OCS EIS/EA
BOEM 2022-049

Empire Offshore Wind Final Environmental Impact Statement Volume 3

September 2023

Estimated Lead Agency Total Costs to Prepare the Draft and Final EIS: $1,743,725

U.S. Department of the Interior

BOEM
Bureau of Ocean Energy Management

OCS EIS/EA
BOEM 2023-049

Empire Offshore Wind, Empire Wind Projects (EW 1 and EW 2) Final Environmental Impact Statement

Volume 3

September 2023

Author:

Bureau of Ocean Energy Management
Office of Renewable Energy Programs

Published by:

U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

This page intentionally left blank.

LIST OF APPENDICES

This page intentionally left blank.

Appendix H. Mitigation and Monitoring

This Final EIS assesses the potential biological, socioeconomic, physical, and cultural impacts that could result from the construction, O&M, and conceptual decommissioning of the Projects proposed by Empire in its COP. As part of the Projects, Empire has committed to implement APMs to avoid, reduce, mitigate, or monitor impacts on the resources discussed in Chapter 3 of the Final EIS.[1] Empire's APMs are part of the Proposed Action, and implementation of APMs is considered in the impact analysis for the Proposed Action and each action alternative. Attachment H-1 describes the APMs included in Empire's MMPA Letter of Authorization Application. Empire's APMs to reduce impacts on other resources are described in Attachment H-2 of this appendix. Attachment H-3 describes Empire's Proposed Bird and Bat Monitoring Framework and Attachment H-4 contains Empire's Fisheries and Benthic Monitoring Plan.

BOEM may select alternatives and require additional mitigation or monitoring measures to further protect and monitor these resources. Additional mitigation and monitoring measures may result from reviews under several environmental statutes (CAA, ESA, MSA, MMPA, and NHPA) as discussed in Appendix A of the Final EIS. Additional mitigation measures identified by BOEM, as well as those that may result from reviews under these statutes, are shown in Table H-1 through Table H-3. Please note that not all of these mitigation measures are within BOEM's statutory and regulatory authority but could be adopted and imposed by other governmental entities. Table H-1 provides descriptions of these mitigation or monitoring measures, as well as those that BOEM has identified for analysis in the Final EIS. Note that the BOEM-proposed measures provided in Table H-1 are written in a form intended to match as closely as possible the text contemplated for inclusion in a letter of approval to Empire if the Projects are approved. Therefore, the draft measures themselves endeavor to use concrete and readily enforceable language even though they are only proposals at this stage and thus fundamentally conditional. Table H-2 provides descriptions of mitigation measures analyzed in the Draft EIS that were not recommended for inclusion in the Preferred Alternative, and the rationale for not including each measure. Table H-3 presents the EFH conservation recommendations proposed by NMFS through the Magnuson-Stevens Fishery Conservation and Management Act consultation.

If BOEM decides to approve the COP, the ROD would state which of the mitigation and monitoring measures identified by BOEM have been adopted, and if not, why they were not. As such, the ROD would inform terms and conditions of COP approval and would compel compliance with or execution of identified mitigation and monitoring measures (40 CFR 1505.3). Empire would be required to certify compliance with certain terms and conditions, as required under 30 CFR 285.633(b). Furthermore, BOEM would periodically review the activities conducted under the approved COP. The frequency and extent of the review would be based on the significance of any changes in available information and on onshore or offshore conditions affecting, or affected by, the activities conducted under the COP.

Monitoring measures may be required to evaluate the effectiveness of a mitigation measure or to identify if resources are responding as predicted to impacts from the Proposed Action. Monitoring programs would be developed in coordination among BOEM and agencies with jurisdiction over the resource to be monitored. The information generated by monitoring may be used to (1) adapt how a mitigation measure identified in the COP or ROD is being implemented, (2) revise or develop new mitigation or monitoring measures required under the COP in accordance with 30 CFR 585.634(b), (3) develop measures for future projects, or (4) contribute to regional efforts for better understanding of the impacts and benefits resulting from offshore wind energy projects in the Atlantic (e.g., potential cumulative impact assessment tool).

[1] APMs that commit to an action that is already required by law (e.g., use of ultra-low sulfur diesel fuel) are not considered mitigation measures.

Unless specified, the proposed mitigation measures described below would not change the impact ratings on the affected resource, as described in Chapter 3 of the Final EIS, but would further reduce expected impacts or inform the development of additional mitigation measures if required.

Table H-1 Potential Agency-Proposed Mitigation and Monitoring Measures Analyzed

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
BOEM OCS Study 2020-039 – Radar Systems Mitigations to Operations					
1	O&M	Mitigation for ARSR-4 and ASR-8/9 radars	Empire Wind will enter into a mitigation agreement with DOD for impacts on ARSR-4 and for ASR-8/9 radars. Possible mitigation measures might include the following: • Passive aircraft tracking using ADS-B or signal/transponder • Increasing aircraft altitude near radar • Sensitivity time control (range-dependent attenuation) • Range azimuth gating (ability to isolate/ignore signals from specific range-angle gates) • Track initiation inhibit, velocity editing, plot amplitude thresholding (limiting the amplitude of certain signals) • Modification mitigations for ARSR-4 and for ASR-8/9 systems: o Utilizing the dual beams of the radar simultaneously o In-fill radars	Other Uses – Radar	BOEM and BSEE
2	O&M	Mitigation for NEXRAD weather radar systems	Possible mitigation measures might include the following: • Wind farm curtailment/curtailment agreement • Research is being conducted to determine whether impacts on weather radar can be mitigated by using phased array radars to achieve a null in the antenna radiation pattern in the direction of the wind turbine.	Other Uses – Radar	BOEM and BSEE
NOAA Integrated Ocean Observing System-proposed Measures					
1	Pre-C, C, O&M	High-Frequency Radar Interference Analysis and Mitigation	1. High-Frequency Radar Interference Analysis and Mitigation (Planning) (Construction) (Operations) The Lessee's Project has the potential to interfere with oceanographic high-frequency (HF) radar systems in the U.S. Integrated Ocean Observing System (IOOS), which is managed by the IOOS Office within the National Oceanic and Atmospheric Administration (NOAA) pursuant to the Integrated Coastal and Ocean Observation System Act of 2009 (Pub. L. 111-11), as amended by the Coordinated Ocean Observation and Research Act of 2020 (Public Law 116-271, Title I), codified at 33 U.S.C. 3601–3610 (referred to herein as "IOOS HF-radar"). IOOS HF-radar measures the sea state, including ocean surface current velocity and waves in near real time. These data have many vital uses ("mission objectives"), including tracking and predicting the movement of spills of hazardous materials or other pollutants, monitoring water quality, and predicting sea state for safe marine navigation. The U.S. Coast Guard also integrates IOOS HF-radar data into its Search and Rescue systems. The Lessee's Project is within the measurement range of 8 IOOS HF-radar systems operated by Rutgers University in: Amagansett, New York; Bradley Beach, New Jersey; Hempstead, New York; Sandy Hook, New Jersey; Loveladies, New Jersey; Moriches, New York; Sea Bright, New Jersey; and Seaside Park, New Jersey. 1.1 Coordination Due to the potential interference with IOOS HF-radar and the risk to public health, safety, and the environment, the Lessee is obligated to mitigate unacceptable interference with IOOS HF-radar from the Lessee's Project at all times the Lessee's Project is in operation. Interference is considered unacceptable if, as determined by BOEM in consultation with NOAA's IOOS Office, IOOS HF-radar performance is or may become no longer within the specific radar systems' operational parameters or fails or may fail to meet IOOS's mission objectives. 1.2 Mitigation Approval After the above coordination, at least 60 calendar days prior to completion of construction or initiation of commercial operations (whichever is earlier), the Lessee must submit to BOEM documentation demonstrating how it will mitigate interference with IOOS HF-radar at all times during operation of Lessee's project. If, after consultation with the NOAA IOOS Office, BOEM deems the mitigation acceptable, the mitigation will be considered required as a term of this permit. 1.2.1 If at any time the NOAA IOOS Office or a HF-radar operator informs the Lessee that the Project will cause a HF-radar system to fall outside of its operational parameters or fail to meet mission objectives, the Lessee must notify DOI of the determination as soon as possible and no later than 30 calendar days from the date on which the determination was communicated. 1.3 Mitigation Agreement	Other Uses – Radar	BOEM and BSEE

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			The Lessee is encouraged to enter into an agreement with the NOAA IOOS Office to implement mitigation, and any such Mitigation Agreement may satisfy the requirement to mitigate interference with IOOS HF-radar. The point-of-contact for development of a Mitigation Agreement with the NOAA IOOS Office is the Surface Currents Program Manager, whose contact information is available at https://ioos.noaa.gov/about/meet-the-ioos-program-office/ and upon request from BOEM. A Mitigation Agreement may serve the purpose of implementing Sections 1.2. If there is any discrepancy between Section 1.2 and the terms of a Mitigation Agreement, the terms of the Mitigation Agreement will prevail. 1.4 Mitigation Implementation Mitigation required under Section 1.2 must address the following: 1.4.1 Before rotor blades are installed within the Project, and continuing throughout the life of the Project until the point of decommissioning where all rotor blades are removed, Lessee must make publicly available via IOOS near real-time accurate numerical telemetry of surface current velocity, wave height, wave period, wave direction, and other oceanographic data measured at Project locations selected by the Lessee in coordination with the NOAA IOOS Office. 1.4.2 If requested by the NOAA IOOS Office, Lessee must share with IOOS accurate numerical time-series data of blade rotation rates, nacelle bearing angles, and other information about the operational state of each turbine in the WDA to aid interference mitigation. 1.5 Additional Notification If a mitigation measure other than that identified in Section 1.2 is agreed to by the Lessee and BOEM, in consultation with the NOAA IOOS Office, then the Lessee must submit information on the proposed mitigation measure to DOI for its review and concurrence. If, after consultation with the NOAA IOOS Office, BOEM deems the mitigation acceptable, the mitigation will be considered required as a term of this permit.		
DOD-proposed Measures					
1	O&M	Mitigation for radar impacts to NORAD’s air defense mission	Empire will notify the North American Aerospace Defense Command (NORAD) 30 to 60 days prior to Project completion and again when the Projects are complete and operational for Radar Adverse Impact Management scheduling.	Other Uses – Radar	BOEM, BSEE, and DOD
2	O&M	Mitigation for radar impacts to NORAD’s air defense mission	Empire will contribute funds in the amount of $80,000 per impacted radar toward the execution of the Radar Adverse Impact Management.	Other Uses – Radar	BOEM, BSEE, and DOD
3	O&M	Mitigation for radar impacts to NORAD’s air defense mission	Empire will implement curtailment for National Security or Defense Purposes as described in the leasing agreement.	Other Uses – Radar	BOEM, BSEE, and DOD
Other NMFS- and BOEM-proposed Measure for Survey Mitigation					
1	C, O&M, D	Federal survey mitigation implementation strategy for the Northeast U.S. region	Consistent with NMFS and BOEM Survey Mitigation strategy actions in the NOAA Fisheries and BOEM Federal Survey Mitigation Implementation Strategy - Northeast U.S. Region (Hare et al. 2022), within 120 calendar days of COP Approval, the Lessee must submit to BOEM a draft survey mitigation agreement between NMFS and the Lessee. The survey mitigation agreement must describe how the Lessee will mitigate the Project impacts on the nine NMFS surveys. The Lessee must conduct activities in accordance with such agreement. If the Lessee and NMFS fail to reach a survey mitigation agreement, then the Lessee must submit a Survey Mitigation Plan to BOEM and NMFS that is consistent with the mitigation activities, actions, and procedures, within 180 days of COP approval. BOEM will review the Survey Mitigation Plan in consultation with NMFS Northeast Fisheries Science Center (NEFSC), and the Lessee must resolve comments to BOEM’s satisfaction and must conduct activities in accordance with the plan. As soon as reasonably practicable, but no later than 30 days after the issuance of the Project’s COP Approval, the Lessee must initiate coordination with NMFS NEFSC to develop the survey mitigation agreement described above. Mitigation activities specified under the agreement will be designed to mitigate the Project impacts on the following NMFS NEFSC surveys: (a) Spring Bottom Trawl survey; (b) Autumn Multi-species Bottom Trawl survey; (c) Ecosystem Monitoring survey; (d) NARW aerial survey; (e) Aerial marine mammal and sea turtle survey; (f) Shipboard marine mammal and sea turtle survey; (g) Atlantic surfclam and ocean quahog survey; (h) Atlantic sea scallop survey; and (i) Seal survey. At a minimum, the survey mitigation agreement must describe actions needed and the means to address impacts on the affected surveys due to the preclusion of sampling platforms and impacts on statistical designs. NMFS has determined that the project area is a discrete stratum for	Other Uses – Scientific Research and Surveys	BOEM, BSEE, and NMFS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			surveys that use a random stratified design. This agreement may also consider other anticipated Project impacts on NMFS surveys, such as changes in habitat and increased operational costs due to loss of sampling efficiencies. The survey mitigation agreement must identify activities that will result in the generation of data equivalent to data generated by NMFS's affected surveys for the duration of the Project. The survey mitigation agreement must describe the implementation procedures by which the Lessee will work with NEFSC to generate, share, and manage the data required by NEFSC for each of the surveys impacted by the Project, as mutually agreed upon between the Lessee and NMFS NEFSC. The survey mitigation agreement must also describe the Lessee's participation in the NMFS NEFSC Northeast Survey Mitigation Program to support activities that address regional-level impacts for the surveys listed above.		
BOEM-Proposed Scenic and Visual Resource Monitoring Measures					
1	C, O&M	Scenic and Visual Impact Monitoring Plan	In coordination with BOEM, Empire will prepare and implement a scenic and visual resource monitoring plan that monitors and compares the visual effects of the wind farm during construction and O&M (daytime and nighttime) to the findings in the COP Visual Impact Assessment, and verifies the accuracy of the visual simulations (photo and video). The monitoring plan should include monitoring and documenting the meteorological influences on actual wind turbine visibility over a duration of time from selected onshore key observation points, as determined by BOEM and the developer. In addition, Empire will include monitoring the operation of ADLS in the monitoring plan. Empire will monitor the frequency that the ADLS is operative documenting when (dates and time) the aviation warning lights are in the on position and the duration of each event. Details for monitoring and reporting procedures are to be included in the plan.	Scenic and Visual Resources	BOEM and BSEE
NHPA Section 106 Mitigation Measures					
1	C and post-C	Comply with the stipulations of the Section 106 MOA	The lessee will comply with the stipulations included in the executed Memorandum of Agreement developed with consulting parties during Section 106 consultation that incudes, but is not limited to, stipulations to avoid, minimize, and mitigate adverse effects to identified historic properties; to implement phased identification and evaluation of historic architectural resources within portions of the visual APE in New Jersey; and to implement post-review discovery plans.	Cultural Resources	BOEM, BSEE, USACE, NY SHPO, NJ SHPO
BOEM-proposed Mitigation and Monitoring Measures for Commercial and Recreational Fisheries					
1	PrC, C, O&M, D	Fisheries Mitigation	No later than 1 year after the approval of the COP, the Lessee shall establish a compensation/mitigation fund (Fund) consistent with BOEM's draft[1] Guidance for Mitigating Impacts to Commercial and Recreational Fisheries on the Outer Continental Shelf Pursuant to 30 CFR 585 (Guidance) to compensate commercial and for-hire recreational fishermen for loss of income due to unrecovered economic activity resulting from displacement from fishing grounds due to project construction and operations and to shoreside businesses for losses indirectly related to the Project. For losses to commercial and for-hire recreational fishermen, the Fund shall be based on the revenue exposure for fisheries based out of ports listed in [FEIS Table of Port Revenue Exposure Cite]. For losses to shoreside businesses, the lessee shall analyze the impacts to shoreside seafood businesses adjacent to ports listed in [FEIS Table of Port Revenue Exposure Cite]. Shoreside business impacts may include (but are not limited to): • Fishing gear suppliers and repair services; • Vessel fuel and maintenance services; • Ice and bait suppliers; • Seafood processors and dealers; and • Wholesale distributors. The Lessee will be required to provide BOEM their analysis (including any model outputs, such as an IMPLAN model or other economic report) verifying the exposed impacts to shoreside businesses and services. The Lessee must submit to BOEM a report that includes (1) a description of the structure of the Fund and its consistency with BOEM's draft Guidance and (2) an analysis of the impacts of the Project on shoreside businesses, for a 45-day review and comment period at least 90 days prior to establishment of the Fund. The Lessee must resolve all comments on the report to BOEM's satisfaction before implementation of the Fund. The Lessee must then submit to BOEM evidence of the implementation of the Fund, including: • A description of any implementation details not covered in the report to BOEM regarding the mechanism established to compensate for losses to commercial and for-hire recreational fishermen and related shoreside businesses resulting from all phases of the project development on the Lease Area (pre-construction, construction, operation, and decommissioning); • the Fund charter, including the governance structure, audit and public reporting procedures, and standards for paying compensatory mitigation for impacts to fishers and related shoreside businesses from lease area development; and	Commercial Fisheries and For-Hire Recreational Fishing	BOEM and BSEE

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			• Documentation regarding the funding account, including the dollar amount, establishment date, financial institution, and owner of the account. The Lessee shall make publicly available on an annual basis the number of claims and number of settlements pursuant to this measure and for gear loss claims. [1] Draft Guidance shall be superseded by final Guidance, if final Guidance is published by issuance of the ROD.		
2	C	Sand Wave Leveling, Boulder Clearance, and Boulder Relocation	Sand wave leveling and boulder clearance should be limited to the extent practicable. Best efforts should be made to microsite to avoid these areas. The Lessee must develop and implement a boulder relocation plan to ensure potential impacts to essential fish habitat and commercial and recreational fisheries are adequately minimized.	Benthic Resources; EFH; Commercial and For Hire Recreational Fisheries	BOEM and BSEE
3	C, O&M	Mobile Gear–Friendly Cable Protection Measures	Cable protection measures should reflect the pre-existing conditions at the site. This mitigation measure chiefly ensures that seafloor cable protection does not introduce new hangs for mobile fishing gear. Thus, the cable protection measures should be trawl-friendly with tapered/sloped edges. If cable protection is necessary in "non-trawlable" habitat, such as rocky habitat, then the lessee should consider using materials that mirror the benthic environment.	Commercial and For-Hire Recreational Fisheries	BOEM and BSEE
BOEM-proposed Mitigation and Monitoring Measures in the NMFS BA					
1	PrC, C, O&M, D	Marine debris awareness and elimination	Marine Debris Awareness Training. The Lessee must ensure that vessel operators, employees, and contractors engaged in offshore activities under the approved COP complete marine trash and debris awareness training annually. The training consists of two parts: (1) viewing a marine trash and debris training video or slide show (described below); and (2) receiving an explanation from management personnel that emphasizes their commitment to the requirements. The marine trash and debris training videos, training slide packs, and other marine debris related educational material may be obtained at https://www.bsee.gov/debris or by contacting BSEE. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities would continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are in fact trained. The training process would include the following elements: • Viewing of either a video or slide show by the personnel specified above; • An explanation from management personnel that emphasizes their commitment to the requirements; • Attendance measures (initial and annual); and • Recordkeeping and the availability of records for inspection by DOI. Training Compliance Report. By January 31 of each year, the Lessee must submit to DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. The Lessee must send the reports via email to BOEM (at renewable_reporting@boem.gov) and to BSEE (at marinedebris@bsee.gov). Marking. Materials, equipment, tools, containers, and other items used in OCS activities, which are of such shape or configuration that make them likely to snag or damage fishing devices or be lost or discarded overboard, must be clearly marked with the vessel or facility identification number, and properly secured to prevent loss overboard. All markings must clearly identify the owner and must be durable enough to resist the effects of the environmental conditions to which they may be exposed. Recovery and Prevention. The Lessee must recover marine trash and debris that is lost or discarded in the marine environment while performing OCS activities when such incident is likely to (1) cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components, with particular attention to marine trash or debris that could entangle or be ingested by marine protected species; or (2) significantly interfere with OCS uses (e.g., the marine trash or debris is likely to damage fishing equipment, or present a hazard to navigation). The Lessee must notify DOI within 48 hours of the incident (using the email address listed on the DOI's most recent incident reporting guidance) if recovery activities are (a) not possible because conditions are unsafe; or (b) not practicable or not warranted because the marine trash and debris released is not likely to result in any of the conditions listed in (1) or (2) above. Notwithstanding this notification, DOI may still order the Lessee to recover the lost or discarded marine trash and debris if DOI finds the reasons provided by the Lessee in the notification unpersuasive. If the marine trash and debris is located within the boundaries of a potential archaeological resource/avoidance area, or a sensitive ecological/benthic resource area, the Lessee must contact DOI for concurrence before conducting any recovery efforts. Recovery of the marine trash and debris should be completed as soon as practicable, but no later than 30 calendar days from the date on which the incident occurred. If the Lessee is not able to recover the marine trash or debris within 48 hours of the incident, the Lessee must submit a plan to DOI explaining the activities planned to recover the marine trash or debris (Recovery	ESA-listed Fish, Marine Mammals, Sea Turtles	BOEM and BSEE

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			Plan). The Lessee must submit the Recovery Plan no later than 10 calendar days from the date on which the incident occurred. Unless DOI objects within 48 hours of the filing of the Recovery Plan, the Lessee can process with the activities described in the Recovery Plan. The Lessee must request and obtain a time extension if recovery activities cannot be completed within 30 calendar days from the date on which the incident occurred. The Lessee must enact steps to prevent similar incidents and must submit a description of these actions to BOEM and BSEE within 30 calendar days from the date on which the incident occurred. Reporting. The Lessee must report to DOI (using the email address listed on DOI's most recent incident reporting guidance) all lost or discarded marine trash and debris. This report must be made monthly and submitted no later than the fifth day of the following month. The Lessee is not required to submit a report for those months in which no marine trash and debris was lost or discarded. The report must include the following: • Project identification and contact information for the Lessee and for any operators or contractors involved • The date and time of the incident • The lease number, OCS area and block, and coordinates of the object's location (latitude and longitude in decimal degrees) • A detailed description of the dropped object, including dimensions (approximate length, width, height, and weight) and composition (e.g., plastic, aluminum, steel, wood, paper, hazardous substances, or defined pollutants) • Pictures, data imagery, data streams, and/or a schematic/illustration of the object, if available • An indication of whether the lost or discarded item could be detected as a magnetic anomaly of greater than 50 nanotesla, a seafloor target of greater than 1.6 feet (0.5 meters), or a sub-bottom anomaly of greater than 1.6 feet (0.5 meters) when operating a magnetometer or gradiometer, side scan sonar, or sub-bottom profiler in accordance with DOI's most recent, applicable guidance • An explanation of the how the object was lost • A description of immediate recovery efforts and results, including photos In addition to the foregoing, the Lessee must submit a report within 48 hours of the incident (48-hour Report) if the marine trash or debris could (1) cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components, which particular attention to marine trash or debris that could entangle or be ingested by marine protected species; or (2) significantly interfere with OCS uses (e.g., the marine trash or debris is likely to damage fishing equipment, or present a hazard to navigation). The information in the 48-hour Report must be the same as that listed for the monthly report, but only for the incident that triggered the 48-hour Report. The Lessee must report to DOI (using the email address listed on DOI's most recent incident reporting guidance) if the object is recovered and, as applicable, describe any substantial variance from the activities described in the Recovery Plan that were required during the recovery efforts. The Lessee must include and address information on unrecovered marine trash and debris in the description of the site clearance activities provided in the decommissioning application required under 30 CFR §585.906. Option to Comply with Most Current Non-Required Measures. The Lessee may opt to comply with the most current non-required measures (e.g., measures in a programmatic consultation that are not binding on the Lessee) related to protected species and habitat in place at the time an activity is undertaken under the Lease. At least 30 calendar days prior to undertaking an activity, the Lessee must notify DOI of its intention to comply with such measures in lieu of those required under the terms and conditions above. DOI reserves the right to object or request additional information on how the Lessee intends to comply with such measures. If DOI does not respond with objections within 15 calendar days of receipt of the Lessee's notification, then the Lessee may conclude the DOI has concurred.		
2	C, O&M	PAM Plan	BOEM, BSEE, and USACE will require Empire to prepare a detailed PAM Plan that describes: all proposed PAM equipment (including sensitivity and detection range); procedures, and protocols (if new systems are proposed proof of concept materials should be provided); a description of the PAM hardware and software used for marine mammal monitoring (including software version) (if new systems are proposed proof of concept materials should be provided); calibration data, bandwidth capability and sensitivity of hydrophone(s); any filters planned for use in hardware or software, and known limitations of the equipment; and deployment locations, procedures, detection review methodology, and protocols. This plan must be submitted to NMFS (at nmfs.gar.incidental-take@noaa.gov), BOEM (at renewable_reporting@boem.gov), and BSEE (at renewable_reporting@boem.gov) for review and concurrence at least 180 days prior to the planned start of PAM activities.	ESA-listed Fish, Marine Mammals, Sea Turtles	BOEM, BSEE, NMFS, and USACE (during construction only)

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			BOEM will review the PAM Plan and provide comments, if any, on the plan within 45 calendar days, but no later than 60 days after it is submitted. Empire must resolve all comments on the PAM Plan to BOEM's satisfaction before implementation of the plan. If BOEM does not provide comments on the PAM Plan within 90 calendar days of its submittal, Empire may conclude that BOEM has concurred with the PAM Plan.		
3	C	Pile Driving Monitoring Plan	BOEM will require Empire to prepare and submit a *Pile Driving Monitoring Plan* to NMFS and BSEE OSWsubmittals@BSEE.gov for review at least 180 days before start of pile driving. The plan will detail all plans and procedures for sound attenuation as well as for monitoring ESA-listed whales and sea turtles during all impact and vibratory pile driving. Empire must obtain BOEM, BSEE, USACE (for pile driving in State waters), and NMFS' concurrence with this plan prior to starting any pile driving.	ESA-listed Fish, Marine Mammals, Sea Turtles	BOEM, BSEE, NMFS, and USACE
4	C	PSO coverage	BOEM, BSEE, and USACE will ensure that PSO coverage is sufficient to reliably detect whales and sea turtles at the surface in clearance and shutdown zones so that Empire can execute any pile driving delays or shutdown requirements. If, at any point before or during construction, the PSO coverage that is included by Empire as part of the Proposed Action is determined not to be sufficient to reliably detect ESA-listed whales and sea turtles within the clearance and shutdown zones, additional PSOs or platforms will be deployed. Determinations prior to construction will be based on review of the *Pile Driving Monitoring Plan* before construction begins. Determinations during construction will be based on review of the weekly pile driving reports and other information, as appropriate.	Marine Mammals, Sea Turtles	BOEM, BSEE, and USACE
5	C	Sound field verification	The Lessee must ensure that the distance to the PTS and behavioral thresholds for marine mammals, sea turtle injury and harassment thresholds, and Atlantic sturgeon injury and harassment thresholds are no larger than those modeled assuming 10 dB re 1 µPa noise attenuation by conducting field verification during pile driving. At least 180 calendar days before beginning the first pile driving activities for the Project, the Lessee must submit a Sound Field Verification Plan (SFVP) for each EW 1 and EW 2 for review and comment to USACE, BOEM (at renewable_reporting@boem.gov), and NMFS (at nmfs.gar.incidental-take@noaa.gov). DOI will review the SFVP and provide any comments on the plan within 30 calendar days of its submittal. The Lessee must resolve all comments on the SFVP to DOI's satisfaction before implementing the plan. The Lessee may conclude that DOI has concurrence in the SFVP if DOI provides no comments on the plan within 90 calendar days of its submittal. The Lessee must execute the SFVP and report the associated findings to BOEM for three monopile foundations, or as specified under the corresponding LOAs for this action. The Lessee must conduct additional field measurements if it installs piles with a diameter greater than the initial piles, if it uses a greater hammer size or energy, or if it measures any additional foundations to support any request to decrease the distances specified for the clearance and shutdown zones. The Lessee must implement the SFVP requirements for verification of noise attenuation for at least three foundations for BOEM for EW 1 and for EW 2, in coordination with NMFS, to consider reducing zone distances. The Lessee must ensure that locations identified in the SFVP for each pile type are representative of other piles of that type to be installed and that the results are representative for predicting actual installation noise propagation for subsequent piles. The SFVP must describe how the effectiveness of the sound attenuation methodology will be evaluated. The SFVP must be sufficient to document impacts in the behavioral harassment zones for marine mammals and injury and behavioral disturbance zones for sea turtles and Atlantic sturgeon.	Marine Mammals, Sea Turtles	BOEM, BSEE, NMFS, and USACE
6	C	Shutdown zones	BOEM, BSEE, and USACE may reduce clearance and shutdown zones for ESA-listed sei, fin, or sperm whales upon request from the Lessee following based upon sound field verification of a minimum of 3 piles. However, the shutdown zone for sei, fin, and sperm whales will not be reduced to less than 1,000 m, or less than 500 m for ESA-listed sea turtles. The clearance or shutdown zones for NARWs will not be reduced regardless of the results of sound field verification of a minimum of three piles.	Marine Mammals, Sea Turtles	BOEM, BSEE, and USACE
7	C	Monitoring zone for sea turtles	To ensure that any "take" is documented, BOEM, BSEE, and USACE will require Empire to monitor and record all observations of ESA-listed sea turtles over the full extent of any area where noise may exceed 175 dB rms (based on modeling or as may be approved by sound field verification results) during any pile driving activities and for 30 minutes following the cessation of pile driving activities.	Sea Turtles	BOEM, BSEE, and USACE
8	PrC, C, O&M, D	Look out for sea turtles and reporting	a. For all vessels operating north of the Virginia/North Carolina border, between June 1 and November 30, Empire must have a trained lookout posted on all vessel transits during all phases of the Projects to observe for sea turtles. The trained lookout must communicate any sightings, in real time, to the captain so that the requirements in (e) below can be implemented. b. For all vessels operating south of the Virginia/North Carolina border, year-round (reflecting year-round sea turtle presence), Empire must have a trained lookout posted on all vessel transits during all phases of the Projects to observe for sea turtles. The trained lookout would communicate any sightings, in real time, to the captain so that the requirements in (e) below can be implemented. c. The trained lookout will review https://seaturtlesightings.org/ before each trip and report any observations of sea turtles in the vicinity of the planned transit to all vessel operators or captains and lookouts on duty that day.	Sea Turtles	BOEM, BSEE, and USACE (during construction only)

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			d. The trained lookout will maintain a vigilant watch and monitor a 500-m Vessel Strike Avoidance Zone at all times to maintain this minimum separation distance between the vessel and ESA-listed sea turtle species. Alternative monitoring technology, such as night vision and thermal cameras, will be available to ensure effective watch at night and in any other low visibility conditions. If the trained lookout is a vessel crew member, lookout will be their designated role and primary responsibility while the vessel is transiting. Any designated crew lookouts will receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. e. If a sea turtle is sighted within 100 m or less of the operating vessel's forward path, the vessel operator must slow down to 4 knots (unless unsafe to do so) and then proceed away from the turtle at a speed of 4 knots or less until there is a separation distance of at least 100 m between the vessel and the sea turtle at which time the vessel may resume normal operations. If a sea turtle is sighted within 50 m of the forward path of the operating vessel, the vessel operator must shift to neutral when safe to do so and then proceed away from the turtle at a speed of 4 knots. The vessel may resume normal operations once it has passed the turtle. f. Vessel captains or operators must avoid transiting through areas of visible jellyfish aggregations or floating sargassum lines or mats. If operational safety precludes avoiding such areas, vessels must slow to 4 knots when transiting. g. All vessel crew members must be briefed on identification of sea turtles, applicable regulations, and best practices for avoiding vessel collisions with sea turtles. Reference materials for identification of sea turtles must be available aboard all Project vessels. The requirement and process for reporting sea turtles (including live, entangled, and dead individuals) must be clearly communicated, including posting in highly visible locations aboard all Project vessels. This communication must clearly convey that sea turtle observations are to be reported to the designated vessel contact (such as the lookout or the vessel captain) and provide a communication channel and process for crew members to do so. h. If a vessel is carrying a PSO or trained lookout for the purposes of maintaining watch for NARWs, an additional lookout is not required so long as the PSO or trained lookout maintains watch for both whales and sea turtles. i. Vessel transits to and from the Wind Farm Area that require PSOs will maintain a speed commensurate with weather conditions and effectively detecting sea turtles. j. Exceptions to the requirements of this mitigation measure (Look out for sea turtles and reporting) are allowed only if the safety of the vessel or crew necessitates deviation from the requirements on an emergency basis. Any such exceptions must be reported to NMFS and BSEE within 24 hours after they occur.		
9	C, O&M	Gear identification	To facilitate identification of gear on any entangled animals, all trap/pot gear used in any Project survey must be uniquely marked to distinguish it from other commercial or recreational gear. Gear must be marked with a 3-foot-long strip of black and white duct tape within 2 fathoms of a buoy attachment. In addition, 3 additional marks must be placed on the top, middle and bottom of the line using black and white paint or duct tape. No variation from these marking requirements may be made without notification and approval from NMFS.	ESA-listed Fish, Marine Mammals, Sea Turtles	BOEM, BSEE, and NMFS
10	C, O&M	Lost survey gear	All reasonable efforts that do not compromise human safety must be undertaken to recover any lost survey gear. Any lost gear must be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) and BSEE (OSWsubmittals@bsee.gov) within 24 hours after the gear is documented as missing or lost. This report must include information on any markings on the gear and any efforts undertaken or planned to recover the gear.	ESA-listed Fish, Marine Mammals, Sea Turtles	BOEM, BSEE, and NMFS
11	C, O&M	Survey training	For any vessel trips where gear is set or hauled for trawl or ventless trap surveys, at least one of the survey staff onboard must have completed NEFOP observer training within the last 5 years or completed other equivalent training in protected species identification and safe handling (inclusive of taking genetic samples from Atlantic sturgeon). Reference materials for identification, disentanglement, safe handling, and genetic sampling procedures must be available on board each survey vessel. Empire must prepare a training plan that addresses how these survey requirements will be met and must submit that plan to NMFS in advance of any trawl or trap surveys.	ESA-listed Fish, Marine Mammals, Sea Turtles	BOEM, BSEE, and NMFS
12	C, O&M	Gillnets in support of sturgeon tagging	If gillnets are utilized to capture sturgeon for acoustic tagging, deployed nets must be continuously monitored for the capture of sturgeon or sea turtles. All gillnet soaks must be limited to 24 hours or less to reduce the potential for serious injury and mortality of entangled sea turtles and sturgeon. All gillnet gear must be in compliance with the Atlantic Large Whale Take Reduction Plan, Bottlenose Dolphin Take Reduction Plan, and the Harbor Porpoise Take Reduction Plan.	ESA-listed Fish, Sea Turtles	BOEM, BSEE, and NMFS
13	C, O&M	Sea turtle disentanglement	Vessels deploying fixed gear (e.g., pots/traps) must have adequate disentanglement equipment onboard, such as a knife and boathook onboard. Any disentanglement must occur consistent with the Northeast Atlantic Coast STDN Disentanglement Guidelines at https://www.reginfo.gov/public/do/DownloadDocument?objectID=102486501 and the procedures described in	ESA-listed Fish	BOEM, BSEE, and NMFS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			"Careful Release Protocols for Sea Turtle Release with Minimal Injury" (NOAA Technical Memorandum 580; https://repository.library.noaa.gov/view/noaa/3773).		
14	C, O&M	Sea turtle/Atlantic sturgeon identification and data collection	Any sea turtles or Atlantic sturgeon caught or retrieved in any fisheries survey gear must first be identified to species or species group. Each ESA-listed species caught or retrieved must then be documented using appropriate equipment and data collection forms. Biological data collection, sample collection, and tagging activities must be conducted as outlined below. Live, uninjured animals must be returned to the water as quickly as possible after completing the required handling and documentation. a. The Sturgeon and Sea Turtle Take Standard Operating Procedures must be followed (https://media.fisheries.noaa.gov/2021-11/Sturgeon%20%26%20Sea%20Turtle%20Take%20SOPs_external_11032021.pdf). b. Survey vessels must have a passive integrated transponder (PIT) tag reader onboard capable of reading 134.2 kHz and 125 kHz encrypted tags (e.g., Biomark GPR Plus Handheld PIT Tag Reader). This reader must be used to scan any captured sea turtles and sturgeon for tags, and any tags found must be recorded on the take reporting form (see below). c. Genetic samples must be taken from all captured Atlantic sturgeon (alive or dead) to allow for identification of the DPS of origin of captured individuals and tracking of the amount of incidental take. This must be done in accordance with the Procedures for Obtaining Sturgeon Fin Clips (https://media.fisheries.noaa.gov/dam-migration/sturgeon_genetics_sampling_revised_june_2019.pdf). i. Fin clips must be sent to a NMFS-approved laboratory capable of performing genetic analysis and assignment to DPS of origin. Empire must cover all reasonable costs of the genetic analysis. Arrangements for shipping and analysis must be made before samples are submitted and confirmed in writing to NMFS within 60 days of the receipt of the Project BiOp with ITS. Results of genetic analyses, including assigned DPS of origin must be submitted to NMFS within 6 months of the sample collection. ii. Subsamples of all fin clips and accompanying metadata forms must be held and submitted to a tissue repository (e.g., the Atlantic Coast Sturgeon Tissue Research Repository) on a quarterly basis. The Sturgeon Genetic Sample Submission Form is available for download at: https://media.fisheries.noaa.gov/2021-02/Sturgeon%20Genetic%20Sample%20Submission%20sheet%20for%20S7_v1.1_Form%20to%20Use.xlsx?nullhttps://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics-greater-atlantic. d. All captured sea turtles and Atlantic sturgeon must be documented with required measurements and photographs. The animal's condition and any marks or injuries must be described. This information must be entered as part of the record for each incidental take. Particularly, a NMFS Take Report Form must be filled out for each individual sturgeon and sea turtle (download at: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null) and submitted to NMFS as described in the take notification measure below.	ESA-listed Fish, Sea Turtles	BOEM, BSEE, and NMFS
15	PrC, C, O&M	Sea turtle/Atlantic sturgeon handling and resuscitation guidelines	Any sea turtles or Atlantic sturgeon caught and retrieved in gear used in fisheries surveys must be handled and resuscitated (if unresponsive) according to established protocols provided at-sea conditions are safe for those handling and resuscitating the animal(s) to do so. Specifically: a. Priority must be given to the handling and resuscitation of any sea turtles or sturgeon that are captured in the gear being used. Handling times for these species must be minimized, and if possible, kept to 15 minutes or less to limit the amount of stress placed on the animals. b. All survey vessels must have onboard copies of the sea turtle handling and resuscitation requirements (found at 50 CFR 223.206(d)(1)) before begging any on-water activity (download at: https://media.fisheries.noaa.gov/dam-migration/sea_turtle_handling_and_resuscitation_measures.pdf). These handling and resuscitation procedures must be carried out any time a sea turtle is incidentally captured and brought onboard the vessel during survey activities. c. If any sea turtles that appear injured, sick, or distressed, are caught and retrieved in fisheries survey gear, survey staff must immediately contact the Greater Atlantic Region Marine Animal Hotline at 866-755-6622 for further instructions and guidance on handling the animal, and potential coordination of transfer to a rehabilitation facility. If survey staff are unable to contact the hotline (e.g., due to distance from shore or lack of ability to communicate via phone), the USCG must be contacted via VHF marine radio on Channel 16. If required, hard-shelled sea turtles (i.e., non-leatherbacks) may be held on board for up to 24 hours and managed in accordance with handling instructions provided by the Hotline before transfer to a rehabilitation facility.	ESA-listed Fish, Sea Turtles	BOEM, BSEE, and NMFS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			d. Survey staff must attempt resuscitate any Atlantic sturgeon that are unresponsive or comatose by providing a running source of water over the gills as described in the Sturgeon Resuscitation Guidelines (https://media.fisheries.noaa.gov/dam-migration/sturgeon_resuscitation_card_06122020_508.pdf). e. If appropriate cold storage facilities are available on the survey vessel, any dead sea turtle or Atlantic sturgeon must be retained on board the survey vessel for transfer to an appropriately permitted partner or facility on shore unless NMFS indicates that storage is unnecessary, or storage is not safe. f. Any live sea turtles or Atlantic sturgeon caught and retrieved in gear used in any fisheries survey must ultimately be released according to established protocols including safety considerations.		
16	C, O&M	Take notification	GARFO PRD must be notified as soon as possible of all observed takes of sea turtles, and Atlantic sturgeon occurring as a result of any fisheries survey. Specifically: a. GARFO PRD must be notified within 24 hours of any interaction with a sea turtle or sturgeon (nmfs.gar.incidental-take@noaa.gov). The report will include at a minimum: (1) survey name and applicable information (e.g., vessel name, station number); (2) GPS coordinates describing the location of the interaction (in decimal degrees); (3) gear type involved (e.g., bottom trawl, gillnet, longline); (4) soak time, gear configuration and any other pertinent gear information; (5) time and date of the interaction; and (6) identification of the animal to the species level. Additionally, the e-mail will transmit a copy of the NMFS Take Report Form (download at: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null) and a link to or acknowledgement that a clear photograph or video of the animal was taken (multiple photographs are suggested, including at least one photograph of the head scutes). If reporting within 24 hours is not possible due to distance from shore or lack of ability to communicate via phone, fax, or email, reports must be submitted as soon as possible; late reports must be submitted with an explanation for the delay. b. At the end of each survey season, a report must be sent to NMFS that compiles all information on any observations and interactions with ESA-listed species. This report will also contain information on all survey activities that took place during the season including location of gear set, duration of soak/trawl, and total effort. The report on survey activities must be comprehensive of all activities, regardless of whether ESA-listed species were observed.	ESA-listed Fish, Sea Turtles	BOEM, BSEE, and NMFS
17	C, O&M	Monthly/annual reporting requirements	Empire must implement the following reporting requirements to document the amount or extent of take that occurs during all phases of the Proposed Action: a. All reports must be sent to: NMFS at nmfs.gar.incidental-take@noaa.gov and BSEE at OSWsubmittals@bsee.gov. b. During the construction phase and for the first year of operations, Empire must compile and submit monthly reports summarizing all Project activities carried out in the previous month, including vessel transits (number, type of vessel, and route), piles installed, and all observations of ESA-listed species. Monthly reports are due on the 15th of the month for the previous month. c. Beginning in year 2 of operations, Empire must compile and submit annual reports that summarize all Project activities carried out in the previous year, including vessel transits (number, type of vessel, and route), repair and maintenance activities, survey activities, and all observations of ESA-listed species. These reports are due by April 1 of each year (i.e., the 2026 report is due by April 1, 2027). Upon mutual agreement of NMFS and BOEM, the frequency of reports can be changed.	ESA-listed Fish, Sea Turtles	BOEM, BSEE, and NMFS
18	C, O&M, D	Geophysical Surveys	Empire must comply with all the Project Design Criteria and Best Management Practices for Protected Species at https://www.boem.gov/sites/default/files/documents//PDCs%20and%20BMPs%20for%20Atlantic%20Data%20Collection%2011222021.pdf that implement the integrated requirements for threatened and endangered species in the June 29, 2021, programmatic consultation under the ESA, revised November 22, 2021.	ESA-listed Fish, Marine Mammals, Sea Turtles	BOEM and BSEE
19	PrC, C, O&M, D	Data Collection Buoys	BOEM will ensure that all Project Design Criteria and Best Management Practices as they may apply to HRG surveys, geotechnical surveys designed to characterize benthic and subsurface conditions and deployment, survey vessel transits, and retrieval of environmental data collection buoys as required in the Atlantic Data Collection consultation for Offshore Wind Activities (June 29, 2021) shall be applied to activities associated with the construction, maintenance and operations of the Empire Wind project as applicable.	ESA-listed Fish, Marine Mammals, Sea Turtles	BOEM and BSEE
20	C	Alternative Monitoring Plan (AMP) for pile driving	Empire must not conduct pile driving operations at any time when lighting or weather conditions (e.g., darkness, rain, fog, sea state) prevent visual monitoring of the clearance and shutdown zones unless BOEM and NMFS have approved an AMP. Empire must submit an AMP to BOEM and NMFS for review and approval at least 180 days prior to the planned start of pile-driving. This plan may include deploying additional observers, alternative monitoring technologies such as night vision, thermal, and infrared	Marine Mammals, Sea Turtles	BOEM and BSEE

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			technologies, or use of PAM and must demonstrate the ability and effectiveness of the proposed equipment and methods to monitor clearance and shutdown zones. The AMP must address daytime conditions when lighting or weather (e.g., fog, rain, sea state) conditions prevent effective visual monitoring of clearance and shutdown zones, and nighttime condition (if permitted), daytime being defined as one hour after civil sunrise to 1.5 hours before civil sunset. The lead PSO will determine as to when there is sufficient light to ensure effective visual monitoring can be accomplished in all directions and when the alternative monitoring plan will be implemented. If a marine mammal or sea turtle is observed entering or found within the shutdown zones after impact pile-driving has commenced, Empire must follow the shutdown procedures outlined in the Protected Species Mitigation Monitoring Plan. Empire must notify BOEM and NMFS of any shutdown occurrence during pile driving operations with 24 hours of the occurrence unless otherwise authorized by BOEM and NMFS. The AMP must include, but is not limited to the following information: • Identification of night vision devices, such as mounted thermal or IR camera systems, hand-held or wearable NVDs, and IR spotlights, if proposed for use to detect protected marine mammal and sea turtle species. • The AMP must demonstrate the capability of the proposed monitoring methodology to detect sea turtles within the clearance and shutdown zones. Only devices and methods demonstrated as being effective of detecting marine mammals and sea turtles within the clearance and shutdown zones will be acceptable. • Evidence and discussion of the efficacy (range and accuracy) of each device proposed for low visibility monitoring must include an assessment of the results of field studies, as well as supporting documentation regarding the efficacy of all proposed alternative monitoring methods (e.g., best scientific data available). • Reporting procedures, contacts and timeframes. BOEM may request additional information, when appropriate, to assess the efficacy of the AMP		
21	O&M	Periodic underwater surveys, reporting of monofilament and other fishing gear around WTG foundations	Empire must monitor potential loss of fishing gear in the vicinity of WTG foundations by surveying at least ten percent of the total installed foundations annually. Survey design and effort may be modified based upon previous survey results after review and concurrence by BOEM. Empire must conduct surveys by remotely operated vehicles, divers, or other means to determine the locations and amounts of marine debris. Empire must report the results of the surveys to BOEM (at renewable_reporting@boem.gov) and BSEE (at marinedebris@bsee.gov) in an annual report, submitted by April 30 for the preceding calendar year. Annual reports must be submitted in Microsoft Word format. Photographic and videographic materials must be provided on a portable drive in a lossless format such as TIFF or Motion JPEG 2000. Annual reports must include survey reports that include: the survey date; contact information of the operator; the location and pile identification number; photographic and/or video documentation of the survey and debris encountered; any animals sighted; and the disposition of any located debris (i.e., removed or left in place). Required data and reports may be archived, analyzed, published, and disseminated by BOEM.	Marine Mammals, Sea Turtles	BOEM and BSEE
22	PrC, C, O&M, D	Minimize survey vessel interactions with listed species (from HRG Programmatic)	All vessels associated with survey activities (transiting [i.e., travelling between a port and the survey site] or actively surveying) must comply with the vessel strike avoidance measures specified below. The only exception is when the safety of the vessel or crew necessitates deviation from these requirements. • If any ESA-listed marine mammal is sighted within 500 m of the forward path of a vessel, the vessel operator must steer a course away from the whale at <10 knots (18.5 km/hr) until the minimum separation distance has been established. Vessels may also shift to idle if feasible. • If any ESA-listed marine mammal is sighted within 200 m of the forward path of a vessel, the vessel operator must reduce speed and shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 500 meters. If stationary, the vessel must not engage engines until the large whale has moved beyond 500 m. • If a sea turtle or manta ray is sighted at any distance within the operating vessel's forward path, the vessel operator must slow down to 4 knots and steer away, unless unsafe to do so. The vessel may resume normal operations once the vessel has passed the sea turtle or manta ray.	Marine Mammals	BOEM, BSEE, and NMFS
BOEM-proposed Bird and Bat Mitigation Measures					
1	O&M	Adaptive mitigation for birds and bats	If the reported post-construction bird and bat monitoring results (generated as part of Empire's *Bird and Bat Monitoring Framework* (Attachment H-3) indicate bird and bat impacts deviate substantially from the impact analysis included in this EIS, then Empire must make recommendations for new mitigation measures or monitoring methods.	Birds and Bats	BOEM, USFWS, BSEE

