Co-authors: Jason Morson and Grace Saba

The Atlantic surfclam fishery has been identified among the most exposed 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 include surfclam surveys in wind energy fishery monitoring plans. A survey tool that samples over a relatively large area and that consistently catches large-bodied clams is needed to accurately estimate biomass, abundance, and size structure of the commercially valuable surfclam stock. In this project, a scientific sampling dredge designed to catch a breadth of sizes of surfclams and to survey within wind lease areas was constructed and used to survey surfclams at an offshore wind lease location. Surveys of wind lease areas are designed as a before-after-control impact study that will continue annually through the construction of the wind farm. Additional experiments are underway to quantify the selectivity and efficiency of the scientific dredge. These experiments will be conducted on the continental shelf off New Jersey; habitats that 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) will be measured in coordination with carbonate chemistry observations in the field. 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.

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Modeling Interactions Among Commercial Shellfish Fishing and Wind Energy

The lucrative shellfish fisheries operating on the Northeast U.S. continental shelf are highly vulnerable to impacts from offshore wind energy development because of the overlap of large areas proposed for wind energy and fishing grounds, limitations to access for bottom-tending gear towed by large vessels, and the high value of the landed product. The economic impacts of future offshore wind farms on these fisheries are evaluated using a modeling framework that integrates spatial dynamics in stock biology, fishery captain and fleet behavior, federal management decisions, and fishery economics. The simulations implemented with the model consider the impacts of proposed wind array configurations on the fisheries that result from anticipated vessel responses to array and turbine locations and responses of stock population dynamics to changing environmental conditions. The simulations are constrained by stock assessment data and detailed input from industry advisory teams about fleet and captain behavior. The model will also be implemented to project responses and consequent impacts on the fishery resulting from stock range shifts, as may occur with climate warming, rotational closures, and management changes. The simulation results provide understanding and identification of the costs to these shellfish fisheries and their surveys produced by displacement or changes in fishing activity due to wind energy and a warming climate. This information is critical for industry and fishery managers to assess approaches for mitigating interactions between commercial fisheries, the growing offshore wind industry, and changing environmental conditions.

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Offshore Wind and Coastal Upwelling

The variability of the offshore wind resource depends largely on air-sea interaction processes related to the exchange of heat and momentum. In this study we explore the effect of coastal upwelling on winds in the marine boundary layer in New Jersey, as well as potential implications for wind energy.

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Assessing the Impacts of Offshore Wind Development in the Eastern Seaboard: Policies and Gaps.

Co-author: Adrian Aranda Alzamora

Offshore wind development (OWD) has been singled out as an environmentally sustainable and cost-effective technology for energy production. Representing the new frontier of blue economic development, wind farms will begin construction off the coast of New Jersey and New York in the next year. While the expansion of OWD seems undaunted, knowledge about the potential short and long-term impacts to ecosystems is limited and much remains to be known about policy avenues for advocacy. In this presentation, we explore policies and white documents about OWD, and bibliographic database of impacts of OWD to commercial fisheries and coastal communities. Findings underscore the lack of a formalized impact assessment tool that can 1) target the full range of social, policy, and environmental impacts of OWD; 2) be consistently employed over time; and 3) engage local actors to empower stewardship and governance accountability. Findings from this project is of value to a multidisciplinary team of scientists from Rutgers and other universities, managers, industry and NGO partners, to propose a long-term monitoring framework to assess the effects of OWD, evaluate vulnerabilities, and advance alternative scenarios for policy-making.

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Renewable Materials for the Next Wave of Renewable Wind Energy

A wind energy generator requires millions of dollars of materials. Every material used in its construction requires a large amount of energy to manufacture, resulting in large sums of carbon dioxide emissions. The amount of CO_2 generated with current manufacturing methods is comparable to the amount of CO_2 avoided by this form of electricity generated over its 10-year lifespan. Furthermore, most of the materials are not recyclable. In addition, some materials may not be available in the quantities required to build all the generators currently planned for installation over the next 10 years. Many of the materials, such as rare-earth-based magnets, are required in quantities that far exceed the amounts that can be recovered from today's mineral sources. When such materials are scarce, their cost goes up and producers use the most productive but highly polluting methodologies. Even noncritical materials, such as concrete, are produced with environmentally destructive methods that are responsible for close to 10% of all anthropogenic CO_2 emissions. This lightning talk will highlight my team's efforts to create manufacturing methods that avoid the pitfalls of current manufacturing practices.

