ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDY

Title	Offshore Wind Impacts on Oceanographic Processes: North Carolina to New York (AT-22-01A and AT-22-01B)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Jennifer Draher (jennifer.draher@boem.gov)
Procurement Type(s)	Contract
Conducting Organization(s)	(A) DHI Water & Environment and (B) RPS Group, Inc.
Total BOEM Cost	$969,082
Performance Period	FY 2022–2024
Final Report Due	December 31, 2023
Date Revised	August 4, 2023
PICOC Summary	
Problem	Offshore wind facilities have the potential to alter the local and regional physical oceanographic processes that drive larval and sediment transport.
Intervention	Hydrodynamic and particle tracking models will be utilized to assess how the introduction of commercial scale offshore wind energy facilities affect local and regional hydrodynamics under average seasonal conditions.
Comparison	These models will be used to examine oceanographic conditions prior to offshore wind construction, post-installation of a single facility, and post full build-out of all current offshore lease areas, using representative turbine array layouts.
Outcome	To understand the potential and cumulative impacts to physical oceanography and transport processes due to commercial scale development of offshore wind
Context	Modeling efforts will cover the U.S. Mid-Atlantic Bight, focusing on the renewable energy leases offshore North Carolina northward through New York.

BOEM Information Need(s): BOEM needs to understand potential changes in physical oceanographic processes, both local and regional, that may affect the transport of organic and inorganic matter. BOEM also has a need to adequately assess individual and cumulative impacts of offshore wind projects as part of impact assessments pursuant to the National Environmental Policy Act and the Magnuson-Stevens Fishery Conservation and Management Act.

Background: BOEM has issued 26 offshore commercial wind energy leases along the U.S. Atlantic Coast. Stakeholders have expressed concerns regarding the alteration of oceanographic processes in the Mid-Atlantic Bight between Cape Hatteras and Cape Cod as a result of offshore wind construction projects. In order to address these concerns, BOEM needs to be prepared to understand potential changes in hydrodynamic flows resulting from the build-out of one or several offshore wind energy facilities. Though this topic has not been extensively studied, available evidence shows that offshore structures change local current velocities and flows, as well as wind velocities and their effect on the water surface and vertical motions (Segtnan and Christakos 2015). Less understood are the cumulative impacts of large and multiple projects on regional circulation patterns, particularly in the Mid-Atlantic. This is especially important in relation to how changes in flow may impact the transport of juvenile fish and larvae to and from habitats used at different life stages and the transport of nutrients and sediments throughout the region.

A previous BOEM-funded study (Chen et al., 2016) examined the potential impacts of a representative wind energy facility offshore southern New England on particle transport during storm conditions using the Finite Volume Community Ocean Model (FVCOM). Following the conclusion of this study, there was increased interest in potential impacts due to average seasonal conditions and the cumulative impacts of multiple offshore wind facilities both offshore southern New England and elsewhere along the Atlantic coast of the US. A second BOEM-funded study (Johnson et al., 2021) assessed how the introduction of commercial scale offshore wind energy facilities offshore Massachusetts and Rhode Island may affect local and regional oceanic responses and related larval transport under typical seasonal conditions using the MIKE Powered by DHI suite of models. Johnson et al. (2021) assessed facility designs currently proposed for development and potential impacts to three species of interest: Atlantic sea scallops, silver hake, and summer flounder.

Both previous BOEM-funded studies assessed the impacts of multiple offshore wind facilities offshore southern New England, thus the need to study the impacts to the areas offshore North Carolina, Virginia, Maryland, Delaware, New Jersey, and New York remains, particularly where offshore wind energy development may interact with the Cold Pool.

During recent discussions and workshops, stakeholders and the oceanographic community have impressed upon BOEM the need to have multiple studies focused on this topic in order to reconcile differences in modeling methodology and interpretations. In its environmental assessments pursuant to NEPA, BOEM uses the best available science to determine impacts of energy development; this includes relying on studies from multiple sources to reduce bias and narrow uncertainties. BOEM recognized this need and awarded two contracts for this study that will utilize distinct hydrodynamic and particle-tracking modeling systems and will provide the government with multiple sources of information to aid in management decisions.

