detecting a change in distribution compared to pre-construction and/or reference sites, as well as the percent change in use of the wind energy area. We then modeled these outcomes as functions of wind farm characteristics (e.g., turbine density, latitude, distance from shore), bird characteristics (e.g., species, taxon, age, season), and the observation process (e.g., monitoring method, control area size and distance, years post-construction). We found that displacement effects varied among species, with the strongest effects observed during the breeding season. Effect detection increased with overall study area footprint and diminished with increasing distance from wind turbines. Wind farm characteristics were highly correlated with one another, but we observed stronger displacement effects at high-latitude, nearshore sites. Density of turbines within the wind farm footprint did not appear to affect displacement levels. More broadly, we found that extracting standardizing responses for meta-analysis was challenging due to differences in reporting among studies. We recommend that future monitoring studies clearly report both means and standard errors of underlying metrics (i.e., abundance and/or density) within clearly defined study areas to allow for robust comparison among sites, species, and survey methodologies.

Regional compensation for fisheries: a new approach to mitigation

Greg Lampman[1], Morgan Brunbauer[1], Kris Ohleth[2]

1 New York State Energy Research and Development Authority, 2 Special Initiative on Offshore Wind

One key issue that has been standing in the way of achieving greater coexistence with the fishing community is the lack of a transparent and inclusive mitigation framework. Such a framework could provide guidance to the offshore wind developer community on how best to approach mitigation, provide more certainty to the fishing community that they would be compensated from any potential losses that are incurred from the construction and operation of offshore wind farms, and provide a path forward for states are currently negotiating compensation approaches on a project by project basis.

While compensation has been utilized as a mitigation approach for potential impacts to fishing communities from offshore wind farms in other countries and has begun here in the US, as well, there has been no clear, overarching federal or state regulatory mechanisms for fisheries compensation. However, in June 2022 the Bureau of Ocean Energy Management (BOEM) released draft mitigation guidance to help ameliorate this issue. Meanwhile, 11 East Coast States have been at work developing a regional fisheries compensation framework for the Eastern Seaboard.

During this robust panel discussion we will learn more about current initiative underway by the 11 States as well as explore BOEM's mitigation guidance and how it will be used going forward to help guide developers as they develop their plans to mitigation potential impacts to the fishing community. The mitigation guidance and this regional framework used together will help to provide more certainty to developers and the fishing community alike as offshore wind is developed in the United States.

Acoustic and environmental monitoring during turbine installation at the South Fork Wind Farm

Arthur Newhall[1*], Y-T Lin[2], James Miller[3], Gopu Potty[3], Derek Buffitt[1], Anwar Khan[4], Kristen Ampela[4]

1 Woods Hole Oceanographic Institute, 2 University of California San Diego, 3 University of Rhode Island, 4 HDR Inc

Environmental and acoustic monitoring was conducted at the South Fork Wind Farm (SFWF) during the installation of multiple wind turbine generators (WTG). Bubble curtains around wind turbine foundations were employed during all pile driving operations for purposes of noise mitigation. Passive acoustic moorings were deployed at multiple ranges and depths during active pile driving to measure both pressure and particle velocity signals generated by the impact pile driving. Sound levels were measured at various ranges, depths, and azimuths from the pile. Ocean Bottom Recorders (OBX) sensors were also deployed to study the impact of active pile driving on the seafloor, especially the generation of Scholte waves. Initial analyses of the data will be presented and implications for the effects on marine life will be discussed. This project was conducted under the United States (U.S.) Department of the Interior's Bureau of Ocean Energy Management's (BOEM) Real-Time Opportunity for Development Environmental Observations (RODEO) Program.

Machine learning and high performance computing for the detection and classification of marine wildlife in digital aerial imagery

Kyle Landolt[1*], Aaron Murphy[1], Matthew Walker[1], Sierra Schuster[1], Timothy White[2], Mark Koneff[3], Bradley Pickens[3], Stella Yu[4]

1 U.S. Geological Survey, 2 Bureau of Ocean Energy Management, 3 U.S. Fish and Wildlife Service, 4 University of Michigan

Avian and wildlife population surveys can help inform environmental assessments and impact analyses for offshore energy development projects. Low-flying ocular aerial surveys have historically been used to estimate waterfowl populations, but place 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, enumeration, and classification of seabirds, waterfowl, and other marine wildlife. Aerial imagery collected from the Atlantic Outer Continental Shelf and the Great Lakes provide data for algorithm development. OpenCV's Computer Vision Annotation Tool (CVAT) is providing the framework for an interactive GUI, allowing wildlife experts to efficiently create annotations and support database development.

We labeled 79,306 objects in 6,030 images. These objects include birds, mammals, reptiles, and more. We developed a benchmark annotation dataset for wildlife detection by tiling up our imagery into uniformly sized 1024x1024 pixel tiles. We had a total of 46,614 tiles, half of them containing only water and the other half containing at least one wildlife object. Using this dataset, we trained a YOLOv8x model on eight wildlife classes (bird, cartilaginous fish, artificial, bony fish, mammal, invertebrate, unknown/other, and reptile) with the goal of detecting wildlife in aerial imagery. The model was trained on the Tallgrass supercomputer in Sioux Falls, South Dakota. The model performed well with mAP50 values of 0.98 for birds, 0.94 for cartilaginous fish, and 0.86 for reptile objects. Additionally, when bird objects are missed, we noticed that the model often considers them as background water while other objects like unknown/other are detected but mislabeled as other classes.

Using the trained YOLO v8x model and high-performance computing resources, large scale implementation can be achieved to quickly scan for wildlife objects in aerial imagery. When requesting 20 GPUs in Tallgrass, the model took only two days to run on approximately 600,000 images, which represents imagery from many seasons of aerial survey collections. Further work will be done to implement a multi-label detection model to detect and predict objects of certain species, age, sex, and activity while taking other co-variates like ground sampling distance into account. Lastly, we find that using deep learning algorithms to detect birds reduces the time manually annotating bird objects and accelerates annotation development.

A novel approach to account for availability bias when estimating harbour porpoise abundance from digital video aerial survey

Kelly Macleod[1*], Naphon Olley[1], Ben Stevenson[2], Catherine Irwin[1], Aidan Harrison[1], Adam Whitehouse[1], Martin Scott[1]

1 HiDef, 2 University of Auckland

Field and analytical methods for robust estimation of cetacean abundance have been the focus of much research over the last few decades. The bias in estimates caused by the behaviour of visual observers (perception bias) and target species (availability bias) can largely be overcome through tailored survey methods and analytical approaches; such methods have been finessed and implemented European waters through the “SCANS” programme. However, there has been little focus on developing comparable methods for surveys undertaken using digital video cameras in place of observers despite digital aerial surveys being the standard approach for monitoring offshore wind developments in the UK and Germany and expanding in use throughout Europe. Digital aerial surveys are also being employed on the U.S. east coast as the benefits of such surveys over visual aerial become more apparent. However, the ability to generate unbiased density and abundance estimates of cetaceans remains a challenge from digital methods yet is of importance for robust impact assessment.

The effects of perception bias are largely negated using cameras, but availability bias in these survey data remain. We undertook a double platform digital aerial video survey (DAS) during July 2022 within a survey block off northeast Scotland, UK with the aim of testing a field and analytical approach to estimate harbour porpoise abundance. The timing of the survey was coincident with that of a visual observer survey as part of the SCANS-IV programme. For the DAS, two aircraft flew in tandem, separated by a long-time lag that was sufficient to allow the availability status of detected porpoise to change between the first and second aircraft camera passes. We then analysed the data by applying a novel approach, namely a point process model Cluster Capture-Recapture. The approach is not dependent on matching detections with certainty as required for traditional mark-recapture methods, but instead models detection locations taking account of their proximity to each other. The analysis was undertaken in the R package PALM and proved to be computationally efficient and generated precise estimates of harbour porpoise abundance that compared well with those generated from the SCANS-IV visual surveys. Furthermore, the model estimated the mean duration of time that harbour porpoise spent at the surface which could be applied as a correction to relative abundance estimates of harbour porpoise from site-specific offshore industry surveys within the same region which are otherwise biased low.

Modeling interactions among commercial shellfish fishing and wind energy using a stakeholder-informed agent-based approach

Daphne Munroe[1*], John Klinck[2], Eric Powell[3], Eileen Hofmann[2], Sarah Borsetti1, Molly Spencer[3], Autumn Moya[3], Andrew Scheld[4,5]

1 Haskin Shellfish Research Laboratory, Rutgers University, 2 Old Dominion University, 3 University of Southern Mississippi, 4 Virginia Institute of Marine Science, 5 College of William & Mary

Increasing use of the offshore coastal ocean is creating novel challenges for managing trade-offs among traditional users such as fisheries and new users such as offshore wind energy (OSW). Evaluation of the costs and benefits of various strategies for managing multiple users in the marine realm require tools that can predict and proactively manage these complicated and interconnected challenges.

Agent-based fisheries models that resolve shellfish fishing systems allow emergent properties to develop from interactive effects of stock dynamics, fishery/fleet decision-making, and management and economic factors. Inclusion of fisher's experiential knowledge in agent-based model development and validation is key to ensuring model realism, and acceptance and use of simulation results. An agent-based modeling framework that included these inputs was implemented to simulate both the Atlantic sea scallop (*Placopecten magellanicus*) and the Atlantic surfclam (*Spisula solidissima*) fisheries which represent two economically important U.S. shellfisheries. Both fisheries occur on the Mid-Atlantic Bight continental shelf, a region that is the focus for U.S. OSW development.

The scallop and surfclam model implementations consider the impacts of proposed OSW array configurations on the fisheries that result from anticipated vessel avoidance of cables and turbines. The simulations are constrained by stock assessment data and informed by fisheries and management experts. This co-development approach supports realistic dynamics of simulated biological, economic, and social systems relevant to intended model use. Simulation results provide understanding of the costs to these shellfish fisheries from displacement or changes in fishing activity due to OSW, implications of survey interruption, and interactions with forecasted habitat changes due to climate change. This information is critical for fishers and managers to assess approaches for mitigating interactions between commercial fisheries, the growing OSW industry, and changing environmental conditions.

Investigating prey fields near foraging right whales in and adjacent to southern New England wind energy areas

Christopher Orphanides[1*], Harvey Walsh[1], Jordan Katz[1], Kelley McBride[1], Elisabeth Broughton[1]

1 National Oceanic and Atmospheric Administration

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 2023 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. We have also summarized data from NOAA's Ecosystem Monitoring program, both in southern New England and throughout the northeast for regional context. Analysis of the winter southern New England prey community from 2020 through 2023 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 *thecalanoid* copepods *Pseudocalanus* spp., *Centropages* spp., and *Temora longicornis*. Analysis of the northeast shelf showed similar dominant species of *C. finmarchicus*, *Pseudocalanus* spp., and *Centropages* spp. that varied by region. Upcoming analysis will compare abundances pre- and post-2010, and examine potential regime shifts. 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.

A comparison of visual and image aerial surveys for marine mammals and sea turtles in the New York Offshore Planning Area

Debra Palka[1*], Lesette Campbell[1],

1 National Oceanic and Atmospheric Administration

To safely continue crewed aerial abundance surveys for marine mammals and sea turtles over offshore wind turbines we will need to change our flight height from 600 to 1500 ft or higher. To continue correctly identifying species at the higher altitude we will need to change data collection from visual observers to images captured by high-definition cameras. However, changing approaches puts into question the ability to integrate new with historical observations. One integration strategy is to seek unbiased absolute abundance estimates from both approaches so that we can make a direct comparison. In this study we compared the abundance survey data collected during 2016 – 2019 by two independent aerial abundance survey programs funded by the State of New York. The New York State Department of Environmental Conservation (NYSDEC) conducted monthly surveys using traditional human-based methods targeting large whales. The New York State Energy Research and Development Authority (NYSERDA) conducted quarterly surveys using high-definition cameras targeting all species (birds, marine mammals, sea turtles, and some fish).

We applied design-based and model-based line transect analysis methods to both data types, and strip transect methods to the image data. For the design-based image analyses, we explored analyses based on individual animals that accounted for over-dispersion and analyses based on schools (similar to traditional line transect methods). Due to the dissimilarity in the target species for each program, we concentrated our comparisons on the NYSDEC targeted large whale species. However, we examined all recorded species.

After attempting to include all platform- and species-specific corrections, the absolute abundance estimates derived from the visual versus image data were similar in most cases. When comparing the difference analysis strategies of the image data, the group analysis method generally resulted in slightly lower estimates. This is partially due to the non-uniform detection functions throughout the survey strip, an assumption of strip transect analyses.

The challenges that still remain with incorporating image aerial survey data include both statistical and logistic issues. Statistically, the most influential challenge is determining the most appropriate correction factors for perception and availability bias. To address availability bias we need to conduct additional field studies. To address perception bias we need to reexamine the images to estimate the false negative and false positive detection rates. Logistic issues include data processing and managing the large number of images that will accumulate. However, it is possible to overcome all of these challenges. In conclusion, it should be possible to integrate image abundance survey data with previously collected visual data to create a consistent, comparable time series of abundance estimates, if resources become available.

From wind to whales: Potential hydrodynamic impacts of offshore wind on Nantucket Shoals region ecosystems

Kaustubha Raghukumar[1*], Jeffrey Carpenter[2], Qin Jim Chen[3], Josh Kohut[4], Richard Merrick[5], Erin Meyer-Gutbrod[6], Douglas Nowacek[7], Kelly Oskvig[8], Nick R. Record[9]

1 Integral Consulting Inc, 2 Institute for Coastal Ocean Dynamics, Helmholtz-Zentrum Hereon, 3 Northeastern University, 4 Rutgers University, 5 National Oceanic and Atmospheric Administration, 6 University of South Carolina, 7 Duke University, 8 Ocean Studies Board, National Academies of Sciences, Engineering, and Medicine, 9 Bigelow Laboratory for Ocean Sciences

Offshore wind is in the early stages of implementation in the US, with only two offshore wind farms in operation: one offshore Virginia and one offshore Rhode Island. However, plans exist to build additional offshore wind farms on the East coast and construction has begun at lease sites in the Nantucket Shoals Region. Part of the permitting process required to install and operate offshore wind farms includes assessing any potential ecosystem impacts; regulated by the Bureau of Ocean Energy Management. One challenge is to understand how the oceanography might be altered by the presence of offshore wind farms. An offshore wind turbine can alter flow by interrupting wind-driven circulation processes and by causing wake effect-induced turbulence in the water column surrounding the pile. These hydrodynamic changes may potentially affect the ecosystem, from phytoplankton to marine mammals. This presentation details findings from a National Academy of Sciences committee on how offshore fixed-bottom wind turbine generators in the Nantucket Shoals Region may alter physical processes such as seasonal stratification, tidal fronts, waves, and currents on local to regional scales, which in turn may impact zooplankton supply, abundance and aggregation. North Atlantic right whales (*Eubalaena glacialis*) have been observed foraging on zooplankton in the Nantucket Shoals Region year-round, and hydrodynamic impacts of turbines may affect their foraging patterns and success. Given the uncertainty in the effects of wind energy operations on right whale prey availability, and thus right whale behavior, distribution and demography, the approach to mitigate negative impacts on this critically endangered species should be broad and accompanied by robust monitoring efforts. Improved understanding of foraging dynamics in this first large-scale wind energy site will provide critical information for planning future wind energy development to avoid large-scale population impacts.

Near real-time North Atlantic right whale density model

Jason Roberts[1*], Patrick Halpin[1]

1 Marine Geospatial Ecology Lab, Duke University

The critically endangered North Atlantic right whale (*Eubalaena glacialis*) entered a population decline around 2011. To save the species without closing the ocean to human activities requires detailed information about its distribution that can be used to assess and mitigate human-caused risks such as fishing gear entanglements and vessel strikes. This call was answered by a large collaboration of marine researchers led by the Duke University Marine Geospatial Ecology Lab (MGEL), who together built a model that estimated mean monthly right whale density across U.S. waters. Although this model is widely used for planning and mitigation at coarse temporal scales, it does not address the need for short-term, real-time knowledge of the species' distribution, which would allow imminent harmful activities to be temporarily redirected, relocated, or postponed.

Currently, whale observations are shared in near real-time through systems such the WhaleMap and Whale Insight portals used by the science and management communities, the Mysticetus software used by collaborating protected species observers, and by citizen science projects like Whale Alert and Happywhale. These systems provide valuable data in the form of point locations where whales were seen or heard and the associated survey tracklines or similar effort data, when available. However, when users ask the question "how many whales are close to my area of interest" they are left to mentally integrate these points and lines, often with no observation effort made recently nearby, into their own cognitive models of whale distribution and then make guesses. We need to replace this guesswork with empirical statistical models, trained on the data, available for public scrutiny, that can predict whale density across U.S. waters, filling in the blanks.

In partnership with NOAA Fisheries, BOEM, and the wider community of marine researchers and stakeholders, MGEL is now building a near real-time modeling system for the right whale. By linking the real-time flow of visual and acoustic observations of right whales to contemporaneous environmental covariates, the system will predict whale density across the eastern seaboard at a daily cadence. Initially, the system will serve as a research and development testbed for a collaborating team of developers to work out the statistical challenges and software workflow needed to obtain reliable automated predictions and accompanying skill assessments, with managers and stakeholders providing guidance and assessing the utility of the results. Once model predictions are judged to be sufficiently effective by a steering committee of researchers, managers, and stakeholders, daily predictions will be made operationally and released to the public. If data allow and suitable methods are developed, the system can be extended to issue short-term forecasts, and expanded to other species. This presentation will provide an overview of the project.

Evaluating the environmental performance of a newly designed ecological scour protection unit

Yaeli Rosenberg[1*], Andrew Rella[1], Maor Bezner[1], Cody Garrison[2], Krystina Braid[2], Gordon Taylor[2], Yong Chen[2]

1 ECOncrete Tech, 2 Stony Brook University

The offshore wind (OSW) industry has rapidly grown in New York State, reflecting a broader trend in the United States, driven by the Biden administration's goal to deploy 30 GW of OSW by 2030 and 100 GW by 2050. The development of these facilities requires the construction of seabed foundations, which can have a significant environmental impact. Hard substrates associated with OSW facilities (e.g., turbines, scour protection, mattresses) offer constructed habitat and, if designed correctly, can provide an opportunity for substrate-dependent organisms and life history stages, including both native and nonnative species, to attach and grow. ECOncrete has developed an environmentally sensitive solution known as DropLock (DL), intended specifically for scour protection measures for offshore wind farms in the US, which will not only meet the industry requirements but also provide ecological services. The proposed research aims to holistically evaluate the environmental impact of the DL units compared to standard scour protection materials.

The experimental setup consists of 4,500 DL units with a control site of an equal volume of rock conducted at the Twelve-Mile Reef site in the Atlantic Ocean at 40-meter depth.

Monitoring efforts, started in October 2023, will be conducted every three months for one year in order to 1) map the test and control areas using high-resolution multibeam techniques to

assess the larger-scale sediment erosion and/or deposition patterns, 2) sample and sequence environmental DNA (eDNA) using four different molecular primers to evaluate biological community structure across all domains of life for DL units compared to traditional rock, and 3) leverage available state and federal data sources to quantify and understand fish biodiversity dynamics via baseline habitat and community models joined with black sea bass diet composition studies identifying potential shifts in localized fish assemblages. Preliminary results mapping and characterizing the study sites suggest material and composition, together with habitat creation results in different community assemblages with defined ecological characteristics. These results will help better understand how these novel scour protection materials are behaving and evolving in the marine environment and what effect they have on the evolution of the nearby seabed. This will allow us to reveal a deeper understanding of the impact of ecologically designed structures on marine biodiversity and what the implications are for offshore wind development going forward. The project has clear and inherently sustainable benefits providing offshore development projects, which currently employ applied products and materials with little environmental benefit, with new technology serving to decrease the ecological footprint of OSW infrastructure on the marine ecosystem.

Best practices regarding indigenous engagement within the offshore wind industry

Lucas Shumaker[1*], Kelsey Leonard[1], Will Rauch-Davis[1], Andrea Villalon[1]

1 University of Waterloo

Indigenous energy justice is an emerging topic, especially as our energy use transitions towards more renewable sources. Throughout this transition, there have been many instances of Tribal Nations being left behind or not receiving the benefits of renewable energy projects built on their Lands and in their Waters. Interest in offshore wind (OSW) is increasing which provides an opportunity to include Indigenous communities throughout the entire lifespan of future developments, from project design to decommission. To evaluate the current state of the risks and benefits of OSW development in North America, we developed a framework. The objective of this framework is to create guidelines for best practices in the OSW industry and a way to measure impacts on local Indigenous communities. This can also be used to direct and evaluate future OSW developments.

Building off of the Just-R metrics presented by Nikita S. Dutta et. al, (2023), in JUST-R metrics for considering energy justice in early-stage energy research and the Free, Prior, and Informed Consent Due Diligence Questionnaire from the University of Colorado Boulder (Free, n.d.), the framework and metrics were created and adapted to best suit the OSW energy sector. This new framework evaluates a variety of areas including policy commitments, impacted communities, community engagement, and agreements. Existing OSW companies were evaluated through these developed metrics. This presentation will share the findings of the evaluation and provide recommendations for future OSW developments based on the designed framework and metrics.

Through preliminary results, Indigenous engagement and best practices within the OSW industry show areas for positive growth. This framework can act as a guide for future developments in the OSW space. By adopting this framework and doing internal evaluations using the metrics, organizations involved in OSW can develop better relationships with communities and contribute to Indigenous energy sovereignty rooted in Free, Prior, and Informed Consent.

Streamlining integration and distribution of metocean data from offshore wind operations for marine stakeholders

Tom Shyka[1], Jake Kritzer[1], Gerhard Kuska[2], Mary Ford[2], Riley Young-Morse[3], Kelly Knee[4], Katy Bland[1]

1 NERACOOS, 2 MARACOOS, 3 Gulf of Maine Research Institute, 4 RPS

The coastal waters of southern New England and the Mid-Atlantic are poised to experience an extensive marine industrial build out as 28 leased wind areas undergo assessment and development. This imminent and unprecedented offshore wind (OSW) development has resulted in a significant increase in meteorological and oceanographic (metocean) observations, which are currently supporting site assessment, engineering, research and monitoring and will increase as wind farms are installed and operated. Although much of the industry-funded metocean data collections are privately held or siloed in disparate data systems, many OSW developers have agreed to or have expressed interest in sharing this data through the Integrated Ocean Observing System (IOOS) Regional Associations (RA).

The IOOS Data Management And Cyberinfrastructure (DMAC) community has developed and employed a set of standards and tools for effective and standards-based data management that meet the FAIR (Findable, Accessible, Interoperable, and Reusable) data principles. The primary goal of this project is to transition the robust and modular data ingestion and management pipelines used by NERACOOS and MARACOOS at regional scales into a common, cloud-native cyberinfrastructure at a national scale that leverages a best-of-breed approach for acquisition, processing, integration, and dissemination of metocean data. Use of the commercial cloud enables development of a scalable and extensible system that can evolve over the lifetime of offshore wind data collection efforts. This scalability ensures network-wide, seamless data access across regional boundaries and improves data accessibility and performances for users.

Private and public data providers will benefit from this effort because there will be a documented, standards based, scalable cyberinfrastructure for them to efficiently deliver data through. The myriad of data consumers will also benefit because they will be able to access the growing volume of data though standard services and existing products. The extensive and effective engagement programs of NERACOOS and MARACOOS will ensure that regional OSW data providers and data consumers are well informed and have opportunities to provide feedback throughout the project

This project is foundational to taking an ecosystem approach and integrating offshore wind, wildlife, and fisheries. By building on a robust system of metocean data integration and access, we will collaboratively improve our collective understanding of the oceanographic processes and provide an expanded resolution of environmental covariates for thorough wildlife studies."

Application of a Bayesian hierarchical density surface model to estimate seasonal abundance of large whales in wind energy areas off the east coast of the U.S.

Douglas B. Sigourney [1 *], Debra Palka[1], Samuel Chavez[1], Elizabeth Josephson[1]

1 National Oceanic and Atmospheric Administration

Offshore wind development is rapidly expanding and represents a major change in the marine infrastructure off the east coast of the United States. An important challenge is mitigating the effects of development and operations on protected species. Under several federal statutes including the Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA), environmental assessments are mandated which often require evaluations of the number of protected species that frequent a proposed wind energy area (WEA). Density surface models (a.k.a., species distribution models) have played a vital role in providing crucial information on abundance and distribution of protected species in proposed areas of development. These models require rigorous input data and sophisticated statistical techniques to ensure robust information. They also require that uncertainty is properly accounted for. Importantly, model results need to be well communicated such that managers and stakeholders can use the output to make informed decisions. To that end, we have developed A Bayesian hierarchical density surface model (BHDSM) for large whales off the east coast of the United States. For input data we use data collected from line transect surveys under the Atlantic Marine Assessment Program for Protected Species (AMAPPS). AMAPPS surveys employ a comprehensive systematic design to collect broad scale data on protected species. Our model includes flexible functions for density-habitat relationships. In addition, the BHDSM framework propagates the uncertainty from several subcomponents such that uncertainty in the final estimates is fully accounted for. We have applied it to several species of large whales that are listed as endangered under the ESA including fin whales (Balaenoptera physalus), humpback whales (Megaptera novaeangliae), minke whales (Balaenoptera acutorostrata), sei whales (Balaenoptera borealis) and sperm whales (Physeter macrocephalus). We use the model results to assess seasonal changes in abundance in proposed WEAs off the east coast of the US. We use posterior simulations from the model to quantify the probability of exceeding a pre-defined threshold. For this case example we use potential biological removal (PBR) as a threshold target. Our results show the probability of abundance exceeding PBR varies seasonally within a species as well as among species and among proposed WEAs. This information could potentially inform decisions such as the timing of construction that will help mitigate the risk of encounter with endangered large whales.