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
2	C, O&M	Annual reporting	Annual Bird and Bat Mortality Reporting during construction and operation, and decommissioning. The Lessee must submit an annual report covering each calendar year, due by January 31 of the following year, documenting any dead (or injured) birds or bats found on vessels and structures during construction, operations, and decommissioning. The report must be submitted to BOEM (at renewable_reporting@boem.gov) and BSEE (at OSWSubmittals@bsee.gov) and USFWS. The report must contain the following information: the name of species, date found, location, a picture to confirm species identity (if possible), and any other relevant information. Carcasses with Federal or research bands must be reported to the United States Geological Survey Bird Band Laboratory.	Birds and Bats	BOEM, USFWS, BSEE
3	C, O&M	Reporting	Any occurrence of dead or injured ESA-listed birds or bats must be reported to BOEM, BSEE, and USFWS as soon as practicable (taking into account crew and vessel safety) after the sighting, but no later than 72 hours after the sighting, and if practicable, carefully collect the dead specimen and preserve the material in the best possible state.	Birds and Bats	BOEM, USFWS, BSEE
BOEM-proposed Mitigation and Monitoring Measures in the NMFS EFH Assessment					
1	C	Scour and Cable Protection	To the extent technically and economically feasible, Empire must ensure that all materials used for scour and cable protection consist of natural or engineered stone that does not inhibit epibenthic growth. The materials selected for protective purposes should mirror the natural environment and provide similar habitat functions, including trawl-friendly cable protection design in areas where trawl gear is used.	Benthic Resources, Finfish and Invertebrates, EFH	BOEM, BSEE, USACE
2	C, O&M, D	Anchoring Plan	Empire will develop and comply with an anchoring plan to reduce impacts on benthic habitats associated with the Proposed Action. This plan should specifically delineate areas of complex habitat around each turbine and cable locations, and identify areas restricted from anchoring. Anchor chains should include midline buoys to minimize impacts to benthic habitats from anchor sweep where feasible. The habitat maps and inshore maps delineating sensitive benthic habitat adjacent to the landfall and O&M facility should be provided to all cable construction and support vessels to ensure no anchoring of vessels be done within or immediately adjacent to these habitats.	Benthic Resources, Finfish and Invertebrates, EFH	BOEM, BSEE, USACE (during construction only)
3	C, O&M, D	Live and Hard Bottom Mapping and Avoidance	Vessel operators would be provided with maps of sensitive hard-bottom habitat in the Project area, as well as a proposed anchoring plan that would avoid or minimize impacts on the hard-bottom habitat to the greatest extent practicable. These plans would be provided for all anchoring activity, including construction, maintenance, and decommissioning.	Benthic Resources, Finfish and Invertebrates, EFH	BOEM, BSEE, USACE (during construction only)
4	C, O&M, D	Live and Hard Bottom Monitoring	Empire would develop and implement a monitoring plan for live and hard bottom features that may be impacted by proposed activities. The monitoring plan would also include assessing the recovery time for these sensitive habitats. BOEM recommends that all monitoring reports classify substrate conditions following the Coastal and Marine Ecological Classification Standards (CMECS), including live bottoms (e.g., submerged aquatic vegetation and corals and topographic features. The plan would also include a means of recording observations of any increased coverage of invasive species in the impacted hard-bottom areas.	Benthic Resources, Finfish and Invertebrates, EFH	BOEM, BSEE, USACE (during construction only)
BOEM-proposed Mitigation and Monitoring Measures in the USFWS BA					
1	O&M	Bird Deterrent	To minimize attracting birds to operating turbines, Empire Wind must install bird perching-deterrent devices on all WTGs and OSSs. Empire Wind must submit for the BOEM and Service approval a plan to deter perching on offshore infrastructure. The plan must include the type(s) and locations of bird perching-deterrent devices, include a maintenance plan for the life of the project, allow for modifications and updates as new information and technology become available, track the efficacy of the deterrents, and a timeline for installation. The plan will be based on best available science regarding the efficacy of perching deterrent devices on avoiding and minimizing collision risk. The location of bird-deterrent devices must be proposed by Empire Wind based on best management practices applicable to the appropriate operation and safe installation of the devices. Empire Wind must confirm the locations of bird perching-deterrent devices as part of the documentation it must submit with the FDR.	Birds	BOEM, USFWS, BSEE
2	O&M	Light Impact Reduction	Empire Wind must use an FAA-approved vendor for the Aircraft Detection Lighting System (ADLS), which will activate the FAA hazard lighting only when an aircraft is in the vicinity of the wind facility to reduce visual impacts at night. Empire Wind must confirm the use of an FAA-approved vendor for ADLS on WTGs and OSSs in the FDR.	Birds	FAA, BOEM, BSEE
3	O&M	Light Impact Reduction	Empire Wind must light each WTG and OSS in a manner that is visible by mariners in a 360-degree arc around the WTG and OSS. To minimize the potential of attracting migratory birds, the top of each light shall be shielded to minimize upward illumination (Conditional on USCG approval).	Birds	USCG, BOEM, BSEE
4	O&M	Adaptive Mitigation for Birds and Bats	BOEM will require that Empire Wind develops and implements a Post-Construction Monitoring [PCM] plan based on the “Empire Offshore Wind Projects (EW 1 and EW 2): Proposed Bird and Bat Monitoring Framework” in coordination with USFWS and other relevant regulatory agencies. Annual monitoring reports will be used to determine the need for adjustments to monitoring approaches, consideration of new monitoring technologies, and/or additional periods of monitoring.	Birds and Bats	BOEM, BSEE, USFWS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			Prior to commencing offshore construction activities, Empire Wind must submit the PCM for BOEM and USFWS review. BOEM and USFWS will review the PCM and provide any comments on the plan within 30 calendar days of its submittal. Empire Wind must resolve all comments on the PCM to BOEM and USFWS's satisfaction before implementing the plan. a. Monitoring. Empire Wind must conduct monitoring as outlined in "Empire Offshore Wind Projects (EW 1 and EW 2): Proposed Bird and Bat Monitoring Framework, which will include acoustic monitoring of bat and bird presence, the use of motus receivers and tags to monitor bird and bat movements, and conducting digital aerial surveys to monitor avoidance behavior and densities. b. Annual Monitoring Reports. Empire Wind must submit to BOEM (at renewable_reporting@boem.gov), USFWS, and BSEE (at OSWSubmittals@bsee.gov) a comprehensive report after each full year of monitoring (pre- and post-construction) within 6 months of completion of the last avian survey. The report must include all data, analyses, and summaries regarding ESA-listed and non-ESA-listed birds and bats. BOEM, USFWS, and BSEE will use the annual monitoring reports to assess the need for reasonable revisions (based on subject matter expert analysis) to the PCM. BOEM, BSEE, and USFWS reserve the right to require reasonable revisions to the PCM and may require new technologies as they become available for use in offshore environments. c. Post-Construction Quarterly Progress Reports. Empire Wind must submit quarterly progress reports during the implementation of the PCM to BOEM (at renewable_reporting@boem.gov) and the USFWS by the 15th day of the month following the end of each quarter during the first full year that the Project is operational. The progress reports must include a summary of all work performed, an explanation of overall progress, and any technical problems encountered. d. Monitoring Plan Revisions. Within 15 calendar days of submitting the annual monitoring report, Empire Wind must meet with BOEM and USFWS to discuss the following: the monitoring results; the potential need for revisions to the PCM, including technical refinements or additional monitoring; and the potential need for any additional efforts to reduce impacts. If BOEM or USFWS determines after this discussion that revisions to the PCM are necessary, BOEM may require Empire Wind to modify the PCM. If the reported monitoring results deviate substantially from the impact analysis included in the Final BA, Empire Wind must transmit to BOEM recommendations for new mitigation measures and/or monitoring methods. e. Operational Reporting (Operations). Empire Wind must submit to BOEM (at renewable_reporting@boem.gov) and BSEE (at OSWSubmittals@bsee.gov) an annual report summarizing monthly operational data calculated from 10-minute SCADA data for all turbines together in tabular format: the proportion of time the turbines were operational (spinning at >x rpm) each month, the average rotor speed (monthly revolutions per minute (rpm)) of spinning turbines plus 1 standard deviation, and the average pitch angle of blades (degrees relative to rotor plane) plus 1 standard deviation. BOEM and BSEE will use this information as inputs for avian collision risk models to assess whether the results deviate substantially from the impact analysis included in the Final BA. f. Raw Data. The Lessee must store the raw data from all avian and bat surveys and monitoring activities according to accepted archiving practices. Such data must remain accessible to BOEM, BSEE and USFWS, upon request for the duration of the Lease. The Lessee must work with BOEM to ensure the data are publicly available.		
5	C, O&M, D	Reporting	Empire Wind must provide an annual report to BOEM and USFWS documenting any dead (or injured) birds or bats found on vessels and structures during construction, operations, and decommissioning. The report must contain the following information: the name of species, date found, location, a picture to confirm species identity (if possible), and any other relevant information. Carcasses with federal or research bands must be reported to the United States Geological Survey Bird Band Laboratory, available at https://www.pwrc.usgs.gov/bbl/. Any occurrence of a dead ESA-listed bird or bat must be reported to BOEM, BSEE, and USFWS as soon as practicable (taking into account crew and vessel safety) and, if practicable, the dead specimen will be carefully collected and preserved in the best possible state.	Birds and Bats	BOEM, USFWS, BSEE
Other BOEM-proposed Mitigation Measures for Marine Mammals					
1	PrC, C, O&M, D	Long-term PAM Monitoring	Highly migratory species like baleen whales occupy different parts of the Atlantic OCS at different times of the year. Passive Acoustic Monitoring (PAM) is an effective tool to monitor baleen whale habitat use, because it can detect the presence of whales when other methods are not feasible, such as periods of low visibility, poor weather, or when animals are far below the ocean's surface. Autonomous PAM systems can be deployed for months at a time and should be configured to record low-frequency sounds (capable of detecting baleen whales and industry-related noise) on a continuous basis; this ensures that species which call in "bouts" do not go undetected. These acoustic recordings are then processed using automatic detection methods to document the presence of particular species. Linking together the time-series of baleen whale detections with other oceanographic data, such as water temperature and plankton abundance, can tell a more complete story about habitat use over	Marine Mammals	BOEM, BSEE, and NMFS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			space and time. These comparisons are critical at the project-specific level, to determine whether there was any change in habitat use as a result of windfarm development, and at a regional level, supporting BOEM's cumulative effects analyses looking across projects. For this reason, BOEM will require that the time-series of species detections and the raw acoustic data are entered into publicly available data portals and archives. The Lessee must conduct long-term Passive Acoustic Monitoring (PAM) to record ambient noise and marine species vocalizations in the Lease Area. Analysis of PAM data collected within the lease area allows for comparisons with acoustic data gathered during pre-construction periods, both in terms of the soniferous species that are present, as well as any changes to ambient noise due to the operation of the wind farm, which could affect species' distributions and/or behaviors. In addition, data collected within a lease area can be compared to data collected throughout the broader region, thus supporting cumulative effects analysis for highly migratory species. BOEM requires that archival, continuous recording systems be deployed at least 30 days prior to foundation pile driving, and their deployment must continue through initial operations, and must be sustained for the lifetime of the lease. The number of devices in each lease area must be sufficient to ensure that vocalizing baleen whales could be detected, based on the assumption of a 10 km detection range for North Atlantic Right Whale calls. The sampling rate of the recorders should prioritize the detection of baleen whale vocalizations, but must also have a minimum capability of detecting and storing acoustic data on noise from vessels, pile-driving, and WTG operation. Throughout deployments and data analysis, the lessee will be expected to follow the best practices outlined in the RWSC best practices document. The lessee must also process the data to document, at the very least, the presence of baleen whale vocalizations and metrics of ambient noise. The lessee will be expected to archive the full acoustic record at National Centers for Ecological Information and to submit baleen whale detections to BOEM, BSEE, and NMFS at least twice a year. As an alternative to conducting PAM in its project area, the lessee may opt to pay into a Regional PAM Fund on an annual basis to support long-term monitoring. The lessee's contribution would cover activities such as the purchase of instruments, annual deployments and refurbishment, data processing, and long-term data archiving. Funding from BOEM and other partners will contribute to the Regional PAM Fund, which will support PAM on non-lease areas and enable broader-scale analyses on cumulative effects to marine species. The lessee will be expected to cooperate with the Regional PAM team to facilitate deployment and refurbishment of instruments within the project area. If necessary, the lessee may request a temporary embargo on the public release of acoustic data that has been collected within the project area.		
2	C	Sound Field Verification of Foundation Installation	The purpose of the Sound Field Verification (SFV) process is to document sound propagation from foundation installation for estimating distances to isopleths of potential injury and harassment to verify that the modeled acoustic fields were conservative enough to not underestimate the number of exposures of protected marine life to sounds over regulatory thresholds. The Lessee will submit an SFV plan for review and written approval by USACE, BOEM and NMFS 90 days before the planned commencement of field activities for pile-driving. The plan will include measurement procedures and results reporting that meet ISO standard 18406:2017 (Underwater acoustics – Measurement of radiated underwater sound from percussive pile driving). The submission of raw acoustic data or data products associated with SFV to BOEM may be required. In order to compare sound fields produced by the full variation in planned installation scenarios with those modeled, the lessee will perform "thorough monitoring" (defined as recording along a minimum of two radials with at least one radial containing recorders at three or more distances) on the first installation in each calendar year, and for the installation of any subsequent foundation planned to have a different combination of the following parameters: foundation type, pile size, installation method, hammer energy rating, water depth, seabed composition, season. The SFV plan should include approximations of the expected variation of these parameters across the project and an estimate of how many thorough monitoring locations will be required to cover this variation. The plan must describe how the Lessee will ensure that the locations selected for thorough monitoring are representative of the rest of the foundations of that type to be installed. The plan must include an "abbreviated SFV check" single recorder placed, 460 feet (750 meters) from the installation of any foundation not requiring "thorough monitoring" to ensure that additional inherent variability does not result in received levels above what was analyzed within the permitting/authorization/assessment/NEPA process. The SFV process must be sufficient to assess sound propagation from the foundation and the distances to isopleths for potential injury and harassment. The measurements must be compared to the modeled Level A and Level B harassment zones for marine mammals (and the injury and behavioral disturbance zones for sea turtles and Atlantic sturgeon), thus the plan should include the target modeled sound levels that each monitored installation will stay below.	Marine Mammals, Sea Turtles, ESA-listed Fish	BOEM, BSEE, and NMFS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
3	C	Foundation installation Received Sound Level Limit	At present, the installation of turbine foundations is largely done (or being requested) using impact pile-driving, and we expect that trend to continue. Bigger piles are also expected as turbine sizes increase in megawatt capacity. For example, recently built monopile foundations have a diameter of 7 to 8 m and pile sizes are expected to increase to 12 m in diameter and 100 m in length for the upcoming generation of 12 to 14 MW wind turbines and for greater water depths. Although the pile diameter is not the only factor in determining noise levels, it is one of the biggest ones. The Received Sound Level Limit (RSLL) is a performance-based target meant to reduce the likelihood of negative impacts from noise on marine life. It could also be considered a quieting target. The concept of RSLL is not new, and its application is familiar to many companies working abroad. Countries such as Germany, Belgium, the Netherlands, United Kingdom, and Denmark have introduced quieting performance goals to protect marine wildlife from both hearing damage and behavioral disturbance. (Koschinski and Lüdemann, 2020) For example, in German waters a mandatory threshold of 160 dB (SEL) and 190 dB (peak-to-peak) at a distance of 750 m during pile driving was established in 2008 for the protection of marine mammals. Here, companies are required to field verify that they are meeting these levels by measuring sound at 750 m and 1,500 m from every pile. (See Sound Field Verification explanation.) BOEM's Center for Marine Acoustics (CMA) carefully evaluated existing information on modeled noise projections, actual field measurements, and quieting policies worldwide. The goal was to determine how to get quieter given the expected increase in impact pile driving noise and the anticipated regulatory drivers under the MMPA and ESA. Part of the effort also included prioritizing species of greatest concern, namely the North Atlantic right whale and other baleen whales (all considered low frequency hearing cetaceans). Based on this analysis, and as of May 1, 2026, BOEM will require a RSLL *for impact pile driving not to exceed 183 weighted LF SEL (dB re 1 µPa^{2}s) or* 202 unweighted Lpk (dB re 1 µPa^2) outside of 1 km from each pile. These numbers are based on current NOAA Fisheries' MMPA acoustic thresholds and weightings for determining permanent threshold shifts (i.e., PTS; permanent hearing damage) for low frequency cetaceans (LFCs). Should changes to thresholds or weightings occur, the lessee must meet any updated numbers available from NOAA Fisheries at the time of installing the first pile. This specific RSLL was chosen to protect species of greatest concern and directed at where it is counts the most, specifically PTS in low-frequency whales from exposure to cumulative sound energy. In addition to protecting animal hearing, the metric also allows for a predictable target from which government and industry can innovate technology and apply flexibilities for meeting the target within each project versus overly prescribing a specific approach. By incorporating a weighting function to more accurately reflect the noise's likelihood of inducing hearing loss based on acoustic frequency content, developers are provided the opportunity for innovation, not just in reducing the total noise generated, but to reduce noise in the bandwidth that is most impactful for low-frequency whales. Although focused on shrinking the zone size associated with potential hearing impacts (also called Level A Harassment under the MMPA), implementation of the RSLL also shrinks the zone for Temporary Threshold Shifts (temporary hearing impacts) by half on average and also reduces the size of the behavioral impact zones (called Level B Harassment under the MMPA). The Level A RSLL alone may not be sufficient in reducing impacts to low and highly endangered populations like the North Atlantic right whales. BOEM therefore intends to develop a second RSLL aimed at reducing Level B Harassment (e.g., potential to disrupt important behaviors), especially for LFCs. BOEM will advise lessees once a second RSLL is developed in order to consider implementation concerns, if any. Koschinski, S.; Lüdemann, K. (2020). *Noise mitigation for the construction of increasingly large offshore wind turbines. Report for German Federal Agency for Nature Conservation (BfN).* https://tethys.pnnl.gov/sites/default/files/publications/Koschinskietal2020.pdf	Marine Mammals, Sea Turtles, ESA-listed Fish	BOEM, BSEE, and NMFS
Other Agency-proposed Mitigation Measures					
1	C	LOA Requirements	The measures required by the final MMPA LOA for Incidental Take Regulations would be incorporated into COP approval. NMFS published receipt of an application for regulations and Letter of Authorization under the MMPA on September 9, 2022 (87 FR 55409) and is currently accepting comments until October 11, 2022. NMFS is currently accepting comments from the public to provide information, suggestions, and comments on Empire's application and has not yet proposed rulemaking on this action.[2]	Marine Mammals	BOEM and BSEE
2	Pre-C	Cable Burial Risk Assessment	Empire will develop a final Cable Burial Risk Assessment for maritime stakeholder review prior to submittal of the relevant cable Fabrication and Installation Report/Facility Design Report (FIR/FDR). The Cable Burial Risk Assessment will identify and	Navigation	BOEM, BSEE, USACE

[2] See Table H-4 for Empire's proposed Mitigation, Monitoring, and Reporting Measures in the MMPA Letter of Authorization.

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			address conflicts with both Federal and Private Aids to Navigation. Empire will document how maritime stakeholder comments were addressed and transmit the comments and responses to BOEM, BSEE, USACE, and USCG.		
3	Pre-C, C, O&M	Cable Maintenance Plan	Empire will develop and implement a Cable Maintenance Plan that requires prompt remedial burial of exposed and shallow-buried cable segments, addresses repeat exposures, and establishes a process for identifying when cable burial depths reach unacceptable risk levels.	Navigation	BOEM, BSEE, USACE
4	C	Cable Separation Distance	Empire will install export cables such that the final corridor width should be as narrow as possible to minimize overall impacts.	Other Uses	Best practice
5	Pre-C	Cable Installation Plan	Empire's Cable Installation Plan or Cable Burial Risk Assessment will: 1. depict precise planned locations and burial depths of the entire cable system; 2. detail how cable installation and operation will be managed to ensure disruption to harbor uses is minimized along the cable routes; 3. evaluate impacts to anchorage area capacity during construction and operations and identify mitigation measures where appropriate. Mooring buoys should be considered as alternative berthing options to offset permanently reduced operational or anchorage capacity (e.g., Gravesend Bay); and 4. evaluate the need for additional mitigation measures, including crossing the Ambrose to Nantucket Traffic Lane.	Navigation	BOEM, BSEE, USACE
6	C, O&M	Cable Alert System	Empire will utilize a service that can create GPS coordinates around the as-built location of the export cable. The service would detect vessels traveling under a speed threshold in the vicinity of the cable that are most likely to drop an anchor and send a notification to those vessels that an asset is buried. In addition Empire will have temperature and acoustic monitoring in place that will register potential anchor strikes. Empire will provide notification if the cable would exit the 30-foot easement in state waters.	Navigation	BOEM, BSEE, USACE
7	C, O&M	Compensation for gear loss and damage	The lessee shall implement a gear loss and damage compensation program consistent with BOEM's draft guidance for Mitigating Impacts to Commercial and Recreational Fisheries on the Outer Continental Shelf Pursuant to 30 CFR 585 or as modified in response to public comment.	Commercial Fisheries and For-Hire Recreational Fishing	BOEM and BSEE
Agency-proposed Mitigation Measures for the Connected Action					
1	C	Wetland Mitigation	NYSDEC will mitigate for impacts to mapped tidal littoral zone wetlands from fill and shading associated with the Connected Action, as required in consultation with NYS agencies.	Wetlands	NYSDEC
USFWS Conservation Measures from the USFWS Biological Opinion Issued June 23, 2023					
1	Project design, O&M	Turbine and Offshore Substation Specific Measures	Empire Wind proposes the installation of up to 57 WTGs for EW1 and up to 90 WTGs for EW2 within the 65,458-acre (26,490-ha) Wind Farm Development Area (Figure 1). The top of the WTGs would extend to a height of up to 951 ft (290 m) above highest astronomical tide with a minimum spacing of no less than 0.65 nm and be oriented in a north-south direction. • To aid safe navigation, Empire Wind must comply with all FAA, USCG, and the BOEM lighting, marking and signage requirements. Empire Wind will comply with all applicable requirements while minimizing impacts through appropriate application, including directional aviation lights, that minimize visibility from shore. (BOEM 2022b; Table 9, Measure 1c). • Empire Wind has committed to lighting reduction measures (BOEM 2022b, p. 62). Empire Wind will use lighting technology that minimizes impacts on avian species to the extent practicable. • Dependent on technical availability, Empire Wind must use an FAA-approved vendor for the ADLS on WTGs and OSSs, which will activate the FAA hazard lighting only when an aircraft is in the vicinity of the wind facility to reduce visual impacts at night in the offshore environment. To further reduce impacts on birds, Empire Wind would limit, where practicable, lighting which is not required by FAA and USCG, during offshore construction to reduce attraction of birds (Tetra Tech 2022 COP Volume 2f, Table 9-1, APM 82; BOEM 2022b, Table 9 [1b], p. 62). • Empire Wind is required to light each WTG and OSS in a manner that is visible by mariners in a 360-degree arc around the structure. To minimize the potential of attracting migratory birds, the top of each USCG-required marine navigation light will be shielded to minimize upward illumination (conditional on USCG approval). The Service understands that the USCG-approved lights may not be shielded, but that marine lanterns typically approved for this type of usage are designed to illuminate a horizonal plane near the sea surface, and do not direct light skyward (BOEM 2022b, Table 9, Measure 1c). • Coordination with USCG regarding maritime navigation lighting occurs post-COP approval, generally at least 120 calendar days prior to installation. The Service will be afforded an opportunity to review a copy of Empire Wind's application to USCG to establish Private Aids to Navigation (PATON), which includes a lighting, marking, and signaling plan. The PATON	Birds	BOEM, BSEE, and USFWS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			application will include design specifications for maritime navigation lighting. The Service may offer recommendations to USCG on the PATON application to minimize or reduce avian impacts. However, expertise and jurisdiction for ensuring safe navigation lay with USCG. No measures to minimize avian impacts will be adopted or pursued that are not deemed by USCG as fully compatible with safe navigation • Following approval of the PATON by the USCG, the BOEM and the Service will work together to evaluate the USCG-approved navigation lighting system. Specifically, we will work together to characterize the color, intensity, and duration of any light from maritime lanterns that is likely to reach the typical flight heights of listed birds and assess the degree to which the light is likely to attract or disorient listed birds. This information will be considered, as appropriate, in future updates to the incidental take statement accompanying this Opinion and in the annual mitigation assessments		
USFWS Other Project Measures from the USFWS Biological Opinion Issued June 23, 2023					
1	C, O&M, D	Monitoring and Data Collection	BOEM will require that Empire Wind develops and implements an Avian and Bat Post-Construction Monitoring Plan (ABPCMP) based on the Avian and Bat Post-Construction Monitoring Framework found in Appendix C of the BA in coordination with Bureau of Safety and Environmental Enforcement (BSEE), the Service, appropriate state agencies, and other relevant regulatory agencies (BOEM 2022b). Annual monitoring reports will be used to determine the need for adjustments to monitoring approaches, consideration of new monitoring technologies, and/or additional periods of monitoring (BOEM 2022b, Table 9 Measure 2b). Prior to, or concurrent with, offshore construction activities, Empire Wind must submit an ABPCMP for the BOEM, BSEE and Service review. The BOEM, BSEE and the Service will review the ABPCMP and provide any comments on the plan within 60 calendar days of its submittal. Empire Wind must resolve all comments on the ABPCMP to the satisfaction of BOEM, BSEE and the Service before implementing the plan and prior to the commissioning of WTG operations. The goals of the ABPCMP will be: (1) to advance understanding of how the target species utilize the offshore airspace and do (or do not) interact with the wind farm; (2) to improve the collision estimates from SCRAM (or its successor) for listed bird species; and (3) to inform any efforts aimed at minimizing collisions or other project effects on target species. 1. Monitoring Empire Wind must conduct monitoring as outlined in the Avian and Bat Post-Construction Monitoring Framework (BOEM 2022b Appendix C), which will include use of radio-tags to monitor movement of ESA-listed birds in the vicinity of the project. The ABPCMP will allow for changing methods over time in order to regularly update and refine collision estimates for listed birds. Specific to this purpose, the plan will include an initial monitoring phase involving deployment of Motus radio tags on listed birds in conjunction with installation and operation of Motus receiving stations on turbines in the Lease Area following offshore Motus recommendations (https://motus.org/groups/atlantic-offshore-wind/). The initial phase may also include deployment of satellite-based tracking technologies (e.g., Global Positioning System [GPS] or Argos tags). The monitoring will also include digital aerial surveys to monitor avoidance behavior and densities. 2. Annual Monitoring Reports Empire Wind must submit to the BOEM (at renewable_reporting@boem.gov), the Service, and the BSEE (via TIMSWeb and at protectedspecies@bsee.gov) a comprehensive report after each full year of monitoring (pre- and post-construction) within 6 months of completion of the last avian survey. The report must include all data, analyses, and summaries regarding ESA-listed and non-ESA-listed birds and bats. The BOEM, BSEE, and the Service will use the annual monitoring reports to assess the need for reasonable revisions (based on subject matter expert analysis) to the ABPCMP. The BOEM, BSEE, and the Service reserve the right to require reasonable revisions to the ABPCMP and may require new technologies as they become available for use in offshore environments. 3. Post-Construction Quarterly Progress Reports Empire Wind must submit quarterly progress reports during the implementation of the ABPCMP to the BOEM (at renewable_reporting@boem.gov), BSEE and the Service by the 15th day of the month following the end of each quarter during the first full year that the project is operational. The progress reports must include a summary of all work performed, an explanation of overall progress, and any technical problems encountered. 4. Monitoring Plan Revisions Within 30 calendar days of submitting the annual monitoring report, Empire Wind must meet with the BOEM, BSEE, Service, and appropriate state agencies to discuss the following: the monitoring results; the potential need for revisions to the ABPCMP, including technical refinements or additional monitoring; and the potential need for any additional efforts to reduce impacts. If, based on this annual review meeting, the BOEM and the Service jointly determine that revisions to the ABPCMP are necessary,	Birds	BOEM, BSEE, and USFWS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			the BOEM will require Empire Wind to modify the ABPCMP. If the projected collision levels, as informed by monitoring results, deviate substantially from the effects analysis included in this Opinion, Empire Wind must transmit to the BOEM recommendations for new mitigation measures and/or monitoring methods. The frequency, duration, and methods for various monitoring efforts in future revisions of the ABPCMP will be determined adaptively based on current technology and the evolving weight of evidence regarding the likely levels of collision mortality for each listed bird species. The effectiveness and cost of various technologies/methods will be key considerations when revising the plan. Grounds for revising the ABPCMP include, but are not limited to: (i) greater than expected levels of collision of listed birds; (ii) evolving data input needs for SCRAM (or its successor); (iii) changing technologies for tracking or otherwise monitoring listed birds in the offshore environment that are relevant to assessing collision risk; (iv) new information or understanding of how listed birds utilize the offshore environment and/or interact with wind farms; and (v) coordination and alignment of tracking, monitoring, and other data collection efforts for listed birds across multiple wind farms/leases on the OCS. The BOEM will require Empire Wind to continue implementation of appropriate monitoring activities for listed birds (under the current and future versions of the ABPCMP) until one of the following occurs: (i) the EW1 and EW2 turbines cease operation; (ii) the Service concurs that a robust weight of evidence has demonstrated that collision risks to all two listed birds from EW1 and EW2 turbine operations are negligible (i.e., the risk of take from WTG operation is discountable); or (iii) the Service concurs that further data collection is unlikely to improve the accuracy or robustness of collision mortality estimates and is unlikely to improve the ability of the BOEM and Empire Wind to reduce or offset collision mortality. 5. Operational Reporting (Operations) Empire Wind must submit to the BOEM (at renewable_reporting@boem.gov) and BSEE (via TIMSWeb and at protectedspecies@bsee.gov) an annual report summarizing monthly operational data calculated from 10-minute supervisory control and data acquisition data for all turbines together in tabular format: the proportion of time the turbines were operational (spinning at >x revolutions per minute [rpm]) each month, the average rotor speed (rpm) of spinning turbines plus 1 standard deviation, and the average pitch angle of blades (degrees relative to rotor plane) plus 1 standard deviation. The BOEM and BSEE will use this information as inputs for avian collision risk models to assess whether the results deviate substantially from the effects analysis included in this Opinion. 6. Raw Data Empire Wind must store the raw data from all avian and bat surveys and monitoring activities according to accepted archiving practices. Such data must remain accessible to the BOEM, BSEE and the Service, upon request for the duration of the lease. Empire Wind must work with the BOEM to ensure the data are publicly available. All avian tracking data (i.e., from radio and satellite transmitters) will be stored, managed, and made available to the BOEM, BSEE and the Service following the protocols and procedures outlined in the agency document entitled Guidance for Coordination of Data from Avian Tracking Studies, or its successor		
2	C, O&M, D	Incidental Mortality Reporting	Empire Wind must provide an annual report to the BOEM, BSEE and the Service documenting any dead (or injured) birds or bats found on vessels and structures during construction, operations, and decommissioning. The report must contain the following information: the name of species, date found, location, a picture to confirm species identity (if possible), and any other relevant information. Carcasses with federal or research bands must be reported to the USGS Bird Band Laboratory, available at https://www.pwrc.usgs.gov/BBL/bblretrv/. Incidental observations are extremely unlikely to document any fatalities of listed birds that may occur due to turbine collision. While this Conservation Measure appropriately requires documentation and reporting of any fatalities observed incidental to O&M activities, the ABPCMP will make clear that lack of documented fatalities in no way suggests that fatalities are not occurring. Likewise, the agencies will not presume that any documented fatalities were caused by colliding with a turbine unless there is evidence to support this conclusion. Any occurrence of a dead or injured ESA-listed bird or bat must be reported to the BOEM, BSEE, and Service as soon as practicable (taking into account crew and vessel safety), but no later than 72 hours after the sighting, and, if practicable, the dead specimen will be carefully collected and preserved in the best possible state (BOEM 2022b, Table 9, Measure 3). The BOEM will coordinate with the Service on procedures and required permits for processing and handling specimens.	Birds	BOEM, BSEE, and USFWS
3	O&M	Collision Risk Model Support	BOEM has funded the development of a Stochastic Collision Risk Assessment for Movement (SCRAM), which builds on and improves earlier collision risk modeling frameworks. The Service fully supports SCRAM as a scientifically sound method for integrating best available information to assess collision risk for the two listed bird species. The first generation of SCRAM was released in early 2023 and still reflects a number of consequential data gaps and uncertainties. BOEM has already committed to	Birds	BOEM, BSEE, and USFWS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			funding Phase 2 of the development of SCRAM. We expect that the current limitations of SCRAM will decrease substantially over time as more and more tracking data get incorporated into the model (e.g., from more individual birds, additional geographic areas, improved bird tracking capabilities, and emerging tracking technologies), and as modeling methods and computing power continue to improve. Via this measure, BOEM commits to continue funding the refinement and advancement of SCRAM, or its successor, with the goal of continually improving the accuracy and robustness of collision mortality estimates. This commitment is subject to the allocation of sufficient funds to BOEM from Congress. This commitment will remain in effect until one of the following occurs: i. the EW 1 and EW 2 turbines cease operation; ii. the Service concurs that a robust weight of evidence has demonstrated that collision risks to all two listed birds from EW 1 and EW 2 turbine operation are negligible (i.e., the risk of take from WTG operation is discountable); or iii. the Service concurs that further development of SCRAM (or its successor) is unlikely to improve the accuracy or robustness of collision mortality estimates.		
4	O&M	Collision Risk Model Utilization	BOEM will work cooperatively with the Service to re-run the SCRAM model (or its successor) for the EW 1 and EW 2 projects according to the following schedule: • At least annually for the first 3 years of WTG operation. • At least every other year for years 4 to 10 of WTG operation (i.e., years 4, 6, 8, and 10). • At least every 5 years between year 10 and the termination of WTG operation (i.e., years 15, 20, and 25 [and beyond if the lease is extended]). Between these regularly scheduled model runs, BOEM will also re-run the SCRAM and Band (2012) models (or its successor) within 90 days of each major model release or update, and at any time upon request by the Service or Empire Wind, and at any time as desired by BOEM. Based on these periodic updates of estimated collision rates, the incidental take statement accompanying this BO will be revised as necessary and appropriate. The above schedule may be altered upon the mutual agreement of BOEM and the Service. The schedule is subject to sufficient allocation of funds to BOEM from Congress. This commitment will remain in effect until one of the following occurs: i. the EW 1 and EW 2 turbines cease operation; ii. the Service concurs that a robust weight of evidence has demonstrated that collision risks to both listed birds from Ew 1 and EW 2 turbine operation are negligible (i.e., the risk of take from WTG operation is discountable); or iii. the Service concurs that further model runs are unlikely to improve the accuracy or robustness of collision mortality estimates. BOEM is currently undertaking a regional environmental assessment of numerous offshore wind leases in the New York Bight, including some leases contiguous with EW 1 and EW 2 Lease Area OCS-A 0512. To account for potential additive and synergistic effects of offshore wind infrastructure buildout across this section of the coast, BOEM will consider collision mortality estimates for EW 1 and EW 2 projects in its assessment of overall collision risk for the New York Bight. The periodic updating of collision mortality estimates for the EW 1 and EW 2 projects, according to the above schedule, may eventually be integrated into a regional or coastwide adaptive monitoring and impact minimization framework.	Birds	BOEM, BSEE, and USFWS
5	O&M	Compensatory Mitigation	To minimize population-level effects on listed birds, the BOEM will require Empire Wind to provide appropriate compensatory mitigation as needed to offset projected levels of take of listed birds from WTG collision. Compensatory mitigation will be consistent with the conservation needs of listed species as identified in Service documents including, but not limited to, listing documents, Species Status Assessments, Recovery Plans, Recovery Implementation Strategies (RISs), and 5-Year Reviews. Compensatory mitigation will preferentially address priority actions, activities, or tasks identified in a Recovery Plan, RIS, or 5-Year Review, for piping plover and rufa red knot; however, research, monitoring, outreach, and other recovery efforts that do not materially offset birds lost to collision mortality will not be considered compensatory mitigation. Compensatory mitigation may include, but is not limited to: restoration or management of lands, waters, sediment, vegetation, or prey species to improve habitat quality or quantity for listed birds; efforts to facilitate habitat migration or otherwise adapt to sea level rise; predator management; management of human activities to reduce disturbance to listed birds; and efforts to curtail other sources of direct human-caused bird mortality such as from vehicles, collision with other structures (e.g., power lines, terrestrial wind turbines), hunting, oil spills, and harmful algal blooms. Geographic considerations may include but are not limited to: (a) any listed species recovery unit(s) or other management unit(s) determined to be disproportionally affected by or	Birds	BOEM, BSEE, and USFWS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			vulnerable to collision mortality; and/or (b) those portions of a species' range where compensatory mitigation is most likely to be effective in offsetting collision mortality. Compensatory mitigation for the EW1 and EW2 projects may be combined with mitigation associated with other offshore wind projects, but in no case will compensatory mitigation be double counted as applying to more than one offshore wind project. BOEM will require Empire Wind to prepare a Compensatory Mitigation Plan (Plan) prior to the start of WTG operation. At a minimum, the Plan will provide compensatory mitigation actions to offset projected levels of take of listed birds for the first 5 years of WTG operation at a ratio of 1:1. At its discretion, Empire Wind may include actions to offset projected take over a longer time period and/or at a higher ratio. The Plan will include: a. detailed description of one or more specific mitigation actions; b. the specific location for each action; c. a timeline for completion; d. itemized costs; e. a list of necessary permits, approvals, and permissions; f. details of the mitigation mechanism (e.g., mitigation agreement, applicant-proposed mitigation); g. best available science linking the compensatory mitigation action(s) to the projected level of collision mortality as described in this Opinion; h. a schedule for completion; and i. monitoring to ensure the effectiveness of the action(s) in offsetting the target level of take Plan development and implementation will occur according to the following schedule: • At least 180 days before the start of WTG operation Empire Wind will distribute a draft Plan to the BOEM, BSEE and the Service, the appropriate state agencies, and other identified stakeholders or interested parties for a 60-day review period. • At least 90 days before the start of WTG operation, Empire Wind will transmit a revised Plan for approval by the BOEM, BSEE, and the Service, along with a record of comments received on the draft. Empire Wind will rectify any outstanding agency comments or concerns before final approval by the BOEM, BSEE and the Service. • Before or concurrent with the start of WTG operation, Empire Wind will provide documentation to the BOEM, BSEE and the Service showing financial, legal, or other binding commitment(s) to Plan implementation. The BOEM will require Empire Wind to prepare and implement a new Plan every 5 years for the life of the project, according to a schedule developed by the BOEM and approved by the Service. Compensatory mitigation actions included in each new Plan will reflect: a. the level and effectiveness of mitigation previously provided by Empire Wind, to date; b. the level of take over the next 5 years as projected by SCRAM (or its successor) (see D. Collision Risk Model Utilization above); c. current information regarding any effects of offshore lighting (see Section III); and d. the effectiveness of any minimization measures that have been implemented as required by the reasonable and prudent measures included in this Opinion		
6	C, O&M, D	Collision Mitigation Coordination	Mitigation Assessments: At least annually, and as detailed below, the BOEM, BSEE, the Service, and Empire Wind will work together to assess the minimization of, and compensatory mitigation for, collisions of listed birds with the EW1 and EW2 turbines. Appropriate state agencies will also be invited to participate in these mitigation assessments. The first mitigation assessment will occur during the EW1 and EW2 construction phase, prior to the start of WTG operation. Subsequent mitigation assessments will be held concurrent with or shortly after the annual monitoring data review. Additional mitigation assessments (addressing minimization and/or compensatory mitigation) may be carried out at any time upon request by the BOEM, BSEE, the Service, appropriate state agencies, or Empire Wind based on substantive new information or changed circumstances. These periodic mitigation assessments for EW1 and EW2 may eventually be integrated into a regional or coastwide adaptive monitoring and impact minimization framework. Minimization: The BOEM will work with the Service, BSEE, appropriate state agencies, and Empire Wind to annually review the best available information regarding technologies and methods for minimizing collision risk to listed species, including but not	Birds	BOEM, BSEE, and USFWS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			limited to: WTG coloration/marking, lighting, avian deterrents, and limited WTG operational changes. The BOEM will require Empire Wind to adopt and deploy such minimization technologies/methods as deemed reasonable and prudent as per the minor change rule [50 CFR §402.14] under the ESA. Operational changes may include, but are not limited to, feathering, which involves adjusting the angle of the blades to slow or stop them from turning under certain conditions. The BOEM will specify the timeframe in which any required minimization measure(s) must be implemented, as well as any requirements to monitor, maintain, or adapt the measure(s) over time.		
Reasonable and Prudent Measures from the USFWS Biological Opinion Issued June 23, 2023					
1	O&M	Reasonable and prudent measure	Periodically review current technologies and methods for minimizing collision risk of listed birds, including but not limited to: WTG coloration/marking, lighting, avian deterrents, and limited WTG operational changes. Operational changes may include, but are not limited to, feathering, which involves adjusting the angle of the blades to slow or stop them from turning under certain conditions.	Birds	BOEM, BSEE, and USFWS
2	O&M	Reasonable and prudent measure	Implement those technologies and methods deemed reasonable and prudent.	Birds	BOEM, BSEE, and USFWS
Terms and Conditions from the USFWS Biological Opinion Issued June 23, 2023					
1	Pre-O&M and O&M	Collision Minimization Report	Periodically review current technologies and methods for minimizing collision risk of listed birds. a) Prior to the commissioning of WTG operations at EW 1 and EW 2, BOEM must extract from existing project documentation (e.g., the BA, other consultation documents, the final EIS, the COP) a stand-alone summary of technologies and methods that were evaluated by BOEM to reduce or minimize bird collisions at the EW1 and EW 2 WTGs. b) Within 5 years of the start of WTG operation, and then every 5 years for the life of the project, BOEM must prepare a Collision Minimization Report, reviewing best available scientific and commercial data on technologies and methods that have been implemented, or are being studied, to reduce or minimize bird collisions at WTGs. The review must be global in scope and include both offshore and onshore WTGs. c) BOEM must distribute a draft Collision Minimization Report to the Service, Empire Wind, and appropriate state agecies for a 60-day review period. BOEM must address all comments received during the review period and issue the final report within 60 days of the close of the review period. d) Within 60 days of issuing the final Collision Minimization Report, BOEM must convene a meeting with BSEE, the Service and Empire Wind. Meeting participants will discuss the report and seek consensus on whether implementation of any technologies/methods are reasonable and prudent. However, if consensus cannot be reached, the Service will make the final determination of whether any minimization measures are reasonable and prudent (i.e., necessary or appropriate to minimize the amount or extent of incidental take), after considering input from BOEM, BSEE, Empire Wind, and appropriate state agencies.	Birds	BOEM, BSEE, and USFWS
2	O&M	Implementation of Collision Minimization Technologies/Methods	Implement those technologies and methods deemed reasonable and prudent. a) BOEM will require Empire Wind to adopt and deploy such minimization technologies/methods as deemed reasonable and prudent. BOEM will specify the Service-approved timeframe in which any required minimization measure(s) must be implemented, as well as any requirements to monitor, maintain, or adapt the measure(s) over time. b) BOEM will require Empire Wind to provide periodic reporting on the implementation of any minimization measure(s) according to a schedule developed by BOEM and approved by the Service.	Birds	BOEM, BSEE, and USFWS
Draft Reasonable and Prudent Measures for the NMFS Biological Opinion (August 23, 2023)					
1	C	Pile Driving	Effects to ESA listed species must be minimized during pile driving.	ESA-listed marine mammals, sea turtles, fish	BOEM, BSEE, and NMFS
2	C, O&M, D	Reporting Requirements	Effects to, or interactions with, ESA listed Atlantic sturgeon, whales, and sea turtles must be documented during all phases of the proposed action, and all incidental take must be reported to NMFS GARFO.	ESA-listed marine mammals, sea turtles, fish	BOEM, BSEE, and NMFS
3	C	Review of Plans	All required plans must be submitted to NMFS GARFO with sufficient time for review, comment, and concurrence.	ESA-listed marine mammals, sea turtles, fish	BOEM, BSEE, and NMFS
4	C, O&M, D	Enforcement	BOEM and BSEE must exercise their authorities to assess and ensure compliance with the implementation of measures to avoid, minimize, and monitor, and report incidental take of ESA listed species during activities described in this Opinion. On-site observation and inspection must be allowed to gather information on the implementation of measures, and the effectiveness of	ESA-listed marine mammals, sea turtles, fish	BOEM, BSEE, and NMFS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			those measures, to minimize and monitor incidental take during activities described in this Opinion, including its Incidental Take Statement.		
Draft Terms and Conditions for the NMFS Biological Opinion (August 23, 2023)					
1	C	Compliance with final MMPA ITA	1. To implement the requirements of RPM 1 and 2 for ESA listed whales, to the extent that the final MMPA ITA requires additional or modified measures from those in the proposed ITA (which are incorporated into the proposed action) to minimize effects of pile driving on ESA listed whales, Empire Wind must comply with those measures. To facilitate implementation of this requirement: a. BOEM must require, through an enforceable condition of their approval of Empire Wind's Construction and Operations Plan, that Empire Wind comply with any measures in the final MMPA ITA that are revised from, or in addition to, measures included in the proposed ITA, which already have been incorporated into the proposed action. b. NMFS OPR must ensure compliance with all mitigation measures as prescribed in the final ITA. We expect this will be carried out through NMFS OPR's review of plans and monitoring reports, including interim and final SFV reports, submitted by Empire Wind over the life of the MMPA ITA and taking any responsive action within its statutory and regulatory authority it deems necessary to ensure compliance based on the foregoing review. c. The USACE must review the final MMPA ITA as issued by NMFS OPR and determine if an amendment or revision is necessary to the permit issued to Empire Wind by USACE to incorporate any new or revised measures for pile driving or related activities addressed in the USACE permit, to ensure compliance with any measures in the final MMPA ITA that are revised from, or in addition to, measures included in the proposed ITA, which have been incorporated into the proposed action; and, if necessary, exercise its regulatory authority to make appropriate amendments or revisions.	ESA-listed marine mammals, sea turtles, fish	BOEM, BSEE, and NMFS
2	C	Sound Field Verification	2. To implement the requirements of RPM 1, the following measures must be implemented by Empire Wind: a. Consistent with the measures incorporated into the proposed action, Empire Wind must implement Sound Field Verification (SFV) on at least the first three monopiles installed (see also T&C 11.e. below). If any of the SFV measurements from any pile indicate that the distance to any isopleth of concern is greater than those modeled assuming 10 dB attenuation, before the next pile is installed Empire Wind must: i. Identify additional noise attenuation measures that are expected to reduce sound levels to the modeled distances (e.g., add noise attenuation device, adjust hammer operations, adjust noise mitigation system [NMS]); provide an explanation to NMFS GARFO and NMFS OPR supporting that determination; and, following NMFS GARFO's concurrence, deploy those additional measures on any subsequent piles that are installed (e.g., if threshold distances are exceeded on pile 1 then additional measures must be deployed before installing pile 2). ii. If any of the SFV measurements indicate that the distances to level A thresholds for ESA listed whales or PTS peak or cumulative thresholds for sea turtles are greater than the modeled distances (assuming 10 dB attenuation), the clearance and shutdown zones (Table 11.1) for subsequent piles must be increased so that they are at least the size of the distances to those thresholds as indicated by SFV (e.g., if threshold distances are exceeded on pile 1 then the clearance and shutdown zones for pile 2 must be expanded). For every 1,500 m that a marine mammal clearance or shutdown zone is expanded, additional PSOs must be deployed from additional platforms to ensure adequate and complete monitoring of the expanded shutdown and/or clearance zone; Empire Wind must submit a proposed monitoring plan describing the location of all PSOs for concurrence by NMFS GARFO. In the event that the clearance or shutdown zone for sea turtles needs to be expanded, Empire Wind must submit a proposed monitoring plan for the expanded zones to NMFS GARFO for concurrence. iii. If after implementation of 2.a.i, any subsequent SFV measurements are still greater than those modeled assuming 10 dB attenuation, Empire Wind must identify an additional noise attenuation device or devices (e.g., additional bubble curtain) and/or modifications to the pile driving operations (e.g., reduced hammer energy) that are expected to reduce noise and reduce the distance to thresholds of concern to no greater than the modeled distances (assuming 10 dB attenuation). Empire Wind must provide an explanation to NMFS GARFO and NMFS OPR supporting that determination and, following concurrence from NMFS GARFO, deploy those additional noise attenuation measures and/or modifications to pile driving operations on any subsequent piles that are installed (e.g., if threshold distances are still exceeded on pile 2 the additional measures must be deployed for pile 3). Clearance and shutdown zones must be expanded consistent with the requirements of 2.b.ii.	ESA-listed marine mammals, sea turtles, fish	BOEM, BSEE, and NMFS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			iv. Following installation of the pile with additional noise attenuation measures required by 2.a.iii, if SFV results indicate that any isopleths of concern are still greater than those modeled assuming 10 dB attenuation, before any additional piles can be installed, Empire Wind must identify an additional noise attenuation device or devices and/or modifications to the pile driving operations that are expected to reduce noise and reduce the distance to thresholds of concern to no greater than the modeled distances (assuming 10 dB attenuation). Following concurrence from NMFS GARFO, Empire Wind must implement those measures and any expanded clearance and shutdown zone sizes (and any required additional PSOs) consistent with the requirements of 2.b.ii. Additionally, Empire Wind must continue SFV for two additional piles with enhanced sound attenuation measures and submit the interim reports as required above (for a total of at least three piles with consistent noise attenuation measures). 1. If no additional measures are identified for implementation, or if the SFV required by 2.a.iv indicates that the distance to any isopleths of concerns for any ESA listed species are still greater than those modeled assuming 10 dB attenuation, NMFS GARFO will presume that reinitiation of consultation is necessary, consistent with 50 CFR 402.16(a)(2) and/or (a)(3). NMFS GARFO, NMFS OPR, BOEM, BSEE, and USACE will meet as soon as possible following completion of the SFV required here (with the goal of meeting within one week of the results being available) to discuss the results and the process for reinitiation of this consultation based on the requirements of 50 CFR 402.16. v. Following installation of the pile with additional noise attenuation measures required by 2.a.iii, if SFV results indicate that all isopleths of concern are within distances to isopleths of concern modeled assuming 10 dB attenuation, SFV must be conducted on two additional piles (for a total of at least three piles with consistent noise attenuation measures). If the SFV results from all three of those piles are within the distances to isopleths of concern modeled assuming 10 dB attenuation, then Empire Wind must continue to implement the additional sound attenuation measures and upon NMFS GARFO concurrence can revert to the original clearance and shutdown zones (Table 11.1) or continue with the expanded clearance and shutdown zones with additional PSOs. b. Consistent with the measures incorporated into the proposed action, Empire Wind must implement Sound Field Verification (SFV) on all piles associated with installation of the first OSS foundation (see also T&C 11.e. below). If any of the SFV measurements from the OSS foundation installation indicate that the distance to any isopleth of concern is larger than those modeled assuming 10 dB attenuation, before the second OSS foundation is installed Empire Wind must: i. Identify additional noise attenuation measures that are expected to reduce sound levels to the modeled distances (e.g., add noise attenuation device, adjust hammer operations, adjust noise mitigation system [NMS]); provide an explanation to NMFS GARFO and NMFS OPR supporting that determination; and, following concurrence from NMFS GARFO deploy those additional measures for the second OSS foundation. Additionally, SFV must be carried out for the second OSS foundation. ii. If any of the SFV measurements indicate that the distances to level A thresholds for ESA listed whales or PTS peak or cumulative thresholds for sea turtles are larger than the modeled distances (assuming 10 dB attenuation), the clearance and shutdown zones (see Table 11.1) for the second OSS foundation must be increased so that they are at least the size of the distances to those thresholds as indicated by SFV. For every 1,500 m that a marine mammal clearance or shutdown zone is expanded, additional PSOs must be deployed from additional platforms to ensure adequate and complete monitoring of the expanded shutdown and/or clearance zone; Empire Wind must submit a proposed monitoring plan describing the location of all PSOs for approval by NMFS GARFO. In the event that the clearance or shutdown zone for sea turtles needs to be expanded, Empire Wind must submit a proposed monitoring plan for the expanded zones to NMFS GARFO for concurrence. c. Empire Wind must submit a Noise Attenuation System (NAS) inspection/performance report to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) within 72 hours of the performance test, which must occur prior to the first pile installation as well as any additional piles for which SFV is conducted. This report must be submitted as soon as it is available, but no later than when the interim SFV report is submitted for the respective pile.		
3	C	Shutdown Zone	3. To implement the requirements of RPM 2, Empire Wind must file a report with NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) and BSEE (protectedspecies@bsee.gov) in the event that any ESA listed species is observed within the identified shutdown zone during active pile driving. This report must be filed within 48 hours of the incident and include the following: duration of pile driving prior to the detection of the animal(s), location of PSOs and any factors that impaired	ESA-listed marine mammals, sea turtles, fish	BOEM, BSEE, and NMFS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			visibility or detection ability, time of first and last detection of the animal(s), distance of animal at first detection, closest point of approach of animal to pile, behavioral observations of the animal(s), time the PSO called for shutdown, hammer log (number of strikes, hammer energy), time the pile driving began and stopped, and any measures implemented (e.g., reduced hammer energy) prior to shutdown. If shutdown was determined not to be feasible, the report must include an explanation for that determination and the measures that were implemented (e.g., reduced hammer energy).		
4	C, O&M, D	Reporting Requirements	4. To implement the requirements of RPM 2, BOEM, BSEE, USACE, and Empire Wind must implement the following reporting requirements necessary to document the amount or extent of incidental take that occurs during all phases of the proposed action: a. All observations or interactions with sea turtles or sturgeon that occur during the fisheries monitoring surveys must be reported within 48 hours to NMFS GARFO Protected Resources Division by email (nmfs.gar.incidental-take@noaa.gov). Take reports should reference the Empire Wind project and include the Take Report Form available on NMFS webpage (https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null). Reports of Atlantic sturgeon take must include a statement as to whether a fin clip sample for genetic sampling was taken. Fin clip samples are required in all cases to document the DPS of origin; the only exception to this requirement is when additional handling of the sturgeon would result in an imminent risk of injury to the fish or the survey personnel handling the fish, we expect such incidents to be limited to capture and handling of sturgeon in extreme weather. Instructions for fin clips and associated metadata are available at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics-greater-atlantic, under the “Sturgeon Genetics Sampling” heading. b. If a North Atlantic right whale is observed at any time by PSOs or project personnel, Empire Wind must ensure the sighting is immediately reported to NMFS. If immediate reporting is not possible, the report must be made within 24 hours of the sighting. i. The report must be made to the appropriate geographic reporting line: ● If in the Northeast Region (ME to VA/NC border) call (866-755-6622). ● If in the Southeast Region (NC to FL) call (877-WHALE-HELP or 877-942-5343). ● If calling the hotline is not possible, reports can also be made to the U.S. Coast Guard via channel 16 or through the WhaleAlert app (http://www.whalealert.org/). The sighting report must include the time (note time format, e.g., UTC, EST), date, and location (latitude/longitude in decimal degrees) of the sighting, number of whales, animal description/certainty of sighting (provide photos/video if taken), lease area/project name, PSO/personnel name, PSO provider company (if applicable), and reporter’s contact information. ii. If a North Atlantic right whale is detected at any time by PSOs/PAM Operators via PAM, Empire Wind must ensure the detection is reported as soon as possible and no longer than 24 hours after the detection to NMFS via the 24-hour North Atlantic right whale Detection Template (https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates). Calling the hotline is not necessary when reporting PAM detections via the template. iii. A summary report must be sent within 24 hours to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov),NMFS OPR (PR.ITP.MonitoringReports@noaa.gov), and NMFS-NEFSC (ne.rw.survey@noaa.gov) with the above information and confirmation the sighting/detection was reported to the respective hotline, the vessel/platform from which the sighting/detection was made, activity the vessel/platform was engaged in at time of sighting/detection, project construction and/or survey activity ongoing at time of sighting/detection (e.g., pile driving, cable installation, HRG survey), distance from vessel/platform to animal at time of initial sighting/detection, closest point of approach of whale to vessel/platform, vessel speed, and any mitigation actions taken in response to the sighting. c. In the event of a suspected or confirmed vessel strike of any ESA listed species, including a sea turtle or sturgeon, by any project vessel in any location, including the sighting/observation of any injured sea turtle/sturgeon or sea turtle/sturgeon parts, Empire Wind or their contractors must report the incident or sighting to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov; for marine mammals to the NOAA stranding hotline: Maine-Virginia, report to 866-755-6622, and from North Carolina-Florida to 877-942-5343 and for sea turtles from Maine-Virginia, report to 866-755-6622, and from North Caroline-Florida to 844-732-8785, as well as BSEE (protectedspecies@bsee.gov) as soon as feasible. The report must include the following information: (A) Time (note time format), date, and location	ESA-listed marine mammals, sea turtles, fish	

