Title	Offshore Wind Impacts on Oceanographic Processes: North Carolina to New Jersey (AT-22-01)
Administered by	Office of Renewable Energy Programs
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Total BOEM Cost	TBD
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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 Jersey.

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 sixteen offshore commercial wind energy leases in southern New England and the Mid-Atlantic. 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. 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 and Beardsley 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). Since the conclusion of this study, interest in potential impacts due to average seasonal conditions and the cumulative impacts of multiple offshore wind facilities have been expressed, both offshore southern New England and elsewhere along the Atlantic coast of the US.

BOEM is currently funding a study on this topic that covers the lease areas offshore Rhode Island and Massachusetts (AT-19-04), but the need to study the impacts to the areas offshore North Carolina, Virginia, Maryland, Delaware, and New Jersey remains, particularly where offshore wind energy development may interact with the Cold Pool. Baseline hydrodynamic and particle transport modeling is currently being conducted offshore New York through other research efforts but may require further analysis in future studies.

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. The results from this study will be validated using empirical data and used to evaluate the need for and the formation of mitigation measures.

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 (est. 100-m resolution in the immediate area of the turbines), 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, and New Jersey. 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 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.

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: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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

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.