Assessing study design options for post-construction avian displacement in the New York Bight

Julia Stepanuk[1*], Evan Adams[1], Wing Goodale[1], Sarah Dodgin[1], Saana Isojunno[2], Lindesay Scott-Hayward[2], Darrel Oakley[3], Len Thomas[2]

1 Biodiversity Research Institute, 2 University of St Andrews, 3 Equinor

Understanding the potential interactions between offshore wind (OSW) development and avian wildlife is essential to effective mitigation strategies. While direct effects, like collision, have obvious population impacts, indirect behavioral impacts, like displacement, may have latent effects on affected populations. Displacement has been observed following OSW construction in Europe in species such as Northern Gannets, Red-throated Loons, and alcids. Given the presence of these species groups in the Northwest Atlantic as well, post-construction monitoring should be designed with particular consideration of these groups, to detect and quantify the amount of displacement that may be observed in, and around, project areas. In this study, we conducted a simulation study to assess the efficacy of survey designs in modeling the pre- and post-construction changes in density with species that have the potential to be displaced by turbines. Using regional and site-characterization survey data, we simulated distributions of Northern Gannets, Common and Red-throated loons, and alcids for a lease area in the New York Bight to use as a case study. A suite of survey designs were tested for efficacy of detection that varied in their footprint, coverage, and frequency. Further, changes in displacement behavior were simulated for the three species groups based on displacement ranges found in European studies (ranging from 2km to 20km, depending on the species). Statistical and simulation tools within the R packages “MRSea” and “MRSeaPower” were used to conduct a spatially explicit power analysis to determine which survey designs were the most effective at statistically differentiating displacement. We found that survey configurations with at least a 10km buffer, 10% coverage, and a total of 8 or more surveys per year had sufficient power to detect displacement for species. In addition, the size of the survey buffer around the project area was the key driver in the ability to detect displacement, as survey designs that prioritized large buffers at the expense of other factors like survey coverage had similar power to detect displacement as surveys that maximized spatial coverage. . This analysis demonstrates the ability to detect, and model displacement of, key taxa across a New York Bight lease area, and provides a statistical assessment of survey designs prior to implementation. Our analysis may benefit both wildlife scientists and developers, as it increases confidence in the quality and usefulness of costly and time-intensive data collection efforts, while providing an understanding of where and when uncertainty in data collection exists at the project scale.

Subseasonal forecasts as a powerful tool for dynamic marine mammal monitoring and management

Julia Stepanuk[1,2*], Hyemi Kim[1], Janet Nye[3], Jason Roberts[4], Patrick Halpin[4], Debra Palka[5], William McLellan[6], Susan Barco[7], LesleyThorne[1]

1 Stony Brook University, 2 Biodiversity Research Institute, 3 University of North Carolina at Chapel Hill, 4 Marine Geospatial Ecology Lab, Duke University, 5 Northeast Fisheries Science Center, 6 University of North Carolina Wilmington, 7 Virginia Aquarium and Marine Science Center Foundation

Predicting when and where mobile marine species are likely to occur can inform efforts to mitigate the impacts of anthropogenic activities, but predictions are often based on prior or near real-time environmental data. Shifting the mindset to an anticipatory framework using ecological forecasting would allow managers to anticipate future conservation risks and make decisions in advance. A NOAA Climate Testbed project, the Subseasonal Experiment (SubX), provides a novel subseasonal global forecasting product from multiple global models that forecasts atmospheric and ocean variables. SubX provides forecasts at weekly-to-monthly time scales that are typically difficult to resolve, and demonstrates high forecast skill for the Northeast US 1-to-2 weeks in advance. We demonstrate the utility of ecological forecasts at these time frames for managing mobile marine species by integrating species distribution models with SubX forecasts using migratory humpback whales in the Northeast US as a case study. We present forecasts of humpback whale density in the Northeast US during the spring migratory period. The density forecasts performed well in predicting spatially-explicit arrival of humpbacks at the foraging ground, and demonstrate appreciable temporal variability between years. By predicting when highly mobile species are likely to occur in areas of high anthropogenic activity, subseasonal ecological forecasts could provide a tool for managers to make operational decisions in advance. Risks to marine mammals throughout offshore wind building and operation include increased vessel traffic and acoustic impacts, and forecasts could inform high risk times and locations for construction avoidance and vessel traffic reductions, which would minimize risk to marine species while preventing costly shutdowns. The framework we present is generalizable and can be developed based on a variety of ecological models, environmental drivers, and taxa, and could prove useful for management scenarios for other taxa impacted by OSW development.

Characterizing the offshore wind farm impacts on NOAA fisheries survey data quality for key Mid-Atlantic fisheries

Ming Sun[1*], Krystina Braid[1], Yong Chen[1]

1 Stony Brook University

The development of Offshore Wind Farm (OWF) in the Mid-Atlantic Ocean can overlap substantially with local fisheries surveys in the Mid-Atlantic region, precluding survey operations in the OWF areas and leading to potential bias in fish abundance data. In our NYSERDA-funded project, we intend to evaluate OWF impacts on Mid-Atlantic fisheries stock assessment. The first task of the project is to characterize the impacts on survey data quality. In this study, we evaluate the potential impacts of OWF development on fisheries stock assessment and management. Using four iconic Mid-Atlantic fisheries with socio-economic importance with distinct life histories (Atlantic surfclam, ocean, summer founder, and longfin inshore squid), we evaluated the OWF impacts on their survey data quality by characterizing truncation of the NOAA Fisheries surveys stations due to OWF and estimated changes in design-based survey abundance indices. Spatial analysis tools (GIS) were used to understand the spatial conflicts between the existing random-stratified survey stations and the leased OWF areas from BOEM. Two evaluation scenarios were considered for the case study fisheries, including a realistic scenario where OWF areas will be effective starting from the leasing year and a simulated retrospective scenario that assumes the survey design changes occur in all historical years. The estimated abundance indices time series for the four species will be compared with the original dataset to demonstrate the scale of spatial overlap between OWF and survey areas, how that overlap will affect the current and historical survey abundances for case study species, and the variations between impacted and unimpacted survey abundances under different scenarios. The impacted survey indices generated from this study will be used as input data for the respective stock assessment for the four species. Findings of the study will shed light on the understanding of OWF impacts on fisheries management and the development of survey mitigating strategies.

Ecosystem effects of large-scale implementation of offshore wind in the North Sea

Luca van Duren[1*], Firmijn Zijl[1], Stendert Laan[1], Thijs van Kessel[1], Erik Hendriks[1], Luka Jaksic[1], Lauriane Vilmin[1], Jan Vanverbeke[2]

1 Deltares USA, Inc, 2 Institute of Natural Sciences

The North Sea is a relatively shallow shelf sea, surrounded by seven highly developed West-European countries. It is one of the busiest marine areas in the world and is strongly impacted by human use, such as fisheries, wastewater run-off, oil and gas production, etc. Development of offshore wind on the North Sea is progressing at a very fast pace, and it is expected that within a few decades a substantial part of the North Sea will be designated to offshore wind. Any kind of infra structure will have local effects on the ecosystem, but the potential scale of implementation of offshore wind may well produce effects on nearly every aspect of ecosystem functioning.

In the Dutch offshore wind ecological programme (Wozep), we have carried out numerical model explorations to assess which areas of the (international) North Sea may be susceptible to fundamental changes in ecosystem functioning. With a suite of coupled state-of-the-art numerical models, we have run scenarios without any wind farms and with different upscaling scenarios. Earlier studies (using a hypothetical upscaling scenario indicated that there were likely very significant effects on processes such as stratification and fine sediment dynamics. Different parts of the North Sea respond differently to the placement of offshore wind farms.

Recent follow-up work has focused on improving the model, validating the effects in and around wind farms. Field observations in a Belgian wind farm confirmed the presence of wakes behind turbines where near-bed water was mixed with surface water. The second new development is the implementation of filter feeders such as mussels on the turbine supports that grow in direct competition with zooplankton. The combination of large amounts of benthic grazers in the upper water levels and more exchange between different water layers and hence more transport of food towards the bed could in theory affect the ratio of carbon fluxes between benthic and pelagic components in the marine food web.

Within this project we are trying to understand the bottom-up effects of offshore wind on the North Sea food web and the potential knock-on effects on higher trophic levels. With the current developments in this ecosystem model, we are setting a further step in this direction.

Assessing the role of ocean currents on prey concentration from hourly to seasonal scales

Jacquelyn Veatch[1*], Josh Kohut[1], Erick Fredj[2]

1 Rutgers University, 2 The Jerusalem College of Technology

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 present in offshore wind lease areas. Consistent or seasonal prey concentrating features created by hydrodynamics could be essential to mapping marine mammal migration and feeding around offshore wind lease areas. These features likely aggregate food sources into marine "grocery stores" that are then targeted by upper trophic predators. Knowledge of where and when prey concentrating features (marine grocery stores) exist and persist could be valuable in understanding feeding habits, spatial distributions, and reliance on northeast shelf oceanography of fishes and marine mammals. Recent advances in Lagrangian Coherent Structure (LCS) analyses aim to identify these concentrating mechanisms, quantify their strength, and link LCS presence to increased prey abundance. While LCSs have been applied to many open ocean regions, the use of these tools in the coastal ocean with much smaller and more complex dynamic scales, has yet to be fully explored. Over a decade of High Frequency Radar (HFR) observed coastal surface currents were used to calculate LCS at a variety of spatiotemporal scales, resulting in a climatology of prey concentrating features in the MAB. This multi-scale approach allows for the comparison of seasonal and interannual variability of LCS patterns, as well as the comparison between sub-mesoscale and mesoscale processes. A large seasonal signal was found, with similar LCS patterns occurring each season over many years. These seasonal patterns in hydrography could be synchronized with local phenology. Persistent LCS features that appear during the same season each year may also serve as reliable migratory pathway, acting as a "marine highway". Results provide a new quantitative methodology for quantifying prey concentrating features, inform ecosystem models, and deepen understanding of the role of physical ocean features in structuring marine ecology in the Mid-Atlantic Bight.

Application of spatial models of marine bird distributions to inform offshore wind energy development

Arliss Winship[1*], Jeffery Leirness[1], Michael Coyne[1], John Christensen[1], David Bigger[2], David Pereksta[2], Timothy White[2]

1 National Oceanic and Atmospheric Administration, 2 Bureau of Ocean Energy Management

Marine birds are a key species group when assessing potential impacts of offshore wind energy development on wildlife. While many data exist for marine birds in US waters, data gaps make it challenging to apply those data directly to inform development, for example the siting of offshore wind farms. Spatial modeling provides a framework for leveraging existing animal survey data to produce comprehensive maps of species' distributions that can be used to quantify potential overlap with offshore wind-related activities and structures. We review more than a decade of marine bird spatial modeling by the National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Science (NCCOS) in partnership with the Bureau of Ocean Energy Management (BOEM). We discuss how the resulting distribution maps can be interpreted, how they have been applied to inform offshore wind energy development, and important caveats regarding their interpretation and use. Statistical models are derived by integrating at-sea counts of birds across numerous surveys and relating those counts to remotely sensed and modeled environmental variables. Models have been developed for more than 80 species in waters off the east and west coasts of the contiguous United States and the main Hawaiian Islands. The models predict the relative densities of species throughout the study areas on a seasonal or monthly basis. The maps represent multi-decadal average distributions during the recent past, and for the latest models, also projected distributions in the near future. The main use of the maps is to identify areas where the density of an individual species is relatively high or low with respect to the region of interest. The maps can also be used to compare the relative density of an individual species between specified areas such as offshore wind energy areas. BOEM has used the model predictions and maps in their planning and assessment processes for offshore wind energy, for example, suitability modeling in partnership with NCCOS and environmental impact statements. Maps have been shared and used more broadly through regional ocean data portals including value-added multi-species products created by the Marine-life Data Analysis Team. The models are regional in scale, which limits their application in some respects, for example, at high spatial resolutions or at the edges of the study areas such as coastal areas. Companion maps that indicate where model predictions are imprecise or lack direct supporting data are always provided and should be taken into consideration when using the distribution maps. The maps provide foundational information that can be used to help minimize potential impacts of current and future offshore wind energy development on marine birds.

Marine observer: Empire Wind case study of long wave infrared camera vessel deployment to detect large whales

Christina Wright[1*], Kevin Sullivan[1], Jon Waltman[1], Mike Wiatt[1], Kochiese Bennet[1], Jennifer Dupont[2], Jurgen Weissenberger[2], Michelle Fogarty[2], Jordan Carduner[2]

1 Toyon Research Corporation, 2 Equinor

The Equinor Empire Wind Project is a commercial offshore wind lease area located 20 miles south-east of Long Island, New York. This area is known to be frequented by many species of large cetaceans including fin, humpback, minke, and the species of most concern, the North Atlantic right whale. Dolphins, porpoises, and sea turtles are also commonly seen. During vessel operations in the area, the standard protocol for vessel strike avoidance includes around-the-clock observations conducted by protected species observers (PSOs). In the past few years, vessel-mounted, long-wave infrared (LWIR) cameras have been tested onboard ships for marine mammal mitigation and navigational aids, military operations, industrial development, and for use on fishing vessels (Judd, 2012; Vlasov, 2020; Zitterbart, 2013). Toyon Research Corporation has developed the Marine Observer wide FOV LWIR camera system for marine mammal detection from moving vessels. Initially funded by NOAA's Southwest Fisheries Science Center, in 2012 Toyon developed a LWIR shore-based whale detection, tracking, and counting system by combining COTS LWIR cameras with Toyon's WhaleSpoutDetector (WSD) software package (Sullivan, 2020).

In autumn 2023, the Marine Observer 66° FOV camera system was deployed on the vessel, Deep Helder, while it surveyed the Empire Wind lease area. The camera operated day and night, from 9 August to 1 November and collected and recorded LWIR video data alongside PSOs who were on station for day and night watches. A Toyon-trained IR camera operator was onboard from 9 August to 6 September, for 28 days, to install and operate the system and to collect data in real time independently from the PSOs. The LWIR video was collected, stored, and processed by the WSD software in real-time during the first 28 days of deployment. The Marine Observer system remained onboard after 6 September and continued collecting LWIR video for an additional 48 days. The resulting detection logs were verified by a human analyst and the human-confirmed whale detections were compared to the PSO sightings. We will present this side-by-side comparison of the Marine Observer 66° FOV System and the round-the-clock PSO sightings along with lessons learned while operating in a real-time setting on a vessel conducting wind-energy surveys.

GPS tracking of Maine’s seabirds indicates varied exposure to forthcoming offshore wind development

Keenan Yakola[1*], Donald Lyons[2]

1 Oregon State University, 2 National Audubon Society

As part of the Biden-Harris administration’s plans to deploy 30 gigawatts of offshore wind energy by 2030, the Bureau of Ocean Energy Management is rapidly moving forward with plans to designate commercial lease areas in the Gulf of Maine, USA. The region is home to a wide diversity of seabirds, but unfortunately relatively little is known about their movement ecology. This lack of information has made it difficult for managers to provide relevant data and recommendations that could minimize negative impacts of forthcoming offshore wind development (i.e. risk of collision, attraction, and displacement). To help fill these data gaps, the National Audubon Society’s Seabird Institute has been deploying GPS tracking devices on several different seabird species with varying life history strategies since 2021: the Atlantic Puffin (*Fratercula arctica*), three different tern species including the federally endangered Roseate Tern (*Sterna dougallii*), and the Leach’s Storm-Petrel (*Hydrobates leucorhous*). Preliminary findings suggest that exposure to forthcoming offshore wind development will likely vary by species, owing to their diverse foraging strategies, migratory movements, and residency time in the Gulf of Maine. While future mitigation efforts may necessitate a species-specific approach, commonalities such as shared breeding and staging sites will likely create opportunities for a broader community-based conservation effort and help to designate areas of critical importance.

Lightning Talks

Listed alphabetically by last name of first author

Evaluating potential commercial fishing impacts in Attentive Energy One's lease area

Matthew Bingham[1*], Jason Kinnell[1]

1 Veritas Economics

Attentive Energy is currently developing the Construction and Operations Plan (COP) for its Attentive Energy One (AE1) Project. This presentation provides an overview of the commercial fishing evaluation that Attentive Energy is undertaking to evaluate the potential commercial fishing impacts associated with AE1. Commercial fishing occurs within a highly variable system of interconnected environmental, ecological, regulatory, market, and operational conditions. From a vessel captain's perspective, trip outcomes of catch, revenue, and profit can only be approximated, and from the modeling viewpoint, it is only possible to identify probabilities of different behaviors and outcomes. Quantitative economic modeling of commercial fishing requires an approach that accurately incorporates the complexities of uncertain trip outcomes and considers the probabilistic nature of modeling captain behaviors. Attentive Energy is employing a probabilistic modeling approach to evaluate AE1's potential impacts to the surfclam and scallop fisheries—the two commercial fisheries that have accounted for approximately 94 percent of the commercial fishing activity in AE1 over the last 14 years. The model's probabilistic structure explicitly incorporates the uncertain nature of fishing and fishing decisions while providing a robust and feasible way to characterize the multifaceted aspects of commercial fishing. The approach, referred to as a sequential choice simulation model, employs a mathematical representation of the following sequence of decisions involved in scallop and surfclam fishing trips:

1. whether to fish on a particular choice occasion,
2. which fishing area to choose,
3. which route to take to an area,
4. where to fish within an area,
5. when to return to port, and
6. what return route to take.

The presentation discusses both the modeling approach and its application to evaluate potential fishery impacts within AE1's Lease Area.

Enhancing precision in environmental impact assessments: A comparative analysis of LiDAR with alternative methods for assessing collision risk for offshore wind

Cameron Bullen[1*], Laura Jervis[1], Beth Goddard[1], Stephanie McGovern[1]

1 APEM Ltd

The accurate assessment of seabird flight heights around offshore wind farms stands as a critical challenge in wildlife conservation and renewable energy development, with this data being key to inform the collision risk models that are playing an increasing role in construction and operation plans. Two prominent technologies - Laser Imaging, Detection, and Ranging (LiDAR) and photogrammetry - offer distinct advantages in acquiring flight height data over the use of 'generic' data from the literature, as it represents the site-specific environment, albeit with varying levels of accuracy and precision. Historically, seabird flight height data relied on boat-based observers or a calculation-based photogrammetry approach, where seabird flight height is estimated by comparing body length measurement to reference information (often referred to as the 'size-based' method). However, these approaches carry inherent disadvantages. Boat-based data may introduce biases due to the presence of the vessel, impacting seabird distribution and airspace utilisation through attraction and avoidance behaviours. Whilst the 'size-based' flight height methodology encounters fewer distribution biases, data utility is restricted by substantial uncertainty in species reference lengths.

APEM Ltd has been employing LiDAR technology through an aircraft-mounted system alongside high-resolution aerial digital stills cameras, providing an alternative means of gathering precise and accurate flight height data. Having discussed the implementation of this technology at a previous State of the Science workshop, this presentation will compare LiDAR based estimates to alternative methods for assessing collision risk. Using data collected through collaboration with the Marine Directorate under a Scottish Government funded project, this analysis demonstrates the precision disparities between LiDAR-measured seabird flight heights and the 'size-based' approach, emphasising their respective strengths and limitations. Achieving precise seabird flight height assessments is pivotal in reducing uncertainties associated with collision risk assessments. This work underpins a broader endeavour to refine impact assessment methodologies, influencing conservation and sustainable development initiatives. This presentation aims to create a constructive dialogue on the selection between LiDAR and 'size-based' data collection strategies and highlights how integrating these methodologies into existing assessment models holds significant importance in shaping future practices for sustainable development.

Application of hydrodynamic and agent-based modeling techniques in the New York Bight

Sarah Courbis[1*], Henrik Skov[2], Frank Cipriano[2], Josh van Berkel[2], Kathleen Marean[3]

1 Worley Consulting, 2 DHI Group, 3 WSP

The purpose of this project was to develop spatially and temporally dynamic information about the distribution of oceanographic characteristics in the New York Bight through the development and application of a dedicated multi-year three-dimensional (3D) flow model and assess the power of available ecosystem and observational data to predict wildlife distribution and movement, enhancing prediction of when and where sensitive species may occur using dynamic variables.

Project objectives: 1) Develop spatially and temporally dynamic information about distribution of oceanographic characteristics in the New York Bight and surrounding area, 2) Apply a dedicated multi-year 3D flow model to enable integration of available ecosystem (e.g., productivity) and observational (e.g., taxa sightings) data, 3) Support future comparative assessments using available ecosystem and observational data to predict wildlife distribution and use patterns, 4) Identify sensitive model variables and important data gaps

To achieve these goals, data were reviewed for a variety of taxa, and the quality and quantity of data was considered in determining the four representative taxa that were used to demonstrate the Dynamic Habitat Model (DHM) and Agent-Based Model (ABM) techniques: Loggerhead Sea Turtles (DHM), Fin Whales (DHM and ABM), Red-throated Loons (DHM and ABM), and Northern Gannets (DHM).

When reflecting on the sufficiency of data in the New York Bight and surrounding areas for application to DHMs and ABMs, the study showed the following:

- Additional observation data beyond the shelf edge would reduce uncertainty around predictions of habitat use patterns and movements in this zone
- Additional fin whale and loggerhead sea turtle sighting data would improve the predictive accuracy of related DHM results
- In some cases (e.g., loggerhead sea turtle and red throated loon) DHMs that did not apply the predictor data from the Hydrodynamic Model [HDM]), did not perform substantially better than existing static empirical data
- Additional fin whale telemetry data would allow for better calibration and, thus, better performance of the ABM.

This project successfully illustrates that species sighting and survey data can be combined with a regional HDM to elucidate environmental and ecological oceanic drivers through use of integrated ecological models that realistically predict the presence, habitat use, and movements of sensitive species in the New York Bight. The project also uncovered areas where data collection in the New York Bight could be improved in support of this type of modeling. Potentially, further integration with environmental stressor models can provide for the dynamic capture of cumulative impacts associated with offshore wind and other coastal development. This project demonstrates the viability of using dynamic modeling systems which can increase the accuracy of impact analyses and related decision-making.

Drone-based photogrammetry reveals differences in humpback whale body condition across North Atlantic foraging grounds

Chelsi Napoli[1*], Nathan Hirtle[1], Julia E. Stepanuk[1,2], Fredrik Christiansen[3], Eleanor Heywood[1], Thomas Grove[4], Alyssa Stoller[4], Flordespina Dodds[4],Maria Glarou[5], Marianne Rasmussen[5], Lesley Thorne[1]

1 Stony Brook University 2 Biodiversity Research Institute, 3 Aarhus University, 4 Whale Wise 5 University of Iceland, Húsavík

Baleen whales are key consumers in marine ecosystems and can serve as ecosystem sentinels. Monitoring baleen whales before, during and after the construction of offshore wind areas is important to assessing potential impacts of offshore wind. Body condition, defined as an individual's energy stores relative to its structural size, can provide a useful proxy for health in baleen whales. Spatiotemporal variability of body condition of baleen whales can reflect differences in energy accumulated during the foraging season. Understanding spatiotemporal variability in body condition prior to the development of offshore wind can provide a more accurate picture of any future impacts of this development. We assess the body condition of humpback whales (*Megaptera novaeangliae*) across four different foraging areas from the West Indies distinct population segment in the Northwest Atlantic. Morphometric measurements of humpback whales were obtained between 2018 and 2022 using unoccupied aerial systems (UAS, or drones) from the New York Bight, the Gulf of Maine, Iceland, and Greenland. Measurements were used to estimate body volume and calculate a body condition index (BCI) for each individual whale. BCI showed significant differences between foraging areas (ANCOVA: $p < 0.001$). Humpback whales in the Gulf of Maine showed significantly higher BCI than those in the New York Bight, Iceland, and Greenland. Standardized Major Axis (SMA) regressions comparing log-log relationships of body volume to total length reinforced these results, implying that humpback whales foraging in the Gulf of Maine accumulated greater energy reserves for a given body size. Regional differences in prey availability or anthropogenic threats could contribute to the observed patterns in body condition. Our findings highlight the importance of regional environmental factors to the nutritional health of baleen whales. This work provides important context for future studies of baleen whale health in relation to offshore wind development in the Northeast US.