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An Autonomous-based Oceanographic and Ecological Baseline to Inform Offshore Wind Development Over the Continental Shelf Off the Coast of New Jersey, Northeast U.S.

Co-authors: Josh Kohut, Kira Lawrence, and Reneé Reilly

With offshore wind construction scheduled to begin in coastal New Jersey over the next year, it is critical that oceanographic and ecological baseline monitoring is taking place and considers time scales of natural variability from seasons to years. Additionally, it is imperative that we test the potential for autonomous underwater vehicle (AUV) platforms, including gliders, to augment or replace historic vessel-based oceanographic and fisheries surveys in wind construction locations. We have initiated a comprehensive "ecoglider" program that will provide a baseline dataset of necessary oceanographic and ecological parameters to inform the responsible development of offshore wind, and provide valuable information relevant to ongoing environmental and ecological change in this productive ecosystem. Over the course of two years, we will conduct a seasonal baseline survey with a pair of Slocum gliders, AUVs that collect high-resolution data at various depths throughout the water column. Deployed gliders will include a full complement of available sensors to simultaneously map oceanographic and ecological variables from phytoplankton 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. A third glider will be deployed to fill gaps between seasonal deployments and enhance temporal presence during the life of the Cold Pool, an ecologically important mass of cold remnant winter bottom water that persists from spring to fall in this region. Example data products will include mapping seasonal trends in ecologically relevant oceanographic parameters in wind energy lease areas and exploring overlap between oceanographic features and distribution of fishes and marine mammals and between marine mammal predators and their prey.

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Offshore Wind Energy and Summer Flounder Distribution

As a highly demanded fish stock for both commercial and recreational purposes, changes in the spatial distribution of summer flounder (Paralichthys dentatus) along the northeast shelf are of high interest, especially in relation to warming ocean temperatures and anthropogenic activities such as offshore wind energy development. Statistical hindcasting of fluke distributions was accomplished with delta-generalized linear mixed modeling (Delta-GLMM) using NEFSC spring and fall bottom trawl surveys, and the ocean temperature data for the years 1990-2019. Shifts in center of biomass and spatial extent were analyzed to determine whether the geographical transitions of the stock were the result of habitat suitability as can be explained by the observed environmental variables. The determined relationship between the distributional parameters and summer flounder dispersal can shed light on the influence of a changing ocean climate and human activities on marine populations. A coastal hydrodynamics model will be developed to simulate the change by future climate change scenarios and offshore wind farms. The obtained change in physical oceanography will be coupled with the Delta-GLMM to predict the future fluke distribution in New Jersey.

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Fisheries Monitoring Plan for Ocean Wind 1: A Plan Overview and Acoustic Telemetry Surveying

Co-authors: Thomas Grothues, Keith Dunton, and Chase Wunder

Much of the New Jersey continental shelf consists of unconsolidated sediments that provide seasonal habitat to many migratory fish species. A prominent structural feature is the connection with numerous estuarine inlets. These provide highly productive and seasonally warm growth habitats. The relative contribution of these estuaries and shelf habitat to residence period in this region has not been quantified. Stakeholders are concerned that these connections may be impacted by infrastructure from planned offshore wind farms. We are telemetering estuarine-dependent or facultative fish species and horseshoe crabs to examine life history patterns of ocean-estuary connection. Fixed hydrophones (VR2W) monitor all estuarine inlets from Belmar to Cape May. Mobile hydrophones on vessels, deployed traps, and submersible gliders episodically monitor coastal waters. All hydrophones have detected fish passage, including those tagged by our own program (primarily summer flounder Paralichthys dentatus and smooth dogfish Mustelus canis) and many tagged by other researchers and programs.