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			(latitude/longitude in decimal degrees) of the incident; (B) Species identification (if known) or description of the animal(s) involved; (C) Vessel's speed during and leading up to the incident; (D) Vessel's course/heading and what operations were being conducted (if applicable); (E) Status of all sound sources in use (if applicable); (F) Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike; (G) Environmental conditions (e.g., wind speed and direction, Beaufort scale, cloud cover, visibility) immediately preceding the strike; (H) Estimated size and length of animal that was struck; (I) Description of the behavior of the animal immediately preceding and following the strike; (J) Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and (K) To the extent practicable, photographs or video footage of the animal. d. In the event that an injured or dead whale, sea turtle, or Atlantic sturgeon is sighted, Empire Wind or their contractor must report the incident to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov). Additionally, injured or dead whales must be reported to the NOAA stranding hotline: Maine-Virginia, report to 866755-6622, and from North Carolina-Florida to 877-942-5343 and for sea turtles from Maine-Virginia, report to 866-755-6622, and from North Caroline-Florida to 844-732-8785, and BSEE (protectedspecies@bsee.gov) as soon as feasible, but no later than 24 hours from the sighting. The report must include the following information: (A) Time (note time format), date, and location (latitude/longitude in decimal degrees) of the first discovery (and updated location information if known and applicable); (B) Species identification (if known) or description of the animal(s) involved; (C) Condition of the animal(s) (including carcass condition if the animal is dead); (D) Observed behaviors of the animal(s), if alive; (E) If available, photographs or video footage of the animal(s); and (F) General circumstances under which the animal was discovered. Staff responding to the hotline call will provide any instructions for handling or disposing of any injured or dead animals, which may include coordination of transport to shore, particularly for injured sea turtles. e. Empire Wind must compile and submit weekly reports during pile driving that document the pile ID, type of pile, pile diameter, start and finish time of each pile driving event, hammer log (number of strikes, max hammer energy, duration of piling) per pile, any changes to noise attenuation systems and/or hammer schedule, details on the deployment of PSOs and PAM operators, including the start and stop time of associated observation periods by the PSOs and PAM Operators, and a record of all observations/detections of marine mammals and sea turtles including time (UTC) of sighting/detection, species ID, behavior, distance (meters) from vessel to animal at time of sighting/detection (meters), animal distance (meters) from pile installation vessel, vessel/project activity at time of sighting/detection, platform/vessel name, and mitigation measures taken (if any) and reason. Sightings/detections during pile driving activities (clearance, active pile driving, post-pile driving) and all other (transit, opportunistic, etc.) sightings/detection must be reported and identified as such. These weekly reports must be submitted to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov), BOEM, and BSEE by Empire Wind or the PSO providers and can consist of QA/QC'd raw data. Weekly reports are due on Wednesday for the activities occurring the previous week (Sunday – Saturday, local time). f. Starting in the first month that in-water activities occur (e.g., cofferdam installation, fisheries surveys), Empire Wind must compile and submit monthly reports that include a summary of all project activities carried out in the previous month, including dates and location of any fisheries surveys carried out, vessel transits (name, type of vessel, number of transits, vessel activity, and route (origin and destination) (this includes transits from all ports, foreign and domestic)), and number of piles installed and pile IDs, and all sightings/detections of ESA listed whales, sea turtles, and sturgeon, inclusive of any mitigation measures taken as a result of those observations. Sightings/detections must include species ID, time, date, initial detection distance, vessel/platform name, vessel activity, vessel speed, bearing to animal, project activity, and if any mitigation measures taken. These reports must be submitted to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) and are due on the 15th of the month for the previous month. g. Empire Wind must submit to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) an annual report describing all activities carried out to implement their Fisheries Research and Monitoring Plan. This report must include a summary of all activities conducted, the dates and locations of all fisheries surveys, including location and duration for all trawl surveys summarized by month, number of vessel transits inclusive of port of origin and destination, and a summary table of any observations and captures of ESA listed species during these surveys. The report must also summarize all acoustic telemetry and benthic monitoring activities that occurred, inclusive of vessel transits. Each annual report is due by February 15 (i.e., the report for 2024 activities is due by February 15, 2025).		

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
5	O&M	BOEM/NMFS meeting requirements for sea turtle take documentation	5. To implement the requirements of RPM 2 and to facilitate monitoring of the incidental take exemption for sea turtles, BOEM, BSEE, USACE, and NMFS must meet twice annually to review sea turtle observation records. These meetings/conference calls will be held in September (to review observations through August of that year) and December (to review observations from September to November) and will use the best available information on sea turtle presence, distribution, and abundance, project vessel activity, and observations to estimate the total number of sea turtle vessel strikes in the action area that are attributable to project operations.	ESA-listed sea turtles	BOEM, BSEE, and NMFS
6	C	Review of Plans	6. To implement RPM 2, within 10 business days of BSEE issuing a no objection to the complete Facility Design Report (FDR)/Fabrication and Installation Report (FIR) (or the soonest time the relevant information is available (but at least 30 calendar days prior to the initiation of pile driving), BOEM and/or BSEE must provide NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) with the following information: number and size of foundations to be installed to support wind turbine generators and offshore substations, installation method for the sea to shore transition (i.e., casing pipe, cofferdam, no containment), the proposed construction schedule (i.e., months when pile driving is planned), and information that has become available on the ports identified for foundation fabrication and load out, WTG pre-assembly and load out, and cable staging. If at that time the amount or extent of incidental take is likely to exceed the maximum amount for each source and type of take considered in this ITS, consultation may need to be reinitiated. NMFS and BOEM will each endeavor to notify the other of the need to reinitiate consultation within 30 calendar days of BOEM's submission to NMFS, and NMFS' receipt of the requested information.	ESA-listed marine mammals, sea turtles, fish	BOEM, BSEE, and NMFS
7	C	Northeast Fisheries Observer Program (NEFOP) training	7. To implement RPM 3 for trawl surveys: a. At least one of the survey staff onboard the trawl survey vessels must have completed NMFS Northeast Fisheries Observer Program (NEFOP) training within the last 5 years or other training in protected species identification and safe handling (inclusive of taking genetic samples from Atlantic sturgeon); documentation of training must be submitted to NMFS GARFO at least 7 calendar days prior to the start of the trawl surveys and at any later time that a different NEFOP trained observer is deployed on the survey. b. If Empire Wind will deploy non-NEFOP trained survey personnel in lieu of NEFOP-trained observers, BOEM, BSEE, and/or Empire Wind must submit a plan to NMFS describing the training that will be provided to those survey observers. This Observer Training Plan for Trawl Surveys must be submitted as soon as possible after issuance of this Opinion but no later than 15 calendar days prior to the start of trawl surveys for which a non-NEFOP trained observer will be deployed. BOEM, BSEE, and Empire Wind must obtain NMFS GARFO's concurrence with this plan prior to the start of any such trawl surveys. This plan must include a description of the elements of the training (i.e., curriculum, virtual or hands on, etc.) and identify who will carry out the training and their qualifications. Once the training is complete, confirmation of the training and a list of trained survey staff must be submitted to NMFS; this list must be updated if additional staff are trained for future surveys. In all cases, a list of trained survey staff must be submitted to NMFS at least one business day prior to the beginning of the survey.	ESA-listed marine mammals, sea turtles, fish	BOEM, BSEE, and NMFS
8	C	Review of Plans	8. To implement RPM 3, the plans identified below must be submitted to NMFS GARFO at nmfs.gar.incidental-take@noaa.gov by BOEM, BSEE, and/or Empire Wind. For each plan, within 45 calendar days of receipt of the plan, NMFS GARFO will provide comments to BOEM, BSEE, and Empire Wind, including a determination as to whether the plan is consistent with the requirements outlined in this ITS and/or in Section 3 of this Opinion. If the plan is determined to be inconsistent with these requirements, BOEM, BSEE and/or Empire Wind must resubmit a modified plan that addresses the identified issues within 30 days of the receipt of the comments but at least 15 calendar days before the start of the associated activity; at that time, BOEM, BSEE and NMFS GARFO and OPR will discuss a timeline for review and approval of the modified plan. If further revisions are necessary, at all times, NMFS GARFO, BOEM, and BSEE will be provided at least three business days for review and whenever possible, NMFS GARFO, BOEM, and BSEE will aim to provide responses within four business days. BOEM, BSEE and Empire Wind must receive NMFS GARFO's concurrence with these plans before the identified activity is carried out: a. Passive Acoustic Monitoring Plan for Pile Driving. BOEM, BSEE, and/or Empire Wind must submit this Plan to NMFS GARFO at least 180 calendar days before impact pile driving is planned. BOEM, BSEE, and Empire Wind must obtain NMFS GARFO's concurrence with this Plan prior to the start of any pile driving. The Plan must include a description of all proposed PAM equipment and hardware, the calibration data, bandwidth capability and sensitivity of hydrophones, and address how the proposed passive acoustic monitoring will follow standardized measurement, processing methods, reporting metrics, and metadata standards for offshore wind (Van Parijs *et al.,* 2021). The Plan must describe and include all procedures, documentation, and protocols including information (i.e., testing, reports, equipment	ESA-listed marine mammals, sea turtles, fish	BOEM, BSEE, and NMFS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			specifications) to support that it will be able to detect vocalizing whales within the clearance and shutdown zones, including deployment locations, procedures, detection review methodology, and protocols; hydrophone detection ranges with and without foundation installation activities and data supporting those ranges; communication time between call and detection, and data transmission rates between PAM Operator and PSOs on the pile driving vessel; where PAM Operators will be stationed relative to hydrophones and PSOs on pile driving vessel calling for delay/shutdowns; and a full description of all proposed software, call detectors, and filters. The Plan must also incorporate the requirements relative to North Atlantic right whale reporting in 6.b. b. BOEM, BSEE, and/or Empire Wind must submit full detection data, metadata, and location of recorders (or GPS tracks, if applicable) from all real-time hydrophones used for monitoring during construction within 90 calendar days after pile-driving has ended and instruments have been pulled from the water. Reporting must use the webform templates on the NMFS Passive Acoustic Reporting System website at *https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates*. BOEM, BSEE, and/or Empire Wind must submit the full acoustic recordings from all the real-time hydrophones to the National Centers for Environmental Information (NCEI) for archiving within 90 calendar days after pile-driving has ended and instruments have been pulled from the water. Confirmation of both submittals must be sent to NMFS GARFO. c. Marine Mammal and Sea Turtle Monitoring Plan – Pile Driving. BOEM, BSEE, and/or Empire Wind must submit this Plan to NMFS GARFO at least 180 calendar days before any pile driving for foundation installation is planned. BOEM, BSEE, and/or Empire Wind must obtain NMFS GARFO's concurrence with this Plan(s) prior to the start of any pile driving for foundation installation. The Plan(s) must include: a description of how all relevant mitigation and monitoring requirements contained in the incidental take statement will be implemented, a pile driving installation summary and sequence of events, a description of all training protocols for all project personnel (PSOs, PAM Operators, trained crew lookouts, etc.), a description of all monitoring equipment and evidence (i.e., manufacturer's specifications, reports, testing) that it can be used to effectively monitor and detect ESA listed marine mammals and sea turtles in the identified clearance and shutdown zones (i.e., field data demonstrating reliable and consistent ability to detect ESA listed large whales and sea turtles at the relevant distances in the conditions planned for use), communications and reporting details, and PSO monitoring and mitigation protocols (including number and location of PSOs) for effective observation and documentation of sea turtles and ESA listed marine mammals during all pile driving events. The Plan(s) must demonstrate sufficient PSO and PAM Operator staffing (in accordance with watch shifts), PSO and PAM Operator schedules, and contingency plans for instances if additional PSOs and PAM Operators are required. The Plan must detail all plans and procedures for sound attenuation, including procedures for adjusting the noise attenuation system(s) and available contingency noise attenuation measures/systems if distances to modeled isopleths of concern are exceeded during SFV. The plan must also describe how Empire Wind would determine the number of sea turtles exposed to noise above the 175 dB harassment threshold during impact pile driving of WTG and OSS foundations and how Empire Wind would determine the number of ESA listed whales exposed to noise above the Level B harassment threshold during impact pile driving of WTG and OSS foundations. d. Reduced Visibility Monitoring Plan/Nighttime Pile Driving Monitoring Plan. BOEM, BSEE, and/or Empire Wind must submit this Plan or Plans (if separate Daytime Reduced Visibility and Nighttime Monitoring Plans are prepared) to NMFS GARFO at least 180 calendar days before impact pile driving is planned to begin. BOEM, BSEE, and Empire Wind must obtain NMFS GARFO's concurrence with this Plan(s) prior to the start of pile driving. This Plan(s) must contain a thorough description of how Empire Wind will monitor pile driving activities during reduced visibility conditions (e.g. rain, fog) and at night, including proof of the efficacy of monitoring devices (e.g., mounted thermal/infrared camera systems, hand-held or wearable night vision devices NVDs, spotlights) in detecting ESA listed marine mammals and sea turtles over the full extent of the required clearance and shutdown zones, including demonstration that the full extent of the minimum visibility zones (WTG foundations: May - November, 2300 m and December, 4,400 m; OSS foundations: May - November 1,600 m and 2,700 m December) can be effectively and reliably monitored. The Plan must identify the efficacy of the technology at detecting marine mammals and sea turtles in the clearance and shutdown zones under all the various conditions anticipated during construction, including varying weather conditions, sea states, and in consideration of the use of artificial lighting. If the plan does not include a full description of the proposed technology, monitoring methodology, and data demonstrating to NMFS GARFO's satisfaction that marine mammals and sea turtles can reliably and effectively be detected within the clearance and shutdown zones for monopiles before and during impact pile driving, nighttime pile driving (unless a pile was initiated 1.5 hours prior to civil sunset) may not occur. Additionally, this Plan must contain a thorough description of how Empire Wind will monitor pile driving activities during		

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			daytime when unexpected changes to lighting or weather occur during pile driving that prevent visual monitoring of the full extent of the clearance and shutdown zones. e. Sound Field Verification Plan - WTG and OSS Installation. BOEM, BSEE, and/or Empire Wind must submit this Plan to NMFS GARFO at least 180 calendar days before pile driving for WTG and/or OSS foundations is planned to begin. BOEM, BSEE, and Empire Wind must obtain NMFS GARFO's concurrence with this Plan(s) prior to the start of these pile driving activities. To validate the estimated sound field, SFV measurements will be conducted during pile driving of the first three monopiles installed over the course of the Project, with noise attenuation activated. SFV measurements will also be conducted during pile driving of the first full pin pile foundation. The Plan(s) must describe how the first three monopile installation sites and installation scenarios (i.e., hammer energy, number of strikes) are representative of the rest of the monopile installations and, therefore, why these monopile installations would be representative of the remaining monopile installations. If the monitored pile locations are different from the ones used for exposure modeling, justification must be provided for why these locations are representative of the modeling. In the case that these sites are not determined to be representative of all other monopile installation sites, Empire Wind must include information on how additional monopiles/sites would be selected for SFV. The Plan(s) must also include the piling schedule and sequence of events, communication and reporting protocols, methodology for collecting, analyzing, and preparing SFV data for submission to NMFS GARFO including instrument deployment, locations of all hydrophones including direction and distance from the pile, hydrophone sensitivity, recorder/measurement layout, and analysis methods, and a template of the interim report to be submitted. The Plan must also identify the number and location of hydrophones that will be reported in the SFV Interim Reports and any additional hydrophone locations that will be included in the final report(s). The Plan must describe how the effectiveness of the sound attenuation methodology would be evaluated based on the results. The Plan must address how Empire Wind will implement Terms and Condition 2a and 2b (see above) which includes, but is not limited to identifying additional noise attenuation measures (e.g., add noise attenuation device, adjust hammer operations, adjust NMS) that will be applied to reduce sound levels if measured distances are greater than those modeled. i. SFV Interim Reports - Pile Driving. Empire Wind must provide, as soon as they are available but no later than 48 hours after the installation of each of the first three monopiles and after the installation of the first full pin pile foundation, the initial results of the SFV measurements to NMFS GARFO in an interim report. If technical or other issues prevent submission within 48 hours, Empire Wind must notify NMFS GARFO within that 48-hour period with the reasons for delay and provide an anticipated schedule for submission of the report. These reports are required for each of the first three monopiles installed, the first pin pile OSS foundation, and any additional piles for which SFV is required. The interim report must include data from hydrophones identified for interim reporting in the SFV Plan and include a summary of pile installation activities (pile diameter, pile weight, pile length, water depth, sediment type, hammer type, total strikes, total installation time [start time, end time], duration of pile driving, max single strike energy, NAS deployments), pile location, recorder locations, modeled and measured distances to thresholds, received levels (rms, peak, and SEL) results from Conductivity, Temperature, and Depth (CTD) casts/sound velocity profiles, signal and kurtosis rise times, pile driving plots, activity logs, weather conditions. If there are any updates to the requirements to the contents of the Interim Plan, including availability of a template, this will be provided to Empire Wind as soon as any such updates are available. Requirements for actions to be taken based on the results of the SFV are identified in 2.a. above. ii. The final results of SFV for monopile and pin pile installations must be submitted as soon as possible, but no later than within 90 days following completion of pile driving for which SFV was carried out. f. Vessel Strike Avoidance Plan. BOEM, BSEE, and/or Empire Wind must submit this plan to NMFS GARFO as soon as possible after issuance of this Biological Opinion but no later than 90 days prior to the planned start of in-water construction activities outside of SBMT (including cable installation). The Plan must provide details on all relevant mitigation and monitoring measures for listed species, vessel transit protocols from all planned ports, vessel-based observer protocols for transiting vessels, communication and reporting plans, proposed alternative monitoring equipment to maintain vessel strike avoidance zones in varying weather conditions, darkness, sea states, and in consideration of the use of artificial lighting. If Empire Wind plans to implement PAM in any transit corridor to allow vessel transit above 10 knots, the plan must describe how PAM, in combination with visual observations, will be conducted to ensure the transit corridor is clear of North Atlantic right whales. PAM information should follow what is required to be submitted for the PAM Plan in 10.a.		

<table>
<tr><th>#</th><th>Proposed Project Phase</th><th>Mitigation & Monitoring Measures</th><th>Description</th><th>Resource Area Mitigated</th><th>Anticipated Enforcing Agency</th></tr>
<tr><td>9</td><td>C, O&M, D</td><td>Enforcement</td><td>9. To implement the requirements of RPM 4, BOEM and BSEE must exercise their authorities to assess the implementation of measures to avoid, minimize, monitor, and report incidental take of ESA listed species during activities described in this Opinion. If any avoidance, minimization, and monitoring measures incorporated into the proposed action or any term and condition(s) is/are not being complied with, BOEM and/or BSEE shall immediately exercise their respective authorities to take effective action to ensure prompt implementation and compliance.</td><td>ESA-listed marine mammals, sea turtles, fish</td><td>BOEM and BSEE</td></tr>
<tr><td>10</td><td>C, O&M, D</td><td>Enforcement</td><td>10. To implement the requirements of RPM 4, Empire Wind must consent to on-site observation and inspections by Federal agency personnel (including NOAA personnel) during activities described in the Biological Opinion, for the purposes of evaluating the effectiveness and implementation of measures designed to minimize or monitor incidental take.</td><td>ESA listed marine mammals and sea turtles</td><td>BOEM, BSEE, and NMFS</td></tr>
<tr><td>11</td><td>C</td><td>Clearance and Shutdown Zones</td><td>11. Table 11.1. Clearance and Shutdown Zones for ESA Listed Species - Impact Pile Driving
<table>
<tr><th>Species</th><th>Clearance Zone (m)</th><th>Shutdown Zone (m)</th></tr>
<tr><td colspan="3">Impact Pile Driving
Minimum visibility zone for WTG and OSS foundations is 1,500 m</td></tr>
<tr><td>North Atlantic right whale – visual PSO</td><td>Minimum visibility zone (1,500 m) plus any additional distance observable by the visual PSOs</td><td>Minimum visibility zone (1,500 m) plus any additional distance observable by the visual PSOs</td></tr>
<tr><td>North Atlantic right whale – PAM</td><td>5,000</td><td>1,500</td></tr>
<tr><td>Blue, fin, sei, and sperm whale – visual and PAM</td><td>2,000</td><td>1,500</td></tr>
<tr><td>Sea Turtles - visual PSO</td><td>500</td><td>500</td></tr>
</table></td><td>ESA listed marine mammals and sea turtles</td><td>BOEM, BSEE, and NMFS</td></tr>
<tr><td colspan="6">Draft NJDEP Federal Coastal Zone Management Consistency Conditions for NJDEP</td></tr>
<tr><td>1</td><td>C, O&M</td><td>Fisheries compensation</td><td>Empire Wind and the State of NJ shall execute a Memorandum of Understanding (MOU) to provide appropriate compensation measures for fisheries resources and fishing industry uses impacted by the authorized project.</td><td>Commercial and Recreational Fishing</td><td>NJDEP</td></tr>
<tr><td>2</td><td>C, O&M</td><td>Compensation for Gear Loss and Damage</td><td>Compensation for Gear Loss and Damage: Empire would implement a gear loss and damage compensation program consistent with BOEM's draft guidance for Mitigating Impacts to Commercial and Recreational Fisheries on the Outer Continental Shelf Pursuant to 30 CFR 585 or as modified in response to public comment. BOEM recognizes that Empire has an applicable gear loss and damage claims process resulting from survey activities. This measure, if adopted, would be applicable to the presence of structures during both construction and operations.</td><td>Commercial and Recreational Fishing</td><td>NJDEP</td></tr>
<tr><td>3</td><td>C, O&M</td><td>Compensation for Lost Fishing Income</td><td>Compensation for Lost Fishing Income: Empire would implement a compensation program for lost income for commercial and recreational fishers and other eligible fishing interests for construction and operations consistent with BOEM's draft guidance for Mitigating Impacts to Commercial and Recreational Fisheries on the Outer Continental Shelf Pursuant to 30 CFR 585 or as modified in response to public comment. This measure, if adopted, would reduce impacts from the IPF presence of structures by compensating commercial and recreational fishing interests for lost income during construction and a minimum of 5 years post-construction. Levels of funding required by Empire to be set aside for fulfilling verified claims would be commensurate with those in Table 3.9-31 of the DEIS, which identifies annual revenues per fish species. If adopted, this measure would reduce the minor to major impact level from the presence of structures to minor to moderate. This is because a compensation scheme could mitigate "indefinite" impacts to a level where the fishing community would have to adjust somewhat to account for disruptions due to impacts but income losses would be mitigated.</td><td>Commercial and Recreational Fishing</td><td>NJDEP</td></tr>
<tr><td>4</td><td>C</td><td>Mobile Gear–Friendly Cable Protection Measures</td><td>Mobile Gear–Friendly Cable Protection Measures: Cable protection measures should reflect the pre-existing conditions at the site. This mitigation measure, if adopted, ensures that seafloor cable protection does not introduce new hangs for mobile fishing gear. Therefore, the cable protection measures should be trawl-friendly with tapered/ sloped edges. If cable protection is necessary in "non-trawlable" habitat, such as rocky habitat, then Empire would use materials that mirror that benthic environment.</td><td>Commercial and Recreational Fishing</td><td>NJDEP</td></tr>
<tr><td>5</td><td>C</td><td>MEC and UXO notification</td><td>If any military munitions and explosives of concern (MECs) or unexploded ordinances (UXOs) are encountered during project construction, Empire shall immediately notify the United States Coast Guard (USCG) of the munition and its location.</td><td>Commercial and Recreational Fishing</td><td>NJDEP</td></tr>
</table>

Table H-2 Mitigation and Monitoring Measures Analyzed in the Draft EIS but not Recommended for Inclusion in the Preferred Alternative

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Rationale
BOEM OCS Study 2020-039 – Radar Systems Mitigations to Operations					
2	O&M	Mitigation for oceanographic high frequency radars	Empire Wind will enter into a mitigation agreement with NOAA, to mitigate operational impacts on oceanographic high-frequency radars. Possible mitigation measures might include the following: Data sharing from turbine operators to include the following: • Sharing real-time telemetry of surface currents and other oceanographic data measured at locations in the Projects with radar operators into the public domain • Sharing time-series of blade rotation rates, nacelle bearing angles, and other information about the operational state of each of the Projects' turbines with radar operators to aid interference mitigation • Wind farm curtailment/curtailment agreement • Signal processing enhancements • Antenna modifications	Other Uses – Radar	Measure is replaced by NOAA IOOS measure #1
BOEM-proposed Mitigation and Monitoring Measures in the NMFS EFH Assessment					
1	C	Impingement and Entrainment Reduction	All intakes for inshore hydraulic dredges should be covered with a mesh screen or screening device that is properly installed and maintained to minimize potential for impingement or entrainment of fish species. The screening device on the dredge intake should prevent the passage of any material greater than 1.25" in diameter, with a maximum opening of 1.25"x 6". Water intakes should be positioned at an appropriate depth to avoid or minimize the entrainment of eggs and larvae. Intake velocity should be limited to less than 0.5 ft/sec.	Finfish and Invertebrates	This measure has not been included as a term and condition in the Record of Decision for other NEPA reviews of COP EISs for offshore wind.
Other Agency-proposed Mitigation Measures					
5	C	Avoid Sand Ridges and Troughs	Empire will avoid perpendicular crossings of sand ridges and troughs for the submarine export cables and inter-array cables.	Benthic Resources, EFH	Measure is similar to CR#4 in Table H-3. BOEM is currently reviewing NMFS's EFH conservation recommendations related to micrositing submarine cables. BOEM's decision on which measures to adopt or partially adopt will be documented in BOEM's written response to NMFS and will consider the technical and economic feasibility of recommended measures.

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Rationale
6	Pre-C, C, O&M, D	Mariner Communication and Outreach Plan	Empire will develop and implement a Mariner Communication and Outreach Plan that covers all project phases from pre-construction to decommissioning and that facilitates coordination with all mariners, including the commercial shipping industry, commercial and for-hire fishing industries, and other recreational users. The Mariner Communication and Outreach Plan will include the following components: a. During Project design, routinely coordinating in-water construction activities and phasing to avoid and minimize disruptions; b. At least 90 days prior to commencing in-water construction activities in any construction season, consultation with stakeholders on an approximate schedule of activities and existing uses within the Project area. Make good faith efforts to accommodate those existing uses. The results of these good faith consultations will be summarized in a report and submitted to the federal agency(ies) prior to the start of each construction season; c. Following COP approval, notice of proposed changes which have the potential to impact fishing or maritime resources or activities; d. Notices to commence construction activities, conduct maintenance activities, and commence decommissioning; e. Status reports during construction with specific information on construction activities and locations for upcoming activities in the next 1-2 weeks; f. Post-construction notice of: (i) all cable protection measure locations (including protection type and charted location); (ii) any areas where the identified burial depth is less than target burial depth; and (iii) other obstructions to navigation created by the Project; g. During operations, notice of locations where cables have shifted outside the cable area identified in Electronic Navigation Charts; and h. Post all notices described above to the Project website with information on how to opt-in for alerts.	Navigation	This measure is redundant with the fisheries communication plan that is required as a lease stipulation. In addition, BOEM expects that a requirement for the lessee to post mariner information sheets following installation of offshore structures would be included as a standard condition of COP approval.
7	C, O&M, D	Fishing Gear and Anchor Strike Incident Reporting	Empire will report fishing gear and anchor strike incidents that fall below or are not captured by the regulatory thresholds outlined in 30 CFR §§ 585.832 and 585.833. Reports will be filed annually during construction and decommissioning, and every 5 years during operations.	Commercial Fishing	A reporting requirement for fishing gear incidents has been added to the fisheries compensation measure.
12	C, O&M	Cable Alert System	Empire will install a cable alert system that alerts vessels to the presence of cables, which could shift over time both horizontally and vertically. Such a system would be prudent in high traffic areas (e.g., navigation channels, crossing TSS, near offshore anchorage).	Navigation	Replaced with agency-proposed measure #6
13	C	Consolidate EW 2 Landfall(s)	Empire will consolidate EW 2 cable landfall(s) to one location for all cables, to the extent practicable, to minimize community and environmental impacts.	Multiple	Measure is not within BOEM's jurisdiction but could be included as a condition of a state approval.
15	O&M	Compensation for lost fishing income	The lessee shall implement a compensation program for lost income for commercial and recreational fishermen and other eligible fishing interests for construction and operations consistent with BOEM's draft guidance for Mitigating Impacts to Commercial and Recreational Fisheries on the Outer Continental Shelf Pursuant to 30 CFR 585 or as modified in response to public comment.	Commercial Fisheries and For-Hire Recreational Fishing	Replaced with BOEM proposed mitigation for fisheries mitigation
16	C, O&M	Navigational Safety Adaptation Fund	Empire will establish an adaptation fund to equip vessel operators with necessary safety training and equipment, including suitable marine vessel radar, where appropriate.	Navigation	Empire is developing an applicant-proposed measure to address the concern and a mitigation requirement would be redundant.
17	O&M	Mobile gear friendly cable protection measures	Cable protection measures should reflect the pre-existing conditions at the site. This mitigation measure chiefly ensures that seafloor cable protection does not introduce new hangs for mobile fishing gear. Thus, the cable protection measures should be trawl-friendly with tapered/sloped edges. If cable protection is necessary in "nontrawlable" habitat, such as rocky habitat, then Empire must ensure that all materials consist of natural or engineered stone that does not inhibit epibenthic growth, to the extent technically and economically feasible. The materials selected for protective purposes should mirror the natural environment and perform similar habitat functions.	Commercial Fisheries and For-Hire Recreational Fishing; Benthic Resources; EFH	This measure is redundant with the measure for scour and cable protection included as a BOEM-proposed measure in the EFH Assessment.