Modeling uncertainty in Great black-backed gull movement in order to accurately quantify risk to offshore wind

Esther Nosazeogie[1*], Kim Lato[1], Julia Gulka[2], Evan Adams[2], Kate Williams[2], Ian Jonsen[3], Lesley Thorne[1]

1 Stony Brook University, 2 Biodiversity Research Institute, 3 Macquarie University

Offshore wind development (OWD) is expanding globally, increasing renewable energy production in response to rapidly accelerating climate change. However, OWD often overlaps with seabird foraging habitats in offshore areas and can pose both direct or indirect risks to these animals, such as collisions with wind turbines and behavioral change (i.e. attraction and displacement). In addition to impacts on horizontal habitat use (latitude and longitude), estimating flight heights of seabirds is important to assessing the risks for seabirds associated with OWD, including collision risk (in relation to the turbine rotor-swept zone) and altitudinal avoidance. Thus, understanding the impacts of OWD on seabirds requires an understanding of seabird habitat use in three dimensions. While GPS tags can provide detailed information on horizontal habitat use, the accuracy of tags in the vertical dimension is often poor. Quantifying and propagating the uncertainty in tag data in both the horizontal and vertical dimensions is critical and necessary for accurately modeling collision risk and making informed management decisions. Here, we quantified the error in the movement data for great black-backed gulls (Larus marinus) off the coast of the Northeast United States, a region of considerable ongoing OWD. We deployed OrniTrack GPS tags on 28 great black-backed gulls using cross-wing harnesses during incubation (May- June) over three years (2021-2023). We fit State Space Models (SSMs) to the data to estimate the true flight height values from observations and to quantify measurement error in the vertical dimension. We report preliminary results of SSMs, along with uncertainty measured, model validation, and estimates of bird positions and flight behavior. We developed a framework for incorporating these uncertainty estimates into risk assessment models for great black-backed gulls and other large seabird species.

Ecological innovations in Dutch offshore wind farm projects: A case study of Shell's contributions

Eldina Salkanovic[1*], Candice Cook-Ohryn[1]

1 Shell Energy

The Dutch North Sea is a hub for offshore wind energy in the Netherlands, playing a significant role in the country's energy transition. The Dutch government has set ambitious targets to reduce the Netherlands' greenhouse gas emissions; these include emission reductions of 45% by 2030 (compared to 1990 levels) and 95% by 2050. In line with the COP15 outcomes and EU Policies on biodiversity, the Dutch government aims to protect and enhance the ecology of the Dutch North Sea.

The government's policy requires offshore wind farms to make demonstrable efforts to avoid and mitigate negative impacts and stimulate positive impacts on the natural environment within the wind farm. This policy has drawn attention from stakeholders within the industry, such as Shell, who have taken active steps to support its realization. This presentation will provide an overview of three Dutch offshore wind farm projects for which Shell is a JV partner: Blauwwind, CrossWind, and Ecowende. It will examine the progression of ecological initiatives incorporated into these wind farms as well as challenges and opportunities presented by integration of initiatives into project design and coordination with internal and external stakeholders.

The initial wind farm, Blauwwind, a collaboration with the Rich North Sea project, initiated an eight-year nature improvement project in 2020, involving the placement of more than 2,400 oysters at the base of four wind turbines to investigate whether oysters can sustainably establish themselves at these sites and examine the potential for attracting new marine life. Next, CrossWind's Hollandse Kust Noord Wind Farm, operational since the end of 2023, has set ambitions to reduce environmental impact in four areas: biodiversity, carbon footprint, circularity, and stimulate co-use opportunity for local communities. The final and third wind farm, Ecowende, the newest joint venture between Shell and Eneco won the highly competitive tender in 2023 due to its strong ecological focus on both investments and innovations and anticipated knowledge dissemination on North Sea ecology. Hollandse Kust West VI wind farm, a part of Ecowende, proposes a suite of measures encompassing the mitigation of negative impacts on birds, bats, and marine mammals, while also stimulating enhancements to the benthic environment and fish species. This overview will illustrate the efforts being undertaken and explored to design offshore wind farms to meet the energy demands of the country while contributing and aiming to enhance the natural environment. With a continued focus on ecology and nature, offshore wind farms can be designed to have a net positive impact on the environment, contributing to a sustainable future for all.

Engineering offshore wind farms to promote nature development

Remment ter Hofstede[1*], Tjeerd J Bouma[2], Mark van Koningsveld[1]

1 Delft University of Technology, 2 Netherlands Institute for Sea Research

Rapid changes are taking place in the marine environment, including the huge roll out of offshore wind farms aimed at renewable energy production. Offshore wind farms modify seascapes by replacing natural habitats and changing environmental conditions critical to habitat persistence. Their designs can incorporate ecological principles that benefit marine life, but achieving impact at scale is challenging. We present the outcomes of an extensive research project, providing insight into the process to identify, select and implement measures to enhance nature in offshore wind farms.

First, we present the results of a dedicated monitoring survey in existing wind farms, demonstrating that their infrastructure indeed contributes to marine biodiversity. Marine life is shown to inhabit the scour protection at the base of the foundation of wind turbines, and the community composition differs from the one living at the surrounding seabed.

Second, the process to further enhance nature within offshore wind farms requires clear operational objectives, in which ruling polices, environmental conditions and the potential for using the infrastructure are aligned. We have developed an approach to support setting such operational objectives, in which stakeholders jointly select the most effective measures to reach shared targets towards effective nature enhancement. The application of the approach is demonstrated for defining operational objectives to conserve and restore the North Sea ecosystem using offshore wind farms.

Third, it is key to define the scale of the interventions needed to achieve overall objectives for nature enhancement of a system. We developed a stepwise procedure to select appropriate measures and to determine their required scale. The procedure provides options for intervention that promote nature at a range of scales, from micro-scale (materials used) to mega-scale (connectivity between systems), and it quantitatively assesses the potential effect of these interventions. We demonstrate the application of the procedure by quantifying potential measures for oyster reef development in offshore wind farms in the North Sea.

Fourth and final, to achieve effective scales in nature enhancement, we plead that scientific insights should be paired with industry-based approaches used for infrastructural development. Consciously connecting science and industry increases the likelihood that marine infrastructure development and improving nature values within a system can be aligned. We substantiate our plea by providing five key principles for successful nature enhancement one should adhere to, each illustrated with an example from practice.

The outcomes of our studies provide guidance for decision-makers to define a management strategy for enhancing ecosystem values in conjunction with the rapid growth in offshore wind energy production.

Evaluating drivers of recent large whale strandings on the US east coast

Lesley Thorne[1*], David Wiley[2]

1 Stony Brook University, 2 National Oceanic and Atmospheric Administration

There is currently considerable public interest in the increased frequency of large whale strandings occurring along the US east coast since 2016, which the US government has deemed an "Unusual Mortality Event" (UME). Interest is accentuated due to a purported link with offshore wind energy development. We review data on strandings, mortalities and serious injuries for humpback whales, the species most frequently involved, along the US east coast. Our analysis highlights the role of vessel strikes, in combination with recent changes in humpback whale distribution and vessel traffic. Humpback whales have expanded into new foraging grounds in recent years. Mortalities due to vessel strikes have increased significantly in these newly occupied regions, which show high vessel traffic that also increased markedly during the UME. Poor humpback body condition and vulnerable surface feeding were likely contributing factors. The construction or operation of offshore wind farms, which consisted of seven wind turbines during this time period, is unlikely to have contributed to strandings or mortalities. This work highlights the need to consider behavioral, ecological and anthropogenic factors in order to understand drivers of mortality and serious injury in large whales and provide informed guidance to decision-makers.

Collating acoustic and visual data for assessing humpback whale presence in the New York Bight: A case study

Sarah G. Trabue[1*], Melinda L. Rekdahl[1], Carissa D. King-Nolan[1], Howard C. Rosenbaum[1]

1 Wildlife Conservation Society

The New York Bight (NYB) is increasingly recognized as an important habitat for several baleen whale species and a variety of research methods have been employed to establish baseline information about the presence, distribution, and habitat use of these large whales. These research methods include passive acoustic monitoring (PAM), boat-based visual surveys, and aerial surveys. However, the results of these studies are often considered in isolation and there is a need to collate results from multiple data streams given the strengths and limitations of each method. For instance, PAM data can be collected continuously and over long time scales, but can only detect animals if they are vocalizing. Visual surveys can detect non-vocalizing animals, but are limited to animals that are at or near the surface and can only collect data during discrete periods of time (i.e., a "snapshot" of species occurrence vs. continuous monitoring using PAM). The value of collating different types of data has been demonstrated in a few studies comparing acoustic and visual data collection methods and comparing the relative detection rate of each method. Additionally, both acoustic and visual detections can trigger Slow Zones by NOAA to alert mariners to the presence of North Atlantic right whales and encourage them to travel at slower speeds, reducing the risk of vessel strike. While it is clear that collating acoustic and visual datasets is invaluable, resources for investigating the relationships between data collected using multiple methods and how to integrate these different data streams have been limited.

Here, we focus on humpback whales (*Megaptera novaeangliae*) as a case study for collating our acoustic and visual datasets to highlight the importance of using multiple data streams to better understand baleen whale occurrence within the NYB. Vessel-based visual observations of humpback whales were collated with weekly acoustic presence from passive acoustic recordings to examine spatiotemporal trends in humpback whale presence and behavior to build a more complete overview of seasonal and annual trends in humpback whale detections and occurrence in the NYB. Humpback whales have been increasingly sighted in the NYB, with foraging as the most common behavior documented, suggesting the NYB may serve as a supplemental foraging ground for humpbacks. Overlap in humpback whale occurrence and human activity in the NYB can lead to increased risk of potential impacts to these animals, including vessel strikes and noise exposure, which are particularly concerning given the ongoing humpback whale Unusual Mortality Event (UME). Considering the ecological importance of the NYB as a potential supplemental feeding ground for humpbacks, this presentation provides a more complete picture for humpback whales and highlights the benefits and limitations associated with various monitoring approaches for large whales in the NYB, especially in the context of offshore wind development.

Pre-construction monitoring of hydrography, copepods, other zooplankton, fish, and other nekton at the Sunrise Wind lease area

Joe Warren[1*], Monique Escalante[1], Hamdy Abo-Taleb[1], Delaney Costante[1], Dean Hernandez[1], Toniann Keiling[1]

1 Stony Brook University

Zooplankton, particularly copepods, are a key food source for a variety of commercially- and recreationally-important fish as well as other higher trophic level predators. However, distributions of these animals are highly variable for a variety of reasons including (but not limited to): prey availability, physical oceanographic processes, predation pressure, and zooplankton behavior. Thus it can be challenging to assess their abundance and distribution and how these may change due to other factors including anthropogenic activities at wind energy development sites. Using a combination of traditional vessel-based sampling techniques (CTD hydrographic profiles, ring net tows, multi-frequency fishery echosounders) we have conducted seasonal surveys from 2022 to the present at two areas (control, Sunrise Wind development site) in order to assess differences in: water column structure and organism (zooplankton and fish) abundance; and how they vary between sites and across space, seasons, and years. Complementary to the vessel sampling, we deployed a multi-frequency (38, 200, and 333 kHz), broadband, upward-looking scientific echosounder on the seafloor at the wind development site which provides full water column coverage at multiple temporal scales over several months (or years depending on when our recovery/turnaround trip occurs this summer). These data provide an invaluable baseline dataset that can be used (with continued sampling) to assess the lower trophic level impacts of wind energy construction and operation activities.

Sampling offshore bat activity with an uncrewed surface vehicle

Michael Whitby[1*], Gabriel A. Reyes[2], Trevor S. Peterson[3], Donald I. Solick[4], Christian M.Newman[4]

1 Conservation International, 2 US Geological Survey, 3 Stantec, 4 EPRI

The United States is aggressively promoting the development of offshore wind energy capacity along the U.S. West Coast. Terrestrial wind energy development is known to cause widespread and considerable bat mortality, particularly among long-distance migratory species during the fall. The cumulative impacts of mortality caused by land-based and offshore wind energy could threaten some species with rapid population declines and potential extinction. Research to inform the patterns and extent of bat use of the offshore environment to help the wind energy industry and regulatory agencies assess and mitigate potential impacts to bats is often limited by the ability, or lack thereof, to sample bats in the offshore environment. The project team worked with Saildrone, Inc to mount and waterproof an SM4 detector with a U2 microphone to a Saildrone Explorer vessel. Saildrone, Inc operates a fleet of Uncrewed Surface Vehicles (USV) that serve as a platform for a wide variety of scientific sampling instrumentation. The Explorer vessels operate with solar and wind and offer a quiet carbon-free sampling platform. The USV sampled around Southeast Farallon Island in September 2023. Southeast Farallon Island is a known stopover point for hoary bats (Lasiurus cinereus) during the autumn and provided an opportunity to confirm detection ability when bat presence was confirmed on the island. The detector operated from September 1 until the vessel was recovered on October 4th. The detector was inspected by Saildrone upon retrieval and no damage or water intrusion was observed. We recorded 1,375 files during the mission. Sonobat filtering determined that 544 (39.6%) were noise and 831 files included bat echolocation calls. SonoBat identified 15 big brown bats, 111 hoary bats, 48 silver-haired bats, and 164 Mexican free-tailed bats (total = 338 bats). Bats were recorded across most of the sampling area and across the entire sampling period. The use of USVs to sample bats provides an opportunity to pair bat activity sampling with other sampling efforts and expand knowledge about bat activity in the offshore environment.

A framework for monitoring ecosystem effects and impacts to ocean users of floating offshore wind infrastructure

Casey Yanos[1*], Carl Wilson[1], Rebecca Peters[1]

1 Maine Department of Marine Resources

With climate change accelerating in recent years, the demand for renewable energy sources to decrease our reliance on fossil fuels has increased drastically. Focus has been placed on offshore wind (OSW) as an alternate energy source. OSW farms are still few in the United States and therefore there is a great deal of uncertainty around which resources will be impacted and to what extent. The State of Maine's floating offshore wind research array (MeRA) provides a unique opportunity to study potential impacts of novel floating wind energy technology on ocean resources and users. Biological surveys will be conducted within MeRA and across multiple concentric strata extending outward from the turbine area to achieve a before-after-gradient sampling design. The strata cover gradients of depth, habitat, and reported intensity of use by commercial and recreational fishing industries. The strata are further divided into three regions (Northern, Southern, and Western) with unique bottom characteristics and geological features. All biological studies will consist of at least five years of pre-construction surveys as well as surveys during and after construction for the lifespan of the array to address fundamental questions of pre- and post-construction ecosystem function that need to be understood. Pre-construction surveys will be conducted to gather baseline data to better understand local oceanographic conditions, resource abundance and distribution, and relationships between resources and ocean conditions. This information can then be compared to the data collected on the same resources, conditions, and relationships throughout the construction and operation phases of MeRA to understand if/how conditions, abundances, distributions, and/or relationships change due to these activities. Data can also be used to understand if/how any direct changes to resources/conditions impact other resources/conditions indirectly. The area is characterized by fine grain mud and is often referred to as a transitional area with connections to inshore and offshore species/fisheries including lobster and groundfish, respectively. Further, many species inhabit the area at various times of the year. MeRA provides an opportunity to gather knowledge on this specific habitat while also serving to create frameworks for similar efforts in other areas in the future. The impact of MeRA to fishing activities will be addressed with a comprehensive anthropological study of current and past use of the area by commercial and recreational fisheries. The study will serve to create a framework for collecting baseline data for use in future studies of impacts of OSW farms on fisheries and communities that rely on these resources. Here we will present the biological and anthropological frameworks as well as initial results from our first year of studies.

Symposia

Building sustainable offshore wind futures through collaborative research programmes

Organizers: Olivia Burke, Carbon Trust; Ivan Savitsky, Carbon Trust; Katy Bland, NERACOOS; Emily Shumchenia, RWSC; Lyndie Hice-Dunton, National Offshore Wind Research and Development Consortium; Mike Pol, ROSA

The development of offshore wind energy has the potential to create local supply chains, green jobs, economic growth, and support transition to a net-zero future. Despite these potential benefits, uncertainties exist regarding specific economic, social, and environmental impacts, necessitating further research. Collaborative programmes provide a well-tested approach to delivering impactful research, tackling a range of issues such as cost reduction, technology, sustainability and environmental impacts. In this panel, we will explore the concept of collaborative programmes in practice (case study presentations) and discuss how these programmes are coordinating and collectively driving meaningful interactions between offshore wind developers and other co-uses of the marine space.

Case study presentations will show the range of collaborative models available (with examples in US context as well as Europe). The symposia will create an opportunity to consider optimization between these models.

The audience will learn why collaboration (and specifically well-designed programmes) can be impactful/beneficial;

1. A model to bring diverse ocean users and stakeholders, including communities, private and public sector together to communicate and coordinate in a transparent manner that encourages constructive discussions and a targeted way to address priorities through robust research
2. Expert support to build a strong and future-proof industry - Delivering market-appropriate technical assistance that is addressing the highest priority environmental and social issues, to build an equitable industry that provides benefits to rate payers
3. Supporting the organised delivery of funding - Coordinating, supporting and leveraging funds to commission research and avoid duplication in activities
4. Avoiding problems and unnecessary delays to offshore wind development - Addressing concerns and developing appropriate mechanisms to support communities in collaboration with those affected, creates steps towards positive engagement and the acceptance of change
5. Cross-border collaboration - this session will introduce programmes that demonstrate collaboration to conduct research. We also plan to discuss opportunities to collaborate internationally, detailing success stories from 2024 and identifying opportunities for coordination of research to benefit multiple markets.

State of the policy: How delivering biodiversity positive outcomes in the marine environment requires the interface of science and policy

Organizers: Tricia Jedele, The Nature Conservancy
Speakers: Marta Ribera, The Nature Conservancy; Anthony Dvarskas, Ørsted; Emily Shumchenia; Regional Wildlife Science Collaborative; Joel Southall, RWE; Shayna Steingard, National Wildlife Federation; Kate McClellan Press, New York State Energy Research and Development Authority

The pace and the scale of offshore wind development in the United States and in the North Sea has focused increased attention of policymakers to ensure not only that siting and construction impacts are avoided, but also to go beyond "no net loss" at a project level by choosing approaches that contribute to global biodiversity goals. This concept of adding value to the marine environment is sometimes referred to as "net positive impact on biodiversity (NPI)." The successful implementation of this concept at a project requires the application of consistent, credible, science-based approaches and regulatory/policy commitments that incentivize and support NPI strategies.

The goals for this session are to define what NPI means in the offshore wind context, to serve as a forum to synthesize NPI-related information from other State of the Science symposia, to support the interface of science and policy by discussing how the policies that are unfolding (in the US and the UK) support NPI objectives, and to discuss how spatial tools might be used to verify the identification of priority species and habitats and the strategic selection of mitigation in service to NPI goals.

Opening Presentation: Define what NPI means in the offshore wind context? Provide a description of the NPI-related policy work that is evolving in the US, the UK and globally (specifically: Development of NPI Principles/Call to Action by the UN Global Climate Compact; the launch of the proposal for a Marine Recovery Fund in the UK (the suitability of the RWSC to this purpose) and the ongoing development of a marine net gain policy; the evolution of non-price criteria state level procurements; non-cash bidding credits for conservation in the BOEM leasing process.

Panel presentations with short overviews and Q&A: Each panelist will provide a 5-minute overview of her/his work in the NPI space before responding to audience questions for approximately 10-15 mins. Following the next session, entitled, State of the Science: The Applications of Compensatory Mitigation and Voluntary Conservation Measures to Achieve No Net Loss or Net Gain to Birds Impacted by Offshore Wind Energy Projects, members from the State of the Policy panel will participate in a joint 30 minute facilitated discussion with members from the State of Science panel on compensatory mitigation and biodiversity positive (science and policy) approaches in the marine environment.

Progressing towards an integrated ecosystem-cased approach to assessing environmental impacts of offshore energy development

Organizers: Jacob Levenson, Jennifer Bosyk, Jennifer Le, Stephannie Webb, Bureau of Ocean Energy Management
Speakers: Beth Fulton, CSIRO; Andrew Lipsky, Howard Townsend, National Oceanic and Atmospheric Administration

The Bureau of Ocean Energy Management's (BOEM) environmental programs are charged with evaluating the environmental impacts of management decisions. Frequently, environmental assessments of the U.S. Outer Continental Shelf (OCS) occur at spatial and temporal scales that render evaluation of BOEM's objectives and responsibilities challenging and limit capacity for avoiding conflict between competing interests and mitigate risk. However, BOEM has prioritized transitioning from environmental assessments that consider socio-ecological resources in isolation to those that consider the interconnectedness of human-nature marine systems and better characterize the way environmental impacts affect the ecosystem as a whole.

Ecosystem-based management (EBM), which encompasses multiple stakeholders, is a process that integrates biological, social and economic factors into a comprehensive tool for environmental management. Integrated ecosystem assessment, a form of applying EBM to the assessment of environmental impacts, can support effective planning for energy development on the OCS. Effective and comprehensive planning can aid in mitigating environmental, ecological, and economic impacts and maximizing responsible stewardship and informed decision-making. Ultimately transitioning to an integrated ecosystem-based assessment approach for the management of the OCS resources under BOEM's purview can help drive more equitable policies for ocean users, foster ecological resiliency, and identify management options that work to balance competing ocean uses.

BOEM proposes gathering a panel of experts from various institutions (e.g., BOEM, NOAA, and academic partners) to share developments in the available modeling tools used in forecasting environmental impacts, as well as presenting relevant case studies at the interface of science and resource management. BOEM would facilitate a workshop where participants share their challenges, failures and strategies for advancing EBM. Discussion topics will include 1) challenges and limitations in the adoption of ecosystem-based modeling into existing statues, 2) physical and biological interactions and changes in ecosystems across trophic levels in response to offshore wind and other stressors, and 3) will examine how machine learning and its utility can help identify management options that minimize immediate and deferred environmental impacts and maximize the immediate and future benefits.

Lessons learned from collaborative efforts to develop fisheries and benthic monitoring plans for offshore wind farms

Organizers: Jennifer Dupont, Equinor; Brian Gervelis, INSPIRE
Speakers: Sarah Borsetti, Rutgers University; Julia Livermore, Rhode Island Department of Environmental Management; Annie Murphy, INSPIRE; Dave Bethoney, CRFR; Dara Wilber, INSPIRE

This session will address the challenges and realities of developing and executing Fisheries and Benthic Monitoring Plans (FBMP) that are aligned with the 2019 BOEM recommendations for renewable energy development. These recommendations include that plans should aim to document the baseline distribution and abundance patterns of dominant species and habitats and quantify potential impacts from offshore wind farm (OWF) operation. Session participants represent government, non-government, and industry stakeholders who have experience designing and executing fisheries and benthic surveys, analyzing/interpreting survey results, and coordinating with the appropriate agencies and stakeholders in these surveys. A positive outcome of the session will be to improve communication and strategies for aligning survey designs, improve data compatibility, and attain regional results.

Presentations will include:

- **Julia Livermore** – Julia will discuss Rhode Island state perspectives on fisheries and benthic monitoring, including their role in state permitting and the value of data sharing. She will also describe work being done in state waters on the Revolution Wind Farm cable route and insight gained from the survey design.
- **Dave Bethoney** – Dave will discuss the challenges and solutions in executing monitoring plans. His discussion will center around experiences from southern New England monitoring conducted by the Research Foundation. Examples of challenges and solutions will focus on survey adaptation, engagement of the fishing industry, and protected species issues.
- **Sarah Borsetti** – Sarah will discuss challenges and recommendations for fisheries monitoring of offshore wind farms based on his experiences conducting surveys off New Jersey. This talk will emphasize lessons learned with regards to survey design, permitting and protected species issues, health, safety, and environmental (HSE) considerations, collaboration with the fishing industry, and database management for regional consistency.
- **Dara Wilber** – Dara will discuss how survey designs influence study outcomes by giving examples from fisheries monitoring at Block Island Wind Farm. Critical design components include choice of sampling gear and reference site locations. Stakeholder input into survey designs creates buy-in but may limit the interpretation of results. Lessons learned and applied to subsequent FMP designs will be discussed.
- **Annie Murphy** – Annie will discuss the requirements and challenges when surveying benthic habitats and introduced hard structures. Marine biota will rapidly colonize these structures with cascading ecosystem level effects, particularly for the surrounding soft sediments. As the need for benthic surveys grows, 1) standardized surveys will facilitate regional scale assessment of cumulative effects, and 2) multi-purposed surveys will increase efficiency.