Photo by Dennis Schroeder, NREL 40465

Summary data on the distribution and timing of passage will be shown. Collaboration with other telemetry efforts through the Mid-Atlantic Acoustic Telemetry Observation System (MATOS) and The Atlantic Cooperative Telemetry Network (ACT) is important to a thorough understanding of this connection. To date 60,755 tag detections have been made on 16 receivers. 104 independent acoustic tags have been identified. The Little Egg Inlet hydrophone location has had the most detections. The hydrophone array shows multiple estuary use among tagged fish. Further sampling and analyses of hydrophone detections will help clarify migration patterns between inlets and continental shelf habitats.

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The Offshore Wind Workforce: Challenges and Opportunities

The development of the offshore wind industry in New Jersey and throughout the region offers many exciting opportunities, but also poses challenges for employers, worker organizations, and educational institutions. What is the projected mix of job skills needed for designing, constructing, and operating an OSW industry in New Jersey? How do those labor demands match with the current labor supply? And how can the new job opportunities serve to reduce inequality, particularly for historically marginalized groups? These questions and more will be explored in this descriptive analysis of the NJ workforce and job projections for the nascent OSW industry.

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Fishing in the Wind: The Impact of Offshore Wind Farms on Local Physical Oceanography and Summer Flounder Distribution

Power curve, the functional relationship that governs the process of converting a set of weather variables experienced by a wind turbine into electric power, is widely used in the wind industry to estimate power output for planning and operational purposes. Existing methods for power curve estimation have three main limitations: (i) they mostly rely on wind speed as the sole input, thus ignoring the secondary, yet possibly significant effects of other environmental factors, (ii) they largely overlook the complex marine environment in which offshore turbines operate, potentially compromising their value in offshore wind energy applications, and (ii) they solely focus on the first-order properties of wind power, with little (or null) information about the variation around the mean behavior, which is important for ensuring reliable grid integration, asset health monitoring, and energy storage, among others. In light of that, this study investigates the impact of several wind-and-wave-related factors on offshore wind power variability, with the ultimate goal of accurately predicting its first two moments. Our approach couples OpenFAST—a multi-physics wind turbine simulator—with Gaussian Process (GP) regression to reveal the underlying relationships governing offshore weather-to-power conversion. We first find that a multi-input power curve which captures the combined impact of wind speed, direction, and air density, can provide double-digit improvements, in terms of prediction accuracy, relative to univariate methods which rely on wind speed as the sole explanatory variable (e.g. the standard method of bins). Wave-related variables are found not important for predicting the average power output, but interestingly, appear to be extremely relevant in describing the fluctuation of the offshore power around its mean. Tested on real-world data collected at the New York/New Jersey bight, our proposed multi-input models demonstrate a high explanatory power in predicting the first two moments of offshore wind generation, testifying their potential value to the offshore wind industry.

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Fisheries Monitoring of an Offshore Wind Farm: Structured Habitat Survey

Fishery monitoring plans (FMP) are critical for evaluating potential impacts of offshore wind development on natural resources. A comprehensive FMP for Orsted's Ocean Wind 1 windfarm off New Jersey has been developed using several different extractive (bottom trawl, trap, hook-and-line, surfclam dredge, acoustic tagging) and non-extractive (eDNA, baited remote underwater video, towed camera, autonomous gliders) fisheries surveying methods. Surveying will occur for six years (2022-2028) with two years of surveying planned for before, during, and after windfarm construction. Our Structured Habitat Survey (SHS) was designed to evaluate the impact of windfarm construction on species typically associated with structured habitats. This survey simultaneously deploys two extractive gears, Chevron traps and hook-and-line, and one non-extractive gear, which includes both benthic and pelagic baited remote underwater videos (BRUVs). Survey stations include impact sites within the windfarm at locations where turbines will be constructed, control "phantom" turbine sites that will remain sand habitat, and control shipwreck sites which will remain structured habitat. Seasonal surveying (six days/season: winter, spring, summer, and fall) will permit evaluation of seasonal variability. Catch-per-unit-effort data will be calculated from the trap and hook-and-line sampling to investigate changes in relative abundance of species important to commercial and recreational fisheries. Similarly, video footage from BRUV deployments will be analyzed to derive measures of relative abundance and efforts are ongoing to develop statistically robust subsampling methods of video footage. Results from this survey will permit evaluation of the impacts of windfarm construction on fisheries resources off southern New Jersey and inform surveying methods employed for FMPs at other windfarms.

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Photo by Lissa Eng/BOEM

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