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Rationale
18	C, O&M	High-frequency radar mitigation	Empire must develop a mitigation plan, to be reviewed and coordinated with the NOAA IOOS Surface Currents Program Manager, for purposes of implementing measures that correct for wind turbine interference. Measures would include sharing real-time telemetry of surface currents, waves, and other oceanographic data with the Surface Currents Program into the public domain, measured at locations in the Project confirmed by the Surface Currents Program and its high-frequency radar operators as sufficient to allow NOAA IOOS mission objectives to be met.	Other Uses	Measure is replaced by NOAA IOOS measure #1

Table H-3 NMFS-proposed Essential Fish Habitat Conservation Recommendations Issued July 27, 2023

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
1	C	Avoid and Minimize Adverse Impacts to Cholera Bank	CR#1: Relocate WTGs B01, C01, B02, D02, B03, and D03 to avoid and minimize adverse impacts to Cholera Bank, an important, regional bathymetric feature that provides important fisheries habitat. Should less than six WTGs be relocated, our order of preference for relocation is: B01, C01, B02, D02, B03, D03.	Benthic resources; EFH	BOEM, BSEE, and NMFS
2	Pre-C, C, Post-C	Avoid and Minimize Impacts to Benthic Habitats	• CR#2: WTGs, Offshore Substations (OSSs) and cables (interarray, interlink, and export) should be microsited/sited to avoid sensitive benthic habitats and UXOs/MECs; low multibeam backscatter return areas absent benthic features (i.e., soft bottom) should be targeted for micrositing. • CR#3: Develop and implement a WTG, OSS and cable micrositing plan to facilitate the avoidance and minimization of impacts to sensitive benthic habitats. We recommend the plan use Benthic Habitat (NOAA complexity category) and Benthic Feature/Habitat Type maps provided in the EFH assessment and various appendices be used in conjunction with backscatter, bathymetry and boulder data layers to inform micrositing. For areas where sensitive benthic habitats cannot be fully avoided through micrositing, the micrositing plan should avoid and minimize areas in the following order of preference: (i) complex habitats with boulders; (ii) complex habitats absent boulders; (iii) heterogeneous complex habitats; (iv) biogenic habitat (i.e., clam beds); and (v) areas with benthic or bathymetric features. A copy of the final plan should be provided to NMFS HESD at NMFS.GAR.HESDoffshorewind@noaa.gov prior to construction. • CR#4: To the extent practicable, cables should cross complex habitat areas perpendicularly at the narrowest points; cables unable to avoid benthic features such as sand waves should be sited along natural benthic contours within troughs/lows, to maximize cable burial while minimizing disturbance to local submarine topography. • CR#5: To minimize impacts to sensitive benthic habitats from boulder/cobble relocation activities, boulders/cobbles should be: (i) relocated as close to the impact area as practicable, in areas of soft bottom but immediately adjacent to similar complex bottom; (ii) placed in a manner that does not hinder maritime users; and (iii) avoids impacts to existing complex habitats. • CR#6: In order to minimize impacts to sensitive benthic habitats from boulder/cobble relocation activities, boulders that will be relocated using boulder "pick" methods should be relocated outside the area necessary to clear and placed along the edge of existing complex habitats such that the placement of the relocated boulders will result in a marginal expansion of complex habitats into soft-bottom habitats. • CR#7: Develop and implement a boulder relocation plan to facilitate the avoidance and minimization of impacts to sensitive benthic habitats. We recommend the plan use Benthic Habitat (NOAA complexity category) and Benthic Feature/Habitat Type maps in conjunction with backscatter and boulder layers (data) to inform micrositing. A copy of the final plan should be provided to NMFS HESD at NMFS.GAR.HESDoffshorewind@noaa.gov prior to construction. • CR#8: To minimize impacts of benthic habitat modification, in all project areas where seafloor preparation activities include the use of plows, jets, grapnel runs or similar methods, post-construction acoustic surveys (e.g. multibeam backscatter and side scan sonar) capable of detecting bathymetry changes of 0.5 feet (ft.) or less, should be completed to demonstrate how the bottom was modified by preparation and construction activities. • CR#9: In areas where plows, jets, or other similar methods are used and the created berm height exceeds three feet above the existing grade, the created berm should be restored to match that of the existing grade/pre-construction conditions.	Benthic resources; EFH	BOEM, BSEE, and NMFS

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			• CR#10: Avoid anchoring or placing jack-up barge spud cans or footings on/in sensitive benthic habitats including any area where large boulders (>/= 0.5 m in diameter) or medium to high multibeam backscatter returns occur. • CR#11: If anchoring is necessary in sensitive benthic habitats, anchor lines should be extended to the extent practicable to minimize the number of times the anchors must be raised and lowered to reduce the amount of habitat disturbance. • CR#12: If anchoring must occur in sensitive benthic habitats and vessels must remain stationary, dynamic positioning systems (DPS) or mid-line buoys on anchor chains should be required to minimize impacts to those habitats. • CR#13: If placement of jack-up barge spud cans is necessary in sensitive benthic habitats, we recommend proposed locations for the spud cans be selected to avoid areas in the following order of preference: (i) complex habitats with boulders; (ii) complex habitats absent boulders; (iii) heterogeneous complex habitats; (iv) biogenic habitat (i.e., clam beds); and (v) areas with benthic or bathymetric features. • CR#14: Develop and implement an anchoring and jack-up barge plan to facilitate the avoidance and minimization of impacts to sensitive benthic habitats. We recommend the plan use Benthic Habitat (NOAA complexity category) and Benthic Feature/Habitat Type maps in conjunction with backscatter, bathymetry and boulder layers (data) to inform micrositing. A copy of the final plan should be provided to NMFS HESD at NMFS.GAR.HESDoffshorewind@noaa.gov prior to construction. • CR#15: To minimize permanent adverse impacts to existing benthic habitats from the placement of scour protection, all cables should be microsited to allow for full penetration/burial, regardless of habitat type (by siting cables in appropriate substrates). Additional bottom surveys should be conducted, as necessary, to inform the micrositing of the cables. • CR#16: To minimize the impacts of habitat conversion from scour protection, natural or engineered rounded stone of consistent grain size that mimics natural seafloor substrates should be used. At a minimum, any exposed surface layer should be designed and selected to provide three-dimensional structural complexity that creates a diversity of crevice sizes (e.g., mixed stone sizes) and rounded edges (e.g., tumbled stone), and be sloped such that outer edges match the natural grade of the seafloor. Should the use of concrete mattresses be necessary, bioactive concrete (i.e., with bio-enhancing admixtures) should be used as the primary scour protection (e.g., concrete mattresses) or veneer to support biotic growth. • CR#17: Avoid the use of plastics/recycled polyesters/net material (i.e. fronded mattresses) in all scour protection, as these materials may degrade and result in plastic pollution. • CR#18: Develop and implement a scour protection plan to facilitate the avoidance and minimization of impacts to sensitive benthic habitats. We recommend the plan use Benthic Habitat (NOAA complexity category) and Benthic Feature/Habitat Type maps in conjunction with backscatter, bathymetry and boulder layers (data) to inform this plan. A copy of the final plan should be provided to NMFS HESD at NMFS.GAR.HESDoffshorewind@noaa.gov prior to construction.		
3	C	Avoid and Minimize Impacts to Longfin Squid and their Designated EFH	CR#19: To minimize adverse impacts to adult spawning habitat and egg/larvae habitat of the aggregate (communal) spawning longfin squid (*Doryteuthis pealeii*) in the project area, impact pile driving or sediment-generating activities should not occur in the lease area or federal portions of export cable corridors in waters 50 meters (m) in depth or less between April 1 and July 31 of any year. HRG sub-bottom profiling (e.g. sparkers, boomers) survey activities should be avoided near Cholera Bank, specifically on/within the 29 northwestern most aliquots of the lease area during the same time period.	Benthic resources; EFH	BOEM, BSEE, and NMFS
4	Pre-C, C	Minimize Adverse Effects to Habitat from Acoustic Impacts	• CR#20: In addition to avoiding pile driving from April 1 to July 31 to avoid impacts to longfin squid, the use of noise mitigating measures should be required during pile driving construction, including the use of soft start procedures and the deployment of noise dampening equipment such as bubble curtains or double-bubble curtains. • CR#21: Additional noise dampening/mitigation measures (e.g., double bubble curtains) should be used for any pile driving activity within 7.7 km of Cholera Bank (inclusive of the entire complex). Additional noise dampening/mitigation measures should also be used during all impact pile driving within 7.7 km of any artificial reef sites/shipwrecks/fish havens (such as Eureka and Broadcast), where fish are known to aggregate. Should sound field verification indicate impacts beyond 7.7 km, noise dampening/mitigation measures should be used within the zone of elevated underwater noise. • CR#22: A plan outlining the noise mitigation procedures for both offshore and inshore activities should be filed with BOEM and the USACE for approval before construction commences. BOEM should provide NMFS HESD with a copy of the final plan at NMFS.GAR.HESDoffshorewind@noaa.gov before in-water work begins. The noise mitigation plan should include (i) passive acoustic sound verification monitoring during pile driving activities - additional noise dampening technology should be applied should real-time monitoring indicate noise levels exceed the modeled 10 decibel attenuation levels; (ii) a process for notifying NMFS HESD within 24 hours if any evidence of a fish kill during construction activity is observed, and	EFH	BOEM, BSEE, NMFS, and USACE

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			contingency plans to resolve issues; and (iii) acoustic monitoring reports that include any/all noise-related monitoring should be provided to NMFS HESD at NMFS.GAR.HESDoffshorewind@noaa.gov.		
5	Pre-C, C, Post-C	Avoid and Minimize Impacts to Estuarine/Nearshore Habitats	• CR#23: Avoid in-water work including cable installation, seabed preparation, pile installation (i.e., for bulkheads/cofferdams, wharfs), HDD pit excavation, or other extractive or turbidity/sediment-generating activities from January 15 to May 31 of any given year in estuarine/nearshore waters of 6 meters (m) in depth or less within the waters of NY Harbor (inshore of Sandy Hook to Rockaway Point). This includes SBMT. In Reynolds Channel, the seasonal restriction is from January 1 to May 31 to avoid impacts to winter flounder early life stages (spawning adults, eggs, larvae). This recommendation is consistent with those developed and followed for other activities within NY Harbor, including the maintenance of the federal navigation channels. • CR#24: Avoid in-water work including cable installation, seabed preparation, pile driving, HDD pit excavation, or other extractive or turbidity/sediment-generating activities from November 15 to April 15 of any given year in the Bay Ridge Channel and adjacent near-pier and inter-pier areas, including the SBMT to avoid impacts to overwintering winter flounder and striped bass. This recommendation is consistent with those developed and followed for other activities within NY Harbor, including the maintenance of the federal navigation channels. • CR#25: In all inshore/estuarine areas where seafloor preparation and cable installation activities will occur, impacts to sensitive benthic habitats should be avoided and minimized through the use of horizontal directional drilling (HDD), micrositing, and re-rerouting. All disturbed areas should be restored to pre-construction conditions, inclusive of bathymetry, contours, and sediment types. Pre-construction surveys to determine conditions and post-construction surveys should be conducted to verify restoration has occurred. Survey results should be provided to NMFS HESD at NMFS.GAR.HESDoffshorewind@noaa.gov. • CR#26: Avoid trenching in open nearshore/estuarine waters. If open trenching is used, excavated materials should not be sidecast or placed in the aquatic environment. In areas with elevated levels of contaminants, a closed clamshell/environmental bucket dredge should be used. All materials should be stored on uplands or barges and placed back into the trench to restore the excavated areas, or removed to a suitable upland disposal site if the material contains elevated levels of contaminants. Trenched areas should be restored to pre-construction conditions with native and/or clean, compatible material. • CR#27: To minimize impacts to estuarine/nearshore habitats associated with excavation of the HDD exit pits for any water-to-shore transitions, unconfined dredging should not be permitted. • CR#28: Dredged materials from HDD exit pits should be stored on a barge or on uplands and used to backfill the excavated areas once construction and installation is complete. If the material excavated at the HDD pits contains elevated levels of contaminants, a closed clamshell/environmental bucket dredge should be used, all excavated material should be disposed of at a suitable upland location, and the HDD pit should be backfilled with suitable, clean material. • CR#29: Frac-out plans should be developed for all areas where HDD is proposed to be used. A copy of the final plan should be provided to NMFS HESD at NMFS.GAR.HESDoffshorewind@noaa.gov prior to construction. • CR#30: To minimize impacts from vessel operation in estuarine/nearshore habitats, all vessels should float at all stages of the tide (i.e., avoid vessel grounding); all vessels should be required to follow other EFH CRs associated with anchoring/avoidance. • CR#31: Areas of moderate to high densities of shellfish (hard clams, soft shell clam, surfclam) should be avoided. Surveys should be conducted to establish baseline distributions and abundances of shellfish beds and monitoring should be conducted to determine impacts to shellfish beds, including their recovery. Restoration of shellfish beds should be required where project activities (pre-sweep, dredging) have impacted areas with moderate to high densities of shellfish or where the beds have not recovered to post-construction conditions. • CR#32: To compensate for unavoidable impacts to winter flounder egg/larvae EFH, a compensatory mitigation plan that satisfies each element of a complete compensatory mitigation plan as identified in the published regulations 33 CFR Parts 325 and 332 “Compensatory Mitigation for Losses of Aquatic Resources,” (Mitigation Rule) and NOAA’s Mitigation Policy for Trust Resources should be required for any permanent elimination of winter flounder egg/larvae habitat (waters of 6 meters depth or less) due to dredging and fill placement at the SBMT. This plan should be provided to NMFS HESD for review and comment prior to construction and should be a condition of the USACE authorization.	Benthic resources; EFH	USACE

<table>
<tr><th>#</th><th>Proposed Project Phase</th><th>Mitigation & Monitoring Measures</th><th>Description</th><th>Resource Area Mitigated</th><th>Anticipated Enforcing Agency</th></tr>
<tr><td>6</td><td>Pre-C, C, Post-C</td><td>Address Uncertainties and Minimize Impacts from Project Operation</td><td>

CR#33: Revise the Benthic Habitat Monitoring Plan to address previous agency comments/concerns (including the NEFSC and GARFO letter sent October 21, 2022) and impacts related to Cholera Bank and the introduction of artificial substrate. The plan should incorporate sufficient samples and replications to identify potential changes to benthic features, habitat complexity, and associated macrobenthic communities (including invasive species [e.g., Didemnum vexillum] growth) across and within each habitat type in the project area, including the artificial substrates to be constructed. The plan should include the collection of at least three years of pre-construction data and post-construction acoustic data (multibeam bathymetry and backscatter and side scan sonar). The applicant should consult with the resource agencies in development of this plan and give the resource agencies a minimum of 90 days to review and comment on the plan. The applicant should submit a final plan to BOEM that addresses, and includes, all resource agency comments, as well as the applicant’s response to those comments. A copy of the final monitoring plan should be provided to NMFS HESD at NMFS.GAR.HESDoffshorewind@noaa.gov prior commencement of any in-water work. All data and metadata should be made available to NMFS HESD.
CR#34: Develop an in situ project specific monitoring program to address uncertainties related to impacts of the operation of the Empire Wind project on EFH and federally managed species. This monitoring recommendation is consistent with principles outlined in NOAA’s Mitigation Policy for Trust Resources which highlights the use of the best available scientific information, such as results of surveys and other data collection efforts when existing information is not sufficient for the evaluation of proposed actions and mitigation, or when additional information would facilitate more effective or efficient mitigation recommendations. The project specific monitoring program should measure in situ the stressors created by project operation on the ecosystem from the presence of turbines, operational noise, and oceanic-wind wake effects. Monitoring plans should include the collection of baseline data and be provided to NMFS HESD at NMFS.GAR.HESDoffshorewind@noaa.gov and NEFSC for review and comment within 90 days of ROD issuance. A response to NMFS comments should be provided. These monitoring studies should be developed in partnership with NMFS and other scientific institutions to aid in addressing these and other questions:
<ol type="a">
How do construction and permanent placement of WTGs, OSSs, and cables impact Cholera Bank (inclusive of the Cholera Bank complex) and sand ridge and trough habitat?
<ol type="i">
What are the effects of construction and operation (presence) on physical characteristics of Cholera Bank and sand ridge and troughs over time, including sediment properties and shape/geometry, depth, and rugosity?
To what extent do fish assemblages and food web dynamics change in/on Cholera Bank as a result of construction and operation of the wind farm?
What is the distribution, abundance, survival, growth rate, and recruitment rate of longfin squid and shellfish (Atlantic surfclam, sea scallop, and ocean quahog) along a distance gradient from offshore wind structures, particularly in the northwestern most portion of the lease area?

How does distribution and abundance of squid eggs (mops) change over time within and adjacent to the wind farm and OECs as a result of WTG, OSS, and cable placement?

How does the placement of WTGs, OSS, and the farm as a whole impact oceanographic and atmospheric processes within and adjacent to the lease area?
<ol type="i">
How far do atmospheric wind wake impacts extend from the Empire Wind Farm during operation and what is the magnitude of impact?
What are the effects of wind farm/turbine presence on physical water column properties, primary and secondary production, and larval dispersal for species with designated EFH in the project area?
To what extent and magnitude does each individual turbine and wind farm as a whole impact subsurface mixing, as it relates to formation and maintenance of the Mid Atlantic Cold Pool (Cold Pool)? To answer this question, the extent of geographic overlap between Empire Wind and the Cold Pool will need to be determined, and appropriate context (Cold Pool variability) given. For example, are there seasonal or interannual periods when the Cold Pool does not overlap with Empire Wind and what is the geographic proximity to the Cold Pool during periods without overlap?
How does turbine/farm presence impact depth stratification of the Cold Pool within and directly adjacent to the lease area and how does it change throughout the seasonal evolution of the cold pool?

</td><td>Benthic resources; EFH</td><td>BOEM, BSEE, and NMFS</td></tr>
</table>

#	Proposed Project Phase	Mitigation & Monitoring Measures	Description	Resource Area Mitigated	Anticipated Enforcing Agency
			c. How far do effects on sound pressure, particle motion, and substrate vibration extend from the individual WTGs and the Empire Wind Farm collectively? i. What effect do these operational noise effects have on the distribution of species with designated EFH in the project area such as longfin squid and prey for these species (i.e. sand lance)? • CR#35: Require the implementation of preventive measures to reduce the risk of contaminant emissions or accidental release of chemicals. Such measures may include backup systems, secondary containments, closed loop systems, and/or recovery tanks. • CR#36: Any anti-corrosion protection methods or systems proposed should be identified. If sacrificial anodes are used, Al anodes should be selected over Zn anodes. Any application of anti-corrosion coatings should be allowed to cure fully on land, and BMPs for reducing spills should be implemented if reapplied offshore.		
7	D	Project Decommissioning	CR#37: The EFH consultation should be reinitiated prior to decommissioning turbines to ensure that the impacts to EFH as a result of the decommissioning activities have been fully evaluated and minimized to the extent practicable. Pre-consultation coordination related to decommissioning should occur at least five years prior to proposed decommissioning.	EFH	BOEM, BSEE, and NMFS
8	C and post-C	FWCA Recommendations	1. The project should be required to mitigate the major impacts to NOAA Fisheries scientific surveys consistent with NMFS-BOEM Federal Survey Mitigation Strategy – Northeast U.S. Region. Empire Wind's plans to mitigate these impacts at the project and regional levels should be provided to NMFS for review and approval prior to BOEM's decision on its acceptance. Mitigation is necessary to ensure that NOAA Fisheries can continue to accurately, precisely, and timely execute our responsibilities to monitor the status and health of trust resources. 2. Locations of relocated boulders, created berms, and scour protection, including cable protection measures (i.e., concrete mattresses) should be provided to NMFS, all other federal agencies with maritime jurisdiction, and the public as soon as possible to help inform all interested parties of potential gear obstructions. 3. Avoiding dredging, pre-sweep and cable installation activities in Lower Bay, particularly along the edges of Ambrose Channel from December 1 to March 31 to avoid and minimize impacts to overwintering, dormant blue crabs.	Other Uses; Commercial and recreational fishing; finfish, invertebrates, and EFH	BOEM, BSEE, NMFS, and USACE

This page intentionally left blank.

ATTACHMENT H-1
MITIGATION, MONITORING, AND REPORTING MEASURES IN EMPIRE'S LETTER OF AUTHORIZATION APPLICATION

This page intentionally left blank.

Table H-4 Proposed Mitigation, Monitoring, and Reporting Measures in the MMPA Letter of Authorization Application, also included in the Proposed Action for Consultation with NMFS as a Co-Action Agency under the ESA for Threatened and Endangered Marine Mammals[3]

Measure	Project Phase	Description	Resource Area Mitigated	Anticipated Enforcing Agency
LOA-1: Vessel strike avoidance procedures	C, O&M, D	Vessel operators and crew must maintain a vigilant watch for cetaceans and pinnipeds by slowing down or stopping their vessels to avoid striking these protected species. Vessel crew members responsible for navigation duties will receive site-specific training on marine mammal sighting/reporting and vessel strike avoidance measures. Vessel strike avoidance measures will include, but are not limited to the following, except under extraordinary circumstances when complying with these measures would put the safety of the vessel or the crew at risk: • Vessel operators and crew will maintain vigilant watch for cetaceans and pinnipeds, and slow down or stop their vessel to avoid striking these protected species; • All vessel operators will comply with 10 knot (18.5 km/hr) or less speed restrictions in any SMA, DMA or visually triggered Slow Zone; • All vessel operators will reduce vessel speed to 10 knots (18.5 km/hr) or less when any large whale, any mother/calf pairs, whale or dolphin pods, or larger assemblages of cetaceans are observed near (within 100 m [330 ft]) an underway vessel; • All vessels will maintain a separation distance of 500 m (1,640 ft) or greater from any sighted NARW; • If underway, vessels must steer a course away from any sighted NARW at 10 knots (18.5 km/hr) or less until the 500 m (1,640 ft) minimum separation distance has been established. If a NARW is sighted in a vessel's path, or within 100 m (330 ft) of an underway vessel, the underway vessel must reduce speed and shift the engine to neutral. Engines will not be	Marine Mammals	BOEM, BSEE, and NMFS

[3] NMFS published receipt of an application for regulations and Letter of Authorization under the MMPA on September 9, 2022 (87 *Federal Register* 55409) and is currently accepting comments until October 11, 2022.

Measure	Project Phase	Description	Resource Area Mitigated	Anticipated Enforcing Agency
		engaged until the NARW has moved outside of the vessel's path and beyond 100 m. If stationary, the vessel must not engage engines until the NARW has moved beyond 100 m; • All vessels will maintain a separation distance of 100 m (330 ft) or greater of any sighted whales. If sighted, the vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside the vessel's path and beyond 100 m. If a survey vessel is stationary, the vessel will not engage engines until the whale has moved out of the vessel's path and beyond 100 m; • All vessels will maintain a separation distance of 50 m (164 ft) or greater from any sighted small cetacean. Any underway vessel must remain parallel to a sighted small cetacean's course whenever possible and avoid excessive speed or abrupt changes in direction. Vessels may not adjust course and speed until the small cetaceans have moved beyond 50 m and/or the beam of the underway vessel; • All vessels underway will not divert or alter course in order to approach any whale, small cetacean, or pinniped. Any vessel underway will avoid excessive speed or abrupt changes in direction to avoid injury to the sighted cetacean or pinniped; and • All vessels will maintain a separation distance of 50 m (164 ft) or greater from any sighted pinniped. Vessel operators will use all available sources of information of NARW presence, including daily monitoring of the Right Whale Sightings Advisory System, WhaleAlert app, and monitoring of Coast Guard VHF Channel 16 to receive notifications of right whale detections to plan vessel routes to minimize the potential for co-occurrence with right whales. As part of vessel strike avoidance, a training program will be implemented. The training program will be provided to NMFS for review and approval prior to the start of surveys. Confirmation of the training and understanding of the requirements will be documented on a training course log sheet. Signing the log sheet		

Measure	Project Phase	Description	Resource Area Mitigated	Anticipated Enforcing Agency
		will certify that the crew members understand and will comply with the necessary requirements throughout the survey event.		
LOA-2: Foundation installation – Seasonal pile driving restrictions	C	Impact pile driving of foundations will not occur from January 1 through April 30. In addition, pile driving will not occur from December 1 through December 31, unless unanticipated delays due to weather or technical issues arise that necessitate extending pile driving into December in which case Empire would notify NMFS and BOEM in writing by September 1 that circumstances are expected to necessitate pile driving in December.	Marine Mammals	BOEM, BSEE, and NMFS
LOA-3: Foundation installation – Pile driving weather and time restrictions	C	Impact pile driving will commence only during daylight hours no earlier than one hour after (civil) sunrise. Impact pile driving will not be initiated later than 1.5 hours before (civil) sunset. Pile driving may continue after dark when the installation of the same pile began during daylight (1.5 hours before [civil] sunset), when clearance zones were fully visible for at least 30 minutes and must proceed for human safety or installation feasibility reasons. Impact pile driving will not be initiated in times of low visibility when the visual clearance zones cannot be visually monitored, as determined by the lead PSO on duty.	Marine Mammals, Sea Turtles	BOEM, BSEE, and NMFS
LOA-4: Foundation installation – Visual monitoring	C	During impact pile driving visual monitoring will occur as follows: • A minimum of two PSOs must be on active duty at the impact pile driving vessel/platform from 60 minutes before, during, and for 30 minutes after all pile installation activity; and • A minimum of two PSOs must be on active duty on a dedicated PSO vessel from 60 minutes before, during, and for 30 minutes after all monopile installation activity, or, an alternate monitoring technology (e.g., UAS) that has been demonstrated as having greater visual monitoring capability compared to two PSOs on a dedicated PSO vessel and is approved by NMFS, will be employed from 60 minutes before, during, and for 30 minutes after all monopile installation activity. If a dedicated PSO vessel is selected, the vessel must be located at the best vantage point to observe and document marine mammal sightings in proximity to the Clearance/Shutdown zones.	Marine Mammals, Sea Turtles	BOEM, BSEE, and NMFS

Measure	Project Phase	Description	Resource Area Mitigated	Anticipated Enforcing Agency
LOA-5: Foundation installation – Pre-start clearance	C	For impact pile driving, the Applicant will implement a 60-minute pre-start clearance period of the Clearance zones prior to the initiation of soft-start to ensure no marine mammals are in the vicinity of the pile. During this period the Clearance zones will be monitored by both PSOs and PAM. Pile driving will not be initiated if any marine mammal is observed within its respective Clearance zone. If a marine mammal is observed within a Clearance zone during the pre-start clearance period, impact pile driving may not begin until the animal(s) has been observed exiting its respective zone, or, until an additional time period has elapsed with no further sightings (i.e., 15 minutes for dolphins and pinnipeds and 30 minutes for all other species). In addition, impact pile driving will be delayed upon a confirmed PAM detection of a NARW, if the PAM detection is confirmed to have been located within the 5 km NARW PAM Clearance zone. Any large whale sighted by a PSO within 1,000 m of the pile that cannot be identified to species must be treated as if it were a NARW. Impact pile driving will not be initiated if the clearance zones cannot be adequately monitored (i.e., if they are obscured by fog, inclement weather, poor lighting conditions) for a 30-minute period prior to the commencement of soft start, as determined by the Lead PSO. If light is insufficient, the Lead PSO will call for a delay until the Clearance zone is visible in all directions. If a soft start has been initiated before the onset of inclement weather, pile driving activities may continue through these periods if deemed necessary to ensure human safety and/or the integrity of the Project.	Marine Mammals, Sea Turtles	BOEM, BSEE, and NMFS
LOA-6: Foundation installation – Clearance and shutdown zones	C	Clearance and Shutdown zones will be established (see Table 42 of the LOA application (Empire Wind 2022) and continuously monitored during impact pile driving to minimize impacts to marine mammals. These zones will be monitored as described under LOA-4 and mitigation enacted as described under LOA-9.	Marine Mammals	BOEM, BSEE, and NMFS
LOA-7: Foundation installation – Passive	C	PAM will occur during all impact pile driving and will supplement the visual monitoring program. During impact pile driving, PAM will begin 60 minutes prior to the initiation of soft-start, throughout foundation installation, and for 30 minutes after impact pile driving	Marine Mammals	BOEM, BSEE, and NMFS

Measure	Project Phase	Description	Resource Area Mitigated	Anticipated Enforcing Agency
acoustic monitoring		has been completed. PAM will be conducted by a dedicated, qualified, and NMFS-approved PAM operator. The PAM operator will monitor the hydrophone signals in real time both aurally (using headphones) and visually (via the monitor screen displays). The PAM operator will communicate detections of any marine mammals to the Lead PSO on duty who will ensure the implementation of the appropriate mitigation measures (i.e., delay or shutdown of pile driving). PAM detection alone (i.e., in the absence of visual confirmation by a PSO of a marine mammal within a relevant Clearance/Shutdown zone) will not trigger mitigation measures (i.e., delay or shutdown of pile driving), with the exception of a confirmed PAM detection of a NARW within the relevant zone. The real-time PAM system will be designed and established such that detection capability extends to 5 km from the pile driving location, for all monopile installations. Real-time PAM will begin at least 60 minutes before pile driving begins. The real-time PAM system will be configured to ensure that the PAM operator is able to review acoustic detections within approximately 15 minutes of the original detection, in order to verify whether a NARW has been detected. Any possible NARW vocalization will be reported as a detection if the vocalization is determined by the PAM operator to be within the Clearance/Shutdown zones.		
LOA-8: Foundation installation – Soft start	C	A soft start refers to initiating the pile driving process at reduced hammer energy to provide marine mammals a warning and an opportunity to vacate the area prior to pile driving at full hammer energy. Soft start will occur at the beginning of the driving of each pile and at any time following the cessation of impact pile driving of 30 minutes or longer. The soft start requires an initial 30 minutes using a reduced hammer energy for pile driving.	Marine Mammals, Sea Turtles, ESA-listed Fish	BOEM, BSEE, and NMFS
LOA-9: Foundation installation – Shut down and power down	C	The Clearance and Shutdown zones around the pile driving activities will be maintained by PSOs for the presence of marine mammals before, during, and after impact pile driving activity. If a marine mammal is observed entering or within the respective zones after pile driving has commenced, a shutdown of impact pile driving will occur when practicable as determined by the lead	Marine Mammals	BOEM, BSEE, and NMFS

Measure	Project Phase	Description	Resource Area Mitigated	Anticipated Enforcing Agency
		engineer on duty, who must evaluate the following to determine whether shutdown is safe and practicable: • Use of site-specific soil data and real-time hammer log information to judge whether a stoppage would risk causing piling refusal at re-start of piling; • Confirmation that pile penetration is deep enough to secure pile stability in the interim situation, taking into account weather statistics for the relevant season and the current weather forecast; and • Determination by the lead engineer on duty will be made for each pile as the installation progresses and not for the site as a whole. If a shutdown is called for but the lead engineer determines shutdown is not practicable due to an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk of injury or loss of life for individuals, reduced hammer energy (power down) will be implemented, when the lead engineer determines it is practicable. Subsequent restart/increased power of the equipment can be initiated if the animal has been observed exiting its respective zone within 30 minutes of the shutdown, or, after an additional time period has elapsed with no further sighting of the animal that triggered the shutdown (i.e., 15 minutes for small odontocetes and 30 minutes for all other species). If pile driving shuts down for reasons other than mitigation (e.g., mechanical difficulty) for brief periods (i.e., less than 30 minutes), it may be activated again without ramp-up, if PSOs have maintained constant observation and no detections of any marine mammal have occurred within the respective zones.		
LOA-10: Noise attenuation during impact pile driving	C	The Applicant will employ noise mitigation techniques during all impact pile driving that will attenuate pile driving noise by a minimum of 10 dB, such that measured ranges to isopleth distances corresponding to relevant marine mammal harassment thresholds are consistent with those modeled based on 10 dB attenuation, determined via sound field verification. The Applicant	Marine Mammals, Sea Turtles, ESA-listed Fish	BOEM, BSEE, and NMFS

Measure	Project Phase	Description	Resource Area Mitigated	Anticipated Enforcing Agency
		will employ a double bubble curtain or an attenuation technology that achieves noise reduction equivalent to or greater than that achieved by a double bubble curtain.		
LOA-11: Sound field verification	C	Sound field measurements will be conducted during the driving of the first three monopile foundations and all piles associated with installation of the first OSS foundation to compare sound field measurements with modeled isopleth distances. Sound field measurements will be conducted at distances of approximately 750 meters, 2,500 meters, and 5,000 meters from the pile being driven, as well as at the extent of the modeled behavioral harassment zones to verify the accuracy of those modeled zones. The recordings will be continuous throughout the duration of all impacts hammering of each pile monitored. The measurement systems will have a sensitivity appropriate for the expected sound levels from pile driving received at the nominal ranges throughout the installation of the pile. The frequency range of the system will cover the range of at least 20 hertz to 20 kilohertz. The system will be designed to have omnidirectional sensitivity and will be designed so that the predicted broadband received level of all impact pile-driving strikes exceed the system noise floor by at least 10 decibels. The dynamic range of the will be sufficient such that at each location, pile driving signals are not clipped and are not masked by the noise floor. A Sound Field Verification Plan will be submitted to NMFS for review and approval at least 90 days prior to the planned start of pile driving. This plan will describe how Empire will ensure that the location selected is representative of the rest of the piles of that type to be installed and how the effectiveness of the sound attenuation methodology will be evaluated based on the results. The Applicant will provide the initial results of the field measurements to NMFS as soon as they are available.	Marine Mammals, Sea Turtles, ESA-listed Fish	BOEM, BSEE, and NMFS
LOA-12: Cable landfall and marina activities – Visual monitoring	C	A minimum of two PSOs will be on active duty on the vibratory pile driving platform, or on a vessel nearby the construction vessel, from 30 minutes before, during, and 30 minutes after all pile driving.	Marine Mammals, Sea Turtles	BOEM, BSEE, and NMFS

Measure	Project Phase	Description	Resource Area Mitigated	Anticipated Enforcing Agency
LOA-13: Cable landfall and marina activities – Pre-start clearance	C	For all pile driving, the Applicant will implement a 30-minute clearance period of the Clearance zones prior to the initiation of installation. During this period the Clearance zones will be monitored by the PSOs, using the appropriate visual technology for a 30-minute period. Installation may not be initiated if any marine mammal is observed within its respective Clearance zone. If a marine mammal is observed within a Clearance zone during the pre-start clearance period, installation may not begin until the animal(s) has been observed exiting its respective zone or until an additional time period has elapsed with no further sightings (i.e., 15 minutes for dolphins and pinnipeds and 30 minutes for all other species). Any large whale sighted by a PSO within 1,000 m of the pile that cannot be identified to species must be treated as if it were a NARW.	Marine Mammals	BOEM, BSEE, and NMFS
LOA-14: Cable landfall and marina activities – Clearance and shutdown zones	C	Clearance and shutdown zones for vibratory pile driving will be established as described in Table 43 of the LOA application.	Marine Mammals	BOEM, BSEE, and NMFS
LOA-15: Cable landfall and marina activities – Shutdown and power down procedures	C	The Clearance and Shutdown zones around pile driving activities will be maintained, as previously described, by PSOs for the presence of marine mammals before, during, and after pile driving activity. An immediate shutdown of the hammer will be required if a marine mammal is sighted within or approaching its respective Shutdown zone. The operator will comply immediately with any call for shutdown by the Lead PSO, except in cases where immediate shutdown would represent a human safety risk. Any disagreement between the Lead PSO and operator will be discussed only after shutdown has occurred. Subsequent restart of the equipment can be initiated if the animal has been observed exiting its respective Shutdown zone within 30 minutes of the shutdown, or, after an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).	Marine Mammals	BOEM, BSEE, and NMFS

Measure	Project Phase	Description	Resource Area Mitigated	Anticipated Enforcing Agency
LOA-16: HRG survey activities	C, O&M	The specific measures identified in the LOA application were current as per the 2021 programmatic ESA section 7 consultation regarding offshore wind geophysical and geotechnical surveys (BOEM and NMFS 2021).	Marine Mammals	BOEM, BSEE, and NMFS

This page intentionally left blank.

ATTACHMENT H-2
OTHER APPLICANT-PROPOSED MEASURES

This page intentionally left blank.

Table H-3 Summary Table

Measure Number	Measure	Description of Measure	Resource	Project Phase
1	Training for extreme weather conditions	In order to mitigate the potential impacts from physical oceanographic and meteorological conditions, Empire will require that all personnel, crew, and contractors complete training and are familiar with the safety plans developed for extreme weather conditions.	Physical and Oceanographic Conditions	Construction, Operations and Maintenance, Decommissioning
2	Project design	The Project will be designed with consideration of conditions in the Project Area.	Physical and Oceanographic Conditions	Construction, Operations and Maintenance, Decommissioning
3	Siting of offshore components to avoid anomalous or challenging geological conditions	The siting of offshore components to avoid anomalous or challenging geological conditions to the extent practicable.	Geological Conditions	Construction & Decommissioning
4	Project design and construction will consider geological condition	Project infrastructure will be designed and constructed with consideration of the geological conditions within the Project Area.	Geological Conditions	Construction & Decommissioning
5	Study and analysis of geological conditions in the Project Area	Additional study and analysis will be completed prior to construction and installation activities to inform the selection of methods to allow for Project infrastructure to be constructed in a way that allows for the least impact, both to and from, the geological conditions in the Project Area.	Geological Conditions	Construction & Decommissioning
6	Siting of onshore components in previously disturbed areas	The siting of onshore components in previously disturbed areas, existing roadways, and/or ROWs to the extent practicable.	Geological Conditions	Construction & Decommissioning
7	Restoration of disturbed areas	Areas disturbed by construction activities will be restored (i.e., graded) to pre-construction conditions, to the extent practicable.	Geological Conditions	Construction & Decommissioning
8	Ongoing monitoring of assets that could be impacted by geological conditions	The on-going monitoring of assets that have the potential to be impacted by geological conditions, including foundations, and interarray and export cables, to confirm the cables have not become exposed or that the scour and cable protection measures have not worn away.	Geological Conditions	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
9	Siting of offshore components to avoid natural and anthropogenic hazard	Siting of the offshore components to minimize and avoid natural and anthropogenic hazards to the extent practicable.	Natural and Anthropogenic Hazards	Construction & Decommissioning
10	Deeper burial the submarine export ongoing discussions with the USACE	Deeper burial of the submarine export cables in areas within certain identified navigation channels, subject to ongoing discussions with the USACE and other applicable stakeholders.	Natural and Anthropogenic Hazards	Construction & Decommissioning
11	Deeper burial the submarine export and interarray cables in areas with seabed penetration	Deeper burial of the submarine export and interarray cables in areas identified as having seabed penetrating fishing activity.	Natural and Anthropogenic Hazards	Construction & Decommissioning
12	Munitions and Explosives of Concern (MEC) survey for necessary areas	Complete detailed, dedicated MEC survey for areas deemed necessary prior to installation.	Natural and Anthropogenic Hazards	Construction & Decommissioning
13	Proper cable burial measures and protection accounting for mobile seabed; planning for potential sandwave removal	Implementation of measures to allow for proper cable burial and protection that accounts for mobile seabed in this area, as well as plan for the possibility of sandwave removal during any future repairs to the cables.	Natural and Anthropogenic Hazards	Construction & Decommissioning
14	Horizontal buffer of 164 ft for identified potential submerged cultural resources	Implementation of a horizontal buffer of at least 164 ft (50 m) for identified potential submerged cultural resources unless further investigation and/or consultation with the appropriate authorities deems unnecessary.	Natural and Anthropogenic Hazards	Construction, Operations and Maintenance, Decommissioning
15	Distribution of information and Local Notice to Mariners (LNM) and active engagement with applicable stakeholders	Distribution of information and LNM and active engagement with applicable stakeholders to ensure awareness of the positions of Project-related assets to avoid any collision or interference.	Natural and Anthropogenic Hazards	Construction, Operations and Maintenance, Decommissioning
16	Periodic inspections of offshore Project components to verify integrity	Periodic inspections of offshore Project components, including foundations, scour protection, and submarine export and interarray cables, to verify integrity of the Project components and to confirm adequate burial.	Natural and Anthropogenic Hazards	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
17	Provide as-built information to NOAA to support necessary updates to navigation charts	Provide as-built information to NOAA to support necessary updates to navigation charts in coordination with NOAA and other stakeholders as needed.	Natural and Anthropogenic Hazards	Operations and Maintenance
18	Implementation of soil erosion and sediment control plans; SWPPP	The implementation of soil erosion and sediment control plans, which will be provided for agency review and approval, as applicable, for each onshore component to the requirements detailed in the New York State Standards and Specifications for Erosion and Sediment Control (Blue Book), including development of a SWPPP, as applicable.	Water Quality	Construction & Decommissioning
19	SSER Comprehensive Management Plan	The incorporation of the NYSDEC Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State into the site-specific best management practices for activities located within the SSER, as recommended by the SSER Comprehensive Management Plan.	Water Quality	Construction & Decommissioning
20	NPDES permits and SWPPP	Obtain an industrial stormwater NPDES permit (if required) and develop a SWPPP if more than 1 ac (0.4 ha) of land is disturbed at any land fall or onshore substation per the CWA (33 U.S.C. § 1342). The plan will identify the measures that will be employed at the site to control the release of erosion and pollutants to the water and will outline an implementation and maintenance schedule.	Water Quality	Construction & Decommissioning
21	Agency-approved inadvertent return plan	Implementation of an agency-approved inadvertent return plan, approved by the applicable agencies, as necessary.	Water Quality	Construction & Decommissioning
22	SPCC Plan	The management of accidental spills or releases of oils or other hazardous wastes through a SPCC plan, which will be provided for agency review and approval, as applicable.	Water Quality	Construction, Operations and Maintenance, Decommissioning
23	Restricted access	Restricting access through wetlands and waterbodies at EW 2 to identified construction sites, access roads, and work zones, to the extent practicable. This is not anticipated to be required at EW 1 and the O&M Base due to the absence of wetlands within the onshore area.	Water Quality	Construction & Decommissioning
24	Following regulation for at-sea discharge and vessel-generated waste	Project-related vessels will operate in accordance with laws regulating the at-sea discharges of vessel-generated waste.	Water Quality	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
25	SPCC Plan; OSRP	The management of accidental spills or releases of oils or other hazardous wastes through a SPCC plan for onshore activities and an OSRP for offshore activities, which will be provided for agency review and approval, as applicable.	Water Quality	Operations and Maintenance
26	SWPPP, SPCC inclusion of stormwater control feature inspection and cleaning	Stormwater control features will be routinely inspected and cleaned to remove debris or excess vegetation that may impede the designed functionality. The inspection schedule will be detailed in the SWPPP and SPCC or appropriate Operations Plan.	Water Quality	Operations and Maintenance
27	Nitrogen oxide and VOC emission reduction credits	Where required, Empire will purchase sufficient emission reduction credits to offset the NOX and VOC emissions for Project-related activities. Empire will provide documentation of the purchase of offsets in accordance with the requirements set forth in the Record of Decision (ROD) and/or the issued OCS air permit.	Air Quality	Construction, Operations and Maintenance, Decommissioning
28	Vessels will meet Tier III Nitrogen oxide standards	Vessels constructed on or after January 1, 2016 will meet Tier III NOX requirements when operating within the North American Emission Control Area (200 nm [370.4 km]) established by the International Maritime Organization (IMO).	Air Quality	Construction, Operations and Maintenance, Decommissioning
29	Ultra-low diesel fuel usage	Project-related diesel-powered equipment will use ultra-low sulfur diesel fuel, per the requirements of 40 CFR § 80.510(b). (Beginning June 1, 2010, all non-road diesel fuel is subject to a 15-ppm sulfur content limit, which is defined in practice as ultra-low sulfur diesel fuel.)	Air Quality	Construction & Decommissioning
30	Low sulfur diesel fuel usage	Project-related vessels will use low sulfur diesel fuel where possible and be at or below the maximum fuel sulfur content requirement of 1,000 ppm established per the requirements of 40 CFR § 80.510(k).	Air Quality	Construction, Operations and Maintenance, Decommissioning
31	EPA emission standard compliance	Project-related vessels will comply with applicable EPA, or equivalent, emission standards.	Air Quality	Construction, Operations and Maintenance, Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
32	Data sharing with BOEM	Empire will provide BOEM with data on horsepower rating of all propulsion and auxiliary engines, duration of time operating in state waters, load factor, and fuel consumption for Project-related vessels to determine actual emissions from Project-related vessels, which will confirm that sufficient emissions offsets have been acquired.	Air Quality	Construction, Operations and Maintenance, Decommissioning
33	Information updates on equipment provided to BOEM and EPA	Empire will provide vessel engines and emissions control equipment information to BOEM and the EPA in accordance with the requirements set forth in the ROD and/or the issued OCS air permit.	Air Quality	Construction, Operations and Maintenance, Decommissioning
34	Compliance with state regulations on engine idling	Project-related vehicles, diesel engines, and/or nonroad diesel engines at the staging site will comply with applicable state regulations regarding idling. In New York State, 6 NYCRR 217-3 prohibits all on-road diesel-fueled and non-diesel-fueled heavy-duty vehicles from idling for more than five minutes. N.J.A.C. 7:27-14 and 7:27-15 restricts the unnecessary idling of diesel and gasoline engines, respectively, to three minutes.	Air Quality	Construction & Decommissioning
35	Construction equipment will be well-maintained	Construction equipment will be well-maintained and vehicles using internal combustion engines equipped with mufflers will be routinely checked to ensure they are in good working order.	In-Air Acoustic Environment	Construction & Decommissioning
36	Quieter-type adjustable backup alarms will be used for vehicles as feasible	Quieter-type adjustable backup alarms will be used for vehicles as feasible.	In-Air Acoustic Environment	Construction & Decommissioning
37	Noisy equipment will be located as far as possible from NSAs	Noisy equipment will be located as far as possible and feasible from NSAs.	In-Air Acoustic Environment	Construction & Decommissioning
38	A noise complaint hotline will be made available	A noise complaint hotline will be made available to help actively address all noise related issues.	In-Air Acoustic Environment	Construction & Decommissioning
39	HDD/Direct Pipe construction activities will occur during daytime period	HDD/Direct Pipe construction activities will occur during daytime period unless otherwise deemed acceptable from the appropriate regulatory authority.	In-Air Acoustic Environment	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
40	In the case of night operations, only the HDD drill rig and power unit will be used	In the case of night operations, only the HDD drill rig and power unit will be used, unless deemed acceptable from the appropriate regulatory authority.	In-Air Acoustic Environment	Construction & Decommissioning
41	Compliance with IMO noise standards	The vessels used for nearshore work and vessels transiting between Project ports and the Lease Area will comply with IMO noise standards, as applicable.	In-Air Acoustic Environment	Construction & Decommissioning
42	Noise-generating equipment may be located inside or outside with the use of noise barriers, if necessary	If necessary, subject to regulatory requirements and stakeholder engagement, noise-generating equipment (e.g., reactors and transformers) may be located inside or outside with the use of noise barriers.	In-Air Acoustic Environment	Operations and Maintenance
43	Limited lighting during construction	Limiting lighting associated with construction vehicles and work zones, to the extent practicable, to reduce the attraction of insect prey for wildlife species such as bats and insectivorous birds.	Terrestrial Vegetation and Wildlife	Construction & Decommissioning
44	Siting in disturbed areas	Siting of onshore components in previously disturbed areas, existing roadways, and/or ROWs to the extent practicable.	Terrestrial Vegetation and Wildlife	Construction & Decommissioning
45	Soil erosion and sediment control plans	The implementation of soil erosion and sediment control plans, which will be provided for agency review and approval, as applicable, for each onshore component to the requirements detailed in the New York State Standards and Specifications for Erosion and Sediment Control (Blue Book), including development of a SWPPP, as applicable.	Terrestrial Vegetation and Wildlife	Construction & Decommissioning
46	Incorporation of the NYSDEC Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection	Incorporation of the NYSDEC Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State into the site-specific best management practices for activities located within the SSER, as recommended by the SSER Comprehensive Management Plan for EW 2.	Terrestrial Vegetation and Wildlife	Construction & Decommissioning
47	Implementation of an inadvertent return plan	The implementation of an inadvertent return plan, which will be provided for agency review and approval, as applicable.	Terrestrial Vegetation and Wildlife	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
48	Implementation of an invasive species control plan	The implementation of an invasive species control plan at EW 2 to avoid the spread of invasive species and replant with native vegetation only, which will be provided for agency review and approval, as applicable. This is not anticipated to be required for EW 1 or the O&M Base due to the highly developed nature of the onshore area and lack of natural vegetation.	Terrestrial Vegetation and Wildlife	Construction, Operations and Maintenance, Decommissioning
49	Revegetation of disturbed areas	Temporarily disturbed areas will be revegetated with appropriate native species at EW 2, as needed and in compliance with applicable permits, mitigation plans, and/or invasive species control plan to prevent the introduction of invasive plant species. This is not anticipated to be required for EW 1 or the O&M Base due to the highly developed nature of the onshore area and lack of natural vegetation.	Terrestrial Vegetation and Wildlife	Construction, Operations and Maintenance, Decommissioning
50	SWPPP and/or SPCC Plan	Management of accidental spills or releases of oils or other hazardous wastes through a SWPPP and/or SPCC Plan, which will be provided for agency review and approval, as applicable.	Terrestrial Vegetation and Wildlife	Construction & Decommissioning
51	staggering silt fencing / erosion control devices	Consideration of staggering silt fencing or other erosion control devices in sensitive areas to facilitate the passage of biota, if deemed effective. The strategy will be implemented on a site-specific basis and finalized during the permitting process.	Terrestrial Vegetation and Wildlife	Construction & Decommissioning
52	Implementation of a mitigation plan	The implementation of a mitigation plan for the mitigation of long-term unavoidable impacts within jurisdictional wetlands, streams, or their regulated buffer areas at EW 2, which will be provided for agency review and approval, as applicable. This is not anticipated to be required at EW 1 or the O&M Base due to the lack of wetlands and streams, as well as the highly developed nature of the onshore area.	Terrestrial Vegetation and Wildlife	Operations and Maintenance
53	Site-specific mitigation	Site-specific mitigation strategies as well as post-construction monitoring will be refined during the permitting process and detailed in an approved mitigation plan and SWPPP.	Terrestrial Vegetation and Wildlife	Operations and Maintenance
54	Limitation of project personnel/vehicles	Limiting access of Project personnel and vehicles beyond existing disturbed areas and approved access roads to the extent practicable.	Terrestrial Vegetation and Wildlife	Operations and Maintenance
55	Lighting reduction measures	The implementation of lighting reduction measures onshore such as downward projecting lights, lights triggered by motion sensors, and limiting artificial light to the extent practicable, where safe.	Terrestrial Vegetation and Wildlife	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
56	Invasive species survey	A formal survey for invasive plant species will be conducted before Project construction, if needed, in accordance with an Invasive Species Control Plan, to document the location of invasive plant stands within the limit of disturbance.	Terrestrial Vegetation and Wildlife	Operations and Maintenance
57	Siting in disturbed areas	The siting of onshore components in previously disturbed areas, existing roadways, and/or ROWs to the extent practicable.	Wetlands and Waterbodies	Construction & Decommissioning
58	Siting structures outside of special FHAs	The siting of structures outside of special FHAs at EW 2 to the extent practicable. Note that this is not possible for EW 1 or the O&M Base, due to the proximity of the Gowanus POI to the shoreline.	Wetlands and Waterbodies	Construction & Decommissioning
59	Implementation of soil erosion and sediment control plans; SWPPP	The implementation of soil erosion and sediment control plans, which will be provided for agency review and approval, as applicable, for each onshore component to the requirements detailed in the New York State Standards and Specifications for Erosion and Sediment Control (Blue Book), including development of a SWPPP, as applicable.	Wetlands and Waterbodies	Construction & Decommissioning
60	NYSDEC Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection management practices	The incorporation of the NYSDEC Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State into the site-specific best management practices for activities located within the SSER, as recommended by the SSER Comprehensive Management Plan for EW 2.	Wetlands and Waterbodies	Construction & Decommissioning
61	Inadvertent return plan	The implementation of an inadvertent return plan, which will be provided for agency review and approval, as applicable.	Wetlands and Waterbodies	Construction & Decommissioning
62	SPCC plan	The management of accidental spills or releases of oils or other hazardous wastes through a SPCC plan, which will be provided for agency review and approval, as applicable.	Wetlands and Waterbodies	Construction & Decommissioning
63	Restricted access	During construction, access will be restricted to existing paved roads and approved access roads at wetland and stream crossings where possible, to avoid excessive soil compaction in sensitive areas.	Wetlands and Waterbodies	Construction & Decommissioning
64	Temporary matting to protect vegetation	The installation of temporary matting at EW 2 if access through wetlands is required during construction activities to protect vegetation root systems, reduce compaction, and minimize ruts. This is not anticipated to be required for EW 1 or the O&M Base due to the lack of wetlands within the onshore area.	Wetlands and Waterbodies	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
65	Invasive species control plan	The implementation of an invasive species control plan at EW 2, which will be provided for agency review and approval, as applicable, to avoid the spread of invasive species and replant with native vegetation only. This is not anticipated to be required for EW 1 or the O&M Base due to the highly developed nature of the onshore area and lack of natural vegetation.	Wetlands and Waterbodies	Construction & Decommissioning
66	Restricted access	Restricting access through wetlands at EW 2 to identified construction sites, access roads, and work zones to the extent practicable. This is not anticipated to be required at EW 1 or the O&M Base due to the absence of wetlands within the onshore area.	Wetlands and Waterbodies	Construction & Decommissioning
67	Restoration of native species	Landscaping and restoration work at EW 2 will be completed with appropriate native species, per a landscape restoration plan or other appropriate plan, which will be provided for agency review and approval, as applicable, and in compliance with an invasive species control plan to prevent the introduction of invasive plant species, which will be provided for agency review and approval, as applicable. This is not anticipated to be required for EW 1 or the O&M Base due to the highly developed nature of the onshore area and lack of natural vegetation.	Wetlands and Waterbodies	Construction & Decommissioning
68	HDD	Consideration of the use of HDD for installation of the export cable landfalls at EW 2 to avoid surficial disturbances.	Wetlands and Waterbodies	Construction & Decommissioning
69	staggering silt fencing / erosion control devices	Consideration of staggering silt fencing or other erosion control devices in sensitive areas to facilitate the passage of biota, if deemed effective. The strategy will be implemented on a site-specific basis and finalized during the permitting process.	Wetlands and Waterbodies	Construction & Decommissioning
70	Restricted access	Protective measures will be installed around Project components at EW 2, to restrict access to wetlands during operation and maintenance activities. This is not anticipated to be required for EW 1 or the O&M Base due to the lack of wetlands within the onshore area.	Wetlands and Waterbodies	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
71	Landscape restoration plan	Revegetation monitoring at EW 2 will be conducted consistent with a landscaping restoration plan and an invasive species control plan, which will be provided for agency review and approval, as applicable, within wetlands, waterbodies, and protected adjacent areas and riparian zones that were temporarily disturbed during Project construction to ensure that functionality is restored in these areas satisfactory to permit requirements. This is not anticipated to be required for EW 1 or the O&M Base due to the highly developed nature of the onshore area.	Wetlands and Waterbodies	Operations and Maintenance
72	Mitigation monitoring for wetlands, waterbodies, and riparian zones	Mitigation monitoring at EW 2, if required and as defined during the regulatory process for any areas identified as mitigation sites as a result of long-term unavoidable impacts to wetlands, waterbodies and protected adjacent areas and riparian zones. This is not anticipated to be required for EW 1 or the O&M Base due to the lack of wetlands within the onshore area.	Wetlands and Waterbodies	Operations and Maintenance
73	Stormwater control features; SWPPP; SPCC	Stormwater control features will be routinely inspected and cleaned to remove debris or excess vegetation that may impede the designed functionality. The inspection schedule will be detailed in the SWPPP and/or SPCC.	Wetlands and Waterbodies	Operations and Maintenance
74	Siting in disturbed areas	Onshore components will be sited in previously disturbed areas, existing roadways, or otherwise unsuitable avian habitat and/or ROWs to the extent practicable.	Avian & Bat Species	Pre-Construction
75	Bat surveys	Empire Wind will be conducting acoustic bat surveys for the EW 2 Project in accordance with the U.S. Fish and Wildlife Service's Range-Wide Indiana Bat & Northern Long-eared Bat Survey Guidelines of 2023. A negative presence survey will be taken as evidence that there is no need for limiting tree clearing or for conducting roost tree surveys.	Avian & Bat Species	Construction & Decommissioning
76	Lighting restrictions	Lighting not required during onshore and offshore construction will be limited to the minimum required by regulation and for safety, to reduce attraction of avian, bat, and sea turtle species.	Avian & Bat Species	Construction & Decommissioning
77	Bird deterrent devices	Installation of bird deterrent devices, where appropriate, on offshore, above-water Project-related structures to minimize introduction of perching structures to the offshore environment.	Avian & Bat Species	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
78	Lighting restrictions	Lighting not required by the FAA and the USCG and for safety during offshore construction will be limited to reduce attraction of birds and bats, where practicable.	Avian & Bat Species	Construction, Operations and Maintenance, Decommissioning
79	Dead/injured bird reporting	An annual report will be submitted to DOI and USFWS by January 31, accounting for any dead or injured birds or bats found on vessels or Project structures during construction, O&M, and decommissioning. The following information will be included: species name, date found, location, photo (if available), other relevant information. Any carcasses that have federal or research bands will be reported to the U.S. Geological Survey Bird Band Laboratory, BOEM, and USFWS.	Avian & Bat Species	Construction & Decommissioning
80	OSRP	The development and enforcement of an ORSP (Appendix F).	Avian & Bat Species	Construction & Decommissioning
81	HDD or other trenchless technology	Consideration of the use of HDD or other trenchless technologies for installation of the export cable landfalls at EW 2 to avoid surficial disturbances.	Avian & Bat Species	Construction & Decommissioning
82	Monitoring program	Development of an offshore bird and bat monitoring program to answer specific questions, including identifying key species of interest, and when possible, to contribute to the understanding of long-term, Project-specific impacts and larger scale efforts to understand cumulative impacts. Implementation of an Avian and Bat Post-Construction Monitoring Plan in coordination with the USFWS.	Avian & Bat Species	Operations and Maintenance
83	Revegetation of disturbed areas	Temporarily disturbed areas will be revegetated with appropriate native species at EW 2, as appropriate. This is not anticipated to be required at EW 1 due to the highly developed nature of the onshore area and lack of natural vegetation.	Avian & Bat Species	Operations and Maintenance
84	ADLS	Lessee will use an FAA-approved ADLS on wind turbines and offshore substations, which will only activate the FAA hazard lighting when an aircraft is in the vicinity of the wind facility, to reduce the visibility of nighttime lighting and nighttime visual impacts.	Avian & Bat Species	Operations and Maintenance
85	Avoidance of sensitive habitat	Avoiding, to the extent possible, siting structures (wind turbines, offshore substations, and submarine export and interarray cables) in areas of sensitive habitat, where feasible.	Benthic & Pelagic Resources	Pre-Construction