Presentations will be followed by a 30-minute panel discussion moderated by EJ Marohn

Offshore Wind Fisheries Monitoring Plan Development, Implementation, & Evolution Discussion Session

Organizers: Renee Riley, Mike Pol, Responsible Offshore Science Alliance

The Responsible Offshore Science Alliance (ROSA) has held a series of coordination sessions to discuss the development, implementation, and evolution of offshore wind fisheries monitoring plans. Sector-specific sessions were conducted to give individuals a neutral space to collaborate, to gather information and document concerns and outstanding questions, to identify potential solutions, and to encourage collaboration. The goal, in part, of these sessions was to characterize challenges and solutions, and to understand through what role ROSA could play to best serve the community as it develops regional monitoring strategies.

ROSA has distilled the outcomes of these sessions into a draft report that will be used to update ROSA's Offshore Wind (OSW) Project Monitoring Framework & Guidelines and inform the Strategic Plan for the organization. The State of the Science Workshop brings together multiple stakeholders, and this side meeting offers an opportunity for discussion of the outcomes across sectors, including developers, regulators, researchers and fishing industry representatives.

ROSA will present the draft results of the discussions to date, and lead a group discussion of the lessons learned. and increase the possibility of attendance beyond the 20-person room capacity.

The use of acoustic telemetry for monitoring the effects of offshore wind development along the US east coast

Organizers: Chris Sarro, Greg DeCelles, Orsted
Speakers: Bradley Peterson, Stony Brook University; Keith Dunton, Monmouth University; Michael Frisk, Stony Brook University, Matthew Sclafani, Cornell University

Acoustic telemetry is an effective, widely used tool to examine animal behavior, distribution and movement in the marine environment. The development of offshore wind along the east coast of the US will introduce electromagnetic fields into the water column from energized cables and alter existing habitats from the introduction of foundations and cable and scour protection. These changes could affect fish and invertebrates in the project areas. Orsted Region Americas, other offshore wind developers, and federal agencies are funding acoustic telemetry acoustic telemetry studies aimed at monitoring the large-scale movement, residence, and fine-scale area usage of tagged individuals in and around the project areas. The studies are focused on species of commercial, recreational, and ecological importance that have been identified as monitoring priorities in the Northeast. This session will provide an overview of some of these projects and discuss their challenges, results and successes.

Goal: To highlight how acoustic telemetry is being used to monitor changes in behavior, distribution and movement of marine fish and invertebrate species in response offshore wind development. Also to highlight challenges posed by various ocean users and what lessons learned can be applied to future acoustic monitoring work.

Session Plans: Individual presentations by the panel members to discuss their projects followed by a facilitated panel discussion and audience questions.

How to achieve net gain for birds from offshore wind energy development: compensatory mitigation and voluntary conservation measures

Organizers: Holly Goyert, Kate Williams, Evan Adams, Wing Goodale, Biodiversity Research Institute; Kim Peters, Orsted; Caleb Spiegel, Scott Johnston, U.S. Fish and Wildlife Service

The rapid pace of offshore wind energy development in the US has resulted in uncertainty surrounding its effects on birds. Since 2023, offshore wind energy projects have been required to offset estimated take of birds listed under the Endangered Species Act, via compensatory mitigation. Developers may additionally choose to implement voluntary conservation offsets to meet internal net positive biodiversity goals. However, a guidance framework on how to link estimated take to either required mitigation or voluntary offsets has yet to be developed for the offshore realm. A Memorandum of Understanding between the US Fish & Wildlife Service (USFWS) and Bureau of Ocean Energy Management (BOEM) identifies the agencies' commitment to offset migratory bird mortalities offshore. Yet the Endangered Species Act Compensatory Mitigation Policy, issued in 2023 by the USFWS, is limited to a goal of no net loss to listed species. Net gain approaches may provide a solution to handling uncertainty surrounding the effects of offshore wind energy on both listed and non-listed birds, by buffering against unforeseen circumstances. This symposium aims to identify existing research efforts that integrate impact assessment with compensatory mitigation and/or voluntary offsets. The objective is to provide examples of methodologies and potential metrics that may be used to estimate no net loss and net gain.
The symposium will include invited presentations by five panelists, followed by audience questions. Presentations are expected to include:

- Introduction: State of the Science: The Applications of Compensatory Mitigation and Voluntary Conservation Measures to Achieve No Net Loss or Net Gain to Birds Impacted by Offshore Wind Energy Projects (Holly Goyert, Biodiversity Research Institute)
- USFWS approaches to compensatory mitigation, and considerations on net gain strategies (Scott Johnston, USFWS)
- Conceptual overview of the methods available to quantify compensation (Aspen Ellis, University of California at Santa Cruz)
- Applications of identifying offsite offsets and acceptable levels of impact from collisions with onshore wind energy in emerging markets (Dave Wilson, The Biodiversity Consultancy)
- Habitat and resource equivalency analyses as potential approaches for net-positive biodiversity estimation (Anthony Dvarskas, Orsted)
- Research to underpin policies designed to offset impacts from offshore wind and achieve net gain in the UK (Kate Searle, UK Centre for Ecology and Hydrology)

Following presentations, there will be a 15-minute Q&A session to answer audience questions. A facilitated panel discussion will then integrate a selection of speakers together with the prior symposium on the "State of the Policy," to discuss the "State of the Science" on compensatory mitigation and biodiversity positive approaches in the marine environment.

Implementing a bird and bat tracking research framework with the Regional Wildlife Science Collaborative for Offshore Wind

Organizers: Pam Loring, Nate Fuller, U.S. Fish and Wildlife Service
Speakers: Kate Williams, Biodiversity Research Institute; Autumn-Lynn Harrison, Smithsonian

Large-scale offshore wind energy development is underway in the U.S., with stakeholders across sectors working collaboratively to help meet national renewable energy goals and mitigate environmental impacts. Impacts to wildlife from offshore wind energy development and operational activities include direct mortality (e.g., collision), behavioral change (e.g., displacement), and habitat alteration. For volant (flying) taxa, such as birds and bats, individual-based tracking studies provide movement data used to estimate exposure to wind projects and associated risk factors. Collaboration across tagging studies is essential for optimizing resource use, maximizing human and animal safety, and producing the best available science for offshore wind planning and monitoring at site specific and regional scales.

The Regional Wildlife Science Collaborative for Offshore Wind (RWSC) was cooperatively established in 2021 and is led by four Sectors (federal agencies, states, environmental non-governmental organizations, and the offshore wind industry) to support research and monitoring for offshore wind in the U.S. Atlantic. The recently released RWSC Science Plan identifies coordination of methods, tag deployments, data, and analysis across bird and bat tracking projects in the U.S. Atlantic as a high priority. A Bird and Bat Tracking Research Framework was developed to address this priority. This symposium will provide a forum for information sharing and facilitated discussions of current progress and objectives, including advancing collaboration, prioritizing species and geographies for tag deployment, centralizing and leveraging resources, coordinating data and analyses, and disseminating information. The workshop will also include presentations highlighting current examples of collaborative tag deployment research and demonstrations of new tools being developed to facilitate analysis of offshore movement data.

Perspectives on collision risk models around the globe

Organizers: Evan Adams, Andrew Gilbert, Holly Goyert, Kate Willams, Biodiversity Research Insitute; Aonghais Cook, The Biodiversity Consultancy; Pam Loring, U.S. Fish and Wildlife Service; Julie Miller, The Scottish Government

Collision risk models (CRMs) have been a tool for avian risk management at wind farms for over 40 years. Fatality estimates from these models have been incorporated into permitting and risk mitigation processes in various ways. In the United States, CRMs have been used to assess permitting decisions and estimate potential take from endangered species, while in the United Kingdom, these estimates are used in the permitting and consenting process to assess whether proposed projects will have acceptable magnitudes of impact on bird populations. As the industry has expanded, the range of analytical approaches for CRM has diversified. Consequently, it is valuable for offshore wind stakeholders to understand 1) how collision risk estimates from these models are derived, 2) how they are used in a regulatory context in different jurisdictions, 3) limitations in current approaches, and 4) areas where additional model framework development or validation could improve risk management for the industry and improve conservation outcomes for birds. To address these questions, this symposium will compare approaches for using CRMs in several jurisdictions (United States, United Kingdom, and Australia). First, we will describe the current state of CRMs, how they have developed, and what kinds of models are used worldwide. Second, we will discuss how CRMs inform conservation and regulatory decisions. Third, we will have a moderated discussion to identify needed next steps for CRMs and their implementation within regulatory decision-making processes.

The continued role of acoustics in marine life monitoring and mitigation for the offshore wind industry

Organizers: Sharon Whitesell, Kim Peters, Ørsted
Speakers: Joe Warren, Stony Brook University; Vince Premus, Thayer Mahan; Susan Parks, Syracuse University

Monitoring changes to marine life is important to understand any potential impacts that may result from offshore wind development, as well as how to mitigate those impacts effectively to ensure no long-term harm to marine species populations. . One of the methods used frequently to both gather data and mitigate is acoustics. Acoustic monitoring can include both passive and active methods and is a tool frequently used to monitor vocal species such as marine mammals but can also be used to monitor other taxa such as plankton and fish populations. As technology progresses and new and novel techniques emerge, it is important to evaluate the effectiveness of current and new tools. The goal of this symposium is to showcase acoustic monitoring techniques and applications currently being used, discuss some of the successes and challenges to using these methods, and examine how the technology is developing. The symposium seeks to explore what is on the horizon and how acoustic monitoring can continue to benefit responsible development of offshore wind.

RWSC Science Plan implementation in 2024 and beyond

Organizers: Emily Shumchenia, Christian Laspada, Regional Wildlife Science Collaborative
Speakers: Samantha Coccia-Schillo Regional Wildlife Science Collaborative; Deborah Brill, Duke University; Sue Barco, Regional Wildlife Science Collaborative; Jordan Katz, National Oceanic and Atmospheric Administration; Nikelene Mclean, Regional Wildlife Science Collaborative

Earlier this year, the Regional Wildlife Science Collaborative for Offshore Wind (RWSC) released the first plan for coordinating regional offshore wind and wildlife research and data collection on the U.S. east coast ("Science Plan"). RWSC is now turning its attention to providing a forum for discussions about how to implement the coordinated research that the Plan recommends. Each RWSC Subcommittee is advancing some of the Science Plan's recommendations, and RWSC is initiating an Offshore Wind and Wildlife Research Fund that will support larger and longer-term projects. In this symposium, RWSC will provide an overview of recent progress implementing Science Plan recommendations and developing the Research Fund. Representatives from each expert Subcommittee will provide updates on progress addressing Science Plan recommendations and present each Subcommittee's recommendations on urgent research needs for 2024-2025. This symposium will inform RWSC partners and participants and prepare them for RWSC's upcoming annual research funding strategy meeting in September 2024.

Presentations will include:

- Brief session introduction: Emily Shumchenia
- Regional long-term archival passive acoustic monitoring coordination and standardization, Debbie Brill
- Urgent data collection needs for sea turtles, Sue Barco
- Acoustic telemetry coordination among RWSC, ROSA, and ACT, Jordan Katz
- Regional bird and bat monitoring coordination, Zara Dowling
- Synthesizing oceanographic and seafloor habitat data to create a regional picture, Nikelene Mclean

Presentations will be followed by a panel discussion of cross-cutting research and coordination needs including Data Governance, Technology, Research Planning Map/Tool development

New York, New York: The interface between science and offshore wind policy in a dynamic ecosystem

Organizers: Howard Rosenbaum, Wildlife Conservation Society; Jennifer Dupont, Equinor
Speakers: Melinda Rekdahl, Wildlife Conservation Society; Carissa King-Nolan, Wildlife Conservation Society; Mark Baumgartner, Woods Hole Oceanographic Institute

The New York Bight (NYB) supports a diverse array of marine life, and shifts in species distributions are occurring with potential links to climate change. There is an urgent need for continued monitoring of species distributions within this dynamic environment, using the best available science to inform policy and management strategies. This is particularly important for mitigation and monitoring to protect marine wildlife as offshore wind (OSW) construction ramps up in the NYB, an already human-dominated region. WCS/WHOI and Equinor are working in partnership using near real-time and archival acoustic monitoring (PAM) effort in the Empire Wind area. This project provides an invaluable long-term, archival dataset (2016-2024, continuing to 2029). The near-real time capabilities are vital for monitoring change over time and informing mitigation approaches even prior to OSW energy development (e.g., NOAA Slow Zones). The symposium provides a broadscale perspective, including more than 8+ years of PAM in Empire Wind for four large whale species. Targeted project results for small and large cetaceans include discussion on how collaboration between researchers and developers has improved the use of our science and how our work can inform policy for monitoring, mitigation, and the development of best management practices for OSW energy development.

Project WOW – An update on project results and plans

Organizers: Doug Nowacek; Duke University; Kate Williams, Biodiversity Research University; Xiaoqin Zang, Pacific Northwest National Laboratory; Susan Parks, Syracuse University; Howard Rosenbaum, WCS

This session will feature updates and plans from the Wildlife and Offshore Wind Project (WOW), which is co-funded by the Department of Energy and the Bureau of Ocean Energy Management. The goal of the session is to update the community on the work conducted during the first two years of the five-year WOW Project. Presentations include:

- Kate Williams will present the paper 'Using seabird tracking efforts to inform risk to offshore wind developments' which will discuss the WOW efforts tagging great black-backed gulls and northern gannets. Our results are preliminary as we have more tagging efforts planned, but the initial results point to some very important behavior by the birds.
- Howard Rosenbaum will present a paper titled 'Behavior and movement of baleen whales off the NY/NJ coasts' which will report data from satellite-linked tags attached to humpback, fin, and minke whales in the vicinity of offshore nearby wind lease areas. Additionally, this talk will present results from various efforts focused on measuring the behavior (e.g., foraging) of these baleen whales.
- Joe Haxel will present 'Using transmission loss models to aid in placement and analysis of fixed PAM assets. This paper will discuss results of noise transmission loss (TL) models run for PAM locations in the WOW integrated regional ecosystem study locations. Understanding the local TL supports numerous aspects of PAM efforts from placement of sensors to localization analyses.
- Saana Isojunno will present 'Gap analyses and risk assessment functions for the planning and analyses of wildlife data'. Saana will present some of the year-one WOW efforts that explored gaps in research on wildlife and offshore wind. Additionally, WOW has constructed risk assessment functions to assist in the planning and management of these activities.
- Susan Parks will present 'Acoustic and diving behavior of fin whales tagged in southern New England waters with multi-sensor acoustic recording tags'. Susan's paper will present the preliminary analyses of data from the nearly 30 fin whales tagged with suction cup attached multi-sensor tags. The results include initial insights into the acoustic activity and the swimming/diving behavior in waters immediately adjacent to active offshore wind construction activities.

The session will include introductory remarks from Nowacek, there will be brief Q&A after each presentation, and then there will be at least 20 minutes for Q&A and discussion after the talks have concluded.

Bats and offshore wind: Addressing three critical needs for effective management

Organizers: Nate Fuller, U.S. Fish and Wildlife Service; Jeff Clerc, Laura Dempsey, National Renewable Energy Laboratory
Speakers: Michael Whitby, Bat Conservation International; Trevor Peterson, Stantec

"Given the population-level impacts of wind facility operation on bats at land-based wind facilities, there is an increasingly urgent need to understand if and at what scale offshore wind generation will affect bats in offshore environments. Tree bats are known to use coastal habitats as migratory pathways and hibernating bat species have been recorded offshore. However, there are considerable knowledge gaps in bat natural history (e.g., distributions, seasonality, migratory patterns), the potential effects of wind facility operation (e.g., collision, displacement), and if necessary, minimization approaches, that we must address to effectively manage bat populations.
This session will focus on three broad categories of critical research needs: natural history, anthropogenic effects, and minimization. Our goal is to address the current state of the science for each category through speakers with first-hand knowledge and experience in each topic. We anticipate speakers to present a mixture of empirical data and modeling techniques to drive discussion toward strategies (methods, partnerships, etc.) to address knowledge gaps.

- Natural history
  - What are the spatial and temporal patterns of bat distribution and abundance?
  - At what scale(s) can we understand migratory movement and pathing?
  - Developing modeling approaches to understand drivers patterns of connectivity and resistance
- Anthropogenic effects
  - What are the direct and indirect effects of turbine construction and operation and how do we reliably measure these?
  - Measuring requires innovations for sensor fusion
  - Are offshore platforms a resource?
- Minimization
  - Where are the opportunities for innovation?
  - What minimization techniques may be feasible?
  - Spatial and temporal scale of assessing risk
- Currently funded efforts – Where do we go next?"

Poster Abstracts

Abstracts are listed alphabetically by last name of first author

Cold pool stratification influences on commercial species dynamics in the Mid-Atlantic Bight

Samantha Alaimo[1*], Josh Kohut[1], Daphne Munroe[1], Bill Bright[2], Jeff Brust[3], Colleen Brust[3], Jeff Kaelin[4]

1 Rutgers University, 2 Captain, F/V Retriever, 3 New Jersey Department of Environmental Protection, Marine Resources Administration, 4 Lund's Fisheries

The Mid Atlantic Bight (MAB) is a dynamic ocean region with strong seasonal cycles. Thermal variability in the MAB is dominated by a distinctly cold, nutrient-dense, “pocket” of bottom water that forms annually known as the Cold Pool. The timing of the annual Cold Pool spring formation, summer intensification, and fall breakdown can all vary from year to year. This interannual evolution of the MAB Cold Pool supports ecological services for a variety of commercial and recreationally targeted species, including the summer flounder (Paralichthys dentatus), striped bass (Morone saxatilis), and spiny dogfish (Squalus acanthias).

With offshore wind development occurring in the Mid-Atlantic region in the coming years, many proposed wind lease areas overlap with commercial/recreational fishing grounds and the Cold Pool. To isolate the ecosystem effects of offshore wind, the community must first comprehend how the ecosystem functions prior to construction. The baseline interactions between the seasonal evolution of the stratification associated with the Cold Pool and the ecology must serve as context to any changes observed during and after construction of these offshore facilities.

This research will examine the relationships between commercially and recreationally relevant species with the seasonal dynamics of the MAB Cold Pool. The summer flounder, striped bass, and spiny dogfish were identified at the recommendation, through personal communication, of a variety of fisheries stakeholders including scientists, state government officials, and members of the fishing industry itself. The species were selected for this proposed work based on their known association with Cold Pool formation and breakdown processes in the spring and fall seasons, respectively, and their economic importance to the region.

The New Jersey Department of Environmental Protection's Ocean Bottom Trawl Survey contains fisheries and oceanographic data sampled across all seasons for ~30 years (1990 to 2019). In conjunction with an ocean model, this research assess whether (1) the nearshore species abundance changes over decadal time is consistent with decadal changes in seasonal stratification associated with the Cold Pool and (2) the seasonally dependent distribution shifts can be explained by changes in the timing of Cold Pool setup, intensification, and break down. Results of this work will provide information on the spatial distribution of habitat and oceanographic features by exploring the link between seasonal Cold Pool dynamics and decadal distribution trends of summer flounder, striped bass, and spiny dogfish.

Offshore bats in the Mid-Atlantic: Seasonal and circadian activity patterns and behavioral classification

Eran Amichai[1]*, Greg Forcey[1], Michelle Vukovich[1], Julia Robinson Willmott[1]

1 Normandeau Associates, Inc.

The accelerated development of offshore wind energy production and its potential impact on bats and birds is highlighting a major knowledge gap about bat presence and behavior – how much are bats present in the offshore environment and what do they do there?

Using our unique Acoustic and Thermographic Offshore Monitoring system (ATOM™), deployed on two Coastal Virginia Offshore Wind (CVOW) pilot turbines located 23 nautical miles (42 km) offshore Virgina, we have monitored and characterized bat presence offshore throughout the year and around-the-clock, through thermal imagery, HD video, and acoustics.

The first two years of this three-year project have been analyzed, and the results so far are intriguing: three species have been identified in our data, all migratory tree-roosting bats: hoary bat, Eastern red/Seminole bat, and silver haired bat. Bats show a very strong seasonal pattern with the vast majority of detections occurring during the fall (late August to early November) and are probably associated with fall migration. Interestingly, we recorded significant activity during daylight hours, and that was correct for all species. We have recorded significant foraging activity, both aerial hawking and gleaning off the tower. In many instances bats were present while turbine blades were moving, and while we documented macro-avoidance behavior and a few air-displacements we never documented a collision.

Our results highlight the need for increased monitoring efforts offshore, using innovative and complementary methods to better understand bats presence, behavior, and their drivers in the offshore environment, especially in light of the expected increase in offshore wind facilities in coming years.

Underwater noise monitoring during construction of the first four offshore wind farms in the U.S.

Kristen Ampela[1*], Anwar Khan[1], Y-T Lin[2], Derek Buffitt[3], Arthur Newhall[3], James Miller[4], Gopu Potty[4]

1 HDR, Inc., 2 University of California San Deigo, 3 Woods Hole Oceanographic Institution, 4 The University of Rhode Island

Underwater noise monitoring was conducted during construction pile driving at the first four offshore wind farms built in the U.S.: Block Island Wind Farm (BIWF), Coastal Virginia Offshore Wind (CVOW) Pilot Project, South Fork Wind Farm (SFWF), and the Vineyard Wind 1 (VW1) Offshore Wind Energy Project. Monitoring was conducted under the Department of Interior's Bureau of Ocean Energy Management's Real-Time Opportunity for Development Environmental Observations (RODEO) Program. The primary purpose of the RODEO Program is to make direct, real-time measurements of the nature, intensity, and duration of potential stressors during the construction and initial operations of selected offshore wind facilities. Acoustic monitoring systems included a three-dimensional (3D) vector sensor hydrophone array, which provided standalone 3D signal validation and broadband 3D directional finding capability; Ocean Bottom Recorders (OBX) sensors and a geosled capable of measuring both sound pressure and particle velocity, and an autonomous underwater vehicle (AUV) equipped with a towed array. Lessons learned from monitoring at each wind farm guided the monitoring strategy for subsequent sites; for example, it was found that the towed array operated more efficiently and provided better data resolution when towed from an AUV instead of a traditional vessel. Underwater noise measurements from all four sites will be presented, and potential effects on marine life will be discussed.

Protected species studies and offshore wind

Kyle Baker[1*], David Bigger[1]

1 The Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM), Environmental Studies Program 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]). Additionally, BOEM is also investing in regional wildlife monitoring with the Partnership for an Offshore Wind Energy Regional Observation Network (POWERON) which is deploying passive acoustic monitoring equipment throughout Atlantic wind energy areas. BOEM is funding the development of regional ocean data products through regional ocean data portals where BOEM-funded data and data products are made available to the public.

BOEM identifies priorities during the development of an annual studies plan (see the 2023-2024 Studies Plan at boem.gov). BOEM priorities for funding environmental studies are informed through public engagement such as intergovernmental task forces, public meetings, formal information solicitations, and recommendations made in BOEM-funded studies. Partnerships such as those forged through the Regional Wildlife Science Collaborative are coordinated research planning across the large coastal regions where offshore wind energy development is occurring. Selected studies pertaining to marine mammals, sea turtles, birds, bats, fish, and ecosystems that demonstrate BOEM's integrated approach to environmental studies planning are summarized. A complete list of studies that are ongoing or completed is available on the BOEM website.

A long range autonomous underwater vehicle for conducting marine biodiversity and ecosystem assessments

James Birch[1*], Brett Hobson[1], Chris Scholin[1]

1 Monterey Bay Aquarium Research Institute

Site assessments and monitoring in marine environments present technical challenges due to the scales of biological observations required – from microorganisms to large marine mammals as well as spatially and temporally. Historically these challenges have primarily been met using crewed vessels and fixed moorings fitted with a variety of sensors. Although crewed ships are effective, their use is limited due to logistical, time, and cost constraints. In recognition of these limitations, the Monterey Bay Aquarium Research Institute (MBARI) has focused on developing a suite of mobile autonomous systems that are highly complementary to ocean observation tools and techniques based on traditional ship operations In particular, this presentation centers on MBARI's Long Range Autonomous Underwater Vehicle (LRAUV) and a variety of sensors and samplers that are routinely used aboard the platform to provide comprehensive biological surveys. Sensor and sampler payloads include those for passive and active bioacoustics, optical imaging for plankton, fish, bird, and larger animals, and environmental DNA (eDNA) collection and preservation. Typically, a number of LRAUVs are fielded simultaneously, each carrying a complementary sensor or sampler, to carry out coordinated observations. Operations include the use of autonomous surface vessels (ASVs; e.g., wave gliders), and intervehicle communications for responding to features of interest (e.g., temperature, salinity, chlorophyll, etc.) to direct targeted eDNA sample collection. We are currently conducting demonstration projects in conjunction with offshore wind energy generation sites, both existing and planned. Here we describe preliminary results and lessons learned from a first ever use of the LRAUV/eDNA sampling system in a windfarm off the west coast of Denmark.