Objectives: The objective of this study is to assess how the construction of multiple offshore wind energy facilities in the Mid-Atlantic Bight will affect local and regional hydrodynamics under average seasonal conditions and the resultant impact on circulation and sediment, nutrient, and larval transport.

Methods: Three model segments will be necessary to address the objective: wind wake, ocean circulation, and particle tracking. A wind wake model or wind wake parameterization will be used to estimate the change in surface wind velocities for input into a high resolution, three-dimensional ocean circulation model capable of resolving small-scale physical processes throughout the water column. The particle tracking model will be an individual-based model used to release and track particles representing sediment, nutrients, and larvae. The particle tracking model will be capable of representing different particle characteristics such as size, location and timing of release, and location and duration in the water column. The baseline regional hydrodynamic and particle tracking models developed through BOEM's prior and current studies on this topic may be utilized where applicable.

The prospective model domain is an area covering the current lease areas offshore North Carolina, Virginia, Maryland, Delaware, New Jersey and New York. The domain may encompass nearby waterbodies such as bays, rivers, and the regional continental shelf to the extent necessary to capture influencing ocean circulation and input.

This study will include literature review and statistical analysis of particles of interest (*i.e.*, larval species and sediment grain sizes) relevant to the study area. This study will also incorporate average seasonal conditions and examine scenarios involving realistic layouts of multiple facilities. Example scenarios include an initial condition absent any wind energy facilities and full build-out of existing lease areas. Additional scenarios may include, but are not limited to, layouts of varying turbine sizes (9–15 MW turbines) with appropriate number and spacing, varying particle characteristics, or a partial build-out of existing lease areas.

This study will assess the scale of change of offshore wind development on particles traveling through and near to the facilities. Information from the model should also permit an assessment of the susceptibility of sediment in Wind Energy Areas (WEAs) to resuspension as a result of offshore wind facility operation. Models should be grounded in empirical evidence from the region(s) assessed, such as acoustic Doppler current profiles, wind measurements, and geophysical data including surficial sediment and bathymetry, which should be available from existing partners/projects.

The two contracts awarded will use the (A) MIKE and (B) Delft3D hydrodynamic models, respectively.

Specific Research Question(s):

1. How do offshore wind energy facilities affect local and regional hydrodynamic processes, such as currents and mixing rates in the Mid-Atlantic Bight?
2. What will be the cumulative impacts of a full build-out of all current offshore wind lease areas in the Mid-Atlantic Bight on regional hydrodynamic processes?
3. How will these changes affect the transport of sediment, nutrients, and larvae during average seasonal conditions?

Current Status: A kick-off meeting was held in October 2022. Modeling us underway for both models.

Publications Completed: N/A

Affiliated WWW Sites:
MIKE model: https://www.mikepoweredbydhi.com/
Delft3D model: https://oss.deltares.nl/web/delft3d

References:

Changsheng Chen, R. C. Beardsley, J. Qi and H. Lin, 2016. Use of Finite-Volume Modeling and the Northeast Coastal Ocean Forecast System in Offshore Wind Energy Resource Planning. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. BOEM 2016-050. 131pp. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/NE-Ocean-Forecast-Model-Final-Report.pdf

Johnson TL, van Berkel JJ, Mortensen LO, Bell MA, Tiong I, Hernandez, B, Snyder, DB, Thomsen, F, Svenstrup Petersen, O: 2021. Hydrodynamic modeling, particle tracking and agent-based modeling of larvae in the U.S. mid-Atlantic bight. Lakewood (CO): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-049. 232 p. https://espis.boem.gov/final%20reports/BOEM_2021-049.pdf

Ole Henrik Segtnan, Konstantinos Christakos, 2015. Effect of Offshore Windfarm Design on the Vertical Motion of the Ocean. Energy Procedia, Volume 80, Pages 213–222, ISSN 1876-6102. http://dx.doi.org/10.1016/j.egypro.2015.11.424