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
86	Spill prevention	Mitigation and avoidance measures to protect water quality, such as spill prevention.	Benthic & Pelagic Resources	Construction, Operations and Maintenance, Decommissioning
87	Designing lighting to avoid exposing wildlife to artificial light	Sensitive lighting schemes to minimize exposure of light.	Benthic & Pelagic Resources	Operations and Maintenance
88	Seasonal work window establishment	Establish seasonal work windows that avoid sensitive life stages, as feasible.	Benthic & Pelagic Resources	Pre-Construction
89	Silt curtains	Installing silt curtains is sensitive areas, as warranted by results of the sediment modeling.	Benthic & Pelagic Resources	Construction & Decommissioning
90	Ramp-up pile driving	Using ramp-up pile driving protocols.	Benthic & Pelagic Resources	Construction & Decommissioning
91	Cable installation tools	Using cable installation tools during trenching/installing/ armoring cable activities that minimize the area and duration of sediment suspension, as feasible.	Benthic & Pelagic Resources	Construction & Decommissioning
92	HDD Plan	The use of HDD at export cable landfall at EW 2 to minimize physical disturbance of coastal habitats.	Benthic & Pelagic Resources	Construction & Decommissioning
93	HDD Plan	Empire would implement appropriate measures during HDD activities at export cable landfalls to minimize potential release of HDD fluid. To minimize an inadvertent fluid return, an HDD Contingency Plan would be developed and implemented.	Benthic & Pelagic Resources	Construction & Decommissioning
94	DPS vessels	Most construction vessels will maintain position using dynamic positioning, limiting the use of anchors and jack-up features, where feasible. Any anchors or jack-up features would be placed within the previously cleared and/or disturbed area around the foundations.	Benthic & Pelagic Resources	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
95	OSRP	Using appropriate measures for vessel operation and implementing an OSRP, which includes measures to prevent, detect, and contain accidental release of oil and other hazardous materials. Project personnel would be trained in accordance with relevant laws, regulations, and Project policies, as described in the OSRP.	Benthic & Pelagic Resources	Construction & Decommissioning
96	Timing of construction	Consideration of the timing of construction activities; working with the fishing industry and fisheries agencies on sensitive spawning and fishing periods to actively avoid or reduce interaction with receptors, where feasible.	Benthic & Pelagic Resources	Construction & Decommissioning
97	Cable burial to 4-6 feet depth	A commitment to sufficiently bury electrical cables (target 6 feet [1.2 meters]) where feasible, minimizing seabed habitat loss and reducing the effects of EMF; where deep burial is not technically feasible, rock armoring will shield the cable from the overlying water.	Benthic & Pelagic Resources	Operations and Maintenance
98	Continued engagement with regulatory agencies and ENGOs	Development of appropriate monitoring program(s) in close coordination with regulatory agencies and stakeholders.	Benthic & Pelagic Resources	Construction, Operations and Maintenance, Decommissioning
99	OSRP	The development and enforcement of an OSRP (Appendix F).	Benthic & Pelagic Resources	Construction, Operations and Maintenance, Decommissioning
100	Scour protection	Installation of scour protection, as needed.	Benthic & Pelagic Resources	Construction
101	Continued engagement with agencies	Continued engagement with regulatory agencies, ENGOs, and other stakeholders on potential mitigation and best practices, as appropriate.	Marine Mammals & Sea Turtles	Construction & Decommissioning
102	seasonal closures	Seasonal pile driving closures.	Marine Mammals & Sea Turtles	Construction & Decommissioning
103	Ramp-ups, clearance & shut-down procedures	Ramp-up measures when impact pile driving is initiated.	Marine Mammals & Sea Turtles	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
104	pre-clearance	Pre-clearance prior to the initiation of pile driving to ensure marine mammals are not located within relevant impact zones when pile driving begins.	Marine Mammals & Sea Turtles	Construction & Decommissioning
105	pile driving shutdown	Shutdown of impact pile driving based on confirmed detection of marine mammals within relevant impact zones, when feasible.	Marine Mammals & Sea Turtles	Construction & Decommissioning
106	Monitoring and exclusion zones	Establishment of clearance and shutdown zones enforced by: o Qualified NOAA Fisheries approved PSOs; o Real-time monitoring systems, as appropriate; o Use of PAM systems; and o Use of reduced visibility monitoring tools/technologies (e.g., night vision, infrared and/or thermal cameras)	Marine Mammals & Sea Turtles	Construction & Decommissioning
107	PSOs	PSOs will be stationed at the pile driving platform/vessel as well as on a dedicated PSO vessel.	Marine Mammals & Sea Turtles	Construction & Decommissioning
108	Noise reducing technologies	Use of commercially available and technically feasible noise attenuation technologies to reduce pile driving noise.	Marine Mammals & Sea Turtles	Construction & Decommissioning
109	Speed restrictions	Project-related vessels will comply with NOAA Fisheries speed restrictions within the Mid-Atlantic U.S. SMAs for North Atlantic right whales of 10 knots (18.5 km/h) or less for vessels 65 ft (20 m) or greater during the period of November 1 through April 30. Project-related vessels will also comply with the 10 knot (<18.5 km/h) speed restrictions in any visually triggered Slow Zone/DMA.	Marine Mammals & Sea Turtles	Construction, Operations and Maintenance, Decommissioning
110	Speed restrictions	Project-related vessels 65 ft (20 m) or greater will comply 10 knot (18.5 km/s) speed restrictions when any mother/calf pairs, pods, or large assemblages of cetaceans are in the vicinity.	Marine Mammals & Sea Turtles	Construction & Decommissioning
111	Vessel collision avoidance mitigation measures	Vessel collision avoidance mitigation measures for Project-related vessels working in or in transit to and from the Lease Area, including 500-m separation distance from North Atlantic right whales, 100-m separation distance from all other large whales and 50-m separation distance from all other marine mammals as well as adherence to vessel strike avoidance measures as advised by NOAA Fisheries.	Marine Mammals & Sea Turtles	Construction, Operations and Maintenance, Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
112	Reference materials	Reference materials will be provided on board all Project vessels for identification of marine mammals.	Marine Mammals & Sea Turtles	Construction, Operations and Maintenance, Decommissioning
113	Any vessel larger than 300 gross tonnes moving into right whale habitat will report in as part of the right whale Mandatory Ship Reporting System	Any vessel larger than 300 gross tonnes moving into right whale habitat will report in as part of the NOAA Fisheries Northeast marine mammal and sea turtle stranding and entanglement hotline: (866) 755-NOAA (866-755-6622). They will be immediately responded to with updated reports of right whale sightings in the area, in addition to reminders of safe vessel speeds and movements within the management area.	Marine Mammals & Sea Turtles	Construction, Operations and Maintenance, Decommissioning
114	PSOs and/or Project personnel will check NOAA's website daily for any update on DMAs/Slow Zones	Marine mammal observers and/or Project personnel will check NOAA's website regularly for updates on Slow Zones/DMAs and will respond with vessel movement strategies or work hours accordingly.	Marine Mammals & Sea Turtles	Construction, Operations and Maintenance, Decommissioning
115	Sightings of North Atlantic right whales will be immediately reported the NOAA Fisheries North Atlantic Right Whale Sighting Advisory System	Sightings of North Atlantic right whales will be immediately reported the NOAA Fisheries North Atlantic Right Whale Sighting Advisory System: (866) 755-6622 (sightings in any location may also be reported to the U.S. Coast Guard via channel 16).	Marine Mammals & Sea Turtles	Construction, Operations and Maintenance, Decommissioning
116	All crew members responsible for navigation duties must receive site-specific training	All crew members responsible for navigation duties must receive site-specific training on protected species sighting/reporting and vessel strike avoidance measures prior to the start of in water construction activities.	Marine Mammals & Sea Turtles	Construction, Operations and Maintenance, Decommissioning
117	Following regulation for at-sea discharge and vessel-generated waste	Project-related vessels will operate in accordance with laws regulating the at-sea discharges of vessel-generated waste.	Marine Mammals & Sea Turtles	Construction, Operations and Maintenance, Decommissioning
118	Avoidance of sensitive habitat	Siting of Project-components to avoid and minimize impacts to habitat of high value to marine mammals, directly and indirectly, to the greatest extent practicable.	Marine Mammals & Sea Turtles	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
119	Use of dedicated lookout to reduce risk of collision	Use dedicated trained crew members lookout (independent of fulfilled by PSO[s] for applicable activities) to help reduce the risk of collision under certain circumstances.	Marine Mammals & Sea Turtles	Operations and Maintenance
120	Monitoring program development	Development of appropriate monitoring program(s) in close coordination with regulatory agencies and stakeholders.	Marine Mammals & Sea Turtles	Operations and Maintenance
121	Use of SOV concept	Use of SOV concept, supported by CTV(s), to reduce vessel traffic associated with Operations and Maintenance for the Project, if technically and commercially feasible.	Marine Mammals & Sea Turtles	Operations and Maintenance
122	buffer area for identified potential submerged archaeological resources	Implementation of a horizontal buffer of at least 164 ft (50 m) for identified potential submerged archaeological resources, unless further investigation and/or consultation with the appropriate authorities deems this unnecessary.	Marine Archaeological Resources	Construction, Operations and Maintenance, Decommissioning
123	Engagement with Tribes and cultural resource stakeholders	Additional evaluation of appropriate measures regarding paleolandscape features to be addressed with regulatory authorities, and informed by engagement with Tribes and cultural resource stakeholders.	Marine Archaeological Resources	Construction, Operations and Maintenance, Decommissioning
124	Siting in disturbed areas	Avoidance of culturally sensitive terrestrial archaeological resources by siting Project components in existing ROWs and previously disturbed areas, to the extent practicable.	Terrestrial Archaeological Resources	Construction & Decommissioning
125	An archaeologist will be present to monitor during ground-disturbing activities	An archaeological monitor will be present where the Project's ground-disturbing activities intersect the "Archaeological Monitoring Area" depicted in **Figure Y-2-12** in **Appendix Y, Attachment Y2**.	Terrestrial Archaeological Resources	Construction & Decommissioning
126	Unanticipated Discoveries Plan	The development and implementation of an Unanticipated Discoveries Plan, which will be developed in coordination with federal and state agencies and the Tribes. The Unanticipated Discoveries Plan will be in accordance with state laws and will outline the procedures to follow if archaeological materials or human remains are discovered during construction activities, including contact information and reporting protocols if unanticipated discoveries are identified.	Terrestrial Archaeological Resources	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
127	Outreach/engagement with Tribes and stakeholders	Continued outreach and engagement with relevant agencies, interested Tribes, and other stakeholders throughout the construction process to identify appropriate mitigation and monitoring measures during ground-disturbing activities, if deemed necessary.	Historic Properties & Architectural Properties	Construction & Decommissioning
128	Siting in disturbed areas	Avoidance of sensitive historic resources by siting onshore Project components in highly developed and previously disturbed areas to the extent practicable.	Historic Properties & Architectural Properties	Construction & Decommissioning
129	Following regulation for marking and lighting of above-water offshore components	Marking and lighting of above water offshore Project components will be consistent with regulatory requirements and guidance (see Section 3 for additional details on the proposed marking and lighting measures).	Historic Properties & Architectural Properties	Operations and Maintenance
130	Wind turbine design and appearance to follow BOEM recommendations	Wind turbine design and appearance will be in line with mitigation measures recommended by BOEM (2007).[1]	Historic Properties & Architectural Properties	Operations and Maintenance
131	Siting in disturbed areas	Onshore components have been proactively sited in highly developed and previously disturbed areas, where feasible, where they will introduce less visual contrast relative to their surroundings.	Visual Resources	Construction & Decommissioning
132	Vegetative screening	Vegetative screening, as needed, at the onshore substation sites to help screen views of the onshore substation by nearby residents, subject to New York permitting requirements.	Visual Resources	Construction & Decommissioning
133	Marking/lighting/painting WTGs according to regulations	Marking and lighting and paint color of above water offshore Project components will be consistent with regulatory requirements and guidance (see Section 3 for additional details on the proposed marking and lighting measures).	Visual Resources	Operations and Maintenance

[1] BOEM (Bureau of Ocean Energy Management). 2007. Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternative Use of Facilities on the Outer Continental Shelf – Final Environmental Impact Statement, Section 5 Potential Impacts of Alternative Energy Development. Available online at: https://www.boem.gov/Renewable-Energy-Program/Regulatory-Information/Alt_Energy_FPEIS_VolIIFrontMatter.aspx. Accessed May 23, 2019.

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
134	Wind turbine design and appearance to follow BOEM recommendations	Wind turbine design and appearance will be in line with mitigation measures recommended by BOEM (2007).[1]	Visual Resources	Operations and Maintenance
135	Lighting design to reduce light pollution	Lighting at the onshore substation site will be designed to include measures to reduce light pollution, where feasible, such as downward projecting lights, lights triggered by motion sensors, and limiting artificial light to the extent practicable	Visual Resources	Operations and Maintenance
136	Use of design standards of Waterfront Revitalization Program	The EW 1 onshore substation and O&M Base will meet the design standards set forth in the Waterfront Revitalization Program policies, as applicable (see Appendix AA).	Visual Resources	Operations and Maintenance
137	ADLS	Implementation of an ADLS on turbines (or a similar system) to turn the aviation obstruction lights on and off in response to detection of nearby aircraft, as a base case, pending commercial availability, technical feasibility, and agency review and approval.	Visual Resources	Operations and Maintenance
138	Vegetative screening	Vegetative screening, as needed, along the north side of the EW 2 Onshore Substation A site to help screen views of the substation by nearby residents, subject to New York and New Jersey permitting requirements.	Visual Resources	Operations and Maintenance
139	Siting in disturbed areas	Installation of onshore components within existing ROWs and within previously developed areas designated for such uses, to the extent practicable.	Population, Economy, Employment, and Housing and Property Values	Construction & Decommissioning
140	Siting in disturbed areas	Installation of onshore components within existing ROWs and within previously developed areas designated for such uses, to the extent practicable.	Land Use and Zoning	Construction & Decommissioning
141	Development of a Traffic Management Plan	The development of a Traffic Management Plan, to be developed in coordination with, and approved by, the affected local municipalities, as applicable.	Land Use and Zoning	Construction & Decommissioning
142	Security measures on active construction sites	The addition of security measures to monitor, and proper marking of, active construction sites, as deemed necessary.	Land Use and Zoning	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
143	Local community updates and communication	Regular updates to the local community through social media and public notices and/or other appropriate communications tools.	Land Use and Zoning	Construction & Decommissioning
144	Coordination with agencies, officials, and stakeholders for future land development plans	Coordination with appropriate local and municipal agencies, officials, and stakeholders, in consideration of future land development plans.	Land Use and Zoning	Operations and Maintenance
145	Marking of onshore components	The onshore components will be properly marked for identification.	Land Use and Zoning	Operations and Maintenance
146	Restoration of onshore project area	The onshore Project Area will be restored to conditions consistent with approvals from local authorities and/or property owners.	Land Use and Zoning	Operations and Maintenance
147	Minimize impacts to public access in the EW 2 onshore substation design, as feasible	Empire will evaluate minimizing impacts to public access in the EW 2 onshore substation design, as feasible.	Land Use and Zoning	Operations and Maintenance
148	Security measures on active construction sites and security vessels monitoring	The addition of security vessels monitoring, and proper marking of, active construction sites.	Recreation and Tourism	Construction & Decommissioning
149	Development of a Traffic Management Plan	The development of a Traffic Management Plan, to be developed in coordination with, and approved by, the affected local municipalities.	Recreation and Tourism	Construction & Decommissioning
150	Local community updates and communication	Regular updates to the local community through the issuance of LNMs, social media, public notices, and/or other appropriate communications tools.	Recreation and Tourism	Construction & Decommissioning
151	Marking of wind turbines and offshore substations with USCG/PATON requirements	The wind turbines and offshore substations will be properly marked in accordance with USCG guidance, including the PATON requirements (see Section 3 for additional details on the proposed marking and lighting measures).	Recreation and Tourism	Operations and Maintenance
152	Vessels will not be restricted from entering the operational wind farms areas	Vessels will not be restricted from entering the operational wind farms areas, and as a result, these structures may attract local charters for sightseeing and recreational fishing.	Recreation and Tourism	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
153	Local community updates and communication	Regular updates to the local community through social media, public notices, and/or other appropriate communications tools.	Environmental Justice	Construction, Operations and Maintenance, Decommissioning
154	Siting in disturbed areas	Installation of onshore components within existing ROWs and within previously developed areas designated for such uses, to the extent practicable.	Environmental Justice	Construction, Operations and Maintenance, Decommissioning
155	Development of a Traffic Management Plan	The development of a Traffic Management Plan, to be developed in coordination with, and approved by, the affected local municipalities, as applicable.	Environmental Justice	Construction, Operations and Maintenance, Decommissioning
156	Development of a Traffic Management Plan	The development of a Traffic Management Plan, to be developed in coordination with, and approved by, the affected local municipalities, as applicable.	Land Transportation and Traffic	Construction, Operations and Maintenance, Decommissioning
157	Development of Project-related vehicle routes	The development of Project-related vehicle routes to and from construction sites, which are consistent with allowable uses, to the extent practicable.	Land Transportation and Traffic	Construction, Operations and Maintenance, Decommissioning
158	Highly visible lighting/marking of active construction sites	Highly visible marking and lighting of active construction sites.	Land Transportation and Traffic	Construction, Operations and Maintenance, Decommissioning
159	Establishment of temporary, localized construction zones	Temporary, localized construction zones to minimize areas or sections of road closure.	Land Transportation and Traffic	Construction, Operations and Maintenance, Decommissioning
160	Local community updates and communication	Regular updates to the local community through social media, public notices, and/or other appropriate communications tools.	Land Transportation and Traffic	Construction, Operations and Maintenance, Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
161	Consultation with DoD Clearinghouse	Continue consultation with DoD Clearinghouse, including the engagement of a formal Mitigation Agreement process to offset identified impacts to radar systems. On July 29, 2020, Empire received a request from the DoD Clearinghouse to enter into a partnership to initiate mitigation discussion for potential impacts resulting from the construction and installation of the Project. Empire intends to enter into this partnership, responding with a confirmation letter on August 19, 2020. Empire met with the DoD in November 2021 and discussions are ongoing to finalize the mitigation agreement.	Aviation	Construction & Decommissioning
162	Minimize and/or mitigate potential impacts to high frequency weather & current radar systems	Coordination with NOAA to minimize, and/or mitigate potential impacts to high frequency weather and current radar systems.	Aviation	Construction & Decommissioning
163	Direction communication with applicable agencies and personnel to alert of construction movements	Direct communication with applicable agencies and personnel to alert the appropriate parties to planned construction movements and actions.	Aviation	Construction & Decommissioning
164	Marking/lighting of wind turbines and construction equipment in accordance with FAA's Advisory Circular number 70/7460-1L	All wind turbines and construction equipment will be properly lit and marked in accordance with FAA's Advisory Circular number 70/7460-1L within FAA jurisdiction and beyond, or other methods as deemed required during consultation and as applicable (see Section 3 for additional information on proposed marking and lighting measures.	Aviation	Construction, Operations and Maintenance, Decommissioning
165	Regular communication/updates with key aviation stakeholders and with DoD Clearinghouse	Regular communications and updates with key aviation stakeholders, including the DoD Clearinghouse, on wind turbine locations. On July 29, 2020, Empire received a request from the DoD Clearinghouse to entire a partnership to initiate mitigation discussion for potential impacts resulting from the construction and installation of the Project. Empire intends to enter into this partnership, responding with a confirmation letter on August 19, 2020. Empire met with the DoD in November 2021 and discussions are ongoing to finalize the mitigation agreement.	Aviation	Operations and Maintenance
166	Continued consultation with stakeholders	Continued consultation with stakeholders, including but not limited to: the USCG, New York Vessel Traffic Service, PANYNJ, and the USACE on best practices.	Marine Transportation and Navigation	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
167	Highly visible lighting/marking of active construction sites	Highly visible marking and lighting of active construction sites.	Marine Transportation and Navigation	Construction & Decommissioning
168	Vessel compliance with international and flag state regulations	Compliance by vessels associated with the Project with international and flag state regulations including the COLREGs and the SOLAS.	Marine Transportation and Navigation	Construction & Decommissioning
169	Compliance with existing uses and management of surrounding waterway	Utilization of existing TSSs, maintained channels, and transit lanes by vessels associated with the Project to comply with existing uses and management of the surrounding waterway, to the extent practicable.	Marine Transportation and Navigation	Construction & Decommissioning
170	Completion of a Cable Installation Plan	Completion of a Cable Installation Plan, detailing how cable installation will be managed to ensure disruption is minimized, in particular within port approaches.	Marine Transportation and Navigation	Construction & Decommissioning
171	Completion of a Construction Method Statement	Completion of a Construction Method Statement, detailing specific construction logistics between New York ports and the Lease Area, inclusive of transport configuration, vessels, and schedule of transport operations.	Marine Transportation and Navigation	Construction & Decommissioning
172	Contract agreement that all construction vessels be equipped with working AIS transceivers at all times	Inclusion by Empire of a requirement in contracts that all construction vessels be equipped with working AIS transceivers at all times.	Marine Transportation and Navigation	Construction & Decommissioning
173	Marine coordination for vessels	Marine coordination for vessels associated with the Project (i.e., a central coordination hub from which all Project vessel movements will be managed, and third-party traffic will be monitored).	Marine Transportation and Navigation	Construction & Decommissioning
174	Minimum advisory safe passing distances for cable laying vessels	Minimum advisory safe passing distances for cable laying vessels (where feasible).	Marine Transportation and Navigation	Construction & Decommissioning
175	Monitoring of third-party vessel traffic by AIS	Monitoring of third-party vessel traffic by AIS.	Marine Transportation and Navigation	Construction & Decommissioning
176	Implementation of a safety zone around active construction sites	The implementation of up to a 1,640-ft (500-m) safety zone around active construction sites (including partially installed wind turbines) pending agreement with USCG.	Marine Transportation and Navigation	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
177	Creation/Implementation of an SMS	Creation and implementation of an SMS (**Appendix G**).	Marine Transportation and Navigation	Construction & Decommissioning
178	Implementation of Layout Rules	Implementation of the Layout Rules (see **Section 3**) during layout design process, most notably: - One nautical mile separation between wind farm and the edge of the TSS lanes. - Straight line edges parallel to TSS lanes (no isolated or protruding turbines). - At least one line of orientation in final layout.	Marine Transportation and Navigation	Construction & Decommissioning
179	Regular updates to the local marine community regarding positions of installation activities	Regular updates, including the positions of installed and partially installed structures, to the local marine community through social media, the USCG LNM, and active engagement with Maritime Association of the Port of New York and New Jersey Harbor Safety, Navigation, and Operations Committee.	Marine Transportation and Navigation	Construction & Decommissioning
180	Ongoing consultation with stakeholders	Ongoing consultation with stakeholders, in particular, in relation to the submarine export cable(s).	Marine Transportation and Navigation	Construction & Decommissioning
181	Use of buoys/support vessels to mark temporary working areas	The potential use of buoys and/or support vessels to mark temporary working areas or potential hazards (e.g., partially installed structures).	Marine Transportation and Navigation	Construction & Decommissioning
182	Project Support Vessel monitoring	The operation of Project Support Vessels monitoring and communicating with vessels operating in the area.	Marine Transportation and Navigation	Construction & Decommissioning
183	Regular updates to the local marine community on safety zones	Regular safety zone updates to the local marine community through social media, the USCG LNM, and active engagement with Maritime Association of the Port of New York and New Jersey Harbor Safety, Navigation, and Operations Committee.	Marine Transportation and Navigation	Construction & Decommissioning
184	Dynamic construction and safety zones	Dynamic construction and safety zones where feasible, focusing on sites being actively worked on, to minimize the extent of the affected area.	Marine Transportation and Navigation	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
185	Marking of wind turbines and offshore substations with USCG/BOEM requirements	The wind turbines and offshore substation will be properly marked and lit in accordance with IALA O-139 and USCG/BOEM requirements, unless a variance is approved by the applicable agency prior to construction (see Section 3 for additional details on the proposed marking and lighting measures).	Marine Transportation and Navigation	Operations and Maintenance
186	Project Layout Rules	Project Layout Rules will be implemented to facilitate ease of navigation in and around the wind farm to minimize allision risk.	Marine Transportation and Navigation	Operations and Maintenance
187	1nm separation distance from vessel traffic within neighboring TSS lanes	Project-enacted “Developable Area” will facilitate a 1-nm (1.8-km) separation distance from vessel traffic within neighboring TSS lanes.	Marine Transportation and Navigation	Operations and Maintenance
188	Updates to NOAA on location of applicable project infrastructure	Information will be provided to NOAA so that charts (nautical and electronic) can be updated with the location of applicable Project infrastructure.	Marine Transportation and Navigation	Operations and Maintenance
189	Minimum blade clearance of 85 ft for wind turbines	Wind turbines will have a minimum blade clearance of 85 ft (26 m) above mean higher high water.	Marine Transportation and Navigation	Operations and Maintenance
190	Vessel compliance with international and flag state regulations	Compliance by vessels associated with the Project with international and flag state regulations including the COLREGs and the SOLAS.	Marine Transportation and Navigation	Operations and Maintenance
191	Development and implementation of an ERP	The development and implementation of an ERP.	Marine Transportation and Navigation	Operations and Maintenance
192	Marine coordination for vessels	Marine coordination for vessels associated with the Project (i.e., a central coordination hub from which all Project vessel movements will be managed, and third-party traffic will be monitored).	Marine Transportation and Navigation	Operations and Maintenance
193	Compliance with existing uses and management of surrounding waterway	Utilization of existing TSSs, maintained channels, and transit lanes by vessels associated with the Project to comply with existing uses and management of the surrounding waterway, to the extent practicable.	Marine Transportation and Navigation	Operations and Maintenance
194	Closed circuit television for site monitoring	Closed circuit television installed on certain structures within the array for the purpose of monitoring activity within the site.	Marine Transportation and Navigation	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
195	Communication with fisherman on location of project structures	Locations of the wind farm structures will be provided directly to fishermen for the purpose of displaying the wind farm electronically via their on-board equipment.	Marine Transportation and Navigation	Operations and Maintenance
196	Facilitation of USCG SAR trials	Facilitation of USCG SAR trials within and near the Lease Area.	Marine Transportation and Navigation	Operations and Maintenance
197	Operational SAR Procedures	Operational SAR Procedures in place that detail how the Project will cooperate with USCG in the event of an emergency situation.	Marine Transportation and Navigation	Operations and Maintenance
198	Development of a marine pollution contingency plan	The development of a marine pollution contingency plan (e.g., **Appendix F Oil Spill Response Plan**).	Marine Transportation and Navigation	Operations and Maintenance
199	Establishment of operational procedures for Project vessels	The establishment of operational procedures for Project vessels such as entry/exit points and designated routes.	Marine Transportation and Navigation	Operations and Maintenance
200	Provision of self-help capability	Provision of self-help capability (i.e., any onshore or vessel/turbine-based resources or facilities available to Empire that may assist in the event of an emergency).	Marine Transportation and Navigation	Operations and Maintenance
201	Cable routing study	Cable routing study, including geophysical and geotechnical surveys, stakeholder input and environmental and social constraints to develop submarine export cable routes that avoid or minimize interactions with anchorage areas.	Marine Transportation and Navigation	Operations and Maintenance
202	Completion of a Cable Installation Plan	Completion of a Cable Installation Plan, detailing how cable installation will be managed to ensure disruption is minimized, in particular within port approaches, and monitored once installation is complete.	Marine Transportation and Navigation	Operations and Maintenance
203	Completion of a CBRA	Completion of a CBRA to identify appropriate cable burial depths and to identify any needs for additional cable protections.	Marine Transportation and Navigation	Operations and Maintenance
204	Periodic monitoring of cable burial and protection measures	Periodic monitoring of cable burial and protection measures to ensure they remain effective, with regular monitoring of protection in vicinity of areas of existing anchoring as identified within the cable burial risk assessment.	Marine Transportation and Navigation	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
205	Potential real-time monitoring of Project cable assets	Potential real-time monitoring of Project cable assets using AIS to proactively notify vessels of potential interactions.	Marine Transportation and Navigation	Operations and Maintenance
206	Implementation of a Fisheries Mitigation Plan	Continued implementation of a Fisheries Mitigation Plan throughout the construction process to alert local fishing industries to relevant construction activities through the use of in-person communications, social media, website communications, and LNMs.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning
207	Cable route planning	Cable route planning to avoid areas of hard or steep seabed where burial is difficult, if those areas coincide with high fishing activity.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning
208	Rolling construction zones	Utilization of rolling construction zones to minimize areas closed off to fishing.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning
209	Minimize overlap with areas/time of high activity	Where feasible, planning the location and timing of construction activities that minimize overlap with areas or times of high activity.	Commercial Fisheries & Recreational Fishing	Pre-Construction
210	Continued engagement with fishing industry	Continued active engagement with the fishing industry on the timing and location of construction so that they can, where possible, elect to fish in other areas and plan accordingly.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning
211	Continued use of offshore OFLRs	Continued use of offshore OFLRs to facilitate communications with the fishing community.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning
212	Continued communications between FLO and	Continued communications between FLO and fisheries on the areas of temporary construction closures, when they are re-opened, updates on schedules through email serves, flyers, websites.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
213	CBRA	A CBRA to determine sufficient burial depth along the submarine export cable route and, where target burial depth cannot be reached, secondary protection shall be considered.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning
214	Identification of sensitive spawning and fishing periods	Continued work with the fishing industry and fisheries agencies to identify sensitive spawning and fishing periods to actively avoid or reduce interaction with receptors during construction, where feasible.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning
215	Marking of wind turbines and offshore substations with USCG/BOEM requirements	Marking and lighting all wind turbines and offshore substations in accordance with USCG, BOEM, and IALA O-139 guidance.	Commercial Fisheries & Recreational Fishing	Construction, Operations and Maintenance, Decommissioning
216	Safety vessel	Utilization of a safety vessel to alert mariners to safety zones and/or active construction areas where appropriate.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning
217	Safety zones	Implementation of 1,640-ft (500-m) safety zones around relevant structures, activities, and vessels in a dynamic approach, as previously defined for the Block Island Wind Farm (81 FR 31862). Should USCG Safety Zone authorities not extend beyond 12 nm (22 km) at the time of construction, Empire will utilize a combination of safety vessels, LNMs, and COLREGS to promote both awareness of these activities and the safety of the construction equipment and personnel.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning
218	AIS	Installation of operational AIS on all vessels associated with the construction and operation of the Project.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning
219	TSS usage	Project construction vessels will utilize, to the extent practicable, the surrounding TSSs while transiting to and from the Lease Area.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
220	Temporary lighting as an alert	Temporary lighting and marking may be used during the construction phase to alert mariners to areas under construction.	Commercial Fisheries & Recreational Fishing	Construction & Decommissioning
221	Continued communications and alerts to fishing industry	In the event of maintenance within the offshore environment, the Project will alert the fishing industry to the occurrence of these activities. Communication methods will include the use of FLOs, social media, website communications, and LNM.	Commercial Fisheries & Recreational Fishing	Operations and Maintenance
222	Layout Rules	The Project will utilize the Layout Rules (as described in **Section 3**) to achieve wind farm layouts, wind turbine spacing and lines of orientation within the array that facilitate continued access to traditional fishing grounds.	Commercial Fisheries & Recreational Fishing	Operations and Maintenance
223	Submarine export and interarray cables	Submarine export and interarray cables will be buried to a target burial depth of 6 ft (1.8 m).	Commercial Fisheries & Recreational Fishing	Operations and Maintenance
224	Following installation of the submarine	Following installation of the submarine export and interarray cables, the Project will conduct cable burial surveys at appropriate intervals to assess if target burial depth is being maintained.	Commercial Fisheries & Recreational Fishing	Operations and Maintenance
225	Micro-siting of the submarine	Micro-siting of the submarine export cable route to further reduce potential impacts on sensitive habitats and minimize areas where burial is more challenging.	Commercial Fisheries & Recreational Fishing	Operations and Maintenance
226	Regular updates to the local	Regular updates to the local marine community through Project websites, social media, the USCG LNM and active engagement with other stakeholders.	Commercial Fisheries & Recreational Fishing	Operations and Maintenance
227	To minimize risk of anchors	To minimize risk of anchors and fishing gear snagging the submarine export cable, the submarine export cable route has been routed to target areas where chances of burial are improved.	Commercial Fisheries & Recreational Fishing	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
228	Limited use of concrete mattresses	The use of concrete mattresses as surface cable protection will be limited.	Commercial Fisheries & Recreational Fishing	Operations and Maintenance
229	Project component locations provided to NOAA	All submarine export cable, interarray cable, wind turbine, and offshore substation locations will be provided to NOAA and updated on nautical charts appropriately.	Commercial Fisheries & Recreational Fishing	Operations and Maintenance
230	Project component marked for navigation	To the extent practicable and in consultation with the fishing industry, turbine locations and cable routes will be marked on the most common types of software used by fishermen for navigation and fishing.	Commercial Fisheries & Recreational Fishing	Operations and Maintenance
231	Installation of AIS signals on WTGs	Installation of AIS signals on turbines, as appropriate, to facilitate safe navigation.	Commercial Fisheries & Recreational Fishing	Operations and Maintenance
232	Vessel usage of existing waterways	Project vessels will utilize transit lanes, fairways, and predetermined passage plans consistent with existing waterway uses, to the extent practicable.	Department of Defense and OCS National Security Maritime Uses	Construction & Decommissioning
233	Regular communications and updates will occur with key national security maritime stakeholders	Regular communications and updates will occur with key national security maritime stakeholders on Project-related construction vessel activities.	Department of Defense and OCS National Security Maritime Uses	Construction & Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
234	Active engagement with key national security stakeholders	Active engagement with key national security stakeholders including U.S. Fleet Forces, the USCG, and U.S. Navy Office of Cable Protection will take place. This engagement will be conducted through the DoD Clearinghouse, with an increase in frequency expected as Empire moves closer to commencement of construction activities. On July 29, 2020, Empire received a request from the DoD Clearinghouse to enter into a partnership to initiate mitigation discussion for potential impacts resulting from the construction and installation of the Project. Empire intends to enter into this partnership, responding with a confirmation letter on August 19, 2020.	Department of Defense and OCS National Security Maritime Uses	Construction & Decommissioning
235	Dynamic construction and safety zones	Dynamic construction and safety zones will be implemented where feasible, focusing on sites being actively worked on, to minimize the extent of the affected area.	Department of Defense and OCS National Security Maritime Uses	Construction & Decommissioning
236	Partially constructed structures and safety zones marked and lit in accordance with IALA O-139/BOEM/USCG guidance	Partially constructed structures and safety zones will be properly marked and lit in accordance with IALA O-139, USCG requirements, and the 2021 BOEM Lighting/Marking Guidance (see **Section 3** for additional details on the proposed marking and lighting measures).	Department of Defense and OCS National Security Maritime Uses	Construction, Operations and Maintenance, Decommissioning
237	Updates to NOAA on as-built information	As-built information will be provided to NOAA Fisheries to support necessary updates to navigation charts in coordination with NOAA Fisheries and other stakeholders as needed.	Department of Defense and OCS National Security Maritime Uses	Operations and Maintenance
238	Coordination with USCG to facilitate training exercises	Empire will work with the USCG to facilitate training exercises within the operational wind farm, as requested.	Department of Defense and OCS National Security Maritime Uses	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
239	Regular communication with key national security stakeholders, including the DoD Clearinghouse	Regular communication and updates will occur with key national security stakeholders, including the DoD Clearinghouse on the timing and location of maintenance activities and Project-related activities that may affect national security operations.	Department of Defense and OCS National Security Maritime Uses	Operations and Maintenance
240	Safety zones up to 1,640 ft (500 m) around active construction sites.	The implementation of up to a 1,640-ft (500-m) safety zone around active construction sites pending agreement with USCG.	Marine Energy and Infrastructure	Construction & Decommissioning
241	Operation of security/support vessels during construction activities	Operate security/support vessels, where appropriate, to monitor and communicate with vessels operating in the area during periods of construction activity.	Marine Energy and Infrastructure	Construction & Decommissioning
242	Highly visible lighting/marking of active construction sites	Use highly visible marking and lighting of active construction sites.	Marine Energy and Infrastructure	Construction & Decommissioning
243	Regular updates to the local marine community	Regular updates to the local marine community through Project websites, social media, the USCG LNM and active engagement with other stakeholders.	Marine Energy and Infrastructure	Construction, Operations and Maintenance, Decommissioning
244	Siting to avoid sensitive habitats, recks, reefs, other structures	Site Project-related components to avoid sensitive habitats, wrecks, reefs, and other structures that support offshore marine uses to the extent practicable.	Marine Energy and Infrastructure	Construction & Decommissioning
245	Siting to avoid sensitive habitats, recks, reefs, other structures	Site Project-related components to avoid sensitive habitats, wrecks, reefs, and other structures that support offshore marine uses to the extent practicable.	Marine Energy and Infrastructure	Construction & Decommissioning
246	Marking of wind turbines and offshore substations with USCG/BOEM requirements	Marking of wind turbines and offshore substations in accordance with IALA O-139, USCG requirements, and the 2021 BOEM Lighting/Marking Guidance (see **Section 3** for additional details on the proposed marking and lighting measures).	Marine Energy and Infrastructure	Operations and Maintenance
247	Vessel transit will not be restricted and may provide recreational opportunities	Vessels will not be restricted from entering the operational wind farms areas, and as a result these structures may attract local charters for sightseeing and recreational fishing.	Marine Energy and Infrastructure	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
248	Provision of locations of structures for inclusion in NOAA charts	Provision of locations of structures for inclusion in NOAA charts.	Marine Energy and Infrastructure	Operations and Maintenance
249	Implementation of a safety zone around active construction sites	The implementation of up to a 1,640-ft (500-m) safety zone around active construction sites pending agreement with USCG.	Other Coastal and Marine Uses	Construction & Decommissioning
250	Operation of security/support vessels during construction activities	Operate security/support vessels, where appropriate, to monitor and communicate with vessels operating in the area during periods of construction activity.	Other Coastal and Marine Uses	Construction & Decommissioning
251	Highly visible lighting/marking of active construction sites	Use highly visible marking and lighting of active construction sites.	Other Coastal and Marine Uses	Construction & Decommissioning
252	Regular updates to the local marine community	Regular updates to the local marine community through Project websites, social media, the USCG LNM and active engagement with other stakeholders.	Other Coastal and Marine Uses	Construction, Operations and Maintenance, Decommissioning
253	Siting to avoid sensitive habitats, recks, reefs, other structures	Site Project-related components to avoid sensitive habitats, wrecks, reefs, and other structures that support offshore marine uses to the extent practicable.	Other Coastal and Marine Uses	Construction & Decommissioning
254	Marking of wind turbines and offshore substations with USCG/BOEM requirements	Marking of wind turbines and offshore substations in accordance with IALA O-139, USCG requirements, and the 2021 BOEM Lighting/Marking Guidance (see **Section 3** for additional details on the proposed marking and lighting measures).	Other Coastal and Marine Uses	Operations and Maintenance
255	Vessels will not be restricted from entering the operational wind farms areas	Vessels will not be restricted from entering the operational wind farms areas, and as a result these structures may attract local charters for sightseeing and recreational fishing.	Other Coastal and Marine Uses	Operations and Maintenance
256	Provision of locations of structures for inclusion in NOAA charts	Provision of locations of structures for inclusion in NOAA charts.	Other Coastal and Marine Uses	Operations and Maintenance

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
257	Design of project components to withstand extreme conditions	Project infrastructure and equipment will be designed to be able to withstand extreme conditions, and will be protected both externally and internally by a lightning protection system.	Public Health and Safety	Construction, Operations and Maintenance, Decommissioning
258	Development of an emergency evacuation plan	Development and implementation of an emergency evacuation plan that will be incorporated into the overall site ERP.	Public Health and Safety	Construction, Operations and Maintenance, Decommissioning
259	Restricted access	Restrict access to both onshore and offshore work sites to authorized and qualified personnel.	Public Health and Safety	Construction & Decommissioning
260	Implementation of a safety zone around active offshore construction sites	The implementation of up to a 1,640-ft (500-m) safety zone around active offshore construction sites pending agreement with USCG.	Public Health and Safety	Construction & Decommissioning
261	Implementation of a safety zone around active onshore construction sites	Implement safety zones around active onshore construction sites.	Public Health and Safety	Construction & Decommissioning
262	Prevention of unauthorized access	Secure onshore construction sites with a fence and lock to prevent unauthorized access.	Public Health and Safety	Construction & Decommissioning
263	Securing construction equipment	Securing construction equipment onshore within fenced work areas.	Public Health and Safety	Construction & Decommissioning
264	Security monitoring onshore/offshore	Use of security to monitor both onshore and offshore construction sites.	Public Health and Safety	Construction & Decommissioning
265	Spill response kits	Construction sites will contain spill response kits.	Public Health and Safety	Construction & Decommissioning
266	Use of secondary containment for oils and greases	Use of secondary containment for oils and greases in accordance with all state and federal regulations.	Public Health and Safety	Construction, Operations and Maintenance, Decommissioning
267	Transport hazardous materials in water-tight containers	Transport hazardous materials in water-tight containers.	Public Health and Safety	Construction, Operations and Maintenance, Decommissioning

Table H-3 Summary Table (continued)

Measure Number	Measure	Description of Measure	Resource	Project Phase
268	Training program for Project personnel	Train Project personnel, as applicable, in accordance with relevant regulations and company policy, including the site-specific emergency evacuation routes, warning signals, locations of fire extinguishers and first aid kits, as well as the chain of command.	Public Health and Safety	Construction, Operations and Maintenance, Decommissioning
269	Lighting/marking of construction sites for safety	Construction sites will be clearly marked and lighted, in a manner sufficient to safeguard personnel and public safety.	Public Health and Safety	Construction & Decommissioning
270	Project-specific SMS development	Development and implementation of a Project specific SMS.	Public Health and Safety	Construction, Operations and Maintenance, Decommissioning
271	SPCC and OSRP plans	Implementation of a SPCC Plan for onshore activities and OSRP for offshore activities that will be provided for agency review and approval, as applicable.	Public Health and Safety	Operations and Maintenance
272	Prevention of unauthorized access	Secure the onshore substation and O&M Base with a fence and lock to prevent unauthorized access.	Public Health and Safety	Operations and Maintenance
273	Marking of wind turbines and offshore substations with USCG/BOEM requirements	Marking of wind turbines and offshore substations in accordance with IALA O-139, USCG requirements, and the 2021 BOEM Lighting/Marking Guidance (see **Section 3** for additional details on the proposed marking and lighting measures).	Public Health and Safety	Operations and Maintenance
274	Use of appropriate, agency-approved marking and lighting around the onshore substations and O&M Base	Use of appropriate, agency-approved marking and lighting around the onshore substations and O&M Base.	Public Health and Safety	Operations and Maintenance
275	Equip the base of turbine tower with a lock	Restrict access to the interior of the wind turbines and offshore substations by a locked door at the base of the tower.	Public Health and Safety	Operations and Maintenance
276	Restricted access	Only trained and qualified personnel will be allowed access to the onshore substations, wind turbines, and offshore substations to perform O&M activities.	Public Health and Safety	Operations and Maintenance
277	Spill response kits	Project sites will contain spill response kits.	Public Health and Safety	Operations and Maintenance

ATTACHMENT H-3
BIRD AND BAT MONITORING FRAMEWORK

This page intentionally left blank.