NERACOOS ocean observing assets: Foundations to taking an ecosystem approach

Katy Bland[1*], Jake Kritzer[1], Tom Shyka[1], Jackie Motyka[1]

1 NERACOOS

NERACOOS works together with local, state and regional stakeholders to better understand their ocean information needs, so we may develop tools that address the concerns of the communities we serve. A foundational element of our observing system is an established network of fixed buoys providing real-time and historic data on weather and ocean conditions to mariners, regulators, researchers, and other users. The buoy network is complemented by other fixed stations measuring specific variables at targeted locations; autonomous gliders and vessel-based observing to provide more widespread and flexible coverage; high-frequency radar that is particularly important for search-and-rescue operations; and satellite observations at a regional scale. These observing tools complement modeling systems that produce forecasts and historical trends of ocean and weather conditions. Observing data and forecasts are delivered through data products that make large data streams accessible and understandable for users.

In addition to day-to-day use by maritime operations, emergency managers, coastal property owners, and companies, NERACOOS observations and model predictions are critical to robust scientific studies in the region and are foundational to taking an ecosystem approach to understand offshore wind and wildlife interactions. This poster will show NERACOOS observing asset locations as well as data access details.

Detection and monitoring of marine mammals during offshore wind construction: An overview of established and emerging technologies

Olaf Boebel[1*], Alfred Wegener[1], Mark Baumgartner[2], Jennifer Miksis-Olds[3], Jim Miller[4], Douglas Nowacek[5], Howard Rosenbaum[6], Jessica Redfern[7]

1 Institute Helmholtz Center for Polar and Marine Research, 2 Woods Hole Oceanographic Institution, 3 University of New Hampshire Center for Acoustics Research & Education, 4 University of Rhode Island, 5 Duke University, 6 Wildlife Conservation Society, 7 New England Aquarium

Mitigation measures to protect whales from anthropogenic underwater noise often depend on the detection or monitoring of their presence, both near and farther away from the noise producing activity. This paper provides a structured compilation of available and emerging detection and monitoring technologies, including some mitigation approaches in a broader sense. It considers both sensors and platforms in various combinations and systematically lists their requirements, constraints and strengths. Detection technologies are evaluated for their technology readiness levels along with a coarse assessment of their capabilities. The paper is intended to serve regulators and stakeholders in marine construction and development alike as a guide to identify the detection and monitoring methods that may best suit their needs and the wellbeing of the whales.

Mitigation measures aimed at ensuring the absence of whales from clearance and shutdown zones around noise sources can coarsely be classified into strategic and operational methods. Strategic methods consider the big picture to minimize the probability that whales are in the area, without necessarily knowing about the location of individuals, e.g., by requesting the halt of activities during migratory peak periods. Operational methods, by contrast, focus on the detection of individual animals in the immediate region around the noise source, aiming at detecting their position in relation to the clearance and shutdown zones.

Both approaches benefit from new, or at least rapidly progressing, technologies, such as passive acoustics, infrared imaging or high-end camera gimbals, which allow taking the centuries-old whalers' whale watch to a new level, employing, e.g., artificial intelligence and high-speed wireless communication. However, the technologies involved offer varying readiness levels, reliabilities, and cost/value ratios, which all need careful consideration, evaluation and planning prior to operational deployment of and regulatory dependency on such technologies.

A comprehensive overview of established and emerging detection and monitoring technologies, their capabilities and constraints, and their current technology readiness levels ranked from 1 ("basic principles observed and reported") to 9 ("actual system "field proven" in operational environment") was performed. The results of the analysis are summarized in a table of detection and monitoring methods along with their technology readiness, capabilities and limitations, based on a subjective assessment of the authors and represents their consensus opinion after repeated discussion.

Monitoring surfclams at offshore wind energy project sites in the Mid-Atlantic

Sarah Borsetti[1*], Daphne Munroe[1], Jason Morson[1], Grace Saba[1]

1 Rutgers University, Marine and Coastal Sciences

The Atlantic surfclam fishery is among the most susceptible to impacts from offshore wind energy development due to potential displacement from fishing grounds that overlap with wind lease areas. These vulnerabilities underscore the need to survey surfclams in Mid-Atlantic wind energy areas. A survey tool that samples over a relatively large area and consistently catches large-bodied clams is needed to accurately estimate biomass, abundance, and size structure of the surfclam stock. A scientific hydraulic sampling dredge designed to catch a breadth of sizes of surfclams was constructed and used to survey surfclams at offshore wind lease locations. Surveys of the wind lease area and control locations will continue annually through the construction and early operation of several wind farms, and a before-after-control-impact sampling design will allow changes in clam abundance due to the wind project to be evaluated. Experiments to calibrate the dredge by quantifying its size selectivity and sampling efficiency have been completed, allowing data generated from this sampling tool to be compared to, and potentially integrated with, long-term federal survey data.

Additionally, the habitats in which these surveys occur are subject to ocean acidification and warming water conditions, environmental stressors to which surfclams are sensitive. A major gap in ocean acidification research is co-located environmental and biological response monitoring; therefore, simultaneous measurements of surfclam biological response indicators (e.g., abundance, size, growth, shell strength, condition index) have been measured in coordination with carbonate chemistry observations at the sampling locations. These coordinated survey programs will enhance understanding of how important fisheries resources may be impacted by construction of offshore wind projects and future environmental conditions.

Strategic planning and best practices for acoustic telemetry applications to offshore wind impact monitoring

Beth Bowers[1*], Matthew Ogburn[1]

1 Smithsonian Environmental Research Center

Research and monitoring related to offshore wind development explores various potential impacts on the marine environment such as increased noise, increased sediment suspension, increased boat traffic, and addition of infrastructure. To measure the corresponding impacts to marine species, baseline animal distribution and movement data are collected in and around wind energy leased areas. Acoustic telemetry is one of several common methods for studying distribution and movement. In support of the NOAA Fisheries and BOEM Federal Survey Mitigation Strategy, we are developing a guide for best practices in acoustic telemetry applications for offshore wind. In this guide, we are assembling guidance on data and metadata standardization, interoperability and management, recommended equipment configurations, spatiotemporal coverage, and limitations of acoustic telemetry. Considerations within this guide will help to streamline research planning, data collection, and data storage, making acoustic telemetry in offshore wind applications more useful now and into the future.

SAV-vy collaboration: How a technical advisory committee steadied the seas for submerged aquatic vegetation restoration planning

David Brizzolara[1*], Deidra Valianti[1], Devan Healy[1], Michael Spina[1], David Yozzo[1]

1 HDR Engineering, Inc.

Submerged Aquatic Vegetation (SAV) beds provide essential habitat and food for many recreationally and commercially important fishery species in Atlantic coast estuaries of the U.S. Orsted's Ocean Wind 1 Offshore Windfarm Project's export cable route (ECR) was planned to cross Barnegat Bay, New Jersey, which supports over 12,000 acres of SAV, including dense beds of eelgrass (*Zostera marina*) and Widgeongrass (*Ruppia maritima*). SAV beds are regulated by the U.S. Army Corps of Engineers and National Marine Fisheries Service (NMFS) and the New Jersey Department of Environmental Protection (NJDEP). While the landfall location was chosen to minimize impacts and meet project design constraints, routing through Barnegat Bay crossed limited and discrete areas of SAV. The Ocean Wind 1 team recognized the benefit of restoring SAV in Barnegat Bay and this compelled the Project Team to think of creative ways of mitigation planning to optimize success. A technical advisory committee (TAC) composed of the mid-Atlantic region's leading SAV experts, was assembled to inform the process. The panel convened monthly in a collaborative environment to provide insights through combined decades of experience and address the difficulties of restoring eelgrass in Barnegat Bay. The Project Team provided a 'syllabus' of discussion topics – known SAV restoration challenges and concerns – and collaborated with the TAC to draw on their collective experience, including coordination with regulatory agencies, sharing resources, and lessons learned. The TAC also added value for the Project Team through lively internal discussions and comparison of SAV restoration outcomes across a range of sites in mid-Atlantic estuaries. The TAC provided direction on the site selection process for mitigation sites and donor beds, restoration methodology including seeding and transplanting, pre- and post-construction monitoring plans, and an adaptive management approach. This format allowed ample space for free form discussions over a period of several months, which brought to light key considerations that improved the quality of the detailed mitigation plan. Thanks to this collaborative environment, the Project Team and TAC developed a well-informed mitigation and restoration plan in just a few weeks for future use in conducting successful SAV restoration in Barnegat Bay. Use of a TAC in this manner and at this stage of the mitigation planning process provides a model for SAV restoration and other resource mitigation planning to help preserve highly valuable natural resources.

An analysis of humpback whale occurrence in the New York Bight and the relationship with the Gulf of Maine feeding ground

Danielle Brown[1*], Jooke Robbins[2], Arthur Kopleman[3], Marianne McNamara[3], Nicole Valendia[4], Paul Sieswerda[1]

1 Gotham Whale, 2 Center for Coastal Studies, 3 Coastal Research and Education Society of Long Island, 4 Boston University

Humpback whales in the U.S. mid-Atlantic have gained considerable interest in recent years. They are now frequently documented feeding in urban areas such as the New York Bight apex, where they were historically thought to be uncommon. The reasons behind this phenomenon are still not clear, but the extended occurrence by some individuals near these highly trafficked areas is a concern. Photographic identification data have been collected on humpback whales in the New York Bight apex consistently for more than a decade, and whale watching efforts have increased substantially since 2019. A previous study from 2011-2018 found that although some individuals exhibit seasonal occupancy and annual return to the New York Bight apex, many also travelled throughout the greater New York Bight during the year. This suggests that their seasonal occurrence may be higher than that calculated only for the apex region. Additionally, because some humpback whales from the New York Bight were matched to the Gulf of Maine population, it is possible that they are using the area as an extension of the Gulf of Maine feeding ground. In this study, we calculate humpback whale occurrence characteristics from 2019-2023, incorporating data from the general public and from seven regional whale watching companies with effort from northern New Jersey to eastern Long Island, NY. We also analyze sightings data from whales confirmed to belong to the Gulf of Maine population to determine whether they transit between the feeding ground and the New York Bight in the same season. These results add to existing knowledge of humpback whale site fidelity to the New York Bight region and provide further insight into how Gulf of Maine whales are using the U.S. mid-Atlantic.

The NJ Offshore Wind Research and Monitoring Initiative: A holistic approach to informing wind energy development and marine resource management

Colleen Brust[1*], Heather Genievich[1], Caitlin McGarigal[1]

1 New Jersey Department of Environmental Protection, Marin Resources Administration

The New Jersey Offshore Wind Research and Monitoring Initiative (RMI) is a scientific program that supports the responsible implementation of offshore wind energy in the waters off New Jersey's coastline. Made possible by funding provided by developers as a requirement of NJ's offtake agreements, the RMI is jointly managed by the NJ Board of Public Utilities, which has a mandate to ensure safe, adequate, and proper utility services at reasonable rates, and the NJ Department of Environmental Protection, tasked with protecting and managing New Jersey's marine and coastal resources. This collaboration identifies and responds to information needs for marine resource management with a holistic approach, maximizing utility and economy with high level planning. Taking an ecosystem-wide approach builds on the 2008/2009 NJ Ecological Baseline Studies that were used to inform siting of NJ's first lease areas.

RMI research priorities span abiotic and biotic components of the marine ecosystem, ranging from oceanographic observations to community effects and ecosystem services. While focused on NJ's economically and ecologically valuable marine resources, priorities are informed by collaborations with federal, state, academic, and non-profit institutions as well as the offshore wind and fishing industry.

The RMI portfolio of projects includes regional studies of chemical and physical oceanography, Cold Pool stability, turbine-based monitoring, whales, seals, sea turtles, birds, bats, pelagic communities, commercial and recreational fisheries, and mitigation research. Projects are hypothesis-based and focused on scientific questions and our project development process identifies opportunities to inform multiple research priorities and cause of change. Techniques like non-extractive sampling, remote sensing, and modeling are economical and reduce the environmental impact of field research. The RMI team facilitates cooperation between diverse projects to leverage data collection, and all data will be publicly available.

Looking forward, the RMI will continue to coordinate with other agencies and stakeholders to identify and meet research needs, expand existing studies so they can capture construction and post-construction effects, and seek opportunities for information and data sharing.

Reeling in insights: Early lessons in how machine learning is transforming video monitoring surveys for offshore wind

Connor Capizzano[1*], Alex Zygmunt[1], Sarah Glancy[1], Jack Reynolds[1], Lianne Allen-Jacobson[1], Brian Gervelis[1]

1 INSPIRE Environmental

Given the existing pressures on coastal fishery species along the U.S. Atlantic coast, the use of non-extractive techniques for monitoring marine ecosystems is vital. Baited Remote Underwater Video (BRUV) is a cost-effective and unobtrusive video monitoring technique used to sample fish populations with minimal impact to target species and sensitive habitat. Collected video footage is often manually analyzed by specialists to identify and count fish that visit the station to evaluate diversity and relative abundance. However, similar to other underwater video data analysis, BRUV video analysis is a time-consuming and resource-intensive process, often taking several hours to successfully analyze a single 1-hour video. Machine-assisted object detection and classification techniques therefore present a unique opportunity to automate this process (partially or fully) and facilitate the viability of long-term video monitoring surveys. Here, we share our insights and experiences with using different video analysis techniques for automating the detection and classification of fish recorded from BRUV systems deployed in an offshore wind project in the New York Bight. Such lessons include the challenges associated with conducting BRUV surveys in temperate marine ecosystems, recommended quality control and video processing workflows, and the strengths and limitations of various machine learning algorithms. Findings from this project will assist in the development of standardized protocols to ensure results from other underwater video monitoring surveys in the region can be synthesized to assess the potential impact of renewable offshore wind energy development on valuable fishery species.

Assessing foraging behavior and population structure of humpback whales (*Megaptera novaeangliae*) in the New York Bight

Anabel Carter[1*], Howard Rosenbaum[1], Melinda Rekdahl[1], Carissa King-Nolan[1], Sarah Trabue[1]

1 Wildlife Conservation Society

Evaluation of trophic level dynamics can provide insight into ecosystem health and function. For example, humpback whales (*Megaptera novaeangliae*) may consume different prey species on feeding grounds, and preferences in their diet can reflect shifts in prey availability across different spatial scales. In the New York Bight (NYB), survey efforts have focused on humpback habitat use and foraging behavior. This region is used by multiple maritime industries, and high levels of anthropogenic activity in this area will continue to increase with forthcoming offshore wind (OSW) developments. Therefore, understanding humpback whale behavior, foraging preferences across multiple spatial scales can inform best practices for monitoring and mitigation, particularly in the context of these developments. Here, we analyzed humpback whale foraging behavior using stable isotope analysis of skin samples collected from whales in the NYB between May and November of 2017–2023. Stable isotope concentrations of nitrogen (δ 15 N) and carbon (δ 13 C), which can reflect recent prey consumption and migration, were compared based on collection region, month, year, and sex. We used standard ellipses and generalized additive models to characterize the relationship between isotopic concentrations and region or distance from shore, respectively. Results showed wide isotopic niches for inshore (<10km from shore) and mid-shelf (10-60km from shore) regions, indicating more variable diets compared to the smaller offshore (>60km from shore) isotopic niche. Additionally, there was little overlap between these niches, suggesting that humpback whales in different regions had distinct diets. Higher concentrations of δ 15 N close to shore indicate that humpback whales are consuming prey at a higher trophic level, which may reflect an observed diet of Atlantic menhaden (*Brevoortia tyrannus*) inshore and sand lance (*Ammodytes dubius*) in the mid-shelf region. Despite the limited number of samples collected from the offshore region (n = 5, ~ 90 km from shore), we observed a narrow isotopic niche and higher δ 13 C concentrations in this region. The isotopic differences in whales from the offshore region suggest that these individuals may not utilize the NYB as their primary feeding ground (i.e., these whales were sampled on their migratory route through New York). Analysis of yearly variation showed significant differences in δ 13 C between 2023 and 2018-2020, which may be attributable to offshore samples which were collected in 2023. Overall, results show that humpback whales in the NYB likely have distinct diets, or there are ecological distinctions that define each region. This new knowledge of feeding and behavioral differences of humpback whales that overlap can help inform the complex dynamics of the NYB ecosystem. Additionally, our results help inform management decisions, especially in areas where humpback whales have overlap with current or proposed OSW related activities.

Integrated, real-time, multi-scale system for monitoring avian interactions with offshore wind energy technologies

Grace Chang[1*], Michael Macrander[1], Marcus Chevitarese[2], Sharon Kramer[3], Shari Matzner[4], Jesse Lewis[5], Lawrence Cheung[6], Charles Seeley[7], Eric Bodnar[8]

1 Integral Consulting, Inc., 2 Sightir, Inc., 3 H.T. Harvey & Associates, 4 Pacific Northwest National Laboratory, 5 DeTect Inc., 6 Sandia National Laboratory, 7. GE Vernova, 8 Velvetwire

The primary goal of the SEABIRD (System for Environmental Assessment of Bird/Bat Interactions with Real-Time Detection) project is to integrate, test, and validate multiple real-time sensing assets across multiple scales for assessing avian interactions with offshore wind technologies. The end-product will inform and improve seabird and bat collision risk model-based forecasting.

Marine radar and thermal tracking (ThermalTracker-3D [TT3D]) technologies provide macro- and meso-scale assessments, and blade-mounted vibration sensors enable micro-scale sensing of avian interactions with offshore wind. Radar and TT3D sensing capabilities are being independently tested and validated prior to system operations and real-time data integration. The integrated system will advance capabilities of each sensor and leverage a combined dataset collected over multiple scales. Impact strikes on wind turbine blades are being modeled; results will inform testing of simulated bird and bat strikes on blades, as well as the feasibility of integrating micro-scale sensing with radar and thermal imaging.

To date, a series of onshore, independent radar and TT3D tests have been performed with real and surrogate seabirds (drones) in environmental conditions relevant to offshore waters. Success metrics for macro-scale sensing are 90% probability of detection between 2 and 6 miles and up to 360° sensing and tracking of aerial movement into the meso-scale range (within 2 miles at 20°). Meso-scale success metrics are to demonstrate the ability to identify up to three different seabird morphologies and/or flight style groups, as well as bat flight characteristics, which are markedly different from seabird flight styles. The blade collision detection system will target 80% accuracy in vibration sensing strike tests. Field test results will be used to inform optimal technology-use modes for the offshore environment and specific bird and bat species of concern. Further, the utility of field test data as inputs to seabird and bat collision risk models will be determined.

This novel, multi-scale monitoring system will increase understanding and reduce uncertainties associated with potential interactions between seabirds and bats with offshore wind technologies, and reduce the timeline and costs associated with environmental permitting. Further, real-time, automated detection and identification information may facilitate targeted curtailments by providing the capacity to assess species presence and abundance. Sandia National Laboratories is managed and operated by NTESS under DOE NNSA contract DE-NA0003525.

Integrating New Jersey community scientists in fisheries eDNA monitoring of offshore wind

Erin Conlon[1*], Jason Adolf[1], Sam Chin[1], Keith Dunton[1], Shannon O'Leary[2]

1 Monmouth University, 2 Saint Anselm College

As offshore wind farm development in New Jersey rapidly approaches, many stakeholders have voiced concerns over impacts on fish community composition, fishing opportunities, and the economy. Well-designed and resilient survey methods that include data collected consistently before, during, and after construction of wind farms are essential to understanding any such impacts. Analyses of the DNA left behind by fish, so called eDNA, can yield fish community composition data that is useful to fisheries monitoring plans (FMPs) for offshore wind development. We are piloting a program to involve community scientists in eDNA collection for fisheries monitoring of offshore wind farm development.

Here, community scientists will sample eDNA from the surf zone along the NJ coast, representing the landward boundary of an eDNA sampling grid designed to detect potential impacts of offshore wind development. Sampling the surf zone in the context of offshore wind development is important because of the potential for changes in surf zone fish community composition which could impact recreational anglers. Community scientists will use equipment (including Smith-Root Citizen eDNA sampler with self-preserving filter capsules) and protocols specifically designed to facilitate eDNA sampling by community members. Separate surf zone sampling will occur at the same times / places using lab equipment (including 1L clean brown bottles on ice, a filtration manifold with sterile frits / funnels, filters, and sterile forceps) and protocols developed for our own eDNA surveys. Both the community and lab filters will then be extracted using a DNeasy PowerWater kit, amplified via PCR, and sent out for sequencing.

We anticipate that this will allow for the comparison of community science eDNA collection techniques to lab based eDNA collection techniques, and engage the community, fostering a direct line of communication between those who research and those who utilize the areas of impact.

Survey and health assessment program for harbor and gray seals in southern New England and New York Bight (NYB)

Robert DiGiovanni Jr[1*], Kimberley T. Murray[2], Allison Deperte[1], Kimberly Durham[1], Monica DeAngelis[3], Lynda Doughty[4]

1 Atlantic Marine Conservation Society, 2 National Oceanic and Atmospheric Administration, 3 Naval Undersea Warfare Center, 4 Marine Mammals of Maine

The occurrence of marine mammals in southern New England and the Mid-Atlantic has increased considerably since the early 2000's. The increase in observations of wild populations of whales and seals were first observed in the Marine Mammal and Sea Turtle stranding records. The early 1990's observed an increase in stranded pinnipeds in the New York Bight. These strandings were represented by three seal species: harbor (*Phoca vitulina*), gray (*Halichoerus grypus*) and harp (*Pagophilus groenlandicus*). The harp seal was the predominant species stranding during the mid-1990s through 2001. After 2001, gray and harbor seals were the dominant species encountered respectively. These increases in species encountered have occurred concurrently with the increase of harbor and gray seals on known and emerging haul-out sites in the region. Harbor and gray seal occurrences in southern New England, New York Bight and Mid-Atlantic have been increasing over the three decades since the early surveys of Payne and Seltzer (1989). That survey covered approximately 20 haul-out sites in RI, CT and NY. Current surveys of the same area document over 50 haul-out sites. Aerial surveys conducted by Atlantic Marine Conservation Society staff have documented the introduction of gray seals to Great Gull Island, NY (N=40) in March of 2005, and the identification of a new gray seal haul-out site at Ft. Tyler, NY in September of 2018. The number of gray seals has increased spatially and temporally. These seals have been observed arriving earlier in the season (October and November) in numbers over 40 animals to a high count of 524 during a March survey. Grays seals have been observed in the area of Ft. Tyler, NY during two consecutive summers (2018, 2019). These sightings were observed by eco- tours that operated for a short interval out of Greenport, NY. An additional gray seal haul-out site has been located on the norther tip of Block Island, RI. Harbor and gray seals were once thought to be primarily juvenile visitors to southern New England and the Mid-Atlantic. Photo identification work conducted by Dr. Arthur Kopelman from Coastal Research and Education Society of Long Island (CRESLI) has document two individual harbor seals returning to the same haul out site (Moriches Bay, NY) for 17 and 19 years (personal communication). Haul-out sites in New York Harbor (Swinburne Island) have also been documented by Gotham Whale. Current efforts are underway to collect biological data on harbor and gray seals while tracking their movements throughout the region. The project has deployed 16 tags during the first two years. Combining aerial, boat and land based historical survey data with current health assessment and tracking data will offer a complete look at pinniped movements through a region of offshore development.

Characterizing anthropogenic induced mortalities of sea turtles in New York

Kimberly Durham[1*], Robert DiGiovanni Jr[1], Allison Deperte[1]

1 Atlantic Marine Conservation Society

Four species of sea turtles: loggerheads (*Caretta caretta*), Kemp's ridleys (*Lepidochelys kempii*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*) inhabit the bays, estuaries, Long Island Sound and New York Bight on a regular basis during summer and into the fall. These data will investigate the factors contributing to anthropogenic mortality of sea turtles in New York waters. Mortalities investigations were documented between 2017 and 2023 from the New York Bight and Long Island Sound. These included 576 sea turtles of which 260 (45%) were loggerheads, 191 (33%) were Kemp's ridleys, 79 (14%) were green, 43 (7%) were leatherback and three (1%) were unable to be identified due to decomposition state. The intent of this study is to identify the frequency of Human interactions (HI) related to sea turtle strandings and provide baseline information to address areas of mitigation. Of the 576 sea turtles encountered during the study period 29% (n=166) had evidence of Human interaction. It is important to note that evidence of human interaction does not indicate it was a factor that contributed to the animal's mortality. The most frequently encountered sea turtle with evidence of Human Interaction is the Leatherback with 53% (n=23). Forty-two percent (n=108) of the loggerhead sea turtles examined had evidence of HI. Examinations documented HI in 13% of the endangered Kemp's ridley sea turtles examined. If the occurrence of cold stunned animals (which strand in the fall) are removed, this frequency rate is considerably higher. The green sea turtle had a HI rate of 11% (n=9) during the study period. This study will outline the procedure for characterizing the factors that make up the classification of HI (fisheries, vessel strike, entanglement, ingestion of debris) as well as identify the seasonality and distribution of these occurrences.