Empire Offshore Wind Projects (EW 1 and EW 2):
Proposed Bird and Bat Monitoring Framework

Submitted by:

M. Wing Goodale, Andrew T. Gilbert, Iain J. Stenhouse, and Merra Howe
Biodiversity Research Institute

Introduction

The purpose of this document is to propose a framework for monitoring measures for bird and bat species for an offshore wind facility located in Lease Area OCS-A 0512 (Lease Area)[1]. Empire Offshore Wind LLC (Empire) has prepared a Construction and Operations Plan (COP) to support the siting, development, and operation of two wind farms within the Lease Area, known as Empire Wind 1 (EW 1) and Empire Wind 2 (EW 2; collectively referred to hereafter as the Project). The COP, as submitted to the Bureau of Ocean Energy Management (BOEM), provides information about the Project and is inclusive of potential impacts and corresponding environmental protection measures for bird and bat species as referred to at the time of COP preparation (Section 5.3). Empire anticipates that turbine installation for EW1 will occur in 2025–2026 and for EW2 2026–2027. This monitoring framework supplements the measures identified in the COP, is intended to cover both EW1 and EW2, and is focused solely on the offshore footprint of the Project within the Lease Area and surrounding waters.

Monitoring questions, equipment, and effort are detailed in Table 1. The monitoring approaches were selected to be consistent with existing permitted projects, technological limitations, and existing baseline data. Empire plans to deploy bat and bird acoustic detectors; deploy offshore and onshore Motus receivers, as well as provide funding to support tagging of target species (e.g., Endangered Species Act [ESA] listed birds, nocturnal migrants, terns, and/or bats); and conduct digital aerial surveys. Empire supports publishing the results in peer-reviewed journals after final reports have been submitted to federal agencies. **A detailed monitoring plan ("Post-Construction Monitoring [PCM] plan" hereafter) will be developed through ongoing discussion with stakeholders and regulators and will be coordinated with regional research efforts**. This framework is independent from environmental research commitments to NYSERDA as part of the EW 2 Purchase and Sale Agreement (PSA), but all offshore bird and bat monitoring efforts occurring at the Project will be coordinated. The detailed plan will include details on how monitoring timing will be related to the project phases.

[1] Little to no long-term impacts are expected from onshore wind activities (see COP Appendix Q and S), and it was thus determined that monitoring of such activities was not necessary.

Table 1. Monitoring Questions, Equipment, and Effort

Focal Group	EW Monitoring Questions	Equipment	Effort
Bats	• What species are present? • What time of year are bats active offshore? • How does activity vary between nacelle and turbine base? • How does bat activity relate to temperature and wind speed?	Acoustic Detectors	• *Start*: EW 2 operation • *Duration*: 2 years • *Frequency*: Nightly, March–December • *Coverage*: up to 6 turbines (nacelle and base)
Nocturnal Migratory Birds	• What vocalizing nocturnal songbird migrants are present? • What time of year are birds migrating offshore? • How is migratory activity related to weather?	Acoustic Detectors	• *Start*: EW 2 operation • *Duration*: 2 years • *Frequency*: Nightly, April–November • *Coverage*: 2 substations
ESA-listed Birds; other tagged birds and bats	• What ESA-listed species are present around the Lease Area? • What time of year are the animals present? • How is activity related to weather conditions?	Motus Receivers and Tags	• *Start*: EW 2 operation • *Duration*: up to 5 years • *Frequency*: Continuous, April–November • *Coverage*: # turbines TBD; 2–4 coastal stations; 300/tags year
Marine Birds	• What is the avoidance behavior of marine birds? • How does density vary across the Lease Area?	Digital Arial Surveys	• *Start*: EW 2 operation • *Duration*: 2 years • *Frequency*: Monthly • *Coverage*: 10%, 4 km buffer
Birds and Bats	• What dead or injured species are found incidentally?	Incidental Observations	Project lifetime

Bat Acoustic Monitoring

Bats have been documented offshore in the U.S. (Grady and Olson 2006; Cryan and Brown 2007; Johnson et al. 2011; BOEM 2013; Hatch et al. 2013; Dowling et al. 2017) and within the Lease Area (COP Appendix R: Bat Survey Report). A 2018 acoustic survey in the Lease Area provided a baseline characterization of the Lease Area prior to construction, including an inventory of the species present in the Area (see Appendix R in of the 2018 Bat Survey Report). However, questions remain about the extent to which bats may fly through the Lease Area after wind turbines are installed. Acoustic detectors installed at the offshore substation or wind turbine platforms (nacelle and base) can improve understanding of the following: (1) what species are present offshore; (2) what the time of year bats are active offshore; (3) how activity varies between the nacelle and wind turbine base; and (4) how bat activity is related to temperature and wind speed.

After EW 2 has started operation, acoustic monitoring will be conducted for at least two years. Effort will consider recommendations from the Regional Wildlife Science Collaborative and logistical constraints. While dependent on logistics and attachment options, up to 12 ultrasonic bat detectors will be installed at up to six wind turbines in the early spring or late winter (March) for each year of monitoring, and Empire will also consider installing acoustic detectors on construction vessels. The final research design will be described in the PCM plan and will include a power analysis (if necessary), location of detectors, data analysis protocols, and data storage protocols. Since studies in Europe demonstrate that bat activity varies between the wind turbine hub and transition platform (Brabant *et al.* 2018), paired detectors will be installed on both nacelle and wind turbine base, to the extent practicable. The detectors will record calls of both migratory tree bats and cave-hibernating bats, including the federally-listed northern long-eared bat (*Myotis septentrionalis*). All recorded acoustic data will be processed with approved software to filter out poor quality data and identify the presence of bat calls. Analysis will adhere to federal guidance as it evolves for northern-long eared bat as well for other species if ESA-listing status changes. All high frequency calls will then be classified by an acoustician. A balanced call review sampling approach will be taken over the two years of data collection, and data review is expected to take a reasonable amount of time.

Nocturnal Migratory Bird Acoustic Monitoring

Breeding songbirds can migrate over the Atlantic Outer Continental Shelf (Drury & Keith 1962, Adams, Lambert, *et al.* 2015, Adams, Chilson, *et al.* 2015), but there are questions about the extent to which migrants use the offshore environment, and how they will be exposed to the wind turbines in the Lease Area. Acoustic detectors have been used at offshore wind facilities (Hüppop *et al.* 2016) and are commonly used to study vocalizing songbird migration (Farnsworth 2005). Acoustic detectors installed at the offshore substation can improve understanding of the following: (1) what vocalizing nocturnal migratory songbird species are present; (2) what time of year are birds migrating offshore; and (3) how is migratory activity related to weather.

After EW 2 has started operation, two avian acoustic detectors will collect data for two spring to fall seasons. A detector will first be tested at a substation to determine if there is any sound interference. Contingent on a successful test, a detector will be installed at each of the two offshore substations—detectors will not be installed at wind turbines because the ambient noise would interfere with bird detection, and the number of detectors is limited by the number of substations. The acoustic data will be post-processed through a filter, and then a final species group identification will be conducted by a qualified avian biologist. Given the potential for large numbers of acoustic detections, the avian acoustic data will be sub-sampled to focus on peak migration periods and analysis will be limited to 400 hours, spread over the two years of data collection.

Motus Tracking Network and Tags

Tracking studies using onshore automated telemetry receiving stations (hereafter, Motus receivers and tags) have been conducted with birds listed under the ESA: Piping Plovers (*Charadrius melodus*), Red Knots (*Calidris canutus rufa*), and Roseate Terns (*Sterna dougallii;* Loring *et al.* 2019, Loring *et al.* 2018). However, the coastal Motus receivers had limited coverage offshore (Loring et al. 2019). Monitoring use of the Lease Area during operation with Motus receiving stations can improve the understanding on use of the Lease Area by ESA-listed birds, as well as other species carrying Motus tags, such as migratory songbirds, shorebirds, and bats.

Motus tracking studies can improve the understanding of the following: (1) what ESA-listed species are present around the Lease Area; (2) what time of year are the birds present; and (3) how is activity related to weather conditions.

Offshore Motus stations will be designed, operated, calibrated, and managed according to the current USFWS's Offshore Motus Guidance[2]. After EW 2 has started operation, monitoring of the Lease Area would be conducted up to five years. Monitoring would be targeted during the spring, summer, and fall, but could continue through the winter, depending on logistics. The number of turbines on which Motus receivers will be installed will be detailed in the PCM plan and based on the current USFWS Motus Guidance. Optimized coverage across both EW 1 and EW 2 will be determined using a design tool currently being developed through a New York State Energy Research and Development Authority (NYSERDA) funded project.[3] Empire will also support the maintenance and/or upgrading of two to four coastal receivers identified by USFWS. Motus tags (up to 300 per year) will be provided to researchers working with ESA-listed birds for at least three consecutive years. The specific species will be determined in consultation with BOEM and USFWS, and Empire will consider providing Motus tags to bat researchers. For the expected life of the supported tags, species presence/absence will be analyzed by comparing detections within the Lease Area to coastal and any other offshore towers. All detections will be analyzed to understand relationships with time of day, season, and weather conditions. Data will be compiled, analyzed, and reported based on recommendations in the current USFWS Offshore Motus Guidance, with a final complete analysis provided approximately six months following the end of the supported tag period projected tag-life.

Digital Aerial Surveys

Existing data provide baseline information on the exposure of birds to the Lease Area: (1) NYSERDA regional digital aerial surveys, (2) NYSERDA New York Wind Energy Area (WEA) specific digital aerial surveys, (3) Empire Wind Lease Area specific digital aerial surveys, and (4) version 2 of the Marine-life Data and Analysis Team (MDAT) marine bird relative density and distribution models (Curtice *et al.* 2016)[4]. The digital aerial surveys covering the Lease Area conducted from 2016–2019 can be replicated post-construction because the aircraft flew above turbine height. Digital aerial surveys can improve understanding of the following: (1) what are the avoidance behaviors of marine birds exposed to the project and do birds identified as being vulnerable to displacement in Europe (e.g., auks) avoid large contemporary turbines which are spaced further apart; and (2) how does the density of birds vary across the Lease Area and are there higher concentrations of birds vulnerable to collision (e.g., gulls) around specific turbines. Digital aerial surveys are also useful in capturing distribution and abundance data for multiple taxa – e.g., birds, marine mammals, sea turtles, fish, bats – as well as human activities in the area, such as fishing vessel activity, and information on floating marine debris[5].

---

[2] Specific protocols will be described in the Post-Construction Monitoring (PCM) plan.
[3] https://www.briloon.org/renewable/automatedvhfguidance
[4] MDAT models supported characterization of the lease area, but they will not be used in pre- and post-construction comparisons.
[5] Collection of information on floating marine debris is already a standard practice for the surveys.

After EW 2 has started operation, following the methods used for the baseline surveys and BOEM guidelines, digital aerial surveys would be conducted monthly for two years, and will have at least 10% coverage by area of the Lease Area, including a sample of the entire lease area, plus a 4 km buffer. A density analysis will be conducted for all species with sufficient detections for a pre- and post-construction comparison, and additional analyses may be conducted on species identified as having a higher exposure to impact-producing factors, as detailed in the Construction and Operations Avian Assessment (COP Appendix Q). The post-construction survey results would be compared to baseline data using spatial models. Since a post-construction survey initiated after EW 2 is built would be approximately eight years after the last baseline survey, a study design assessment would be conducted to determine how sensitive species abundance and distribution is to temporal variation. The results of this analysis could support decision making on whether other funds could be used to expand the survey effort through both space and time. Density models will be developed while surveys are ongoing so that upon completion of the final survey these models need only be updated with new data.

Documentation of Dead and Injured Bats and Birds

Empire will document dead or injured birds or bats found incidentally on vessels and project structures during construction, operation, and decommissioning in an annual report to BOEM. For each animal found, a form will be filled out that will include basic site information, GPS location, and photos taken from multiple perspectives along with a ruler for scale. Experienced biologists will determine if any carcasses could be ESA-listed. If a listed species is identified, Empire will then report the record to BOEM, USFWS, and appropriate state agencies. Carcasses with federal or research bands or tags will be reported to the U.S. Geological Survey (USGS) Bird Band Laboratory, BOEM, and USFWS. Due to health and safety concerns and logistical constraints, it will not be possible to collect carcasses, but EW will evaluate alternative options, including possibly collecting feathers from the carcasses.

Reporting

For the lifetime of the monitoring effort, Empire will submit an annual report to BOEM that will summarize all information as recommended in USFWS's Offshore Motus Guidance, including but not limited to monitoring activities, preliminary results, and any proposed changes to the monitoring plan. The report will be presented to BOEM and USFWS in an annual meeting and, if needed, adjustments to the monitoring will be considered. In addition, all observation and effort data from pre- and post-construction surveys will be provided to relevant regional, publicly accessible databases, such as the Ocean Biodiversity Information System's Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP), the Northwest Atlantic Seabird Catalog, and the North American Bat Monitoring Program (NABat). Depending on the methodology, tracking data will also be added to appropriate regional databases, such as the Motus Wildlife Tracking System.

References

Adams, E., P. Chilson, & K. Williams. 2015. Using WSR-88 weather radar to identify patterns of nocturnal avian migration in the offshore environment Williams, K., E. Connelly, S. Johnson, & I. Stenhouse (eds). Biodiversity Research Institute, Portland, ME. Available at http://www.briloon.org/uploads/BRI_Documents/Wildlife_and_Renewable_Energy/MABS Project Chapter 27 - Adams et al 2015.pdf.

Adams, E., R. Lambert, E. Connelly, A. Gilbert, & K. Williams. 2015. Passive acoustics pilot study: nocturnal avian migration in the Mid-Atlantic Williams, K., E. Connelly, S. Johnson, & I. Stenhouse (eds). Biodiversity Research Institute, Portland, ME. Available at http://www.briloon.org/uploads/BRI_Documents/Wildlife_and_Renewable_Energy/MABS Project Chapter 26 - Adams et al 2015.pdf.

Brabant, R., Y. Laurent, & B. Jonge Poerink. 2018. First ever detections of bats made by an acoustic recorder installed on the nacelle of offshore wind turbines in the North Sea. 2018 WinMon report 2018. Royal Belgian Institute of Natural Sciences.

Bureau Of Ocean Energy Management. 2013. Information Synthesis on the Potential for Bat Interactions with Offshore Wind Facilities. OCS Study BOEM 2013-01163. US Department of the Interior, Bureau of Ocean Energy Management, Herndon, VA. 119 pp.

Cryan, P. ., & A. C. Brown. 2007. Migration of bats past a remote island offers clues toward the problem of bat fatalities at wind turbines. Biol. Conserv. 139: 1–11.

Curtice, C., J. Cleary, E. Shumchenia, & P. Halpin. 2016. Marine-life Data and Analysis Team (MDAT) technical report on the methods and development of marine-life data to support regional ocean planning and management. Prepared on behalf of the Marine-life Data and Analysis Team (MDAT). Available at http://seamap.env.duke.edu/models/MDAT/MDAT-Technical-Report.pdf.

Dowling, Z., P. R. Sievert, E. Baldwin, L. Johnson, S. von Oettingen, & J. Reichard. 2017. Flight Activity and Offshore Movements of Nano-Tagged Bats on Martha's Vineyard, MA. OCS Study BOEM 2017-054. US Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, Virginia. 39 pp.

Drury, W. H., & J.A. Keith. 1962. Radar studies of songbird migration in coastal New England. Ibis 104: 449–489.

Farnsworth, A. 2005. Flight Calls and Their Value for Future Ornithological Studies and Conservation Research. Auk 122: 733–746. Available at https://doi.org/10.1093/auk/122.3.733.

Grady, F. V, & S. L. Olson. 2006. Fossil bats from quaternary deposits on Bermuda (chiroptera: vespertilionidae). J. Mammal. 87: 148–152.

Hatch, S. K., E. E. Connelly, T. J. Divoll, I. J. Stenhouse, & K. A. Williams. 2013. Offshore observations of eastern red bats (*Lasiurus borealis*) in the Mid-Atlantic United States using multiple survey methods. PLoS One 8: e83803.

Hüppop, O., K. Hüppop, J. Dierschke, & R. Hill. 2016. Bird collisions at an offshore platform in the North Sea. Bird Study 63: 1–10.

Johnson, J. B., J. E. Gates, & N. P. Zegre. 2011. Monitoring seasonal bat activity on a coastal barrier island in Maryland, USA. Environ. Monit. Assess. 173: 685–699.

Loring, P. H., J. D. McLaren, P. A. Smith, L. J. Niles, S. L. Koch, H. F. Goyert, & H. Bai. 2018. Tracking Movements of Threatened Migratory rufa Red Knots in U.S. Atlantic Outer Continental Shelf Waters. OCS Study BOEM 2018-046. US Department of the Interior, Bureau of Ocean Energy Management, Sterling (VA) 145 pp. OCS Study BOEM 2018-046. U.S. Department of the Interior, Bureau of Ocean Energy Management, Sterling, VA. 145 pp.

Loring, P. H., P. W. C. Paton, J. D. McLaren, H. Bai, R. Janaswamy, H. F. Goyert, C. R. Griffin, & P. R. Sievert. 2019. Tracking offshore occurrence of Common Terns, endangered Roseate Terns, and threatened Piping Plovers with VHF arrays. OCS Study BOEM 2019-017. US Department of the Interior, Bureau of Ocean Energy Management, Sterling, VA. 140 pp. Available at https://espis.boem.gov/final reports/BOEM_2019-017.pdf.

Welcker, J. 2020. Weather-dependence of nocturnal bird migration and cumulative collision Bio ProBIRD report Weather-dependence of nocturnal bird migration and cumulative collision risk at offshore wind farms in the German North and Baltic Seas Jorg Welcker , Raúl Vilela.

ATTACHMENT H-4
EMPIRE WIND FISHERIES AND BENTHIC MONITORING PLAN

This page intentionally left blank.

EMPIRE WIND FISHERIES AND BENTHIC MONITORING PLAN

Prepared for:

equinor

Empire Offshore Wind LLC
Stamford Office
600 Washington Blvd
Suite 800
Stamford, CT 06901

Prepared by:

INSPIRE ENVIRONMENTAL

INSPIRE Environmental
Newport, Rhode Island 02840

May 26, 2023

TABLE OF CONTENTS Page

ATTACHMENTS

TABLES Page

FIGURES Page

LIST OF ACRONYMS

ACCOL	Anderson Cabot Center for Ocean Life
ANOSIM	Analysis of Similarities
aRPD	apparent redox potential discontinuity
BACI	Before-After-Control-Impact
BAG	Before-After Gradient
BIWF	Block Island Wind Farm
BOEM	Bureau of Ocean Energy Management
BRUV	Baited Remote Underwater Video
CI	Confidence Interval
CPUE	Catch per Unit Effort
CTD	Conductivity Temperature Depth
CV	coefficient of variation
ECDF	Empirical cumulative distribution function
EFH	Essential fish habitat
EFP	Exempted Fishing Permit
Empire	Empire Offshore Wind LLC
EMF	Electromagnetic fields
EW1	Empire Wind 1
EW 2	Empire Wind 2
FMP/BMP	Fisheries and Benthic Research Monitoring Plan
ft	feet
GAM	Generalized Additive Model
GLM	Generalized Linear Model
GLMM	Generalized Linear Mixed Model
ha	hectare(s)
HD	High definition
HMS	Highly Migratory Species
ITIS	Integrated Taxonomy Information System
kg	kilogram(s)
km	kilometer(s)
LOA	Letter of Acknowledgement
LPIL	lowest possible taxonomic unit
m	meter(s)
mm	millimeter(s)
mi	mile(s)
nm	nautical mile(s)
NEFOP	Northeast Fisheries Observer Program
NEFSC	Northeast Fisheries Science Center

NEFSC PSB	Northeast Fisheries Science Center Protected Species Branch
NJDEP	New Jersey Department of Environmental Protection
nMDS	non-metric Multidimensional Scaling
NMFS	National Marine Fisheries Service
NMFS-PRD	National Marine Fisheries Service Protected Resources Division
NOAA	National Oceanic and Atmospheric Administration
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
OCS	Outer Continental Shelf
OSS	offshore substation
POI	Points of Interconnection
PV	Plan View
ROSA	Responsible Offshore Science Alliance
ROV	Remotely Operated Vehicle
SMAST	School for Marine Science and Technology
SPI	Sediment Profile Imaging
µm	micron
UHD	ultra-high definition
USBL	Ultra Short Baseline
VMS	Vessel Monitoring System
VTR	Vessel Trip Report
WEA	Wind Energy Area
WTG	wind turbine generator

1.0 INTRODUCTION

Empire Offshore Wind LLC (Empire) proposes to construct and operate an offshore wind farm located in the designated Renewable Energy Lease Area OCS-A 0512 (Lease Area). The Lease Area covers approximately 79,350 acres (ac; 32,112 hectares [ha]) and is located approximately 14 statute miles (mi) (12 nautical miles [nm], 22 kilometers [km]) south of Long Island, New York and 19.5 mi (16.9 nm, 31.4 km) east of Long Branch, New Jersey (Figure 1-1). The Lease Area was awarded through the Bureau of Ocean Energy Management (BOEM) competitive renewable energy lease auction of the Wind Energy Area (WEA) offshore of New York.

Empire proposes to develop the Lease Area in two wind farms, known as Empire Wind 1 (EW 1) and Empire Wind 2 (EW 2). Monitoring efforts at both EW 1 and EW 2 will be combined and covered in this Fisheries and Benthic Monitoring Plan. EW 1 and EW 2 will be electrically isolated and independent from each other. Each wind farm will connect via offshore substations (OSS) to separate Points of Interconnection (POIs) at onshore locations by way of export cable routes and onshore substations. In this respect, the Project includes two onshore locations in New York where the renewable electricity generated will be transmitted to the electric grid.

Offshore components of the Project will consist of up to 174 wind turbines and supporting tower structures, and two offshore substations, using up to 176 foundations. In addition, there will be associated support and access structures (for the wind turbines and offshore substations) and up to 260 nm (481 km) of inter-array cable (up to 116 nm [214 km] for EW 1 and up to 144 nm [267 km] for EW 2), all of which will be located in federal waters within the Lease Area. In addition, the Project will include up to 66 nm (122 km) of submarine export cables, consisting of up to two routes to New York:

- Up to 40 nm (74 km) to the EW 1 landfall, of which 24 nm (44 km) is in federal waters and 16 nm (30 km) in state waters; and
- Up to 26 nm (48 km) to the EW 2 landfall, of which 18 nm (33 km) is in federal waters and 8 nm (15 km) is in state waters

The Project includes two onshore substation locations:

- EW 1 onshore substation in Brooklyn, New York; and
- EW 2 Onshore Substation A or EW 2 Onshore Substation B in Oceanside, New York.

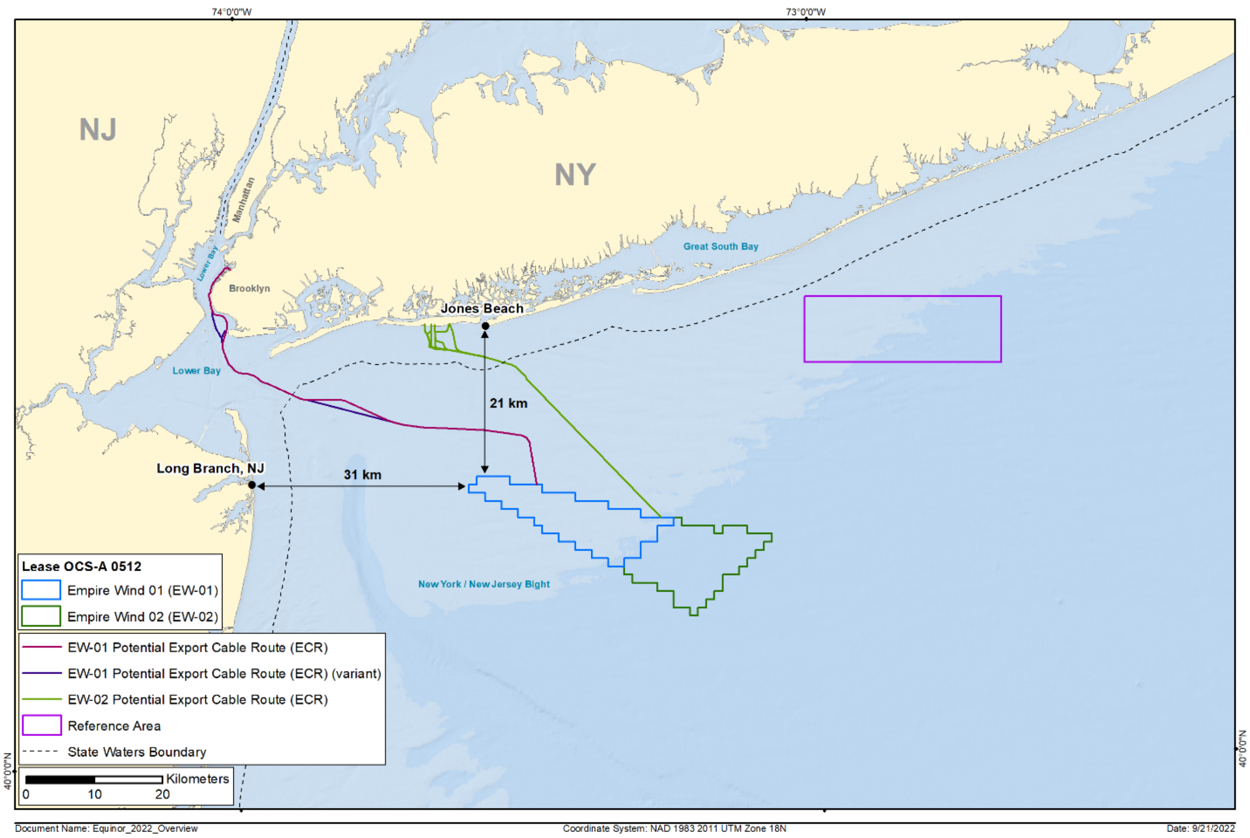


Figure 1-1. Map of the Project Area, including Export Cable routes

2.0 OVERVIEW OF FISHERIES AND BENTHIC MONITORING

This Fisheries and Benthic Research Monitoring Plan (FMP/BMP) has been developed in accordance with recommendations set forth in "Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf" (BOEM 2019), which state that a fishery survey plan should aim to:

- Identify and confirm which dominant benthic, demersal, and pelagic species are using the project site, and when these species may be present where development is proposed;
- Establish a pre-construction baseline which may be used to assess whether detectable changes associated with proposed operations occurred in post-construction abundance and distribution of fisheries;
- Collect additional information aimed at reducing uncertainty associated with baseline estimates and/or to inform the interpretation of research results; and
- Develop an approach to quantify any substantial changes in the distribution and abundance of fisheries associated with proposed operations.

BOEM also provides guidance related to specific survey gears that can be used to complete the fisheries monitoring including otter trawl, beam trawl, gillnet/trammel net, and ventless traps. BOEM guidelines stipulate that two years of pre-construction fisheries monitoring data are recommended, and that data should be collected across all four seasons. Consultations with BOEM and other agencies are encouraged during the development of fisheries monitoring plans. BOEM also encourages wind developers to review existing data, and to seek input from the local fishing industry to select survey equipment and sampling protocols that are appropriate for the area of interest. Benthic monitoring that is planned for New York state waters is described in a separate monitoring plan.

Additional fisheries monitoring guidance was obtained from the Responsible Offshore Science Alliance's "Offshore Wind Project Monitoring Framework and Guidelines" (2021). These guidelines build on existing BOEM guidance, outlining the fundamental elements to include in offshore wind fisheries monitoring plans and associated studies for commercial-scale offshore wind farms and identifying the primary resources to help draft and review such plans. Based on existing BOEM guidance and best practices developed to date, this document helps to:

- Streamline project monitoring plan development and review by providing comprehensive standardized recommendations for monitoring marine resources affected by offshore wind development projects;
- Ensure project monitoring plans and supporting studies are effectively designed to provide necessary information that can be used to understand and minimize adverse impacts on marine resources from offshore wind development consistent with established BOEM, National Marine Fisheries Service (NMFS), and state guidelines, best science practices, and decision maker and developer data needs;
- Encourage the use of standardized protocols to collect and analyze biological and environmental data that can be integrated with existing survey data and other research;
- Support the integration of monitoring efforts across multiple spatial and temporal scales (site-specific to regional/ecosystem and before/after construction);
- Focus monitoring efforts on important commercial and recreational species, habitats, and other resources that may be impacted by or vulnerable to offshore wind development; and
- Encourage proactive engagement, collaboration, and involvement among state and federal agencies, research institutions, wind developers, and fishery members and representatives.

This monitoring plan will be revised through an iterative process, and survey protocols and methodologies have been and will continue to be refined and updated based on feedback received from stakeholder groups. The majority of the research described in this plan will be performed on contracted commercial and recreational fishing vessels whenever practicable. Further, the fieldwork, data analysis and interpretation, data management, and reporting described in the monitoring plan will be performed by INSPIRE Environmental unless otherwise identified.

Empire is committed to conducting research and monitoring in a responsible manner. While this plan does incorporate some traditional fisheries independent survey techniques, the majority of the proposed survey designs utilize non-extractive methodologies to reduce mortality of fish and invertebrate species, as well as minimize interactions with protected resources (Table 2-1). Advanced technologies will be used to assess potential impacts to fish and invertebrates while limiting impacts from the monitoring itself. Where practicable, surveys have been designed to utilize protocols and methodologies from monitoring projects within other offshore wind lease areas to increase data compatibility and comparability and contribute to regional monitoring efforts.

Table 2-1. Overview of Fisheries and Benthic Monitoring Surveys at Empire Wind

Survey	Gear/Equipment	Survey Design	Objectives	Timing
Bottom trawl targeting Longfin squid	Bottom Otter Trawl with TED	Before-After, Control-Impact (BACI)	Monitor for changes in CPUE of longfin squid and bycatch species between the impact and reference area before, during, and after construction	Summer (July-August); Annual
Baited Remote Underwater Video (BRUV)	Benthic BRUV with twin cameras	Before-After Gradient (BAG)	Monitor for changes in species abundance and diversity along a distance gradient from turbine foundations before, during, and after construction	Seasonally (Winter, Spring, Summer, Fall); Annual
eDNA	Water samples	Paired with trawl and BRUV surveys	Monitor for changes in fish community composition, including those species not encountered in the trawl and BRUV surveys, before, during, and after construction	Summer; Seasonally; Annual
Acoustic Telemetry	Vemco VR2AR receivers and transmitters	Even distribution of receivers within lease area to maximize detection range	Monitor for changes in the presence, persistence, and movements of key species within the lease area before, during, and after construction	Year-Round
Atlantic Sea Scallop Imagery	Plan View Imaging	Before-After, Control-Impact (BACI)	Monitor for changes in average abundance and spatial distribution of sea scallops between impact and reference area before, during, and after construction	Late Summer/Early Fall; Annual
Epifaunal Growth on Novel Hard Bottom Structures	ROV video imagery, photogrammetry	Stratified random selection of structures (WTG foundations, protected cable segments), stratified by water depth	Monitor changes in epifaunal biomass, community composition, with depth and time since construction	Late Summer/Early Fall (Y0, Y1, Y2, Y3, Y5)
Benthic function on seafloor surrounding WTG foundations	SPI/PV	Before-After Gradient (BAG) (same turbines as above)	Monitor changes in benthic function (aRPD depth, organic matter content, infaunal successional stage) with distance from foundation and time since construction	Late Summer/Early Fall (Y0, Y1, Y2, Y3, Y5)

3.0 FISHERIES MONITORING

3.1 SUMMARY OF REGIONAL FISHERIES MONITORING

Existing fishery independent and dependent data were identified and reviewed during the development of this FMP. Several established fisheries independent surveys have been conducted within the Empire Wind Lease Area, as well as in the vicinity the Export Cable Route. These surveys provide examples of on-going and recent work that help to characterize marine communities throughout the NY Bight and surrounding region. This section provides a summary of fisheries monitoring within the region, prior to construction of the Empire Wind Project.

Guida et al. (2017) compiled a regional overview of the species composition and seasonal dynamics within the NY WEA. Catches from the Northeast Fisheries Science Center (NEFSC) bottom trawl survey, conducted between 2003 and 2016, showed a seasonal shift in species composition for this region that occurs between winter and summer. During colder months, Atlantic herring, little skate, and winter skate were the numerically dominant species caught. In the warmer months, this transitioned to butterfish, little skate, longfin squid, and Atlantic sea scallop (Guida et al. 2017). Longfin squid were a core species present in August in beam trawl catches that also collected their benthic egg mops (Guida et al. 2017).

The New Jersey Department of Environmental Protection (NJDEP) and the New York State Department of Environmental Conservation (NYSDEC) have developed bottom trawl surveys that operate within NJ and NY state waters, respectively. The Ocean Stock Assessment Program samples 30-39 stations from Sandy Hook to Cape May, New Jersey, five times per year (NJDEP 2022). In New York, the Nearshore Ocean Trawl Survey is a ten-year long project that started in 2017. The survey is conducted once per season and samples from Breezy Point to Block Island Sound in water depths up to 30 meters (m) (NYSDEC 2022). In addition to traditional trawl survey sampling, the Nearshore Ocean Trawl Survey also tags striped bass during fall surveys. The top species sampled (by weight) in 2021 were winter skate, clearnose skate, smooth dogfish, little skate, scup, summer flounder, longfin squid, and Atlantic sturgeon (NYSDEC 2022).

The Fish and Fisheries Study, commissioned by the New York State Energy Research and Development Authority (NYSERDA) as part of the New York State Offshore Wind Master Plan, examined available data within an ‘Area of Analysis’ off the coast of New York and New Jersey. This area contained the majority of the Empire Wind Lease Area (Ecology and Environment Engineering, P.C. 2017). Datasets including habitat data, fishery-independent data, and fishery-dependent data were obtained from state and federal agencies, fisheries councils and commissions, universities, and non-governmental organizations. Feedback was also provided by industry stakeholders such as regulatory agencies, industry representatives and active commercial fishermen. The Fish and Fisheries Study provides a review and summary of available biological and fisheries information within the region. It also provides spatially explicit data on the geographic patterns of fishing effort and revenue in the area, based on information collected through Vessel Monitoring Systems (VMS), Vessel Trip Reports (VTR), and stakeholder input.

Recent work by Ingram et al. (2019) utilized acoustic monitoring techniques as a non-extractive method to collect baseline data on Atlantic sturgeon movement through the NY WEA. From November 2016 through February 2018, 181 unique sturgeon were detected throughout the WEA. Sturgeon presence was highly variable between seasons, peaking in detections in late fall through early winter (November- January), with few detections during warmer months (July-September).

Additional data sources that characterize NY Bight regional baseline data include:

- Atlantic sea scallop resource surveys including School for Marine Science and Technology's (SMAST) drop camera surveys (Bethoney et al. 2018), dredge surveys (Hart 2015), and Coonamesset Farm Foundation (CFF) Habitat Camera (HabCam) surveys (CFF 2022).
- Northeast Area Assessment and Monitoring Program (NEAMAP) bottom trawl survey that samples annually from Cape Cod, MA to Cape Hatteras, NC, in water depths ranging from 60 to 120 feet (ft) (NEAMAP et al. 2021).
- Larval fish and lower trophic level zooplankton surveys (Thorne et al. 2020).
- Acoustic surveys, paired with bottom trawl surveys to quantify abundance and distribution of pelagic fishes and squid in the NY Bight (Thorne et al. 2020).
- Bottom trawl surveys conducted within NY state waters along the South Fork Wind Farm export cable route by Cornell Cooperative Extension (CCE) from Smith Point Inlet to Montauk Point (CCE 2022).

Regional approaches to monitoring have been suggested to better understand potential cumulative effects of offshore wind development on fisheries resources and operations. Utilizing standardized fisheries monitoring protocols will aid in understanding the spatial extent of impacts to marine resources, outside of disturbance to the individual lease areas (McCann 2012; MADMF 2018; ROSA 2021). This FMP was designed to complement existing data collection efforts, where practicable, by federal and state agencies, research institutions and other offshore wind developers as recommended by the Responsible Offshore Science Alliance (ROSA).

3.2 ESSENTIAL FISH HABITAT

The Empire Wind Project (Lease Area and cable routes) is designated Essential Fish Habitat (EFH) to 39 species with one or more life stages existing within the project area. These species include:

- New England Fisheries Management Council Managed Fish Species –Atlantic cod, Atlantic herring, clearnose skate, haddock, little skate, monkfish, ocean pout, pollock, red hake, silver hake, white hake, windowpane flounder, winter flounder, winter skate, witch flounder, and yellowtail flounder;
- Mid-Atlantic Fisheries Management Council Managed Fish Species Fish – Atlantic butterfish, Atlantic mackerel, black sea bass, bluefish, scup, and summer flounder;

- Invertebrates – Atlantic sea scallop, Atlantic surfclam, longfin squid, and ocean quahog; and
- Highly Migratory Species (HMS) – albacore tuna, bluefin tuna, skipjack tuna, yellowfin tuna, basking shark, blue shark, common thresher shark, dusky shark, sandbar shark, sand tiger shark, shortfin mako shark, smooth dogfish, spiny dogfish, tiger shark, and white shark.

Several species without designated EFH but listed as National Oceanic and Atmospheric Administration (NOAA) Trust Resources can also be found within the project area. These species include several species of shad and river herring (alewife and blueback herring), American eel, Atlantic menhaden, Atlantic striped bass, tautog, weakfish, Jonah crab, and horseshoe crab.

3.3 FISHING ACTIVITY IN THE REGION

Commercial fishing activity within the Empire Wind Lease Area and along the Export Cable routes was characterized using several sources of publicly available information that include VMS and VTR data from the Northeast and Mid-Atlantic Ocean Data Portals (Northeast Ocean Data 2022; Mid-Atlantic Data Portal 2022) and VTR data from NOAA Fisheries (2022a). Equinor's Fisheries Liaisons have also acquired information on the fisheries that operate in the region through extensive outreach and conversations with commercial, charter, and recreational fishermen.

Recently, NOAA Fisheries (2022a) developed a public website that uses VTRs and Dealer Reports to summarize annual landings and revenue for each offshore wind project along the US East Coast. These reports help to characterize the major species harvested, gear types used, and the ports most likely to be affected by offshore wind development, for federally permitted species (NOAA 2022a). Fisheries that include VTR reporting requirements, including party/charter vessels, are represented in these summaries, whereas summaries are not provided for those fisheries without federal reporting requirements (e.g., federally permitted lobster vessels, state permitted vessels, and some HMS permitted vessels). The socioeconomic data regarding commercial fishing activity in the Empire Wind Lease Area from 2008-2019 are summarized below.

Various federally permitted fisheries conduct operations within the Empire Wind Lease Area, but the area has experienced lower levels of fishing effort in recent years. The number of commercial trips peaked in 2008, when 4,519 trips were taken in the Empire Wind Lease Area, and has been decreasing since (Table 3-1). Vessels from Point Pleasant, NJ, Freeport, NY, and Point Judith, RI conducted the greatest number of trips in the area in 2019 (Table 3-2). Point Pleasant, NJ had the highest number of vessels conduct trips in the area in 2019 (n = 30), followed by Point Judith, RI (n = 29) and New Bedford, MA (n = 27) (Table 3-2). During the same year, the target species that accounted for the greatest number of trips to the Empire Wind Lease Area were summer flounder, black sea bass, monkfish, longfin squid, and skates (Table 3-3).

In terms of revenue, the top-five most valuable species landed from 2008 to 2019 within the Empire Wind Lease Area were the Atlantic sea scallop, longfin squid, summer flounder, Atlantic mackerel, and surf clam (Table 3-4). Atlantic herring was the species with the highest landings by weight, followed by Atlantic mackerel, longfin squid, Atlantic sea scallop, and surf clam. Additional species landed from the area include monkfish, American lobster, and black sea bass (Table 3-4).

Over the same twelve-year time-period, the scallop dredge fishery accounted for the highest revenue, followed by the bottom trawl and clam dredge fisheries (Table 3-5). VMS data for the scallop dredge fleet from 2015 to 2016 show that the fishery operated in the eastern portion of the Lease Area (Figure 3-1). The multispecies groundfish bottom trawl fleet scarcely used the eastern portion of the Lease Area (Figure 3-2), while the squid fleet operated in the middle to eastern portion of the area (Figure 3-3). The multispecies groundfish and clam dredge fisheries (from 2015 to 2016) scarcely operated within the Empire Wind Lease Area (Figure 3-4). The mid-water trawl fishery had the highest number of landings, followed by the bottom trawl and scallop dredge fisheries from 2008 to 2019 (Table 3-5). From 2015 to 2016, the mid-water trawl fishery operated mainly in the central portion of the area, with lower amounts of effort on the western and eastern boundaries (Figure 3-5). Other gear types fished in this area include lobster pots, sink gillnets, pots (other), purse seines, and handlines (Table 3-5).

Party/charter vessel usage of the Empire Wind Lease Area reached an 11-year high in 2018, when the annual revenue stemming from the area was estimated to be $155,000; a $125,000 increase when compared to the year before (Table 3-6). During the same time period, NOAA (2022a) estimates that for-hire vessels from only NY and NJ ports used the area. These vessels mainly targeted black sea bass, scup, red hake, bluefish, Atlantic cod, summer flounder, tautog, sea robins, and triggerfish (Table 3-7).