Proving that automatic whale and blow detection works

Ross Eaton[1*]

1 Charles River Analytics

Offshore wind farm survey, construction, and maintenance activities have the potential to detrimentally affect marine mammals if appropriate mitigations are not in place. One critical step to mitigating any potential harm is maintaining an effective lookout that can alert vessels to the presence of marine mammals early enough that appropriate action can be taken. Currently, protected species observers (PSOs) keep a lookout for whales. However, people tire when performing tedious tasks, and even the most assiduous PSO cannot see in the dark. Efficient deep learning has made computer vision a viable tool to help with this marine mammal lookout task, and thermal infrared (IR) cameras offer visibility 24-hours per day. Combining these algorithms and sensors, smart cameras with artificial intelligence (AI) can provide unblinking whale and blow detections in the vicinity around offshore vessels. Yet the question remains: how can we determine if these automatic detection systems actually work? More precisely, how well do these systems work, and in what conditions? What variables affect performance and to what degree? We will discuss our experience attempting to answer these questions with respect to our whale and blow detection system, Awarion. In addition to describing a variety of data collections from deployments on offshore vessels, whale watching cruises, and fishing boats, we will detail the construction of an artificial whale blow and the structured experiments we have conducted with it. We will describe the data analysis process, including key performance metrics and critical challenges. Finally, we will examine how our efforts fit into the overall process of fostering the adoption of automatic whale detection technologies.

Developing communications materials about offshore wind energy activities and whale mortality eEvents

Eleanor Eckel[1*], Megan Ferguson[1], Julia Gulka[1], Julia Stepanuk[1,2], Kate Williams[1], Kate McClellan Press[3]

1 Biodiversity Research Institute, 2 SoMAS, Stony Brook University, 3 New York State Energy Research and Development Authority

Recent whale strandings off the U.S. east coast have received media attention and led to the spread of misinformation regarding the effects of offshore wind development on whales. There is no evidence that offshore wind is a contributing cause to any of these mortalities despite a growing narrative to the contrary. To help ensure that the public receives accurate information, a specialist committee, made up of thirteen subject matter experts, has been convened under the auspices of the New York State Environmental Technical Working Group (E-TWG), an independent advisory body to the State of New York. Committee members represent a variety of sectors including offshore wind developers, government agencies, and environmental nonprofit organizations. The objectives of this specialist committee are to improve coordination, communication, and transparency related to topics such as the recent whale strandings, offshore wind development activities, and potential marine mammal impacts from offshore wind. To achieve these objectives, the committee, with scientific support from the Biodiversity Research Institute, has been working to develop an FAQ (frequently asked questions) document to aid in the dissemination of current, accurate, and readily understandable information around recent whale mortality events and the level of potential risk to whales from offshore wind energy development activities. The FAQ development process includes multiple rounds of expert review from experts external to the committee, as well as by the E-TWG. New sections of the FAQ document are being publicly released as they are finalized (available at https://www.nyetwg.com/communications-resources). The initial end product, the working FAQ document, is a resource that can be used by various stakeholders in their own communications around the topics of interest and will continue to be expanded by the committee over time.

A comprehensive assessment of drivers of north Atlantic right whale habitat wse in the northeast United States: Beyond *Calanus finmarchicus*

Taylor Evans[1*], Nick R. Record[2], Camille H. Ross[3], Lesley Thorne[1]

1 Stony Brook University, 2 Bigelow Laboratory for Ocean Sciences, 3 New England Aquarium

Understanding drivers of distribution for the critically endangered North Atlantic right whale (*Eubalaena glacialis*) is critical to improving the predictive capacity for this species in wind energy areas in both space and time. Marked shifts in the distribution of North Atlantic right whales since 2010 have underscored the need to better understand drivers of right whale habitat use. However, knowledge of prey species other than Calanus finmarchicus south of the Gulf of Maine (GOM), is limited. We used data from NOAA's Ecosystem Monitoring Program between 1980 – 2019 to examine spatiotemporal changes in the community composition and abundance of copepods in the Northeast US and links with spring and fall thermal transitions. Changes in copepod prey species were particularly dramatic in regions showing marked climate-driven oceanographic change, in agreement with previous studies. We found strong and widespread changes in the date of the fall thermal transition throughout the Northeast US, reflecting the persistence of relatively warm waters later into the year in association with climate-driven warming. These changes in the fall thermal transition were most pronounced in regions where C. finmarchicus abundance and observations of North Atlantic right whales decreased in summer and fall. Further, we found a marked increase in a warm water species of copepod, *Centropages typicus*, in regions that have recently been abandoned by foraging right whales. *C. typicus* is much smaller and less calorically rich than C. finmarchicus, and thus increases in this species may diminish the energetic returns of prey patches for foraging right whales. This work highlights the role of oceanographic and prey drivers in understanding and predicting patterns of habitat use in North Atlantic right whales.

New resources on Tethys: A knowledge hub on environmental effects of offshore wind energy

Hayley Farr[1*], Johnathan Whiting[1], Zara Miles[1], Linnea Weicht[1], Mark Severy[1], Cris Hein[2], Samantha Rooney[2], Laura Dempsey[2]

1 Pacific Northwest National Laboratory, 2 National Renewable Energy

When environmental data and information are openly available and easily accessible, they enhance understanding of potential environmental effects, provide more effective guidance for research and development for monitoring and mitigation strategies, and help developers and regulators make decisions with confidence. To that end, Tethys (https://tethys.pnnl.gov/) is an open knowledge hub with information and resources on the environmental effects of wind energy development around the world. Funded by the U.S. Department of Energy, Tethys is actively curated by a multidisciplinary team at the Pacific Northwest National Laboratory (PNNL), that works closely with the International Energy Agency's Task 34, Working Together to Resolve the Environmental Effects of Wind (WREN), to publish updates on the state of the science, host public webinars, and develop useful resources for the international wind-wildlife community. In 2022, Tethys and WREN launched the Wind Energy Monitoring and Mitigation Technologies Tool (https://tethys.pnnl.gov/wind-energy-monitoring-mitigation-technologies-tool), which catalogs a wide variety of monitoring and mitigation technologies for assessing and reducing potential wind-wildlife effects, including information on development status and links to related validation studies on their effectiveness.

The Tethys team reviews the entries on an annual basis to keep information up-to-date and encourages the wind-wildlife community to contribute additional technologies for consideration. More recently, Tethys and WREN launched Offshore Wind Metadata (https://tethys.pnnl.gov/offshore-wind-metadata), which is a growing collection of information on offshore wind energy projects around the world and the associated environmental monitoring, including links to related reports, studies, and publicly available datasets. The Tethys team drafts metadata project pages in collaboration with offshore wind developers to ensure the information is accurate and encourages interested developers to reach out to contribute. Additional resources on Tethys include a searchable documents library with over 6,600 journal articles, reports, and conference papers; an events calendar with wind conferences, webinars, and workshops; an archive of webinars on a variety of wind-wildlife topics; and outreach materials such as educational summary materials and the bi-weekly Tethys Blast newsletter. After 15 years of operation, Tethys is an internationally recognized, one-stop shop for wind-wildlife resources that enables open, transparent sharing of environmental data and information to support the sustainable development of wind energy worldwide.

New Jersey RMI contributions to understanding regional baseline conditions

Heather Genievich[1*], Cailtin McGarigal[1], Colleen Brust[1]

1 New Jersey Department of Environmental Protection, Division of Science and Research

Responsibly managing our oceans and wildlife while embarking on a new era of wind energy in the northeast United States requires a regional approach. The New Jersey Offshore Wind Research and Monitoring Initiative (RMI) coordinates with federal, state, regional, and nonprofit entities to design and fund studies that will further the scientific understanding of baseline ecological and environmental conditions in the mid-Atlantic region. The RMI is investing in remote sensing infrastructure for New Jersey that will integrate with and expand on existing regional monitoring networks. For example, the RMI is adding stations to the Motus Wildlife Tracking network for birds and bats, deploying aquatic acoustic telemetry receivers to monitor tagged fish, adding coverage to NOAA's cetacean aerial survey, and deploying several archival passive acoustic monitoring (PAM) units along with one near real time PAM buoy to monitor cetacean vocalizations. Other projects that will contribute to the regional understanding of baseline conditions include using underwater gliders to monitor physical oceanographic conditions, a study of cold pool dynamics, and three tagging studies for sea turtles, harbor seals, and fin and humpback whales. In addition, environmental DNA will be used to study fish presence and movement, and a surf clam project has already yielded a novel dredge design that will allow commercial boats to dredge amongst the future turbines. By coordinating with others doing the same kind of research, NJ RMI is able to align methods, leverage data, and build a better scientific understanding of the current state of our ocean resources in order to better assess and respond to future impacts of offshore wind development.

Guidance for regional research to understand effects to wildlife and the environment from offshore wind energy development in the U.S. Atlantic

Julia Gulka[1*], Kate Williams[1], Rebecca Green[2], Mark Severy[3], Hayley Farr[3], Frank Oteri[2], Kate McClellan Press[4]

1 Biodiversity Research Institute, 2 National Renewable Energy Laboratory, 3 Pacific Northwest National Laboratory, 4 New York State Energy Research and Development Authority

Offshore wind energy development is a rapidly growing industry in the United States. To inform our understanding of wildlife populations and ecosystems, and to be able to detect changes in these systems as a result of offshore wind energy development, research must be conducted at a range of spatial and temporal scales. Coordination of these efforts will be required to inform our understanding of offshore wind effects, and in particular the potential consequences and cumulative impacts of these effects on wildlife populations and their habitat. The Offshore Wind Environmental Technical Working Group, a stakeholder advisory group led by New York State, and the U.S. Department of Energy determined that guidance was needed to ensure that regional research to understand wildlife and ecosystem effects of offshore wind development is conducted efficiently and effectively. Thus, the Regional Synthesis Workgroup developed recommendations for addressing research questions that: a) require data from a larger geographic scope than that of a single wind farm site; b) focus on methodological needs and/or implementation of mitigation to inform environmental research, risk assessments, and adaptive management decisions; and/or c) contribute to a mechanistic understanding of ecosystem processes, even if such studies are conducted at small spatial scales. The two main products are: 1) The U.S. Atlantic Offshore Wind Environmental Research Recommendations Database (available at https://tethys.pnnl.gov/atlantic-offshore-wind-environmental-research-recommendations), a database that compiles and synthesizes previously identified research needs related to wildlife and environmental effects of OSW energy development for the U.S. Atlantic; and 2) High-level recommendations on how to design, implement, and communicate regional research and monitoring efforts. Potential end users of these products include government entities who are funding regional research in the next 1-3 years, offshore wind developers who are funding regional research and monitoring efforts, and regional research entities. Synthesis of research questions and data gaps, and development of guidance for studies that require regional-scale efforts, will help to inform funding allocations and other decisions around research and monitoring for offshore wind development in the coming years.

Refining methods for quantifying ecological effects of rock reefs at the base of wind turbines

Steve Heck[1*], Carl LoBue[2], Brad Peterson[1], Adam Starke[1]

1 Stony Brook University, 2 The Nature Conservancy

When hard structures are sunk in the ocean, they often turn into habitat for fish and other marine life. While they're called ‘artificial reefs’, the benefits they provide – like food and shelter – are very real. Ocean experts have seen submerged shipwrecks and bridges become home to a wide array of marine species, and then, become popular destinations for anglers and divers. There is currently considerable interest in gaining a better understanding of if or how the design and materials used in reef construction can be improved to enhance its value as a habitat. Specifically, researchers are exploring the potential of using materials that are environmentally friendly to marine life in the design and construction of offshore wind turbine foundations. Although studies have demonstrated that larger and taller structures can support more fish, it remains challenging for scientists and engineers to quantitatively compare the fish habitat value of similarly sized underwater structures, especially in deep ocean environments with the added impact of fishing on fish populations. The difficulty arises because some traditional monitoring methods lack the precision needed to detect modest differences.

This study, which just began this season, will compare combinations of existing and novel monitoring methods to gauge their efficacy at detecting modest differences in how fish and other marine life interact with different structures that have already been constructed by NYS DEC at Atlantic Beach Artificial Reef off Rockaway Beach NY.

Comparison of bat acoustic detectors: Implications for post-construction monitoring at offshore wind projects

Merra Howe[1*], Evan Adams[1], Bri Frankina[1], Ethan Gilardi[1], Wing Goodale[1], Josh Guilbert[1], Kate Williams[1]

1 Biodiversity Research Institute

Acoustic monitoring is an effective method for detecting bats and has recently provided new information on their presence in the United States' marine environment. However, bat exposure to offshore wind projects proposed in the Atlantic remains uncertain, as acoustic monitoring for bats has occurred sporadically and opportunistically from vessels transiting across lease areas. With the ongoing decline of many bat species due to White Nose Syndrome, among other factors, understanding potential interactions with offshore wind projects becomes increasingly critical to developing effective mitigation measures. In recognition of the crucial need for more data on the potential exposure of bats to offshore wind projects in the Atlantic, federal regulators have begun requiring projects to conduct bat acoustic monitoring once operations commence. With funding support from Equinor, as well as the Department of Energy and Bureau of Ocean Energy Management via Project WOW (Wildlife and Offshore Wind), we evaluated different bat acoustic detector models proposed for deployment at offshore wind projects. This assessment focused on signal detection and species identification accuracy. This comparison included a variety of detectors, including the Wildlife Acoustics SM4Bat and Song Meter with Analysis and Remote Transfer System and the Pettersson D500X. Representative calls from eastern U.S. bat species across both phonic groups (high frequency, low frequency) were played at their characteristic frequency ranges (20 kHz at the lower limit and 50 kHz at the upper limit) for a 10-second duration through an ultrasonic speaker at varying horizontal and vertical distances to the detectors. The procedure was repeated during different weather conditions (light winds <5 mph, strong winds >10 mph). The recordings were processed with the autoclassification software Kaleidoscope Pro, BCID East, and SonoBat to assess whether the software (1) detected the bat call, and (2) assigned the correct species identification. Results are forthcoming and will help inform a key component of federally mandated bat acoustic monitoring efforts at offshore wind projects in the Atlantic and future Wind Energy Areas.

Drone-based observations of entanglement and vessel strike scars in juvenile and adult humpback whales in the New York Bight

Siobhan Keeling[1,2*], Julia Stepanuk[1,3], Chelsi Napoli[1], Nathan Hirtle[1], Joshua Meza-Fidalgo[1], Lesley Thorne[1]

1 SoMAs, Stony Brook University, 2 New York State Department of Environmental Conservation Division of Marine Resources, 3 Biodiversity Research Institute

Vessel strikes and entanglement in fishing gear are major threats to large whales globally. Both entanglements and vessel strikes can leave scars that can indicate whether individuals have experienced either anthropogenic impact. The presence and location of scars can provide information on how entanglements occur. Until recently, studies of scars on large whales primarily relied on vessel-based photo-identification or visual observations and focused mainly on the fluke and tail stock of the body. Unoccupied aerial systems (UAS) provide full-body aerial images of whales which can be used to assess scars across the whole body. UAS footage of humpback whales (Megaptera novaeangliae) was obtained during vessel-based line transect and opportunistic surveys conducted in the New York Bight (NYB) from May to October between 2018 to 2023. Still images were obtained from UAS footage, where the entire dorsal surface of the whale is visible at the surface and were examined for scarring reflective of previous entanglements or vessel strikes, as well as lateralized feeding behavior for both juvenile and adult humpback whales in the NYB, a region with dense vessel traffic (N= 49 juveniles and 17 adults). The majority of both adult (94%) and juvenile (78%) humpbacks showed entanglement scars. Observed juveniles were likely < 7 years of age, suggesting that whales are frequently interacting with fishing gear, even at early life stages. Further, we observed scarring indicative of vessel strikes in 8% of observed juveniles. Scarring indicative of lateralized feeding behavior was observed more frequently in adults than in juveniles (82% vs. 43%, respectively), suggesting that this behavior may be learned or executed as whales mature. This research highlights the importance of understanding and mitigating anthropogenic threats to juvenile humpback whales in heavily urbanized coastal regions such as the NYB.

Projecting the effects of offshore wind-mediated benthic changes on U.S. marine ecosystems

Kimberly Lato[1*], Kate Williams[1], Ulrike Braekman[2], Jan Vanaverbeke[2], Steven Degraer[2], Len Thomas[3], Saan Isojunno[3], Josh Kohut[4], Oscar Schofield[4], Pat Halpin[5], Corrie Curtis[5], Beatrice Smith[5], Jesse Cleary[5], Evan Adams[1]

1 Biodiversity Research Institute, 2 Royal Belgian Institute of Natural Science, 3 University of St. Andrews, 4 Rutgers University, 5 Duke University

Submerged sections of offshore wind (OSW) structures can act as artificial reefs and promote the colonization of fouling filter feeders, such as mussels and barnacles. This colonization alters benthic community composition and can attract a variety of mobile benthic invertebrates and fishes to the offshore wind area. Consequently, these benthic community changes can affect prey availability for higher trophic level animals, including seabirds and marine mammals, whose movements and behaviors rely heavily on forage fish and other prey distributions. As OSW development expands across the east coast of the United States (US), it is important to anticipate changes to benthic communities and subsequent impacts to higher trophic level animals to gain a more holistic understanding of how OSW can shape marine ecosystems.

Building upon regional research through Project WOW (https://offshorewind.env.duke.edu/), this project focuses on benthic change in wind energy areas within the New York Bight and southern New England. Taking an ecosystem-focused approach, we will synthesize current information on OSW-mediated impacts from other oceanic regions (e.g., Europe) to assess potential changes to benthic faunal communities in the northeastern US. Using food web modeling and expanding upon Project WOW consequence assessment frameworks, we will evaluate the mechanistic relationships between benthic change and higher trophic level species, adding valuable information on the potential for ecosystem-wide OSW impacts. Using decision science, we will then create a research plan framework for scientists, developers, and agencies to effectively monitor for potential future changes in the northwest Atlantic ecosystem. This highly collaborative project brings together scientists from the US and Europe and builds upon current regional research efforts to broaden our understanding of OSW impacts and guide future study.

Random rorest modeling of AIS data to improve estimates of development exposure for the scallop fishery in southern New England

Julia Livermore[1*], Todd Guilfoos[2]

1 RI DEM Division of Marine Fisheries, 2 University of Rhode Island, Department of Environmental and Natural Resource Economics

As offshore development expands on the US East Coast the need for accurate estimates of fishing landings coming from harvest in areas slated for development, or fisheries exposure, increases. A variety of fisheries-dependent datasets exist to address this need, but all current corresponding data products present limitations (e.g., inadequate spatiotemporal resolution, low coverage rates). This intent of this work is to generate improved maps of fishing effort and landings values at sea, focused on Southern New England, as well as an enhanced methodology that can be applied more broadly. The project forms a baseline that can be used to limit conflicts between wind development and commercial fishing and to assess changes in fishing practices after wind farm development, using the scallop fishery as an example. To achieve the project goals, we have merged data from the AIS (Automatic Identification System), VMS (Vessel Monitoring System), VTRs (Vessel Trip Reports), dealer reports, United States Coast Guard registry records, and the NOAA Observer Program to produce a more comprehensive fisheries exposure estimate. We employ a novel approach of using fishing industry input for expert labelling of the AIS data and develop a machine learning approach to modeling the probability of fishing based on vessel activity at the Fishery Management Plan (FMP) level. Model results enable creation of fishing activity maps by extrapolating to the full unlabeled data set “falling back” to existing VMS and VTR approaches for trips not covered through the AIS dataset. The final data product uses the best available data and methodology for each individual trip. Finally, we measure differences and improvements of our landings estimates and methods relative to existing approaches.

Opportunistic data collected aboard whale watching vessels reveal interannual variability in cetacean abundance and distribution off Montauk, New York

Arthur Kopelman[1]*, Marianne McNamara[1], Jooke Robbins[2], Danielle Brown[3], Paul Sieswerda[4], Lindsey Jones[5]

1 Coastal Research and Education Society of Long Island, 2 Center for Coastal Studies, 3 Rutgers University, 4 Gotham Whale, 5 College of the Atlantic

Whale watching is a popular recreational activity with tremendous educational and scientific potential. When used as platforms of opportunity, whale watching vessels provide access to abundant data across consistent time and spatial frames. Data collected from CRESLI trips over a 15-year span demonstrate recent and dramatic shifts in the abundance and distribution of cetaceans off Montauk, NY. The number of humpback whale, Megaptera novaeangliae, sightings have increased off eastern Long Island since 2013. Photo-identification of individuals corroborates this trend, with 41 individuals identified in 2022 and a record number (n=61) individuals in 2023, including 5 calves. Long-term population monitoring at Montauk, combined with detailed demographic data for individuals matched to the adjacent Gulf of Maine, are contributing to our understanding of M. novaeangliae population use of this area. Additionally, CRESLI documented differences in morphology and habitat usage by common bottlenose dolphins, *Tursiops truncatus*, which were formerly divided into two morphotypes in the Eastern New York Bight: the inshore (Western North Atlantic Northern Migratory Coastal Stock) and offshore (Western North Atlantic Offshore) forms. In 2023, the coastal morphotype was recognized as a new species, Tamanend's bottlenose dolphin, *T. erebennus*. CRESLI encountered both species during seasonal whale watches between 2009-2023, documenting differences in water depth and distance-from-shore parameters, further contributing to and supporting the distinction of these two morphotypes into distinct species. CRESLI also documented its 188th photo-identified finback whale (*Balaenoptera physalus*) since 1996. Encounters with minke whales (*Balaenoptera acutorostrata*) and common dolphins (*Delphinus delphis*) were also documented and observations of pelagic birds, sea turtles, and other marine species of interest were noted.

Seabird line transect surveys in the New York Bight

Joshua Meza-Fidalgo[1*], Kimberley Lato[1], Michael Wethington[1], Lesley Thorne[1]

1 SoMAS Stony Brook University

There are limited data on the abundance and distribution of seabirds in the New York Bight. We initiated line transect surveys in the summer of 2022 to collect baseline data that will be useful for assessing potential impacts of climate change and future offshore wind energy development on seabird habitat use and species composition within the New York Bight. Surveys are conducted quarterly across four line transects, each running approximately 65km across the shelf; two of the line transects pass through the Fairways North Offshore Wind Planning Areas. Our sampling protocol was adapted and modified from the Eastern Canada Seabirds at Sea standardized protocol for pelagic seabird surveys. Survey data will be used to generate seabird density estimates for the New York Bight. To date, we have surveyed over 1380km and documented 1040 seabird sightings, comprised of an estimated 3579 individual seabirds across 19 different species. These preliminary data show overall higher counts of seabirds in fall and winter than spring and summer. Diving ducks, particularly the genus Melanitta, and northern gannets (Morus bassanus) were the most frequently observed seabirds during winter. Gulls (Larus genus), particularly herring gulls (L. argentatus) were the most frequently observed seabirds during spring. Wilson's storm petrels (Oceanites oceanicus) were the most frequently observed seabirds during summer. Melanitta spp., gulls, and dovekies (Alle alle) were the most frequently observed seabirds during fall. These baseline data, along with ongoing surveys planned for the next 5 years, will provide important information on the distribution and abundance of seabirds in the New York Bight and how these factors may change in response to climate change and the development of offshore wind energy.

Preliminary profiles for seabird flight heights in the northern Gulf of Mexico

Pamela Michael[1*], J. Christopher Haney[1]

1 Terra Mar Applied Sciences

Seabird species' potential to interact with offshore infrastructure differs due to many factors. One such factor is the flight height that a given species tends to fly at. Using recently collected vessel-based survey data from multiple survey efforts in 2017 – 2019 and 2021-202, we report a preliminary characterization of the observed flight heights of seabirds in the northern Gulf of Mexico within the U.S. EEZ. We construct flight height profiles and proportions of each species attracted to offshore anthropogenic structures in the Gulf of Mexico. Flight height profiles will be compared to the height of offshore structures, including the rotor swept zone of typical offshore wind energy turbines. We anticipate screening ±40 species that regularly occur in the Gulf and will discuss a subset of species with distinct flight height profiles and habitat use that suggest different potentials to interact with offshore structures (e.g., Sooty Tern *Onychoprion fuscatus*, Magnificent Frigatebird *Fregata magnificens*, Brown Pelican *Pelecanus occidentalis*). A better understanding of the flight height profiles for seabirds can inform modeling, monitoring, and mitigation efforts wherever the installation of offshore infrastructure is being considered or interactions with structures are monitored.