Table 3-1. The Number of Trips and the Corresponding Number of Vessels Utilizing the Empire Wind Lease Area from 2008 to 2019 (NOAA 2022a)

Year	Number of Trips	Number of Vessels
2019	1,105	180
2018	1,696	208
2017	1,796	226
2016	2,201	279
2015	2,106	276
2014	2,353	338
2013	2,260	229
2012	3,187	322
2011	3,398	384
2010	3,006	374
2009	4,300	365
2008	4,519	330

Table 3-2. The Number of Trips and the Corresponding Number of Vessels Utilizing the Empire Wind Lease Area, by Port in 2019 (NOAA 2022a)

Port	Number of Trips	Number of Vessels
Atlantic City, NJ	11	4
Beaufort, NC	17	11
Cape May, NJ	36	13
Chincoteague, VA	7	7
Freeport, NY	104	4
Hampton Bay, NY	5	3
Hampton, VA	20	11
Montauk, NY	20	7
New Bedford, MA	44	27
Newport News, VA	7	7
Point Judith, RI	64	29
Point Pleasant, NJ	336	30
Shinnecock, NY	7	3
Stonington, CT	5	3
Total	**683**	**159**

Table 3-3. The Number of Trips and Coinciding Number of Vessels by Target Species, Taken within the Empire Lease Area During 2019 (NOAA 2022a)

Species	Number of Trips	Number of Vessels
Summer Flounder	615	97
Black Sea Bass	505	89
Monkfish	451	98
Longfin Squid	434	86
Scup	401	80
Skates	381	51
Silver Hake	265	59
Red Hake	258	45
American Lobster	231	27
Bluefish	205	54
Butterfish	191	53
Atlantic Mackerel	133	40
Dogfish Smooth	109	20
Jonah Crab	102	10
Sea Scallop	87	53
Rock Crab	77	3
Dogfish Spiny	74	14
Squeteague Weakfish	67	25
Conger Eel	65	25
Tautog	57	8
Menhaden	44	5
Atlantic Herring	38	12
Sea Robins	27	12
Surf Clam	24	10
Northern Puffer	17	11
Bonito	15	7
Triggerfish	13	9
Golden Tilefish	12	5
Blueline Tilefish	9	3
King Whiting	9	7
Nk Eel	9	4
American Eel	8	4
Striped Bass	6	3
Spanish Mackerel	4	4
Amber Jack	3	3
Knobbed Whelk	3	3
Total	**4949**	**1039**

Table 3-4. The Revenue and Landings by Species, for the Empire Wind Lease Area during 2008 to 2019 (NOAA 2022a)

Species	Twelve Year Revenue	Twelve Year Landings
Sea Scallop	$5,960,000	610,000
Longfin Squid	$877,000	711,000
Summer Flounder	$343,000	110,000
Atlantic Mackerel	$166,000	719,000
Surf Clam	$112,000	156,000
Atlantic Herring	$101,000	793,000
American Lobster	$55,000	11,000
Monkfish	$53,000	23,000
Black Sea Bass	$39,000	11,000
All Others	$37,000	55,000
Total	**$7,743,000**	**3,199,000**

Table 3-5. The Revenue and Landings by Gear Type for the Empire Wind Lease Area during 2008 to 2019 (NOAA 2022a)

Gear Type	Twelve Year Revenue	Twelve Year Landings
Dredge-Scallop	$5,466,000	546,000
Trawl-Bottom	$1,948,000	1,316,000
Dredge-Clam	$290,000	346,000
Trawl-Midwater	$187,000	1,319,000
Pot-Lobster	$62,000	16,000
Gillnet-Sink	$24,000	16,000
All Others	$13,000	32,000
Pot-Other	$6,000	4,000
Seine-Purse	$2,000	14,000
Handline	$2,000	1,000
Total	**$8,000,000**	**3,610,000**

Table 3-6. The Party/Charter Vessel Estimated Revenue by Year from the Empire Wind Lease Area (NOAA 2022b)

Year	Annual Revenue
2008	$23,000
2009	$2,000
2010	$42,000
2011	$24,000
2012	$22,000
2013	$12,000
2014	$39,000
2015	$27,000
2016	$26,000
2017	$30,000
2018	$155,000
Total	**$403,000**

Table 3-7. The Estimated Catch from Party/Charter Vessel Target Species in the Empire Wind Lease Area from 2008 to 2018 (NOAA 2022b)

Species	Eleven Year Fish Count
All Others	6,980
Black Sea Bass	6,807
Scup	6,241
Red Hake	5,830
Bluefish	742
Cod	702
Summer Flounder	464
Tautog	176
Sea Robins	40
Triggerfish	17
Total	**27,999**

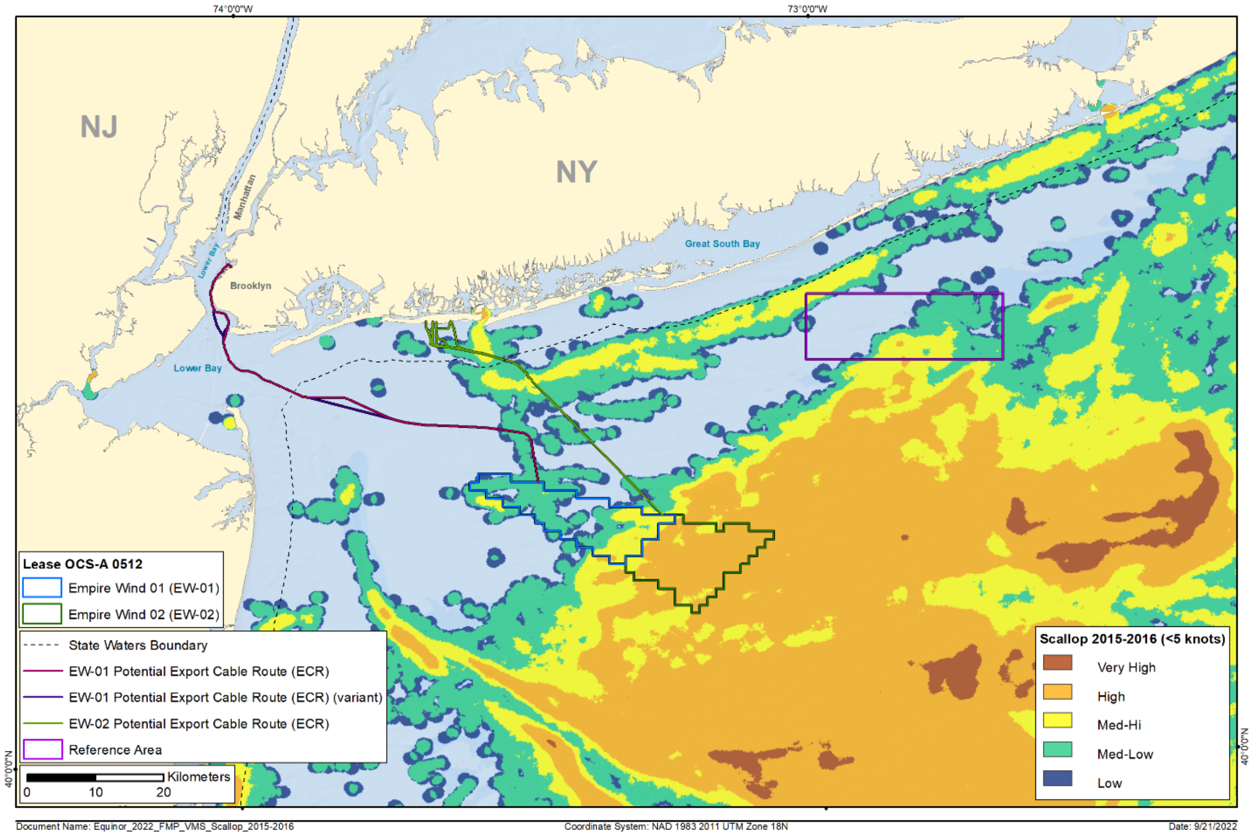


Figure 3-1. VMS data for the scallop dredge fleet from 2015 to 2016 in the Empire Wind region

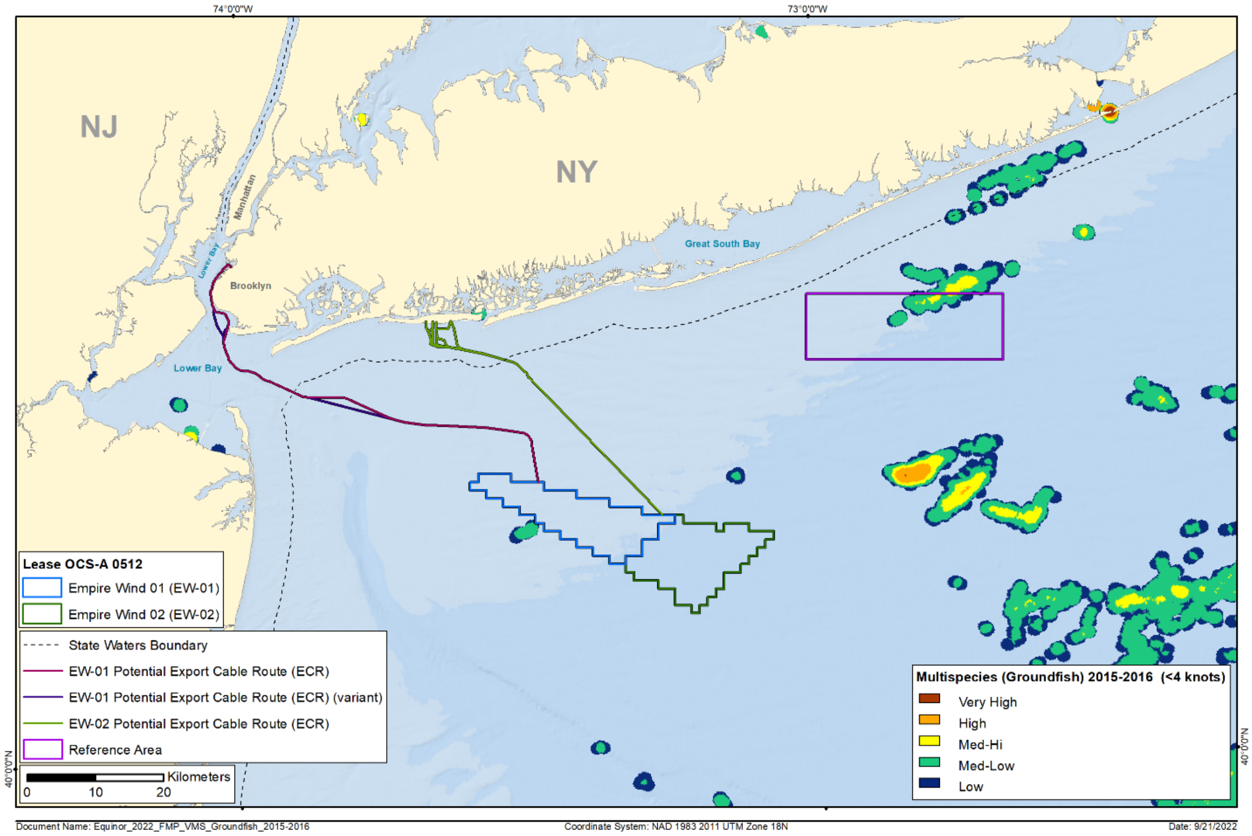


Figure 3-2. VMS data for the multispecies groundfish fishery from 2015 to 2016 in the Empire Wind region

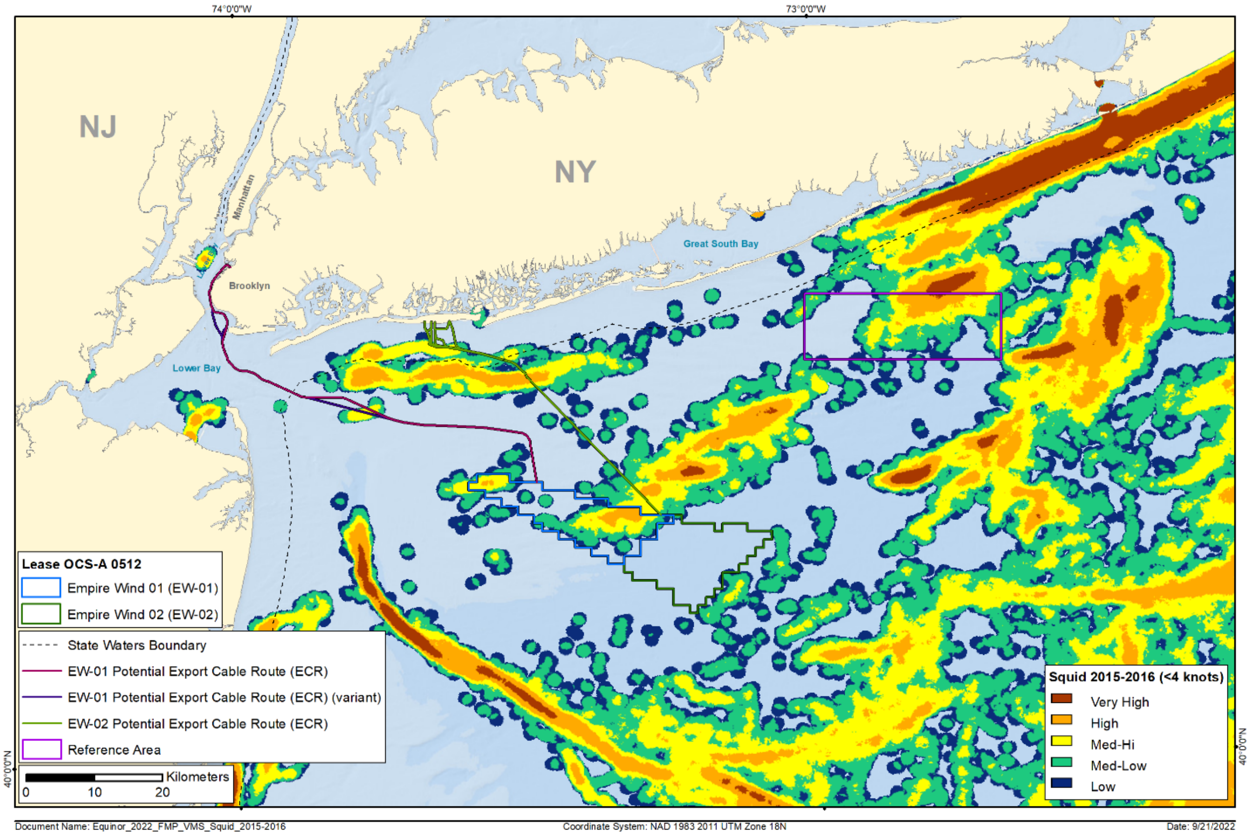


Figure 3-3. VMS data for the squid fishery from 2015 to 2016 in the Empire Wind region

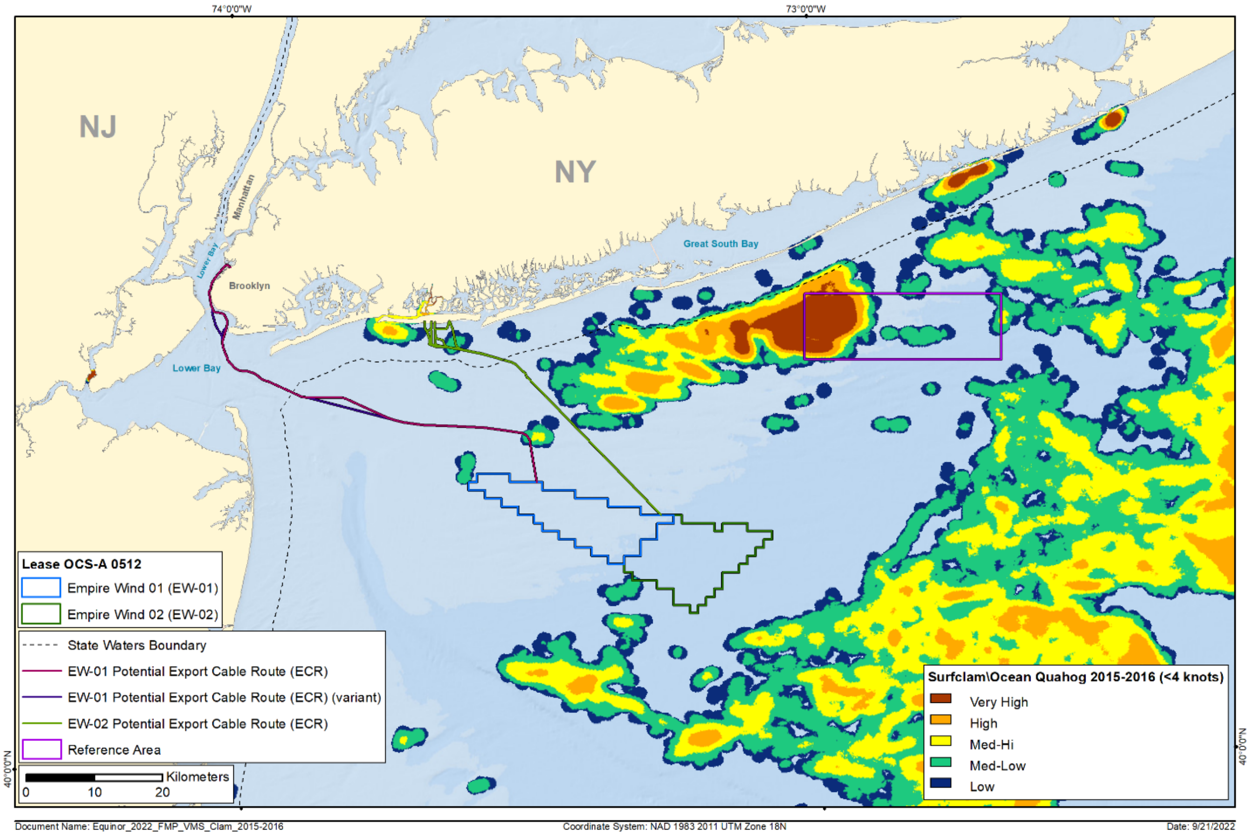


Figure 3-4. VMS data for the clam dredge fishery from 2015 to 2016 in the Empire Wind region

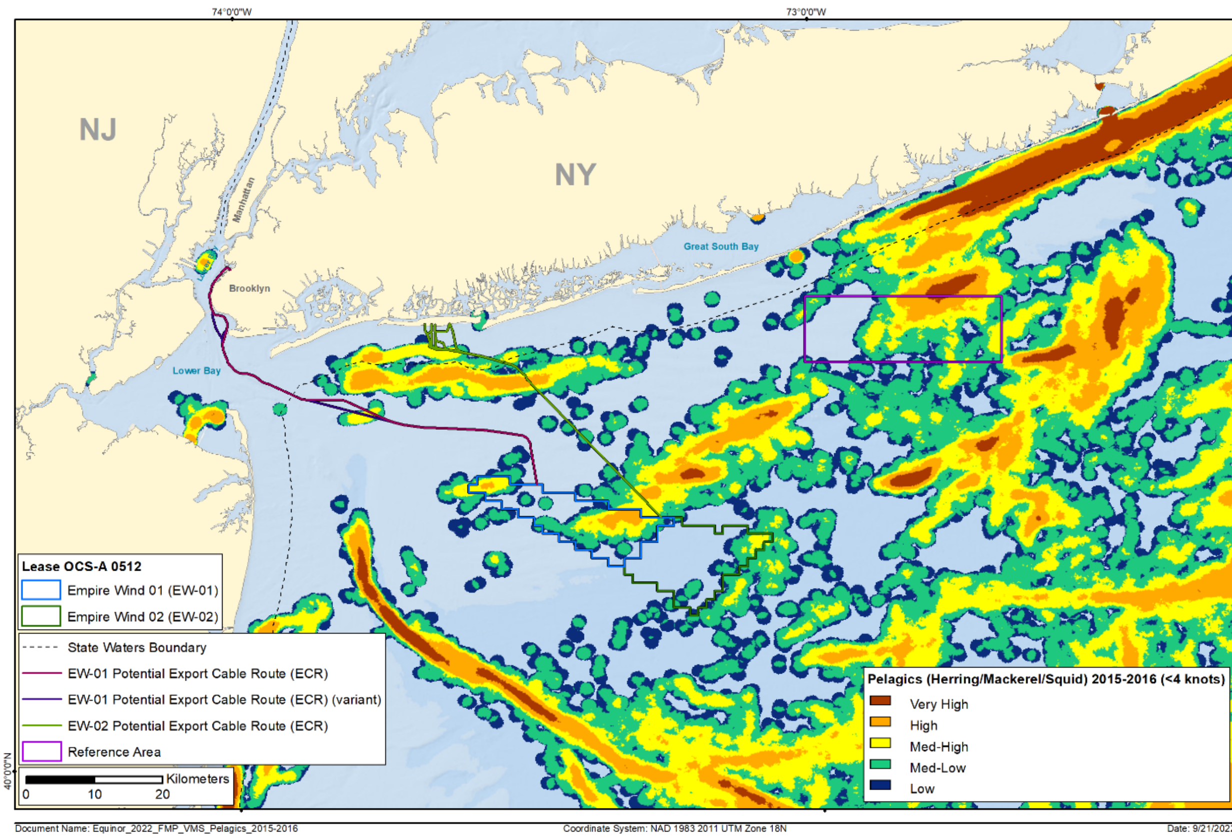


Figure 3-5. VMS data for the mid-water trawl (pelagics) fishery from 2015 to 2016 in the Empire Wind region

3.4 FISHERIES MONITORING SURVEY METHODS

Based on the review of fisheries activities and available fisheries independent data in the Empire Wind Lease Area and along the export cable routes, this FMP was designed to address several focused objectives related to impacts of the Empire Wind development on fisheries in the area. As outlined in Section 2.0, the proposed fisheries monitoring techniques focus on the use of non-extractive methodologies or propose modifications to traditional techniques to reduce mortality of fish and invertebrate species and to minimize interactions with protected species.

3.4.1 Trawl Survey

3.4.1.1 Survey Design

A trawl survey targeting longfin squid within the Lease Area will be conducted in the Summer (July and August) using a symmetrical Before-After-Control-Impact (BACI) experimental design. This trawl survey will be conducted by a contracted commercial fishing vessel with experience targeting squid in the trawl fishery and with the capability of operating the survey gear. Longfin squid are typically targeted using bottom otter trawl gear and the fishery has been active in the central portion of the Lease Area (Figure 3-3) with longfin squid constituting the third highest landings and second highest revenue over the last 12 years (Table 3-4).

The primary objective of the pre-construction monitoring survey is to investigate the biomass (kilograms [kg/tow]) of longfin squid and fish and invertebrate bycatch species in the Empire Wind Lease Area (Impact Area) relative to the reference area (Control). The trawl survey will also collect information on size structure of the target species as well as on the size structure and fish condition for bycatch species. Two years of pre-construction sampling will occur starting in the fall of 2023. Sampling will continue during the construction phase of the project and for a minimum of two years post-construction, with the duration of post-construction monitoring being informed by developing guidance from BOEM and ROSA.

The objectives of the trawl survey targeting longfin squid are as follows:

- **Objective 1** - Evaluate relative changes in the biomass of longfin squid and fish and invertebrate bycatch species between the Empire Wind Lease Area and the reference area between pre-construction, during construction, and post-construction time periods.
- **Objective 2** - Assess potential changes in the size structure of longfin squid and fish and invertebrate bycatch species between Empire Wind Lease Area and the reference area between pre-construction, during construction, and post-construction time periods.
- **Objective 3** - Investigate potential changes in the composition of fish and invertebrate species between Empire Wind Lease Area and the reference area between pre-construction, during construction, and post-construction time periods.

A BACI study design will allow for quantitative comparisons of relative biomass and size structure to be made before and after construction between the Empire Wind Lease Area and the reference area (Underwood 1992; Smith et al. 1993). Sampling replication across time and space allows for the detection of possible changes caused by construction and operation of the wind farm (Underwood 1992).

3.4.1.2 Sampling Stations

The trawl survey will be executed using a BACI experimental design, with observations occurring within the reference area serving as a regional proxy for relative abundance of longfin squid and bycatch fish and invertebrate species away from the influence of project activities or activities associated with other offshore wind development. The reference area encompasses the same approximate area as the Empire Wind Lease Area (325 km^2), is approximately 30 km southwest of the Empire Wind Lease Area, 10 km from the Sunrise Wind export cable to the northeast, and is outside the major shipping lanes stemming from New York Harbor (Figure 1-1).

The reference area was selected to reflect similar depths and benthic habitats as the Empire Wind Lease Area. Data provided in the Northwest Atlantic Ecoregional Assessment indicate that the Empire Wind Lease Area primarily consists of fine, medium, and coarse sand (Greene et al. 2010). Additional site characterization assessments commissioned by Equinor confirm that the site is primarily comprised of sands of varying grain sizes (see Section 4.1 below; Empire Offshore Wind Construction and Operations Plan [COP] Appendix T, Benthic Resource Characterization Reports, Tetra Tech 2022). The reference area was also evaluated relative to the survey strata of the NEFSC bottom trawl survey. The NEFSC trawl survey is the only regional trawl survey that overlaps with the offshore location of the Empire Wind Lease Area. The Lease Area is mostly contained within Stratum 1010 with a small portion of the western end of the Lease Area within 3110 (Figure 3-6). Modifications to the location of the reference area may be considered based on input received from local fishing industry groups, state and federal agencies, or following discussion with the fishing industry partners that are selected to execute the trawl survey.

Both the Empire Wind Lease Area and reference area exhibit a depth range of 22-42 m. The trawl survey will be stratified by depth with the number of survey tows evenly distributed between a “shallow” depth stratum (<35 m) and a “deep” stratum (>35 m). Each survey stratum will be evenly divided into grid cells and two grid cells will be selected randomly within each stratum for sampling tows before each survey trip (Figure 3-7). The location of trawl sampling stations may be subject to change due to the presence of fixed gear (e.g., gillnets), or other factors that may preclude a randomly selected location from being sampled safely. Therefore, alternate sampling locations will be randomly chosen within each grid cell for each survey. If a primary sampling location is found to be untrawlable based on the captain’s professional judgement, sampling will instead occur at one of the randomly selected alternate sampling locations. If any marine mammals or other protected species are sighted in the vicinity of a trawl tow (< 500m), sampling will be delayed at that location in order to minimize the risk of an interaction. Empire will work with the survey scientists and captain and crew of the trawl vessel(s) to evaluate whether construction activities will impact the execution of the trawl survey.

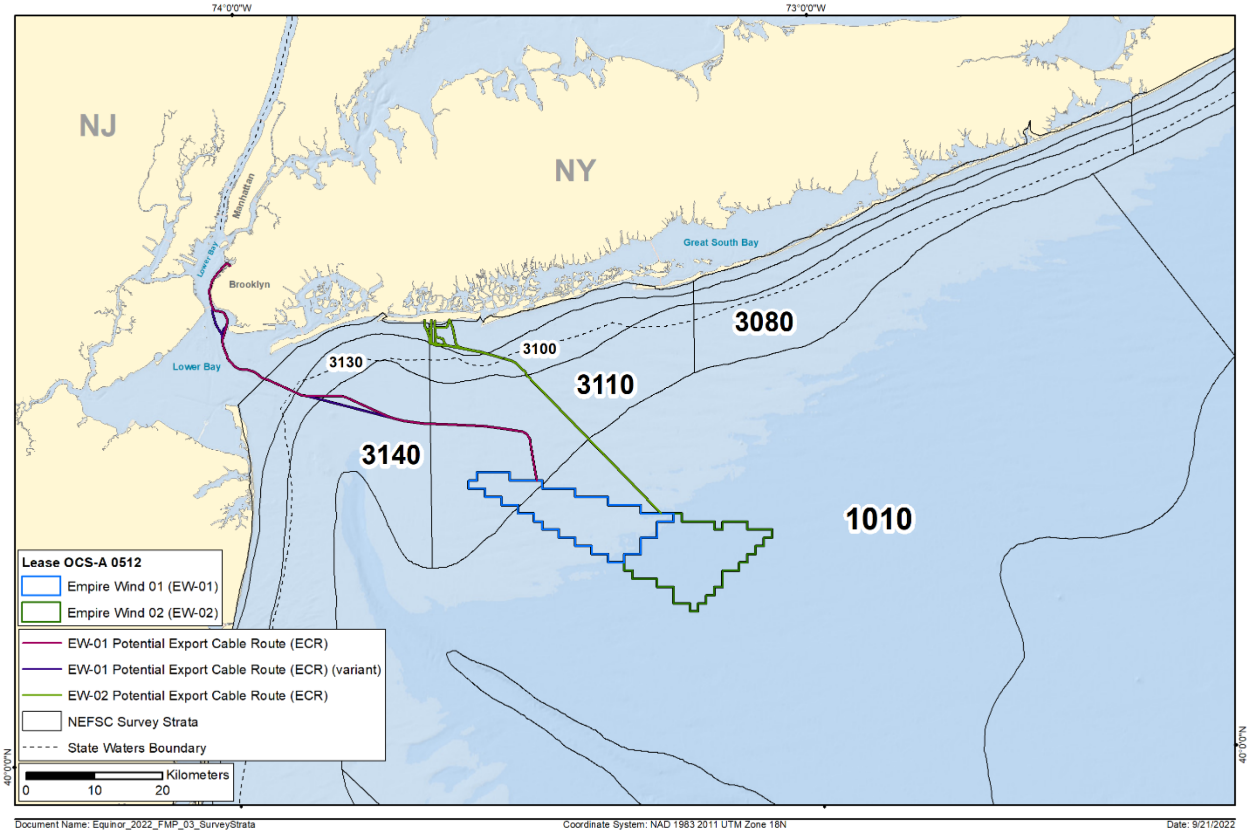


Figure 3-6. NEFSC survey strata and the Empire Wind Lease Area

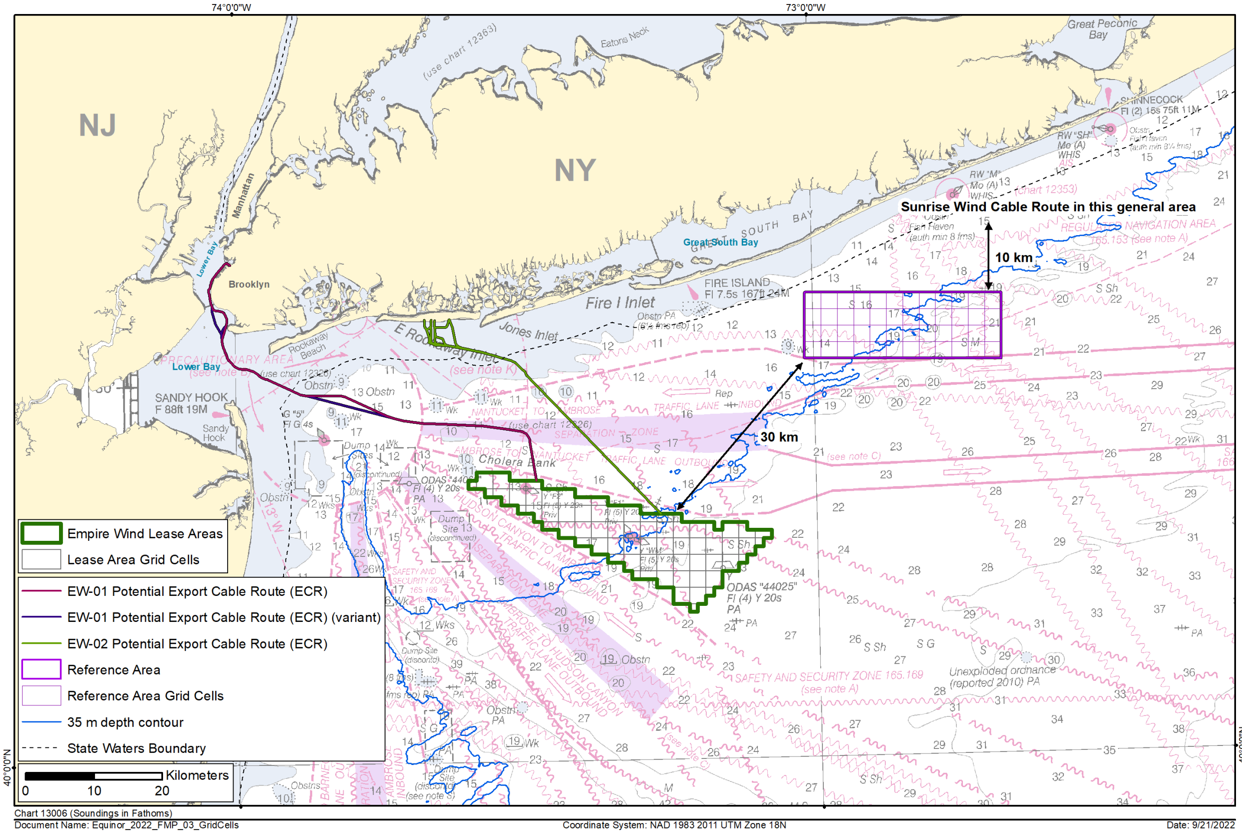


Figure 3-7. Map of the Empire Wind Lease Area and planned reference area for the trawl survey with the areas divided into grid cells and the 35 m depth contour identified

A power analysis was conducted using trawl survey data from the Block Island Wind Farm (BIWF) and NEFSC trawl survey datasets (Attachment A) to determine sample sizes needed to achieve sufficient statistical power to detect a potential impact, given background variability in catches. NEFSC trawl survey data from 2010 through 2018 were obtained from Phil Politis (Northeast Fisheries Science Center Bottom Trawl Program Lead, personal communication), and only tows from Stratum 1010 were used to inform the power analysis. From 2010 through 2018, the NEFSC trawl survey sampled in the spring and fall. Monthly catch data from the two reference sites sampled during the BIWF trawl survey were also reviewed to determine the extent to which the seasonal NEFSC trawl survey captured intraannual biomass peaks for different species of interest. Power analysis represents the relationships among the four variables involved in statistical inference: sample size (N), effect size, and type I (α) and type II (β) error rates (Cohen 1992). Of primary interest for this study is the interaction between temporal and spatial factors, specifically the contrast between the temporal change at the Empire Wind Lease Area relative to the temporal change at the reference site (Equation 2 in Attachment A). Power curves were constructed to demonstrate how statistical power for the interaction contrast varies as a function of the variance in the catch data, the effect size (i.e., the percent change at the Empire Wind Lease site relative to the reference site), sample size (i.e., number of trawl tows per area in each season), and the number of reference sites that are sampled (Attachment A, Figures A4 and A5). When analyzing for changes in relative biomass, achieving a statistical power of at least 0.8 is intended, which is generally considered to be the minimum standard for scientific monitoring (Cohen 1992). This ensures that the monitoring will have a probability of at least 80% of detecting an effect of the stated size when it is actually present. A single alpha (0.10) was used for the power analysis, and the power analysis was completed assuming two years of pre-construction and post-construction monitoring.

A sample size of 16 trawl tows per area will be targeted per sampling season in each year at the start of the survey. Based on the results of the power analysis (Attachment A, Figure A5), this level of sampling is expected to have at least 80% power to detect a 50% temporal decrease for longfin squid biomass at the Project area relative to the reference area for moderate coefficient of variation (CV) estimates (0.6-0.8). An examination of the NEFSC and BIWF trawl survey data indicates that longfin squid exhibited moderate to high levels of inter-annual and intra-annual (e.g., seasonal or monthly) variability in catch rates (Attachment A, Figures A2 and A3 and Table A1). Given the magnitude of variability in catch rates that will likely be exhibited in the Empire trawl survey, it is not practicable to attempt to capture a small effect size (e.g., 25%) for longfin squid. This power analysis assumes that the variance in the catch rates during the Empire trawl survey will be similar to the variance observed during the BIWF and NEFSC trawl surveys. Following the collection of the first year of trawl survey data, the observed intra-annual variability will be calculated for longfin squid in the catch. The achievable effect sizes will also be identified following the first year of the survey, once the realized magnitude of variability is better understood, and once regional guidance regarding target effect sizes has been formalized through ROSA. Given the predicted power of the study design for the anticipated magnitude of variability (i.e., range of CVs from 0.6 to 0.8), the sample sizes proposed for the first year of the trawl survey are robust.

3.4.1.3 Trawl Survey Methods

All survey activities will be subject to rules and regulations outlined under the Marine Mammal Protection and Endangered Species Acts. Efforts will be taken to reduce marine mammal, sea turtle, and seabird injuries and mortalities caused by incidental interactions with fishing gear. As mentioned above, deploying trawl gear will be delayed if marine mammals are sighted in the vicinity of the sampling station. All gear restrictions, closures, and other regulations set forth by take reduction plans (e.g., Harbor Porpoise Take Reduction Plan, Atlantic Large Take Whale Reduction Plan) will be adhered to as with typical scientific fishing operations to reduce the potential for interaction or injury.

The trawl survey will be carried out during summer, when longfin squid is most abundant in the region as indicated in the BIWF and NEFSC trawl survey data (Attachment A, Figures A2 and A3). Four survey tows (two in each depth stratum) will be conducted in both the Empire Wind Lease and the reference area, twice each month (16 tows total in each area in each sampling year). Two sampling events will occur each month to distribute sampling effort and target the peak seasonal biomass. Within a sampling event, the replicate tows within the Empire Wind Lease Area and the reference area will be completed within as few days as possible, given practical constraints imposed by weather or other factors (e.g., mechanical issues with vessel). Efforts will also be made to have consistent timing between surveys (e.g., two weeks), to the extent possible.

The trawl net used will be typical of the local squid fishery and utilize a codend fitted with a 2.5 cm (1 inch) knotless codend liner to sample squid and other marine taxa across a broad range of size and age classes.

Net mensuration equipment will be used during the survey to provide the captain and scientific crew with real-time information on door spread, wing spread, and headrope height. This information also allows the area swept (km^2) to be calculated for each tow, which is needed in order to estimate absolute abundance. The position, heading, and speed of the vessel will be monitored throughout each tow using a software program that is integrated with a GPS unit (e.g., NEFSC Fisheries Logbooks Data Recording System, or similar). A temperature logger attached to the trawl net will be used to record bottom temperature continuously (e.g., every 30 seconds) during trawling.

Similar to the methods employed on other regional surveys (e.g., NEAMAP and NYSDEC Nearshore Ocean Trawl survey), all tows will be completed during daylight hours, and the target tow duration will be 20 minutes. The relatively short tow duration is also expected to minimize the potential for interactions with protected species and marine mammals. A target tow speed of approximately 3 knots will be used. The tow will begin when the winches are locked, and an acceptable net geometry is established. The amount of wire set with each trawl to achieve the target net geometry will be left to the professional judgement of the captain, dependent upon the depth and the in-situ conditions.

Animals collected from each trawl tow will be sorted, identified to the species level, weighed, and enumerated consistent with the sampling approach of NEAMAP. Taxonomic guides that can be utilized to assist with species identification include *NOAA's Guide to Some Trawl-Caught Marine Fishes* (Flescher 1980), *Bigelow and Schroeder's Fishes of the Gulf of Maine* (Collette and Klein-MacPhee 2002), Kells and Carpenter's (2011) *Field Guide to Coastal Fishes from Maine to Texas.* Species will be identified consistently with the Integrated Taxonomy Information System (ITIS). The following information will be collected for each trawl that is sampled; catch per unit effort (CPUE), species diversity, and size structure of the catch. All species captured will be documented for each valid trawl sample. When large catches occur, sub-sampling may be used to process the catch, at the discretion of the lead scientist. The three sub-sampling strategies that may be employed are adapted from the NEAMAP survey protocols and include straight subsampling by weight, mixed subsampling by weight, and discard by count sampling (Bonzek et al. 2008). The type of sub-sampling strategy that is employed will be dependent upon the volume and species diversity of the catch.

The biomass (weight, kg) of each species will be recorded on a motion-compensated marine scale and used to calculate CPUE. Length will be recorded for the dominant (i.e., most commonly encountered) and priority species in the catch. To assess the condition of individual organisms, up to 100 individuals of each species (and size class) will be measured (to the nearest cm) and individually weighed. Length (e.g., total length, fork length, mantle length) will be recorded for each species consistent with the measurement type specified in the Northeast Observer Program Biological Sampling Guide. After sampling, all catch will be returned to the water as quickly as possible to minimize mortality.

Oceanographic data will be collected at each trawl station using a Conductivity Temperature Depth (CTD) sensor (or similar). The CTD will sample the vertical profile of the water column at each station. The CTD profile will be collected at either the start or end of each tow at the discretion of the captain and/or lead scientist. Bottom temperature information will be collected for the duration of each tow using a gear mounted temperature sensor or a temperature sensor that is included in the suite of net mensuration electronics.

Should any interactions with protected species (e.g., marine mammals, sea birds, sea turtles, sturgeon) occur, the contracted scientists will follow the sampling protocols described for the Northeast Fisheries Observer Program (NEFOP) in the Observer On-Deck Reference Guide (NEFSC 2016). If any protected species are captured during trawling, the data collection (measurements, photos, etc.) and release of those animals will take priority over sampling the rest of the catch. Reporting of interactions with marine mammals, such as small cetaceans and pinnipeds, will be dependent on the type of permit issued to the project; once the permit type has been specified, Empire will contact NMFS Protected Resources Division (NMFS-PRD) for guidance on reporting procedures. Additionally, protocols for handling live or deceased protected species of sea turtles, sturgeon, or marine mammals will be dependent on the type of permit (i.e., Exempted Fishing Permit [EFP] or Letter of Acknowledgement [LOA]) issued to the project. Once the permit type has been specified, Empire will contact NMFS-PRD for guidance on handling protocols. Entangled large whales or interactions with sea turtle species will be reported immediately to NOAA's stranding hotline via telephone (866-755-NOAA) and interactions with sturgeon species will be reported immediately to NOAA via the incidental take reporting email (nmfs.gar.incidental.take@noaa.gov); a follow up detailed written report of the interaction (i.e., date, time, area, gear, species, and animal condition and activity) will be provided to the NMFS Greater Atlantic Regional Fisheries Office (incidental.take@noaa.gov) within 24 hours. Any biological data collected during sampling of protected species will be shared as part of the written report that is submitted to the NMFS Greater Atlantic Regional Fisheries Office, and any genetic samples obtained from sturgeon will be provided to the NMFS Greater Atlantic Regional Fisheries Office Protected Resources Division. Due to the potential for communicable diseases, all physical sampling and handling of marine mammals and seabirds will be limited to the extent Empire health and safety assessments and plans allow.

3.4.1.4 Trawl Station Data

The following data elements will be collected during each sampling effort:

- Station number
- Latitude and longitude at the start and end of the tow
- Time at the start and end of the tow
- Vessel speed and heading
- Water depth at the start and end of the tow
- Wind speed
- Wave height
- Weather conditions (e.g., cloud cover, precipitation)
- Tow speed
- Gear condition/performance code at the end of the tow
- Oceanographic data, as collected using a CTD and a temperature logger (see Section 3.4.1.3).

3.4.1.5 Data Management and Analysis

All field data will be reviewed and verified before being entered into a relational database. Rigorous quality control audits will be performed on database tables using standardized, systematic queries to identify data and input errors. Species names (common and scientific) will be verified and tabulated for consistency with regional databases. Only audited and verified data will be exported from the relational database for use in analyses.

The pre-construction data will allow for characterization of the baseline fish and invertebrate community structure (with focus on longfin squid) in both the Project Area and reference area. For the pre-construction monitoring, the results presented in annual reports will focus on descriptive and quantitative comparisons of the fish and invertebrate communities in the Project

Area and the reference area to describe spatial, seasonal, and annual differences in relative abundance, species composition, and size distribution. For the dominant species in the catch, relative abundance will be compared amongst the reference and impact areas using descriptive statistics (e.g., mean, range) and length frequency data by species will be compared between areas using descriptive statistics, graphical techniques (empirical cumulative distribution function [ECDF] plots), and appropriate statistical tests (e.g., the Kolmogorov-Smirnoff test). Species composition will be compared between the impact and reference area using appropriate multivariate techniques (e.g., Analysis of Similarities; ANOSIM). By continuing sampling during and after construction, the trawl survey will allow quantification of any detectable changes in relative abundance, demographics, or community structure associated with proposed operations. The BACI design for this survey plan allows the catch of numerically dominant species to be compared between the before and after construction periods in the two treatment types (reference and impact), using appropriate statistical modeling. The use of a reference area will ensure that larger regional changes in demersal fish and invertebrate community structure will be captured and delineated from potential impacts of the proposed Project. Analyses presented in the final synthesis report will focus on identifying changes in the fish community in the Project Area between pre-and post-construction that did not also occur at the reference area (or the reverse) that could be attributed to either construction or operation of the wind turbines.

Once post-construction data are collected, the primary research question to be addressed will examine the magnitude of difference in the temporal changes in relative longfin squid biomass between the reference and impact areas. This research question can be framed using the following hypotheses:

- $H_Ø$-Changes in relative biomass in both the reference and impact areas will be statistically indistinguishable between time periods (before and after).
- H_1-Changes in relative biomass will not be the same at the reference and impact areas between time periods (before and after; two-tailed).

In this symmetrical BACI design, there are multiple years of sampling in each time period (pre- and post-construction) and two depth strata within the reference area. A Generalized Linear Modeling (GLM) framework will be used to describe the data and estimate the 90% Confidence Interval (CI) on the BACI contrast. At a minimum, season and location (impact or reference site) will be evaluated as covariates in the model, but the modeling framework could be expanded to include other relevant covariates such as temperature, depth, and salinity. Multiple error distributions will be evaluated to determine the model structure that best describes the data. The interaction contrast that will be tested is the difference between the temporal change (i.e., average over the post-operation period minus the average over the pre-operation period) at the wind farm and the average temporal change at the reference area. A statistically significant impact would be indicated by a 90% CI for the estimated interaction contrast that excludes zero. Using a 90% CI allows 95% confidence statements for the lower or upper bound (e.g., if the lower bound of the 90% CI for the mean is greater than 0, this indicates 95% confidence that the mean exceeds 0).

Length frequency data for the dominant species in the catch will be analyzed. The first goal of the length-frequency analysis will be to examine whether the size structure of these species changes over time (pre- vs. post-construction). The second goal will examine how the size structure of these species varies between areas (Project Area vs. reference area). To achieve these two goals, length frequency data will be compared between times and locations for common species using descriptive statistics (e.g., range, mean) and graphical and statistical comparisons using ECDFs, a Kolmogorov-Smirnov test (Sokal and Rohlf 2001), or another appropriate method based on the characteristics of the data.

An adaptive sampling strategy will be employed, whereby data collected early in the study will be analyzed to assess statistical power and modify the sampling scheme or sampling intensity as needed (Field et al. 2007). Upon completion of the first year of trawl survey sampling, a power analysis (e.g., Gerrodette 1987) will be conducted. The variance (e.g., Relative Standard Error [RSE]) associated with the relative abundance estimates for dominant species in the catch will be calculated. Power curves will be used to demonstrate how statistical power varies as a function of effect size and sample size (i.e., number of trawl samples per area). When analyzing changes in the relative biomass of dominant species in the catch, we will aim to attain a statistical power of at least 0.8 to ensure that the monitoring will have a probability of at least 80% of detecting a 50% decrease in longfin squid biomass at the Project Area relative to the reference area. A single two-tailed alpha (0.10) will be evaluated during the power analysis, assuming two years of pre-construction and post-construction monitoring. The results of the power analysis could be used to modify the monitoring protocols in subsequent years. The decision to modify sampling will be made after evaluating several criteria including the amount of variability in the data, the statistical power associated with the study design, and the practical implications of modifying the monitoring protocols.