Artificial intelligence method to automate the detection and classification of marine mammals to support acoustic monitoring in offshore wind

Stephanie Milne[1*], Atasha Smith[1], Ben Finkes[1]

1 TetraTech

RPS, a TetraTech company has developed a unique artificial intelligence (AI) method, patented Neptune, to automate the detection and classification of marine mammals to support real-time acoustic monitoring conducted as a regulatory requirement. Our AI was trained using acoustic files collected during the activities on which we propose to employ our system, rendering it robust in identifying faint low and mid-frequency vocalizations across all species groups especially in environments with high-level background noise. This technology is especially important for acoustic monitoring use cases in offshore wind where independent systems are deployed for long durations and where data must be transmitted in near real time to inform offshore activities, requiring a lot of power. Neptune was developed from over 5,000 files with their metadata, selected from diverse regions and platforms. A comprehensive review of any data source imbalances was performed to identify and remove potential sources of bias. Sea Mammal Research Unit (SMRU) provided validation marine mammal vocalization. The training samples were split into low-frequency (LF) (0-1.5kHz) and mid-frequency (0 to 24 kHz) samples separate models were developed for each. Samples were also split into training and testing datasets. Mid-frequency modelling trials achieved 90% accuracy on classification of marine mammal mid-frequency vocalizations in both training and validation. On LF samples, we achieved an accuracy of 86% in the LF domain. AI was then deployed on vessels of opportunity. Both backend and frontend were developed in Python and using SQLite database technology to store raw audio. We provided a frontend component allowing the user to further validate the recorded sample and include additional metadata or disagree with a sample from the AI predictive models. The backend included additional logic to treat the predictions as a continuous time series and use prediction pooling to improve overall accuracy, reduce instances of false positives and provide longer recordings to reduce the burden associated with review and validation. Analysis of the first field datasets show AI detected 100% of real-time PAM Operator marine mammal detections and PAM Operators agreed with 94% of AI identified marine mammal detections. This scalable system handles large data volumes and is easily adapted to different offshore wind monitoring scenarios.

The use of a towed video sled for habitat characterization and biological surveys in offshore wind project areas

Stephen Davies[1] William Misa[1]
1 RPS TetraTech

To support initial habitat characterization in offshore wind project areas, typical benthic-oriented geophysical (seismic) and geotechnical (physical) surveys include an environmental component that involves surficial sediment sampling and optical assessments. To standardize habitat classifications across project areas, the Coastal and Marine Ecological Classification Standard (CMECS) is used. CMECS provides a hierarchical approach to defining benthic habitat characteristics resulting in standardized classifications that can be applied across offshore wind project areas to monitor environmental impacts. Using video and still images collected by a towed video sled outfitted with downward-facing cameras, megafauna and percent cover analyses are carried out to characterize benthic habitats. Video recordings are reviewed and annotated in full to enumerate megafauna (>2.5 cm) and note the occurrence of other benthic biota and habitat features. Still images are assessed for visibility and quality prior to selection. A pair of scaling lasers mounted to the towed camera system enables image calibration and surface-area cover calculation. Using a photo quadrat analysis software, 50 uniform points are laid over a selected image from which a percent cover of different substrate types is determined to the furthest extent possible under a NMFS-modified version of CMECS standards. To establish a CMECS biotic component classification for each image analyzed, individual counts of organisms are recorded regardless of point placement. This analysis results in a complete CMECS classification of each benthic habitat sampled that encompasses both substrate and biotic components. The towed video field survey results together with physical grab sampling make up key components of the benthic assessment report used by offshore wind developers in project site characterization and environmental baseline surveys that inform future benthic habitat monitoring plans. With the growing number of offshore wind projects in the United States and the required baseline environmental assessment and monitoring of fisheries and benthic resources throughout all phases of project development, there is a need for standardized, efficient, and cost-effective methods for conducting fisheries and benthic surveys. By attaching forward-facing cameras to the towed video sled used in benthic assessments, simultaneous visual sampling of fishes within a study area is made possible with minimal disturbance to habitat and target species. In addition to the increased survey efficiency where both benthic and fisheries monitoring requirements can be accomplished in a single survey effort, the use of non-extractive survey technologies also contributes to the potential of achieving a net positive impact during offshore wind development.

Tracking post-release movement patterns of New York's rehabilitated sea turtles provides insight into their utilization of New York waters

Maxine Montello[1*], Wendy McFarlane[2], Josheph Warren[3]

1 NY Marine Rescue Center, 2 Manhattanville College, 3 Stony Brook University

Long Island Sound and the Great Peconic Bay (New York, USA) contain southern barrier lagoons and eastern bays and are known habitats for foraging juvenile populations of sea turtles during summer months. Sea turtles strand for various reasons including entanglement, vessel interaction, malnourishment, debilitation, and cold stunning. Many of the stranding cases can be linked to human activities in this region which overlap with sea turtle habitat. This project monitored the post-release movement pattern of 31 sea turtles rehabilitated at the New York Marine Rescue Center (NYMRC). The NYMRC rescues and rehabilitates all sea turtles stranding along the extensive coastline of New York. Between 2019 and 2023, NYMRC attached satellite (Wildlife Computers - SPLASH and SPOT) tags to 31 of the 194 sea turtles that were rehabilitated and released (16%). Three different species of sea turtles were tagged as part of this project: Kemp's ridley (Lepidochelys kempii, n=10), Atlantic green (Chelonia mydas, n=8) and loggerheads (Caretta caretta, n=13). Data collected from these tags supports the rehabilitation efforts of NYMRC by illustrating the post-release movement patterns and survivorship of successfully rehabilitated sea turtles. Preliminary data shows southern-coastal and offshore movement patterns that have previously been associated with preferable (i.e., "normal") post-release behavior. Tag duration ranged from 29-672 days, with more than 80% of tags transmitting at least 100 days, with an average tag life of 220 days. Of the 31 released turtles two restranded following release and one turtle was found deceased with evidence of vessel interaction. Data from these turtles provides crucial information on local foraging areas used by these species in New York state and federal waters in the late summer and early fall. On average, released turtles spent about 75 days (1-157 days) within state waters before navigating south or offshore. To further understand sea turtle behavior within state waters, Customized Animal Tracking Solutions (CATS) tags were implemented in 2023. Data obtained from both tags will provide a more complete understanding of New York's sea turtle population.

Winter Exploration: An ecological and oceanographic survey of the outer shelf of the Mid Atlantic Bight

Laura Morse[1], Josh Kohut[2]

1 Jasco, 2 Rutgers University

To inform and advance our science strategy Leading Light Wind (LLW) is funding a 1 month slocum glider mission, carried out by the Rutgers University RUCOOL research group. The glider will be deployed in late February 2024 for a 3-4 week mission sampling the waters in the LLW lease area and offshore to the shelf break. As NARW presence in the region is more frequent in the winter and early spring months, this glider survey will be adapted to focus on the offshore region of the Mid Atlantic Bight, an area not typically sampled during this time period of increased occurrence. This mission will fill a critical temporal and spatial gap of existing glider-based DMON surveys in the central Bight. The glider will be equipped with a CTD to determine water depth, temperature, salinity, and density, an optics puck measuring chlorophyll-a and colored dissolved organic matter (CDOM) fluorescence, an Optode measuring dissolved oxygen, and a DMON passive acoustics sensor for marine mammal monitoring and detection. The glider will also carry a fish telemetry receiver (Vemco) to track tagged species moving through the region. The sensor suite on the glider will simultaneously characterize the ecosystem's physical structure (Temperature, Salinity, Density; Seabird CTD) tagged fish presence (Vemco receiver), and marine mammal presence (passive acoustics; DMON). The glider will sample these variables at a vertical resolution of 0.25 m and a horizontal resolution of a vertical profile approximately every 100 m along the path. In this talk I will present the results of the mission and how the data is being shared publicly. The data from this effort will support baseline characterization of the lease and surrounding waters, and inform planning for longer term strategies in ecosystem monitoring in the lease area and export cable route. I will further discuss the value of integration of mobile autonomous underwater vehicles to the execution of a long term regional monitoring effort as it pertains to offshore wind development.

Surfclam fisheries enhancement: What do (and don't) we know?

Daphne Munroe[1*], Sarah Borsetti[1], Andrew Scheld[2,3]

1 Rutgers University, 2 Virginia Institute of Marine Science, 3 William and Mary

Mitigation for loss of access to commercial fishery stocks is an important consideration as offshore wind projects are developed. Federal guidance documents prioritize strategies that mitigate lost and altered fishing opportunities while supporting social, cultural, and ecological goals. Mitigation for offshore wind projects that overlap surfclam fishing grounds could be derived from production of surfclam juveniles (also known as seed) in an aquaculture setting (hatcheries and nurseries) to be deployed on fishing grounds to enhance fishing opportunities outside of offshore wind farms. A recent study demonstrated that this mitigation strategy may be feasibly supported by hatchery production of seed annually at a scale of 374M to 2.1B Atlantic surfclams at the end of the hatchery stage to produce 1M bushels of market-sized animals. An ongoing project is reviewing regional commercial hatchery capacity to assess how this level of seed production might be supported with existing infrastructure or what investments in additional hatchery capacity might be necessary. A series of field experiments are also underway to evaluate how varying seed size and density alters the survival and growth of hatchery-reared surfclams when deployed on the continental shelf. Finally, a project is being initiated to develop and test mechanisms to plant clam seed at scales sufficient to support a large-scale, fishery-relevant enhancement strategy and to use machine learning to help identify optimal planting locations. These recent, ongoing, and upcoming programs all aim to address uncertainties to help fully appreciate the potential for this enhancement strategy to mitigate use-conflicts while maintaining social, cultural, and ecological services and are supported by a combination of funding sources from the fishing industry, offshore wind companies, and state and federal agencies.

Dynamic ocean features and their potential impacts on right whale distributions

Laura Nazzaro[1*], Josh Kohut[1], Rhyan Gregch[1], Courtney Dreyfus[2], Jessica Redfern[3], Mark Baumgartner[4], Julianne Wilder[5], Matthew Oliver[6]

1 Rutgers University, 2 JASCO Applied Sciences, 3 New England Aquarium, 4 Woods Hole Oceanographic Institution, 5 National Oceanic and Atmospheric Administration, 6 University of Delaware

The North Atlantic right whale (NARW) is a critically endangered species with calving grounds spanning the coast of North Carolina to Florida and key foraging grounds off the coast of New England. The whale's distribution and movements through the Mid-Atlantic Bight (MAB) is not well documented, especially compared to the well-surveyed foraging and calving grounds. There is a need to effectively detect and/or predict their presence due to the near-future plans for widespread wind farm construction. While there is a lack of consistent NARW observations in the MAB, the environmental conditions throughout the region are well-documented with decades long time-series of in situ and remote data feeds including shipboard field collections, gliders, high-frequency radar, and satellites, as well as four-dimensional assimilative hydrodynamic models. We aim to use these datasets to determine if the NARW select for particular environmental conditions within the highly dynamic MAB. NARW detections from opportunistic and aerial sightings, and from passive acoustics on board glider deployments, are matched to collocated glider data (ie temperature, salinity, dissolved oxygen, chlorophyll, and others) and satellite data (surface temperature, frontal gradients, and others) and compared to background environmental conditions to identify potential patterns in NARW distributions within the MAB. Preliminary results show no relationship with in situ ocean variables (temperature and salinity). However, there are a handful of cohesive satellite-defined water masses in which whales are observed more frequently than those water masses are seen in background conditions, and vice versa. We also observed a tendency for whales to avoid weak surface frontal gradients in favor of moderate strength fronts. Several of these results coincide with a 2016 regime shift in the Nantucket Shoals foraging region, after which whales were observed more frequently than pre-2016, as well as year-round instead of seasonally. Around the same time, we observed an increase in frequency of strong gradients seemingly preferred by NARW, as well as a decrease in frequency of occurrence of certain regional water masses that seem to be avoided by NARW based on our MAB analysis. While these preliminary results cannot predict where and when right whales will be present (or absent), they suggest some promising tools with long-term regional-scale coverage that can be used in NARW models in the future. Using the most effective models possible is key to decreasing the risk to the threatened NARW population as wind farm construction begins across the region.

Noisy wind farms and marine mammals – What mitigation and monitoring is needed?

Georg Nehls[1*], Michael Bellman[2]

1 BioConsult SH, 2 ITAP GmbH

Construction, operation and maintenance of offshore windfarms causes underwater noise immission which may disturb and even harm marine mammals. In Europe, the harbour porpoise *Phocoena phocoena* is a strictly protected but widely distributed species which is present in almost every wind farm site. Noise mitigation is increasingly used to reduce noise immission during pile driving and deterrents to deter porpoises from the risk area. In addition, monitoring by observers or Passive Acoustic Monitoring may be applied to further reduce risks of injuries. Little is so far given to vessel noise during construction and operation.

In the presentation we will review the experience of a decade of marine mammal protection at offshore windfarms. We will elaborate on the effort to reduce noise immision and show that a reduction beyond a certain point does not further reduce the risk of injury and disturbance and that deterrents may even exceed the disturbance from piling. Recommendations will be given how to optimize noise mitigation, marine mammal deterrents and monitoring during the phases of offshore wind farming.

The rich North Sea toolbox: Strengthening underwater nature in offshore wind farms

Eline van Onselen[1*], Sam Kragtwijk[2], Renate Olie[1], Marjolein Kelder[3]

1 The North Sea Foundation, 2 Accenture, 3 Natuur & Milieu

Offshore wind farms (OWFs) are promising locations for strengthening ecological values. They offer hard substrate surfaces and often, less or no bottom disturbance. The Rich North Sea programme (a joined effort between The North Sea Foundation and Natuur & Milieu) aims to support nature in OWFs by creating reefs and increasing biodiversity and wants nature development in OWFs to be well implemented in policy. We run projects in offshore locations with partners in the offshore industry such as Vattenfall, Eneco, Orsted and van Oord, and are involved in scientific projects with different stakeholders. The focus of the programme is now shifting to the long term: how to keep implementing nature enhancement options and nature inclusive designs into an even busier North Sea? How can we balance the benefits of offshore wind with the opportunities (and risks) to the natural environment? And how can we share our knowledge on strengthening nature on an international level?

Part of the programme is to create a platform for knowledge sharing. We created “The Toolbox”, an online, open access platform for knowledge sharing. In the Toolbox we share information on our own projects but also on other nature inclusive design options. This website will be the legacy of The Rich North Sea programme and hopefully will help kick-start other nature enhancement projects in the North Sea and beyond.

The Toolbox is currently being developed in close collaboration with Accenture. By using ‘design-thinking’ the project should do justice to the available knowledge, be it scientific, practical or other. We want to share our own findings but also give others the opportunity to add their own projects. Sharing information regarding these projects, from location to owners, from permits to results. Other information we have added to in the Toolbox involve different types of Nature Inclusive Design, info on rules and regulations, legislation, safety and suppliers. We plan to deliver the first online version of the Toolbox in February 2024 (soft launch). We’re aiming to have the Toolbox be of use for different stakeholder groups such as scientists, governments, industry and consultancy. This way we want to help speed up nature restoration through offshore renewables building upon the best available practices.

Seasonal and diel acoustic activity of sei whales (*Balaenoptera borealis*) in the New York Bight

Maria Papadopoulos[1*], Melinda Rekdahl[1], Anita Murray[2], Maine Department of Marine Resources, Samantha Strindberg[1], Mark Baumgartner[3], Woods Hole Oceanographic Institution, Howard Rosenbaum[1],

1 Wildlife Conservation Society, 2 Maine Department of Marine Resources, 3 Woods Hole Oceanographic Institution

Forthcoming offshore wind development along the U.S. east coast may have both direct and indirect potential impacts to baleen whales. It is therefore vital to establish baseline species distribution and behavioral patterns to effectively monitor for and mitigate potential impacts of offshore wind development on baleen whales. In the New York Bight (NYB), studies contributing to such efforts have been focused on species such as the humpback, fin, and North Atlantic right whales; however, comparatively little is known about the endangered sei whale (Balaenoptera borealis) due to its poorly understood patterns of occurrence and even cryptic nature in the NYB. Sei whales have only been visually sighted twice, once in 2018 and once in 2019, during the most recent broad scale aerial surveys of the NYB. Here, we used passive acoustic monitoring (PAM) to investigate sei whale seasonal and diel acoustic presence and vocal activity in the NYB from 2017-2020, and investigated the relationship between seasonal acoustic activity and environmental variables [sea surface temperature (SST) and chlorophyll-a concentration (Chl-a)] using generalized additive models. Although acoustic detections did not vary significantly throughout the day, sei whale acoustic presence significantly varied by season. Sei whales were primarily detected in spring, with a large peak of activity in March and early April. While detection rates were relatively low in other seasons, sei whales were detected in all months except December and January, suggesting sei whales are present at low levels for most of the year in the NYB. In spring, sei whale detections were highest at low SSTs (~5-9°C), and the peak in acoustic detections coincided with the preferred SST range of the copepod Calanus finmarchicus, sei whales' preferred prey species in the northwestern Atlantic. These analyses provide an indication that the NYB could serve as an opportunistic feeding ground for sei whales in the spring. Given that visually observing sei whales in the NYB is challenging, using acoustic monitoring as a method for observing sei whale distribution and behavior, in conjunction with visual surveys, will be invaluable in expanding our understanding of when, where, and how sei whales are using this habitat. This baseline data can help better inform improved monitoring and potentially relevant mitigation measures, which are particularly important given forthcoming offshore wind activities and other anthropogenic activities in the NYB.

An improved approach to dredge depletion experiments to support regional clam surveys

Sophia Piper[1*], Ailey Sheehan[1], Sarah Borsetti[1], Jason Morson[1], Daphne Munroe[1]

1 Rutgers University

Innovation of new survey methods and cross-calibrated platforms for collecting data is increasingly essential as offshore wind farms are constructed. One way to support regional data comparisons is by using calibrated survey gear. Depletion experiments are used to calibrate equipment by gathering information about the efficiency of towable survey gear. Depletion experiments are conducted by repeatedly sampling an area until the resource is depleted. These experiments are important for estimating absolute abundance of a resource and allow direct data comparison with other calibrated survey tools; however, they tend to be time-consuming and expensive to conduct. Additionally, it is often difficult to determine whether the target sampling location has been sampled multiple times, or if the gear has missed portions of the target area. To mitigate this spatial uncertainty, we used a combination of tow-by-tow spatial and catch analysis to determine the experiment's efficacy in real time. This case study used a series of experiments across offshore wind lease areas to estimate catch efficiency of a hydraulic dredge targeting Atlantic surfclams. In these experiments, a high-resolution (<½ m) GPS receiver was used with navigation software to record location every two seconds. After each tow, sampled track locations were loaded into ArcGIS and ArcPy was used to determine the percent overlap of tows. Simultaneously, the number of individual surfclams and volume of catch were recorded. The catch time series was evaluated as the depletion relative to the highest catch in the time series and using a depletion model. When the percent tow overlap was greater than 80%, the catch (both volume and number caught) was depleted to 20% of the highest observed, and the slope of the depletion curve was below 20% of the maximum slope, the experiment was considered complete. Using these metrics in real time improved the data quality derived from the experiments and made the experiments more efficient. This calibrated survey tool will be used to evaluate clam abundance in and around offshore wind lease areas, and to compare those data to other survey data collected elsewhere to provide a more comprehensive understanding of possible changes to the stock over time.

Historical stranding trends of sea turtle and pinniped species in New York State (1980-2023)

Jill Pryor[1*], Maxine Montello[1]

1 New York Marine Rescue Center

New York Marine Rescue Center (NYMRC) is the primary responder for sick and injured sea turtles and pinnipeds for the entire state of New York. Information gathered from stranded marine animals can provide insight on age, size composition, diet, reproductive status, health, population trends and cause of ortality. Since inception in 1980, NYMRC has responded to a total of 2,644 pinnipeds and 2,334 sea turtles between 1980-2023. These numbers only include animals that were reported directly to NYMRC and do not account for animals that may have been observed and not reported. Pinniped strandings were epresented by five species; 43.9% harp (*Pagophilus groenlandicus*), 29.9% harbor (*Phoca vitulina*), 25.6% gray (*Halichoerus grypus*), 4.5% hooded (*Cystophora cristata*) and 0.3% ringed (*Pusa hispida*). Pinnipeds stranded most frequently along the south shore of Long Island due to illness, malnourishment, external injuries, or due to human caused strandings (fisheries and vessel interaction, and harassment). After 2017, NYMRC no longer responded to reports of deceased pinnipeds and data after this point only pertains to live pinnipeds responses. Sea turtle strandings were represented by four species; 34.8% Kemp's ridley (*Lepidochelys kempii*), 34.1% loggerhead (Caretta caretta), 17.0% leatherback (Dermochelys coriacea), and 13.7% green (Chelonia mydas). The remaining percentage is epresented by hybrid species (0.1%) or species that could not be identified due to body decomposition (0.2%). Most sea turtle strandings occurred in New York during the winter months due to cold stunning, an event similar to hypothermia that causes the sea turtles to become weak and lethargic as water temperatures drop. These cold stunning events are highly focused on the north shore and east end of Long Island. Other causes of strandings in sea turtles included malnourishment, debilitation, fisheries, and vessel interaction as well as ingestion of marine debris. Preliminary results indicate that strandings have increased in recent years and many of those strandings are linked to human influence and overlap between human and marine species populations. There is limited information known about wild populations of sea turtle and pinniped species in New York. Historical data related to sea turtle and pinniped standings provides insight on population trends and can be crucial in predicting the health of future populations. It is important that organizations like NYMRC continue to collect data on these critical species to support conservation and preservation of wild populations.

Approach and findings for reduction of aircraft bird strikes using ultraviolet radiation

Donald Ronning[1*]

1 Lite Enterprises

A study using a prototype (PAR46) sized landing light that incorporated ultraviolet light emitting diodes (UV LEDs) was flown on a remote controlled (RC) plane and later on a single engine turbine powered aircraft. The planes were flown in the direction of avian species to measure their behavioral response to the approaching plane with custom fabricated landing lights emitting UV and near UV light in addition to normal white light. Data concurrently collected from multiple sources including cameras onboard the plane and from the ground as well as a bird radar unit measuring the flight path separation between the plane and the birds. The multiple data sources were cross referenced when appropriate to validate the distance between the avian species and the plane. The flights were conducted during daytime hours, and at a nominal altitude of <500 ft above ground. The nominal speed of the remote controlled (RC) plane was 30 knots/hr. The nominal speed of the single engine turbine powered aircraft was 150 knots/hr. Results from several hundred bird-plane interactions determined that the presence of UV and near UV light induced avoidance behavioral responses that increased flight path. The model of behavioral response to visual stimulus suggested by recent neuroscience research was followed to derived three variables from the unique environmental conditions data corresponding to each bird-plane interaction. The model accurately predicts the effective distance of a bird's behavioral response. A presence of specie bias dependency on the effective distance of a bird's behavioral response was suggested in the data, but was not conclusively identified. Possible application extension of latest approach and findings:

Research motivations and objectives - Mitigation of morbidity and mortality involving offshore wind farms involving avian and airborne species. Methodology - Nonlethal, passive deterrence of species within the high-risk airspace (rotor sweep area) surrounding the wind turbine or any other critical structure. Further the understanding of unique specie physiology within the framework of the predictive model identified in prior research may lead to techniques of implementation that are optimized for the species likely to be encountered any unique windfarm site. The notional implementation technique involves mounting location(s) upon the wind turbine structure and power sourced from the wind turbine.

Summary of results - The mean distance of the avoidance response was statistically significantly greater with the presence of UV and near UV light induced avoidance behavioral responses. The neuroscience based model characterized localized environmental conditions to derive values of the neurophysiological mechanisms.

Implications of findings - The insight from the neurophysiological model of behavioral response is likely to be applicable to a wide range of species, applications, and environments.

Studying the effects of offshore wind construction noise on rish and invertebrates

Brendan Runde[1*], Kate Wilke[1], Andrew Lipsky[2], Elizabeth Methratta[2], Jessica McCordic[2], Sofie Van Parijs[2]

1 The Nature Conservancy, 2 National Oceanic and Atmospheric Administration Fisheries

The immediate and long-term effects of offshore wind construction activity on living marine resources are priorities for research. The in-progress Coastal Virginia Offshore Wind project (CVOW-C) is an ideal location for investigating the effects of construction noise on fish and invertebrates, because of its proximity to the already-built CVOW-Research area. We affixed acoustic transmitters to fish and invertebrates, including black sea bass and channeled whelk, and released them at the two CVOW-Research turbines before and during pile driving at CVOW-C. We simultaneously deployed an array of acoustic receivers and passive acoustic hydrophones. Three-dimensional fine-scale positioning (i.e., Vemco Positioning System) will be used to infer behavioral tendencies of tagged animals. We will analyze whether behavioral changes corresponded with ambient noise levels from construction activity. Further, we will develop metrics to describe: 1) species- and size-specific use of the vertical habitat provided by wind turbine foundations, 2) the influence of existing transmission cables on habitat selection, and 3) changes in the ambient soundscape that co-occur with construction noise. Our results will inform future monitoring and mitigation requirements for activities on the U.S. Outer Continental Shelf and beyond.

An autonomous-based oceanographic and ecological baseline to inform offshore wind development

Grace Saba[1*], Caitlin McGarigal[2], Kira Lawrence[3], Josh Kohut[1]

1 Rutgers University, 2 New Jersey Department of Environmental Protection, Division of Science and Research, 3 New Jersey Board of Public Utilities

New Jersey has set a goal to procure half of its energy from renewable resources by 2030. Offshore wind power will play a critical role in achieving this goal. On the continental shelf off New Jersey, including areas leased for offshore wind development, the ocean is characterized by remarkable variability across time scales from days to seasons to decades. This variability drives an equally variable ecosystem from primary producers to highly migratory fishes and marine mammals. With offshore wind construction scheduled to begin in this region within the next few years, it is critical that oceanographic and ecological baseline monitoring begins quickly and considers time scales of natural variability from seasons to years. Our team has initiated a comprehensive "ecoglider" program that is providing both a baseline dataset of necessary oceanographic and ecological parameters to inform the responsible development of offshore wind and valuable information relevant to ongoing environmental and ecological change in this productive ecosystem. Deployed gliders include a full complement of available sensors to simultaneously map oceanographic and ecological variables from phytoplankton to fish to marine mammals, including water depth, temperature, salinity, pH, optical properties including chlorophyll-a, and dissolved oxygen. Ecological sensors include a passive acoustics sensor for marine mammal monitoring and detection, multi-frequency echo sounders for active acoustic detection of pelagic fish and zooplankton, and acoustic telemetry receivers to track tagged species moving through the region. Ecoglider data are mapping seasonal trends in ecologically relevant oceanographic parameters in wind energy lease areas and exploring overlap between oceanographic features and distribution of fishes, marine mammals, and their prey.

Quantifying the vulnerability of winter skate (*L. ocellata*) and smooth dogfish (*M. canis*) to EMF's from offshore wind in the Mid-Atlantic Bight

Rachel Sechrist[1*], Tobey Curtis[2], Kevin Friedland[2], Paul Bologna[1]

1 Montclair State University, 2 National Oceanic and Atmospheric Administration

Quantifying the vulnerability of winter skate (*L. ocellata*) and smooth dogfish (*M. canis*) to EMF's from offshore wind in the Mid-Atlantic Bight Offshore wind energy production in the U.S. is growing to meet the demands for renewable energy, and it is extremely important that we assess the impacts it may have to marine life. Development in the northeastern shelf will contribute to the success of the renewable energy market, but will also overlap with numerous fisheries that contribute important economic, recreational, and cultural resources. With looming climate change impacts due to the excessive use of fossil fuels, renewable alternatives are critical to maintaining ocean ecosystem stability and sustainable fisheries. All elasmobranchs possess the ability to detect electrical signals using ampullae of Lorenzini. However, the level of detection or sensitivity varies by species due to differences in morphology, habitat use, and prey type.

The quantity and distribution of ampullae of Lorenzini determine a species' sensitivity to electromagnetic fields (EMF)'s. The winter skate, *Leucoraja ocellata*, is considered a resident species of the region and is among the largest commercial fisheries in the Northeastern United States, harvested for wing meat sold as imitation scallops. Smooth dogfish, *Mustelis canis*, is another important species to the Northeastern commercial fishery, and is also considered a highly migratory species. Both species may be impacted by offshore wind development if their exposure to EMF's generated by subsea cables is significant. As such, if they are negatively impacted by high EMF exposure, it could affect the economic value of these fisheries. Assessing the location of offshore wind development relative to specific species' preferred habitat will allow for comparisons to be made about their abundance in the area before and after long-term operation of offshore wind farms (OWF)'s. This study aims to quantify the vulnerability of these two species as a function of exposure to the cables plus physiological sensitivity to electromagnetic fields. Using GIS, cable routes from offshore wind energy were overlayed with winter skate and smooth dogfish biomass in the region of interest to show the degree of overlap.

The initial evaluation related to winter skate biomass indicates that OWF placement off the coasts of Rhode Island and Massachusetts are within regions of high biomass. Evaluation of smooth dogfish distributions are ongoing. Additionally, the first pore maps for both species will be constructed in order to understand their ability to detect the fields, if exposed. A species with high exposure and high sensitivity would infer more concern than a species with high exposure but little detection ability due to a low number of ampullae of Lorenzini.

Before-After-Gradient fishery monitoring design in the US wind project areas

David Secor[1*] , Michael O'Brien[1] , Evan Kostelecky[1], Vachelsav Lyubchich[1]

1 University of Maryland, Center for Environmental Science

The goal of the 8-yr UMCES-US Wind Fishery Resource Monitoring program is to evaluate the extent that black sea bass (BSB) change their aggregation behaviors between 2-yr periods: before, during, and after construction and alter their availability to commercial and recreational charter fisheries. BSB are structure-oriented with large aggregations occurring on artificial reefs and wrecks. The US Wind Project Areas (MarWin and Momentum) will build out to 1100 MW (>60 turbines) in a 320 km 2 leased area, 27-40 km offshore (25-40 m depth) of Maryland and

Delaware coasts. Turbine foundations will add three-dimensional structure where very little currently exists. Under these new conditions, we will test for highly aggregated distributions centered on turbines and increased accessibility to commercial and recreational fisheries. Study designs utilize Before-After-Gradient and Before-After-Control-Impact procedures testing for hypothesized changes in catch amplitude and variance. Operating from commercial vessels, the pot survey consists of sets of 15 commercial pots each that are spaced proximate and distant to turbine structures to capture both turbine- and project-scaled changes in catch rates. Rope-less gear is used to avoid whale and turtle entanglements. Statistical power analysis shows that the sampling design will support expected changes owing to the hypothesized turbine reef effect. The recreational survey includes standard drop and jigging techniques and compares two artificial reef sites (control) to two turbine sites. In both surveys, BSB size, sex and diet metrics are taken during all study phases.

Aerial drones for marine protected species monitoring and mitigation in offshore wind construction

Atasha Smith[1], Stephanie Milne[1], Benjamin Finkes[1]

1 TetraTech

Protected species monitoring is a requirement for some offshore wind (OW) operations to implement mitigations as needed to reduce any potential impacts to these species. Monitoring has historically been undertaken by Protected Species Observers (PSOs) deployed on vessels. Augmented with binocular equipment, PSOs can monitor out to several kilometers but where the efficacy of detecting animals at larger distances is highly impacted by factors like sea state. Aerial surveys have been used to monitor larger marine regions relatively quickly, but aerial surveys are expensive, high-risk operations.

Aerial drones can supplement protected species monitoring to reduce the risk to humans while still providing PSOs with an increased field of view to detect marine species. Since 2017 when RPS investigated using drones for oil & gas platform decommissioning operations, we have conducted a series of research investigations into the various types of drone technologies and the accompanying camera payloads. Trials were designed to evaluate: (1) The operating parameters of the craft, considering OW use cases (2) Health Safety and Environmental (HSE) risks and benefits. Trials with several hybrid drones and with a tethered drone system. The offshore trials demonstrated that the camera systems could detect obscure species, but hybrid drones are not capable of achieving flight times that would be sufficient to conduct continuous monitoring. Tethered drones can receive continuous power via the tether, enabling unlimited flight time. But while the tethered drone could be deployed for unlimited time periods, the height at which the tethered drone could be deployed to (and therefore the field of view that could be achieved for the cameras) was significantly limited by wind speed.

A new, more targeted application for a free-flying drone where long flight times are not required was identified. Specifically, observations of large whales that cannot be excluded to be North Atlantic right whales will often require that construction activities be delayed, which can have significant impacts to projects. Identifying those unidentified whales to species, excluding the potential of a NARW, could significantly reduce downtime to costly construction operations.

In partnership with an OW developer, an offshore trial will be performed in Q1 of 2024 to test this application. Land and offshore trials have already been completed to test the technical capabilities of the drone and camera systems and to evaluate HSE limitations relevant to marine operations. The goals of the trials were to (1) Safety launch/retrieve the drone from a moving vessel, (2) Operate the drone at sufficient heights to monitor for marine species and (3) Transmit clear imagery from the drone while in flight such that species identifications could be made. These objectives were each met, and the results of the upcoming trial will be available to be presented at this workshop.

Establishing baseline data on bat activity along the U.S. West coast

Donald I. Solick[1*], Christian M. Newman[1], Gabriel A. Reyes[2], Trevor S. Peterson[3], Michael Whitby[4], Robert Hamilton[5], Bethany Schulze[2], Caroline Byrne[3], Jessie Bunkley[4]

1 EPRI, 2 U.S. Geological Survey, 3 Stantec Consulting, 4 Bat Conservation International, 5 Woods Hole Oceanographic Institute

The United States is aggressively promoting the development of offshore wind energy capacity along the U.S. West Coast. Terrestrial wind energy development is known to cause widespread and considerable bat mortality, particularly among long-distance migratory species during the fall. These species are known to fly offshore along the U.S. East Coast, but very little is known about bat activity along the West Coast. The cumulative impacts of mortality caused by land-based and offshore wind energy could threaten some species with rapid population declines and potential extinction. There is urgent need to determine the patterns and extent of bat use of the offshore environment in Oregon and California to help the wind energy industry and regulatory agencies assess and mitigate potential impacts to bats as offshore wind expands. Our team has been funded by the Department of Energy to monitor acoustic bat activity to define the environmental conditions under which most bat activity occurs. Acoustic monitoring will include a combination of fixed locations in offshore, coastal, and inland environments and mobile, vessel-based monitoring sites. This sampling effort will allow us to describe the weather conditions associated with high offshore bat activity and model the frequency that conditions conducive to bat activity occur across the entire spatial domain (within 50 km of Oregon & California coastlines). We will also conduct a telemetry-based stopover study focused on the Farallon Islands. Our project will generate a robust dataset to determine the feasibility and potential costs of measures to avoid or minimize impacts to vulnerable wildlife from offshore wind energy development.

Reliable and unreliable methods to locate and census calling whales via time differences of arrival between widely separated receivers

John Spiesberger[1*], Maya Mathur[1], Devin Pascoe[1]

1 University of Pennsylvania

Confidence intervals of location (CIL) of calling marine mammals, derived from time-differences-of-arrival (TDOA) between receivers, depend on errors of TDOAs, receiver location, clocks, and sound speeds. Simulations demonstrate a time differences-of-arrival-beamforming-locator (TDOA-BL) yields CIL in error by O(10–100) km for experimental scenarios because it is not designed to account for relevant errors. The errors are large and sometimes exceed the distances of detection. Another locator designed for all errors, sequential bound estimation (SBE), yields CIL always containing the true location. TDOA-BL have been widely used for censusing and understanding potential effects of environmental stress on marine mammals; a use worth reconsidering. (Mathur et al., Confidence intervals of location for marine mammal calls via time-differences-of-arrival: Sensitivity analysis. JASA Express Lett. 1 February 2024; 4 (2): 021201. https://doi.org/10.1121/10.0024634).Statistical distance-sampling approaches for censusing may be appropriate when used with reliable estimates of distance between a hydrophone and call. Reliable locations derived with SBE yield calling abundance without tunable parameters and may offer a more sensitive means for detecting correlation between marine mammal activity and activities of the offshore wind industry (Spiesberger et al., Bounding the number of calling animals with passive acoustics and reliable locations. J Acoust Soc Am. 2021 Aug;150(2):1496. doi: 10.1121/10.0004994. PMID: 34470266).

High-definition digital aerial surveys inform offshore wind development in the Gulf of Maine

Iain Stenhouse[1*], Kate Williams[1], Evan Adams[1], Andrew Gilbert[1], Julia E. Stepanuk[1,2], Kelly MacLeod[3], David Thain[3], Martin Scott[3]

1 Biodiversity Research Institute, 2 SoMAs Stony Brook University, 3 Hidef Aerial Surverying Ltd

Data on marine wildlife distributions and abundance in the offshore environment is critically needed in the Gulf of Maine. The Bureau of Ocean Energy Management (BOEM) has funded a 1–2 year ecological baseline survey across a significant portion of the Gulf of Maine to broadly inform offshore wind development in the region. These extensive seasonal surveys are centered on an area of greatest potential development interest, and Diamond Offshore Wind has added project funds to increase the density of transects specifically within that focal area. The Biodiversity Research Institute (BRI) and HiDef Aerial Surveying (HiDef) are using digital aerial videography to capture observations of a range of taxonomic groups, including birds and marine mammals, as well as abiotic objects, such as buoys and vessels. Surveys are conducted using HiDef's GEN 2.5 survey rig which contains four extremely high-resolution digital video cameras mounted in a fixed wing aircraft and is designed specifically for high quality wildlife surveys. Surveys are flown at 400 m altitude at a ground speed of 220 km/h (~120 knots). The cameras provide digital imagery at 1.5 cm ground sample distance (GSD) resolution, which supports the identification of relatively small seabirds. Flight heights are estimated based on body measurements. The survey area was reviewed and refined through a stakeholder review process – extending from the boundary of state and federal waters out to deeper waters, including parts of Platts Bank, Jeffreys Bank, and Cashes Basin. Surveys began in spring of 2023 and a total of four surveys were flown between May 2023 and January 2024. Data is currently under review and analysis is forthcoming. On completion, survey imagery will be publicly available in an online mapping tool.

Using harbor seal haul-out correlation with environmental factors to advise satellite tagging efforts in Great Bay, New Jersey

Jacalyn Toth Sullivan[1*], Thomas M. Grothues[2], Robert DiGiovanni Jr[3]

1 Stockton University, 2 Jacques Cousteau National Estuarine Research Reserve and Rutgers University Field Station, 4 Atlantic Marine Conservation Society

Harbor seals (*Phoca vitulina*) occur in Great Bay, New Jersey annually from late Fall (October) to late Spring (May). In January 2022, we began monitoring the occurrence, sighting patterns, and haul-out dynamics of this seasonal population to help determine patterns of occurrence and habitat use in this southern NJ estuary. Photos were taken of the Great Bay haul-out site during daylight hours (7am-5pm, every 2 hours) using a remote solar-powered camera system (TrueLook PTZ 1080 IR). Local environmental conditions were collected over the same period (tide, wind speed, wind direction, precipitation, barometric pressure, relative humidity, air and water temperature). From January 16, 2022 to January 31, 2024, 133,211 images of the haul-out site were recorded, along with concurrent daily environmental conditions. A December 2022 subset was used to fit seal haul-out number to the recorded environmental factors. A total of 6,148 photos were taken in December 2022 (range = 0 – 206 seals) and 5,819 in December 2023 (range = 0 – 247 seals). A best-fit general linear mixed model excluded water temperature and relative humidity, but included air temperature, tide, wind speed, barometric pressure, air/water temperature interaction, and air temperature/wind speed interaction. In collaboration with Stockton University, Atlantic Marine Conservation Society (AMSEAS), NOAA Northeast Fisheries Science Center, Marine Mammals of Maine, and the Naval Undersea Warfare Center, a satellite tagging effort funded by NJ Department of Environmental Protection Research and Monitoring Initiative is planned for December 2024 to help elucidate offshore movement patterns and habitat use of these harbor seals beyond Great Bay. This long-term data set will provide a framework for understanding population dynamics of harbor seals that utilize Great Bay while informing the future tagging efforts at this location. Results, efficacy, and applicability of the summary data and GLMM will be discussed.

Size and abundance of juvenile Atlantic surfclams (*Spisula solidissima*) in wind lease areas offshore of New Jersey

Hails Tanaka[1*], Sophia Piper[1], Grace Saba[1], Daphne Munroe[1]

1 Rutgers University

The Atlantic surfclam (*Spisula solidissima*) is an important commercial fishery in New Jersey that has been monitored annually since the 1980s by New Jersey state and federal fisheries entities. Throughout these surveys for inshore populations, a northward and offshore shift has been documented for the surfclam population. With the development of offshore wind operations increasing in the last several years, characterizing the surfclam population in offshore wind lease areas can inform the impact wind turbine installations may have on this population. This project examines the distribution of juvenile surfclams at stations in and around wind lease areas off the coast of New Jersey as part of the New Jersey Offshore Wind Research and Monitoring Initiative (RMI) surfclam survey. In August 2022, forty stations were sampled with a benthic Petersen grab, which retrieves the top 5 to 10 centimeters of sediment and collects the newly settled surfclams that live in the upper sediments. Each grab was sieved (2mm mesh) and all clams retained were identified, counted, and measured. Little change in size frequency of these small (<18 mm) clams was evident latitudinally or by depth. Among all surfclams collected in the benthic grab, one size mode (3.7 mm) was observed which indicates a spring spawn predominant in the population. Overall, 154 total juvenile surfclams were collected, with the highest abundance from central stations and the lowest abundance from northern stations. These results provide novel insight about the distribution of juvenile surfclams in and around wind lease areas. Specifically, they indicate where future cohorts may be found based on juvenile surfclam presence in the area. Further sampling of these regions will provide a clearer picture of how young-of-the-year surfclam size distributions are changing in federal waters off the coast of New Jersey. This sampling encompassed only one year, so future studies should compare the year-to-year variation of surfclam recruitment and growth in these offshore habitats. Similar surveys of juvenile surfclams conducted in coastal waters off Virginia and New Jersey in 2023 could serve as a first opportunity to expand these results.

Paired comparison of echolocation click eetectors to monitor for dolphins and porpoises

Caroline Tribble[1*] , Helen Bailey[1] , David Secor[1] , Vyacheslav Lyubchich[1]

1 University of Maryland, Center for Environmental Science

Echolocation click detectors are used widely in passive acoustic monitoring of porpoises and dolphins. The Cetacean POrpoise Detector (C-POD, Chelonia Ltd.) has been a key detector but is now being superseded by the Full waveform capture POD (F-POD, Chelonia Ltd.) introduced in 2020. To bridge historical (C-POD) and future (F-POD) acoustic monitoring as part of an offshore wind impact study, TailWinds (tailwinds.umces.edu), we undertook a paired comparison at two sites. An F-POD and C-POD were co-deployed at a site within the MarWin US Wind lease area (30 km east of Ocean City MD) and an inshore site (12 km east of Ocean City) from April to October 2023. At both sites, only delphinid species were detected during this period. On the F-PODs, hourly detections were 13.1% higher and feeding buzzes were 9.6% higher than on the C-PODs. The inshore site experienced higher levels of dolphin occurrence. Temporal patterns in occurrence and feeding buzz rates were consistent between the two PODs. POD performance was more variable at the inshore site. At the MarWin site, overall occurrence and buzz rates were lower, and POD performance showed greater consistency in hourly detections (F-POD 13.1% higher), seasonality and buzz rates. Future work will continue to build on assessing POD performance with an additional co-located LS-1X acoustic recorder that provides the full audio recording for validation of dolphin click detections.

Deep water wind technical concepts study

Katy White[1*], Brian Dresser[1], Janelle Lavallee[1], Morgan Brunbauer[2]

1 TetraTech, 2 New York State Energy Research Development Authority

The Deep Water Wind Technical Concepts Study supported the New York State Energy Research and Development Authority's Offshore Wind Master Plan 2.0 in the Area of Analysis (AoA) at or exceeding depths of 60 meters in the New York Bight. Identifying offshore wind (OSW) leases in deep water areas in the New York region will be required to reach federal and New York State targets for OSW in a timely manner.

In this presentation, we will summarize the findings of this Study, within the following topics; 1) technical specifications associated with deep water wind turbines, moorings, anchoring, export and inter-array cables, substations, and risks for each; 2) potential environmental impacts and considerations of deep water OSW infrastructure within the AoA, focusing on physical and biological benthic constraints, oceanographic processes, and risks to marine resources and fisheries; 3) next generation technologies that could stretch the limits of what is currently deemed feasible and may help to mitigate impacts on some environmental factors; and 4) future considerations for deep water OSW development within the AoA.

This presentation will discuss the challenges associated with each of the three distinct depth zones considered as part of the AoA such as seabed morphology, presence of sponges and corals, sediment type, fisheries conflict, distance from shore, environmental impacts, and logistics developing an area. All three zones are substantially different with varying degrees of potential environmental, fisheries, and maritime industry conflicts. The three zones present firm deep water OSW limitations. Physical factors such as seabed morphology, water depth, and sediment type dictate the deep water OSW structures feasible in a particular area; from the anchors to the turbines. The long distance to shore from the AoA could pose a feasibility issue with high voltage direct current cables. Fisheries-use, gear types, slopes and canyons, and sponges and corals vary throughout the AoA. The reality of powering wind within Zone 3 and suspending an inter-array cable past Zone 2 and buried into Zone 1 is theoretically achievable, though difficult to engineer.

Underwater deep water OSW structures also pose oceanographic and fisheries-use challenges. Multiple mooring lines within the water column could potentially impact currents essential for upwelling. Impacts to fisheries from deep water OSW operations could lead to permanent loss of fishing grounds for certain gear types, potential loss of gear due to entanglement, and the potential for navigation risk. Bottom contact gear would be most impacted by deep water OSW infrastructure.

This presentation will reveal limitations, challenges, and opportunities for future considerations to support planning for deep water OSW in the New York Bight. Innovative technology, infrastructure monitoring, accurate siting, and array designs could move New York closer to reaching its state goals.

Mitigation options for birds and bats at offshore wind facilities: A review

Kate Williams[1*], Julia Gulka[1], Steve Knapp[1], Leigh LaMartina[1], Anna Soccorsi[1], Paul Knaga[2], Stephanie Avery-Gomm[2]

1 Biodiversity Research Institute, 2 Environment and Climate Change Canada

Mitigation of the effects of anthropogenic activity on wildlife can include efforts to avoid, minimize, restore, or compensate for these effects. Mitigation of the effects of offshore wind energy (OSW) development on aerofauna (birds and bats) can be implemented during the planning and design phase, by changing characteristics and operational parameters of wind facilities once they are built, via habitat enhancement/reduction (on-site or off-site), or via the use of off-site compensation measures. However, it is difficult to test mitigation approaches offshore; such validation efforts tend to be expensive and may suffer from a lack of statistical power. As a result, some mitigation measures may be considered or implemented without reliable evidence of efficacy, potentially leading to 1) false assurance that effects of OSW on aerofauna are being mitigated, and 2) wasted resources spent implementing ineffective mitigation measures.

We conducted a literature review to examine the state of knowledge of offshore mitigations for aerofauna. This review included the identification of 1) mitigations that have been used or proposed to be used in offshore wind developments, 2) the weight of evidence supporting (or not supporting) existing mitigation approaches, and 3) knowledge gaps in mitigation effectiveness. This literature review also examined mitigation approaches for other industries as appropriate, including terrestrial wind energy and offshore oil and gas. Relatively few on-site mitigation measures that are currently implemented at OSW facilities have been adequately tested to assess their efficacy. In part, this is because of the preponderance of data that is required to examine the efficacy of different study design choices (e.g., requiring data from multiple comparable OSW facilities with differing characteristics). Mitigation measures implemented in other contexts, such as deterrents to agricultural pests, are largely ineffective over the long term. Many measures implemented for terrestrial wind energy development, such as curtailment of turbine operations to protect bats, have yet to be tested offshore. Very few mitigation approaches have sufficient data to support current implementation at OSW facilities without the need for additional data on their efficacy, either in the short or long term. Effective monitoring programs to assess mitigations can be difficult to design and implement. We identify mitigation measures that could be universally implemented, or at least considered for implementation, at all OSW sites based on current evidence; approaches that need additional data to assess their effectiveness; and approaches that likely should not be considered further in the context of minimizing effects to birds and bats from OSW. In the absence of proven on-site mitigation to avoid and minimize effects, compensatory and off-site mitigation measures should be carefully considered.

A framework for studying the effects of offshore wind energy development on birds and bats in the eastern United States

Kate Williams[1*], Julia Gulka[1], Aonghais Cook[2], Robert Diehl[3], Andrew Farnsworth[4], Holly Goyert[1], Cris Hein[5], Pamela Loring[6], David Mizrahi[7], Ib Krag Petersen[8], Trevor Peterson[9], Kate McClellan Press[10], Iain Stenhouse[1]

1 Biodiversity Research Institute, 2 The Biodiversity Consultancy, 3 U.S Geological Survey, 4 Cornell University, 5 National Renewable Energy Laboratory, 6 U.S. Fish and Wildlife Service, 7 New Jersey Audubon, 8 ECOS, 9 Stantec Consulting, 10 New York State Energy Research and Development Authority

Offshore wind energy development, while a key strategy for reducing carbon emissions, has potential negative effects to wildlife that should be examined to inform decision making and adaptive management as the industry expands. We present a conceptual framework to guide the long-term study of potential effects to birds and bats from offshore wind energy development. This framework includes a focus on exposure and vulnerability as key determinants of risk. For birds and bats that are exposed to offshore wind energy development, there are three main effects of interest that may impact survival and productivity: 1) collision mortality, 2) behavioral responses, including avoidance, displacement, and attraction, and 3) habitat-mediated effects to prey populations. If these offshore wind effects cause changes in survival and/or breeding success (e.g., fitness), they have the potential for population-level consequences, including changes in population size and structure. Understanding the influence of ecological drivers on exposure and effect parameters can help to disentangle the potential impacts of offshore wind energy development from other stressors. We use this theoretical framework to summarize existing relevant knowledge and identify current priority research questions (n=22) for the eastern United States, where large-scale development of offshore wind energy is primarily in the planning and early construction phase. We also identify recommendations for study design and further prioritization of research topics.