3.4.2 Baited Remote Underwater Video (BRUV) Survey

3.4.2.1 Survey Design

Empire will partner with INSPIRE Environmental to conduct a Baited Remote Underwater Video (BRUV) survey to assess the relative abundance and community composition of structure-oriented fish species within the Empire Wind Lease Area. Observations from wind farms in Europe have indicated that a community shift may occur when foundations are installed in areas that lack structured habitat, where structure-oriented species begin to inhabit these introduced turbine foundations due to a “reef effect” (Degraer et al. 2020). At Block Island Wind Farm located in Rhode Island state waters, abundances of structure-oriented species (black sea bass and Atlantic cod) increased near the wind farm after turbine installation (Wilber et al. 2022). Additionally, it is expected that structure-oriented species from more southerly regions will begin to inhabit foundations as their distributions continue to shift northward due to climate change (Hare et al. 2016). Traditional fisheries-independent survey techniques such as trawls do not sample structure-oriented species reliably as these gears are not able to survey in complex habitats (Hilborn and Waters 1992).

Traditionally, fixed-gear types are used for fisheries-independent sampling in hard bottom habitats (lobster traps, fish pots, gillnets) and these techniques are being utilized for monitoring within other offshore wind lease sites in the Northeast that contain complex bottom (South Fork Wind, LLC and INSPIRE Environmental 2022; Revolution Wind, LLC and INSPIRE Environmental 2021). These gear types often employ the use of vertical lines attached to buoys that float at the surface for use in retrieval of the gear after an extended soak time (days). With current efforts to minimize interactions of vertical lines with protected species, particularly the critically endangered North Atlantic Right Whale, non-traditional survey methods must be implemented to reduce the potential for these interactions. Additionally, these fixed-gear surveys are extractive fisheries methods that likely introduce a degree of mortality to the catch. BRUVs offer the advantages of a shorter soak time (minutes), non-extractive sampling, the ability to sample species not caught in traditional gear types, sampling a wide range of habitats, and examining video footage at a later time if needed (Langlois et al. 2020; Curry-Randall et al. 2020). Because the cameras are baited, BRUVs are particularly adept at detecting species highly attracted to bait, such as sharks (Torres et al. 2020). BRUVs have been proven to be an effective tool to monitor fish species in a variety of habitats around the world (Langlois et al. 2010; Mallet and Pelletier 2014; Harrison and Rosseau 2020; Cole et al. 2022), including structure-oriented species at wind farms in Europe (Griffin et al. 2016).

The BRUV survey will utilize a Before-After Gradient (BAG) design to assess the spatial extent of wind farm effects on adult and juvenile structure-oriented fish species. In particular, the survey will provide information on whether the abundances of structure-oriented species increase with increasing proximity to the turbines following construction. An increase in abundance would suggest a “reef effect”, whereby the addition of offshore wind foundations and scour protection creates new habitat for fish, which leads to subsequent increases in abundance in the Project Area (Anderson and Ohman 2010; Bergstrom et al. 2013). This “reef effect” has been documented in approximately half of the offshore wind farm monitoring studies that have tested for this impact (Glarou et al. 2020). The proposed survey design also eliminates the need for a Reference Area, which is required in a BACI design. Sampling effort is focused on sampling sites along a spatial gradient within the work area, rather than using a reference location that may not wholly represent conditions within the work area (Methratta 2020). This design also allows for the examination of spatial variation and does not assume homogeneity across sampling sites within the Project Area (Methratta 2020).

3.4.2.2 Sampling Stations

The Empire Wind BRUV survey is designed to occur seasonally (spring, summer, fall, winter) within the Lease Area, with monitoring targeted for two years pre-construction and two years post-construction. Monitoring is also planned during construction, provided the survey will not interfere with construction operations.

The methodologies and sampling distances employed in previous offshore wind studies were considered in the design of the BRUV survey. Bergstrom et al. (2013) used fyke nets to sample along transects that spanned a distance of 20 to 1,350 m from a turbine foundation and observed that four of the seven fish species examined demonstrated increased densities near the turbine. Griffin et al. (2016) used BRUVs to compare fish abundance and assemblage composition between locations adjacent to turbine foundations vs. 100 m distant in the Irish Sea. Stenberg et al. (2015) used gillnets to sample at three increasing distance categories from the turbine foundations ('near' = 0-100 m, 'middle' = 120-200 m, and 'far' = 230-330 m) and demonstrated that fish with an affinity to rocky habitats were most abundant close to the turbine foundations. In a review of European wind farm case studies, Methratta (2020) noted that the majority of direct effects associated with turbine foundations (e.g., habitat provision, attraction, food provision) are expected to occur on a local scale (i.e., 10 - 100s of meters from the turbine foundation). Currently, the South Fork Wind Farm is conducting a BAG study utilizing a 900-m string of 18 fish pots, spaced 50 m apart, deployed in a straight line away from the base of turbine foundations to examine the spatial extent of wind turbine effects on black sea bass (South Fork Wind, LLC and INSPIRE Environmental 2022).

Sampling will occur at eight randomly selected planned turbine locations. These sampling locations will remain fixed for the duration of the survey (pre- and post-construction). As with the squid trawl survey, the Lease Area with be comprised of two depth strata, where four turbine locations will be sampled in each of the "shallow" (<35 m) and "deep" (>35 m) strata. At each sampling station, four BRUV's will be deployed at increasing distances from the planned turbine foundation location to examine the spatial extent of effects from the turbine foundation and surrounding scour protection (Figure 3-8). During the pre-construction period the first BRUV will be placed within the buffer zone around the planned turbine foundation location. Post-construction, the BRUV will be placed as close to the turbine foundation as is safely possible and that will allow for an adequate field of view around the turbine base. Three additional BRUVs will be placed at distances of 50 m, 100 m, and 200 m from the base of the turbine so that sampling occurs close to the turbine base and outside of habitat altered by turbine construction.

3.4.2.3 Survey Methods

To ensure data comparability and compatibility across wind farm projects, The BRUV survey will be conducted following best practices outlined in Birt et al. 2021 and gear designs provided by Langlois et al. 2020 (Figure 3-9) as outlined in the Ocean Wind Offshore Wind Farm Fisheries Monitoring Plan (2021). BRUVs will be rigged with a vertical line and buoy to the surface to facilitate retrieval of each BRUV. BRUVs will be deployed for approximately 60 minutes. Video will be captured using a camera with high resolution such as GoPro Hero 9 cameras or similar. The video recorded by the BRUVs will be processed by INSPIRE Environmental using computer software appropriate for video analysis (Behavioral Observation Research Interactive Software [BORIS; Friard and Gamba 2016] or similar). All fish will be identified to species when possible. The primary response variable that will be generated from the BRUV's is MaxN, which is the moment in the video where the maximum number of individuals for a given species are observed. MaxN is the most common metric associated with BRUVs (Bicknell et al. 2019) and is considered to be a conservative estimate of relative abundance because it removes concerns that the same fish can be counted more than once (Griffin et al. 2016). Strategic design of each of the BRUVs with two video cameras can enable fish length and distance measurements to be estimated from the recordings. Measurements will only be taken for those species of greatest interest and fisheries value (e.g., black sea bass, tautog). As recommended by Langlois et al. 2020, individual fish lengths will be measured at the same time that MaxN is observed. In order to estimate fish length from the video footage the methods from previous work (e.g., Langlois et al. 2020; Birt et al. 2021; Harvey et al. 2021) will be followed. A secchi disk will be lowered from the vessel at each sampling station to assess the transparency of the water and help quantify visibility and assist with video data analysis.

3.4.2.4 Station Data

The following data elements will be collected during each sampling effort:

- Station number
- Latitude and longitude for each BRUV deployment
- Time at the start and end of the BRUV deployment
- Water depth at each BRUV location
- Wind speed
- Wave height
- Weather conditions (e.g., cloud cover, precipitation)
- Bait type used
- Oceanographic data, as collected using a CTD and a temperature logger (see Section 3.4.1.3).

3.4.2.5 Data Management and Analysis

The BAG survey design will allow for the characterization of pre-construction community structure of fish species present in the Empire Wind Lease Area and will continue sampling after construction to quantify any changes in relative abundance associated with the construction and operation of wind turbines at the site. For the pre-construction monitoring, the results presented in annual reports will focus on descriptive and quantitative comparisons of the fish metrics at increasing distances from a wind turbine foundation to describe spatial, seasonal, and annual differences in relative abundance, species composition, and size distribution. Several statistical models will be compared (e.g., GLM, Generalized Linear Mixed Model [GLMM], or Generalized Additive Model [GAM]) with distance treated as a main effect (continuous variable), and the best fitting model for each species will be used to estimate the 90% CI on the before-after change in the distance coefficient. Further, information on depth and bottom temperature collected at sea may be considered as covariates in the model to evaluate their influence on fish abundances.

Habitat data collected during the benthic SPI/PV surveys (Section 4.0) and from Equinor geophysical surveys can also be considered as covariates in the model to evaluate the influence of habitat on fish abundance. Species composition will be compared before and after construction using a Bray-Curtis Index and multivariate techniques (e.g., ANOSIM). Graphical methods and descriptive statistics will be used to assess changes in the fish assemblage over time, as a function of distance from the turbines. These graphical techniques may help to elucidate the spatial scale at which relative abundance changes the most with distance from the turbine foundation. By continuing sampling during and after construction, the BRUV survey will allow quantification of any detectable changes in relative abundance, demographics, and community structure associated with proposed operations. Analyses presented in the final synthesis report will focus on identifying changes in the fish community in the Project Area between pre-and post-construction time periods at increasing distance from the turbine foundations that could be attributed to either construction or operation of the wind turbines.

The primary question to be addressed is whether fish metrics (either abundances of individual species or assemblage composition) will change relative to distance from a turbine foundation following their installation. This research question can be framed using the following hypotheses:

- $H_{Ø}$-Fish metrics will not change over time and will remain consistent with respect to the distance from a turbine.
- H_1-Fish metrics will change over time and will not be consistent with respect to distance from the turbine.

Species composition will be compared before and after construction using a Bray-Curtis Index and multivariate techniques (e.g., ANOSIM).

An adaptive sampling strategy will be employed, whereby data collected early in the study will be analyzed to assess statistical power and modify the sampling scheme or sampling intensity as needed (Field et al. 2007). Upon completion of the first four seasonal sampling events, a power analysis (e.g., Gerrodette 1987) will be conducted to evaluate the power of the sampling design. The intra-annual variance associated with the relative abundance estimates for dominant species in the catch will be calculated. Power curves will be used to demonstrate how statistical power varies as a function of effect size and sample size (i.e., number of samples per area). A single two-tailed alpha (0.10) will be evaluated during the power analysis. The results of the power analysis will be considered and can be used to modify the monitoring protocols in subsequent years. The decision to modify sampling will be made after evaluating several criteria including the amount of variability in the data, the statistical power associated with the study design, and the practical implications of modifying the monitoring protocols.

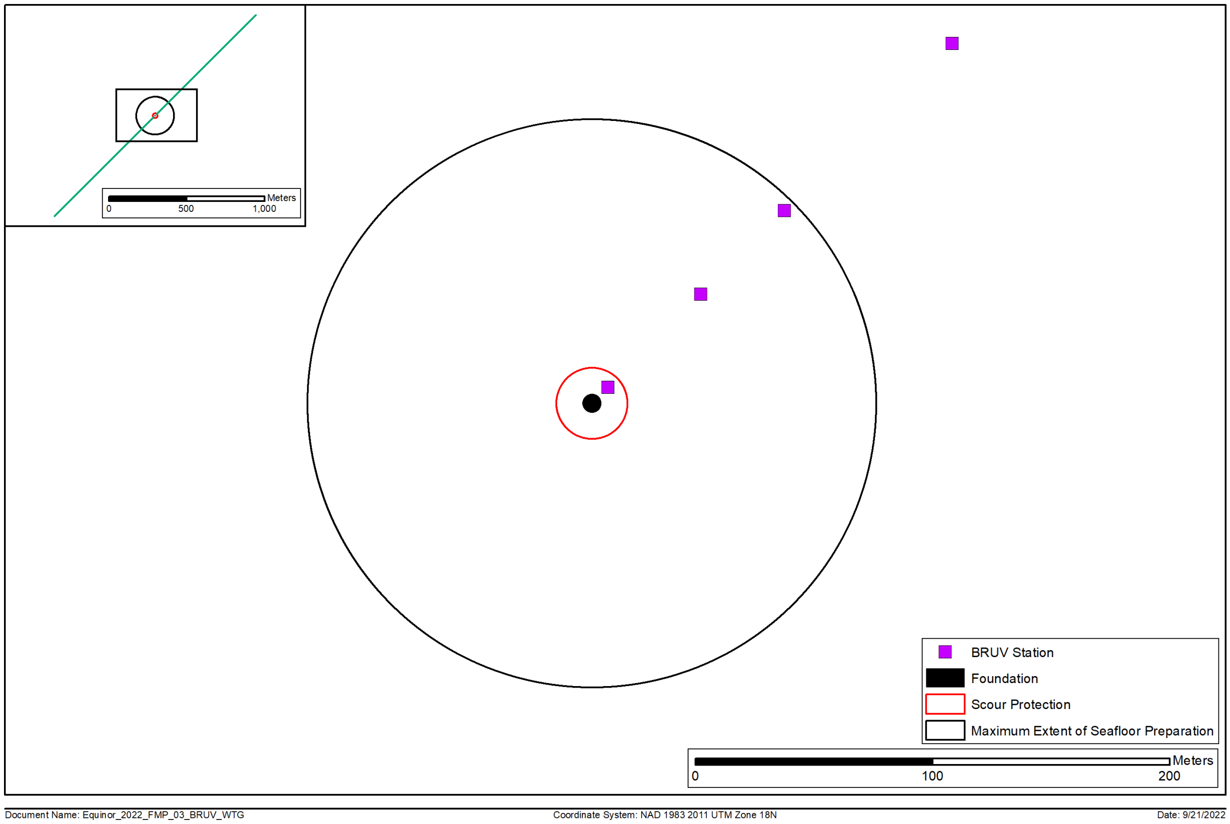


Figure 3-8. Proposed BRUV survey sampling distances

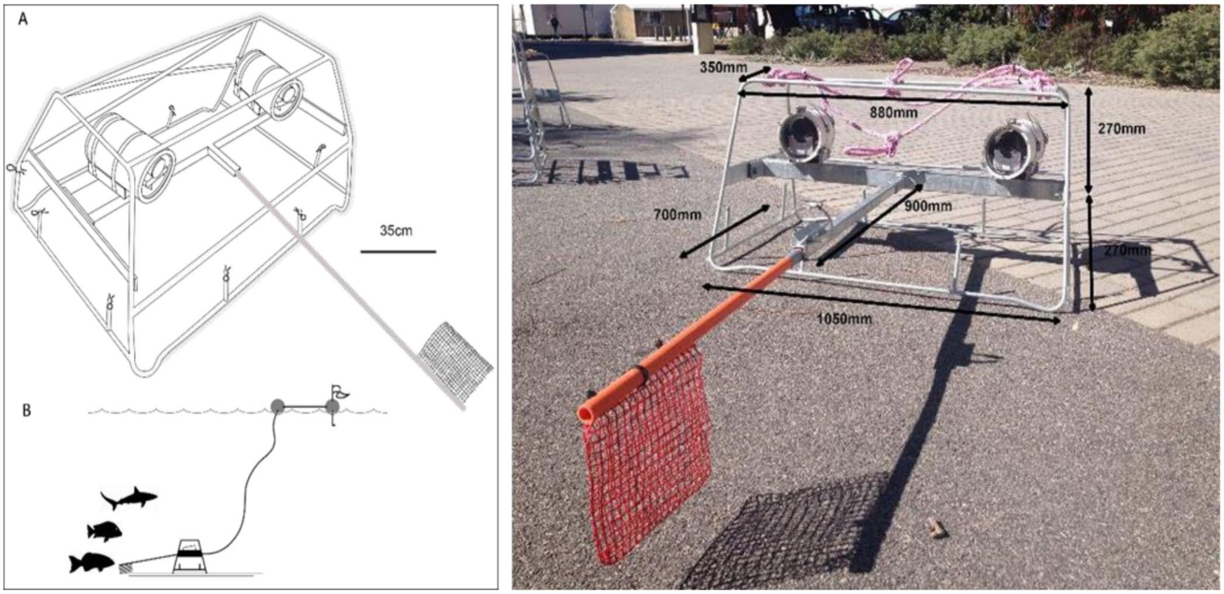


Figure 3-9. Example of BRUV (from Langlois et al. 2018) design to be adapted for use in the Empire Wind BRUV survey

3.4.3 Environmental DNA (eDNA) Sampling

Empire Wind is partnering with researchers from INSPIRE Environmental, Monmouth University, and St. Anselm's College to carry out a comprehensive eDNA survey at the Empire Wind Lease Area. The eDNA sampling will occur concurrent with the trawl and BRUV surveys, enabling a more holistic understanding of the relative abundance and composition of the species assemblage at the Empire Wind site, while ground-truthing a relatively novel, non-extractive monitoring method.

eDNA sampling can be used to collect information on species presence/absence, abundance, and biodiversity. Aquatic animals constantly shed their DNA into the surrounding water in the form of scales, damaged tissue, eggs, metabolic waste, and other biological residue. This DNA persists in the water for a short time period. During eDNA sampling, a small volume of water is collected and filtered. The sample is then analyzed, and the DNA collected in the sample is compared to a genetic reference library. Because each species has a unique complement of genes, the DNA fragments collected in the sample can be used to identify the species that were present in the area when the sample was taken.

eDNA analysis is typically conducted in one of two ways, metabarcoding or qPCR analysis. qPCR is typically used when the analysis is focused on a single species of interest, and the objective is to estimate the relative abundance of the species in the sampling area. With metabarcoding, high throughput genetic sequencing is used to sample for the presence of multiple species in order to investigate questions related to biodiversity and community composition. With metabarcoding, different genetic primers are used to assess the diversity of different taxonomic groups. A metabarcoding approach will be implemented for this monitoring effort and each sample of water will be analyzed for two primers: bony fish and cartilaginous fish, with a third primer analyzed for invertebrates from trawl survey samples.

eDNA offers several advantages over traditional fisheries sampling methods because it is non-extractive, it does not result in stress or mortality to the organisms that are identified. Unlike bottom-tending mobile sampling gear, eDNA sampling can be performed without causing any damage to the benthic habitat, and eDNA does not necessitate the use of fixed vertical lines that can lead to marine mammal entanglements. In addition, eDNA samples can be taken in areas with hard bottom benthic habitats that cannot be sampled using a trawl or other mobile bottom-tending sampling gear. eDNA can also detect a species throughout each stage of its' life cycle, thus avoiding issues associated with size/age selectivity. In the marine environment, experiments suggest that eDNA is detectable for ~48 hours (Collins et al. 2018), meaning that detections represent recent presence of a given fish species, making eDNA a valuable tool for time series. However, one drawback associated with eDNA sampling is understanding the rate at which different species shed DNA into the water column and understanding how that varies as a function of ontogeny, behavior, and abiotic factors such as temperature (Knudsen et al., 2019).

eDNA offers an exciting opportunity to investigate several questions of importance to fisheries science including; monitoring the presence/absence of rare and endangered species, estimating relative abundance, understanding community composition, detecting shifts in species distribution, monitoring the spread of invasive species, and understanding how introduced habitats affect species diversity and abundance. Improvements to DNA reference libraries are continuously occurring (e.g., Stoeckle et al. 2020a) enabling a greater variety of species to be detected through eDNA sampling.

Recent studies have completed paired sampling using eDNA and a trawl survey, and the results offer insights into the capabilities of this innovative technology to improve our understanding of the marine ecosystem (e.g., Thomsen et al. 2016; Knudsen et al. 2019; Liu et al. 2019; Salter et al. 2019; Stoeckle et al. 2020b; Afzali et al. 2021; Kirtane et al. 2021; Russo et al. 2021; Maiello et al. 2022). Stoeckle et al. (2020b) compared species diversity and relative abundance between eDNA samples and trawl catches from the NJDEP seasonal trawl survey. This study used a metabarcoding approach, and two primers were analyzed, one for bony fish, and another for cartilaginous fish. During a given month, 70-87% of the fish species detected by eDNA were also captured in the trawl, and peak seasonal abundance agreed between the two methods for 70% of the fish species. Interestingly, in all months, eDNA results indicated a greater species diversity than trawl sampling, illustrating the promise of eDNA for investigating biodiversity in the coastal ocean.

Salter et al. (2019) conducted paired sampling using eDNA and a trawl survey in the coastal waters of the Faroe Islands. This study used a qPCR approach, where the eDNA sampling was focused primarily on evaluating the distribution and abundance of Atlantic cod. In general, there was good agreement between the two sampling methods with regards to the presence and absence of cod. At the spatial scale of an individual sampling station there was generally low correlation between the biomass of cod observed in trawl catches and the concentration of cod DNA in the sample. However, when the data were aggregated and examined at a regional level, a strong correlation was found between the standardized CPUE of cod in the trawl and the concentration of cod DNA obtained in the sample.

Knudsen et al. (2019) completed paired sampling between eDNA and a trawl survey to compare the relative abundance and distribution of cod, herring, plaice, Atlantic mackerel, and European flounder in the Baltic Sea. While this study did not find significant correlations between eDNA concentrations and trawl survey catch rates, the eDNA concentrations measured for some species were associated with areas where different species were known to be most abundant. In addition, some species such as mackerel and European eel were detected using eDNA but were not present in trawl survey catches. Closek et al. (2019) used multiple methods (eDNA, trawl survey, and visual survey for marine mammals) to investigate the species composition in the Central California Current ecosystem. eDNA samples detected 48 fish taxa, and 11 species of marine mammals. Of the 48 fish taxa identified using eDNA, only 17 taxa were also collected using a trawl. On the other hand, the trawl survey observed 28 fish taxa, of which 17 taxa were also identified using eDNA. This study indicates that paired sampling using eDNA and trawl provides a more holistic understanding of species composition and biodiversity.

Stat et al. (2019) used eDNA metabarcoding and BRUV's to examine species diversity on reef and seagrass communities inside and outside a marine reserve in Western Australia. The fish community described by eDNA and BRUV's combined contained greater than 30% more generic richness than either method sampled on its own. In addition, species not detected by one method were very often detected by the other. Cole et al. (2022) also utilized eDNA and BRUV's to compare biodiversity between structured (oyster reefs) and unstructured (sand) habitats. eDNA metabarcoding detected a greater number of species than BRUV's, but both were able to resolve differences in species diversity between both habitats at fin spatial scales. Mercaldo-Allen et al. (2021) used eDNA in combination with video footage to assess fish assemblages attracted to oyster aquaculture cages and boulder habitat in Long Island Sound. Seven species were identified in the videos compared to 42 species by eDNA.

Two years of sampling are planned prior to the commencement of offshore construction. The eDNA survey will continue during the construction phase, and a minimum of two years of eDNA monitoring will be completed following offshore construction.

The primary research question associated with the eDNA survey is, does the construction and operation of the Empire Wind Project impact the community composition of fishery resources? Several metrics will be evaluated to assess the community composition, including species richness, dominant species, and relative abundance. The use of a BACI sampling design in the bottom trawl survey will allow for quantitative comparisons of community composition to be made before and after construction, and between reference and impact areas (Underwood 1992; Smith et al. 1993). The BAG design of the BRUV survey will allow for the examination of changes in community composition at increasing distance away from turbine locations. Pairing the eDNA sampling with the trawl and BRUV surveys will allow for a more holistic evaluation of community composition over time and space.

3.4.3.1 Sampling Stations

At each trawl survey sampling location in the Empire Wind Lease Area and the reference area, an eDNA sample will be collected (see Section 3.4.1.2). Therefore, during each sampling event, eight samples will be targeted for collection in the Empire Wind impact area and the trawl survey reference area, for a total of 32 samples each year. At each BRUV survey location, one sample will be taken that corresponds to the sites where video data is recorded closest to the mid-line of the total transect, for a total of 8 samples per seasonal sampling event, for a total of 32 samples each year. Additional surface samples will be taken at a subset of station locations (See Section 3.4.2.2).

3.4.3.2 Survey Methods

To ensure consistency with prior regional eDNA sampling efforts, samples will be collected using the procedures described in Stoeckle et al. (2020b). Briefly, water will be collected with a 1.2 L stainless steel polypropylene-lined Kemerer bottle. The bottle will be triple-rinsed with sample water before collection. At each location, water samples will be collected within 2 m of the bottom. At a subset of locations, paired surface and bottom water samples will be collected to check for differences in the community composition between the surface and the bottom. In addition, to ensure that the water samples have not been contaminated, control samples will be collected during each survey. The final sample will be collected into a sterilized 1-liter polypropylene bottle and stored on ice or in a freezer until transferred to a laboratory for filtering. If the sample cannot be filtered within 24 hours it will be stored frozen.

Preceding the collection of water samples for eDNA analyses, water quality parameters will be measured in vertical profiles using a CTD as described in Section 3.4.1.3 (in trawl survey). To promote consistency with regional sampling efforts, the filtration and processing procedures described in Stoeckle et al. (2020b) will be followed. Collection bottles will be thawed for ~24 hours at 4°C and contents poured into a glass filter manifold attached to wall suction with a 47-mm, 0.45 µm pore size nitrocellulose filter (Millipore). Filters will be folded to cover retained material and stored in sterile 15-milliliter tubes at -80°C. As negative controls for each sampling event, several 1-liter samples of laboratory tap water will be filtered using the same equipment and procedures, and on the same day as the field samples. After filtration of contents, collection bottles will decontaminated by washing extensively with tap water, including vigorous shaking of partially filled containers with tops closed, and then air-dried and stored at room temperature-a procedure which relies on mechanical cleansing and dilution, eliminates amplifiable fish DNA from field collection bottles and filtration equipment, while avoiding possible exposure of water samples to residual bleach or other DNA destroying agents (Stoeckle et al. 2017). Frozen filters will be shipped to the Analytical Laboratory at University of MD Institute for Marine and Environmental Biotechnology for DNA extraction, library building for finfish, cartilaginous fish, and marine invertebrates, and Illumina sequencing. Products of this service will include de-multiplexed FastQ files and the extracted DNA, which will be archived in a monitored, alarmed –80°C freezer at Monmouth University.

3.4.3.3 Station Data

The following data will be collected during each sampling effort:

- Station number and sample ID
- Latitude and longitude
- Time
- Water depth
- Wind speed
- Wave height
- Weather conditions
- Oceanographic data, as collected using a CTD

3.4.3.4 Data Management and Analysis

Bioinformatics will use the DADA2 package (Callahan et al. 2016) run in R statistical computing environment according to procedures, and using the internal 12S bony / cartilaginous fish libraries, described in Stoeckle et al. (2017) and Stoeckle et al. (2020b). A 100% sequence match will be used to assign species-level taxonomic identifications. The results of bioinformatics analyses will be the number of sequence reads per taxonomic unit identified in the 12S reference sequence list. These data will be summarized in tables and graphs for each sampling event. Raw and processed data will be archived on secure servers at Monmouth University, as well as on removable media (e.g. external SDD drives).

The bioinformatics will be used to test the following hypothesis:

- $H_{Ø}$: Fish community composition will not differ before, during, or after construction of the Empire Wind Project
- H_1: Fish community composition will differ before, during, or after construction of the Empire Wind Project.

The following univariate metrics of the fish community composition will be evaluated in the analyses: species richness, dominant species, relative abundance, in addition to appropriate multivariate techniques (Bray-Curtis dissimilarity, non-metric Multidimensional Scaling [nMDS]) The hypothesis will be evaluated for each of the indicators using appropriate means testing techniques depending on the distribution of data collected (ANOVA or Kruskal-Wallis for parametric vs. non-parametric assessment, respectively, and analysis of similarities (ANOSIM) for the multivariate data). If significant differences are found among time periods, or among sampling areas, while controlling for seasonality, additional post-hoc testing will be performed to determine where differences were detected (e.g., before, during, after). In addition, the eDNA samples will be compared to data collected during the trawl and BRUV surveys to evaluate how information on relative abundance, presence/absence and community composition differ between the different sampling approaches. Comparisons of species richness and dominant species can be made seasonally or annually in tables or bar charts. Regression analyses can be used to examine the relationship between relative abundance determined through trawling/video vs. eDNA surveys. Specifically, relative abundance by eDNA will be computed as the number of ‘reads’ for a given species relative to all reads recovered for fishes in a given sample set (e.g., season), compared to relative trawl abundance (e.g., biomass/tow) of a given species relative to total mass of fish caught in a given season. Similar analyses using these relative proportions were recently published comparing trawl and eDNA assessments of fish community composition and relative biomass (Figure 8 in Stoeckle et al. 2020b). Additionally, in deep-water habitat off southwest Greenland, eDNA sequence reads from fish assemblages were correlated with biomass and abundance data obtained from trawling (Thomsen et al. 2016).

3.4.4 Acoustic Telemetry

3.4.4.1 Survey Design

Empire Wind is partnering with researchers from Monmouth University, Stony Brook University, INSPIRE Environmental, and the Anderson Cabot Center for Ocean Life (ACCOL) at the New England Aquarium to conduct acoustic telemetry monitoring at the Empire Wind Lease Area.

This study will use an array of fixed station acoustic receivers to monitor the movements, presence, and persistence of several commercially and recreationally important species (e.g., black sea bass, summer flounder, winter flounder, tautog) as well as the federally endangered Atlantic sturgeon. The focal species and array design were determined based on previous work conducted by the research team within the Empire Wind Project Area (Frisk et al. 2019).

Acoustic telemetry can be used to monitor animal presence and movements across a range of spatial and temporal scales. Individuals tagged with an acoustic transmitter that pass within the range (tens to hundreds of meters) of an acoustic receiver provide information on an animal's presence, movements, and behavior at a fine scale within the area of interest. The use of this technology has grown over the last decade with hundreds to thousands of receivers deployed along the US. East Coast (Hussey et al. 2015; Freiss et al. 2021). By utilizing information collected across receiver arrays and shared through established data sharing networks, telemetry can also monitor animal presence and movement over a range of spatial scales (tens to hundreds of kilometers) and time scales (e.g., months to years). Therefore, acoustic telemetry is an ideal technology to monitor presence, residency, and movements of species within WEAs using non-lethal methods and to evaluate short and long-term impacts of wind energy projects on these movement parameters.

Acoustic telemetry has been used to investigate the behavior and movements of fish species in offshore wind areas in Europe. Reubens et al. (2013a) monitored juvenile cod residency patterns, habitat use, and seasonal movement at the C-Power offshore wind farm in the North Sea and found that the majority of cod aggregated near the foundations and were resident within the wind farm for extended periods of time in the summer and autumn. Winter et al. (2010) tagged sole (n=40) and cod (n=47) with acoustic transmitters and tracked their movements within the Egmond aan Zee wind farm and a nearby reference area. They concluded that sole did not exhibit avoidance of the wind farm, nor did they appear to be attracted to the foundations. Instead, seasonal movements were interpreted as occurring at spatial scales larger than the wind farm.

Several acoustic telemetry projects are ongoing or proposed at offshore wind lease sites along the US East Coast. Scientists from the Massachusetts Division of Marine Fisheries, the UMass Dartmouth School for Marine Science and Technology, Rutgers University, the Nature Conservancy, Woods Hole Oceanographic Institute, and the Northeast Fisheries Science Center are using acoustic telemetry (fixed and mobile) to monitor habitat preference and utilization of spawning Atlantic cod in and around Cox Ledge within the South Fork (South Fork Wind, LLC and INSPIRE Environmental 2022) and Revolution Wind (Revolution Wind, LLC and INSPIRE Environmental 2021) lease areas. Researchers from the ACCOL and INSPIRE Environmental are conducting a long-term acoustic telemetry project examining the presence and persistence of several HMS within the nine lease areas comprising the Southern New England Wind Energy Area. Researchers from Rutgers University and Delaware State University are using multiple acoustic methods to monitor several different species both within and around the Ocean Wind lease area off the New Jersey coast (Ocean Wind, LLC 2021). Researchers from Monmouth University, Stony Brook University, and the Cornell Cooperative extension are also using acoustic telemetry to monitor the potential effects of electromagnetic fields (EMF) and fish and invertebrate species along the export cable routes of the South Fork and Sunrise Wind Farms (South Fork Wind, LLC and INSPIRE Environmental 2022; Sunrise Wind LLC 2022).

Within the Empire Wind project area, Frisk et al. (2019) demonstrated the use of acoustic telemetry to monitor the habitat utilization of Atlantic sturgeon, winter flounder, summer flounder, black sea bass, striped bass, and several species of elasmobranch. The authors observed seasonal occupancy of the Lease Area by these species, with Atlantic sturgeon utilizing the entire Lease Area in winter. The study greatly enhanced the understanding of sturgeon movements in offshore environments where data are lacking. The current monitoring study will build on the pre-construction findings of Frisk et al. (2019) as well as continue monitoring during construction and post-construction to better understand the movements and utilization of the Project Area by these species.

3.4.4.2 Survey Methods

A receiver array comprised of 48 receivers is proposed for deployment within the Empire Wind Project Area (Figure 3-10). Vemco VR2AR-X acoustic release omnidirectional receivers will provide maximum coverage for robust and rigorous reporting. The VR2AR-X receivers can detect a tagged individual from a radius of 700 to 1,100 m from the receiver location depending on sea conditions, ambient noise, and transmitter strength. Previous ocean arrays maintained by the research team suggest an average detection radius of 1 km. Each receiver will therefore continuously monitor an area of approximately 2 to 3 km^2 over the course of the proposed study. Each receiver will be equipped with a mooring recovery system that will utilize the receiver's acoustic release mechanism to deploy a retrieval line once the receiver is recalled to allow for recovery of the mooring used to anchor the receiver in place (Figure 3-11). The receivers will be deployed year-round and receivers will be retrieved for data download twice per year. Deployed acoustic receivers are in four main groups with 23 receivers monitoring offshore, 10 receivers along EW 1 export cable route (six within New York state waters and four within federal waters), Five receivers along the EW 2 export cable route and 10 receivers which will bracket the EW 2 export cable landing within New York state waters (Figure 3-10).

Vemco acoustic transmitters will be deployed on several species of interest including, but not limited to, striped bass, black sea bass, summer flounder, winter flounder, and Atlantic sturgeon. Capturing of animals tagged within this study will be successfully completed through a variety of proven fishery sampling techniques (e.g., gillnet, long line, rod-and-reel) appropriate for each species. Trawling may be conducted two times per year with a three-to-one two-seam trawl (25-m headrope, 30.5-m footrope) with 12-cm stretched mesh forward netting that tapered down to 8-cm stretched mesh rear netting lined with a 6.4-mm mesh codend liner and towed with 1.5-m Thyboron brand type 11 steel trawl doors (Dunton et al. 2010; Dunton et al. 2015; Melynchuk 2017). Tows will be conducted for 5-10 minutes at speed of 3-3.5 knots. If gillnets are used to sample Atlantic sturgeon, deployed nets from 91.4 m to up to 366 m (example sample nets may be Net 1: up to 365.76 m or 4 panels 13.97 cm Stretch mesh x .90 mm 25 meshes deep; Net 2: up to 365.76 m or 4 panels 25 – 33 cm Stretch x.90 mm 12 - 15 meshes deep). Deployed nets will be continuously monitored, and the vessel will not leave the site of deployed gear. Fish may also be tagged through commercial fish trap and/or rod-and-reel.

Individuals will be surgically implanted with various Vemco acoustic transmitters depending on the size of the fish. Over the duration of the project, 425 tags will be deployed per year. Larger individuals (e.g., striped bass, Atlantic sturgeon) will be implanted with a V16 ultrasonic transmitter (69 kHz, high-power output = 158 dB re 1 μPa at 1 m, random transmitter delay = 120 s, life span = 2,435 d). Medium to small individuals (summer flounder, winter flounder, black seabass, tautog, juvenile striped bass) will be tagged with either a V13 (69 kHz, high-power output = 151 dB re 1 μPa at 1 m, random transmitter delay = 180 s life span = 648 d) or a V9 (69 kHz, high-power output = 152 dB re 1 μPa at 1m, random transmitter delay = 120 s life span = 520 d). Once the transmitter has been inserted, the incision will be closed with a minimum of three absorbable interrupted sutures. The incision area will then be cleaned once more with betadine. A betadine/petroleum ointment will also be put on sutures and site of the incision site to aid in the recovery of the animals to deter bacterial infection. Sampling will be conducted throughout the proposed Empire Wind Lease Area and export cable routes, but at least 50 winter flounder and 50 juvenile striped bass will be specifically targeted within New York state waters around the EW 1 Export Cable Route in Lower Bay per year. All other species will be targeted within the offshore project area or near the related project areas.

3.4.4.3 Data Management and Analysis

The resulting detection data downloaded from acoustic receivers will be analyzed with the overall goal of establishing pre-construction information on species presence and persistence in the Empire Wind Lease Area. The primary question to be addressed is, what is the presence, persistence, and space utilization of the species of interest within the Empire Wind Lease Area? This research question can be framed using the following hypotheses:

- $H_{Ø}$-Species presence, persistence, and movements will not change between time periods (before and after).
- H_1- Species presence, persistence, and movements will change between time periods (before and after).

Short- and long-term presence, site fidelity (i.e., residency/persistence), fine- and broad-scale movement patterns, and inter-annual presence within the Lease Area (i.e., whether individuals return to the receiver array each year) will be examined. Any detection data obtained through participation in regional telemetry data sharing networks (see below) will be incorporated into analyses, particularly to examine the distribution and movements of species beyond the boundaries of the Lease Area. Analyses will include detailed detection history plots for each tagged individual that depict all detections logged for an animal over the course of a year. Summary tables and figures will be generated that describe: the number of times each fish was detected by receivers within the array, the detection history for each fish, the total number of receivers each individual was detected on, movements within the array, and monthly patterns in presence and persistence. In addition to the local-scale acoustic monitoring achieved by the proposed receiver array, broad-scale movement data will be accomplished through participation in regional telemetry data sharing programs, by obtaining detection data from our tagged animals detected within arrays deployed by other researchers in the greater Atlantic region.

All detection data of animals tagged by other researchers and recorded by the acoustic receivers in this study will be distributed to those researchers through participation in regional telemetry networks such as the Ocean Tracking Network or the Mid-Atlantic Acoustic Telemetry Network (MATOS). Detection data obtained for transmitters that are not deployed as part of this study will be disseminated to the tag owners (it is the policy of regional data sharing programs that the 'owner' of the data is the entity that purchased and deployed the transmitter, not the entity that detected it on their receiver). Inclusion of these detection data in analyses will be requested of the tag's owner (i.e., metadata on the species detected, number of detections, amount of time the animal was detected in our receiver array, etc.). Participation in data sharing networks will increase both the spatial and temporal extent of monitoring for species tagged as part of this study and allow for the collection of additional data on the presence and persistence of other marine species tagged with acoustic transmitters in and around the Empire Wind Lease Area.

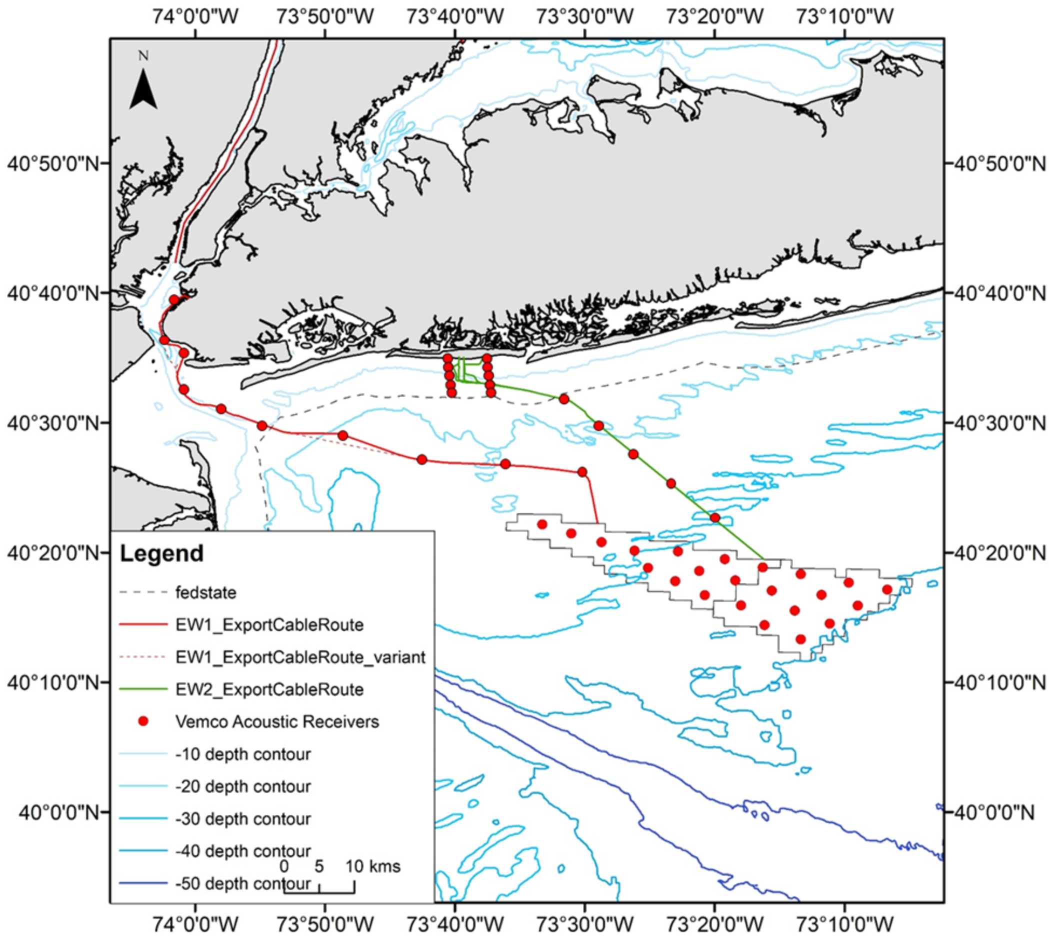


Figure 3-10. Proposed receiver locations within Empire Wind Project Area

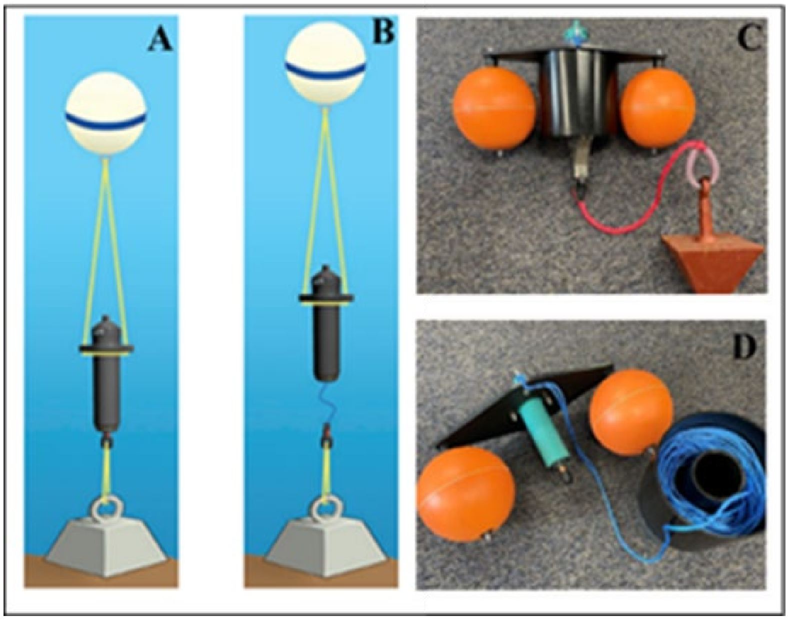


Figure 3-11. Diagram of Vemco VR2AR (Acoustic Release) receiver submerged and triggered to release. Mooring Systems recovery mooring acoustic release (C-D) system showing canister and recoverable pyramid anchor. D) Show "triggered" VR2AR trailing a high strength Dynema rope allowing us to retrieve, recover, and redeploy the whole mooring system.

3.4.5 Sea Scallop Plan View (PV) Camera Surveys

Sea scallops (*Placopecten magellanicus*) are an important benthic species in the area of the Empire Wind Project. The scallop population in this region support a productive and lucrative commercial fishery (Table 3-4). In particular, the eastern portion of the Lease Area is actively fished for scallops (Figure 3-1). The objective of this monitoring component is to evaluate changes in the density of sea scallops and potential shifts in the spatial distribution of sea scallops within the Empire Wind Lease Area following the construction of the Empire Wind project. These monitoring surveys will be based on seafloor imagery data collected using a plan view camera system. Several long-term fisheries independent scallop surveys utilize similar methods to assess the distribution and density of scallops in the region (UMass Dartmouth School for Marine Science and Technology [SMAST] drop-camera survey and the Habitat Mapping Camera [HabCam] Survey conducted by Coonamesset Farm Foundation). Non-extractive optical-based surveys may provide more accurate estimates of the sea scallop populations compared with dredge surveys, particularly in areas with substantial contributions of recently settled juvenile scallops that evade survey dredges (Rudders 2015).

3.4.5.1 Survey Design

Shifts in the abundance and density of sea scallops in the Empire Wind Lease Area will be assessed using a BACI study design, with observations occurring within the reference area serving as a regional proxy for sea scallop abundances and density. The same reference area used in the trawl survey will be selected for this set of surveys (see Section 3.4.1). The reference area was selected to reflect similar depths and benthic habitats as the Empire Wind Lease Area. Both the Empire Wind Lease Area and reference area exhibit a depth range of 22-42 m. The scallop survey will be stratified by depth with the number of survey stations evenly distributed between a “shallow” depth stratum (<35 m) and a “deep” stratum (>35 m).

Similar to other fisheries-independent surveys for scallops in the area, including the UMass Dartmouth SMAST drop-camera survey and the Habitat Mapping Camera (HabCam) Survey conducted by Coonamesset Farm Foundation, this Empire Wind monitoring survey will be conducted annually every summer. Additionally, any potential temporal shifts in the spatial distribution of scallops within the lease area will be evaluated using spatial statistical analyses. Monitoring will include two years of pre-construction data collection, sampling during construction, and for at least two years after construction is completed.

Stations will be distributed systematically in a grid design across the Empire Wind lease area and reference area, which will be the same area selected for the trawl survey (see Section 3.4.1). The sequencing of surveys (trawl and scallop PV surveys) will ensure PV stations will not occur in areas that were recently trawled. A power simulation study was conducted for a BACI design and analysis contrasting scallop abundance between an impact area and reference area. A description of the components of the statistical power analysis are described in Attachment A, which, although specific to the trawl survey, the fundamental elements of the power analysis apply to this BACI designed scallop study, as well. The only major deviation from the trawl survey power analysis methods was the simulation model used. Since changes in density (i.e., scallop counts) will be assessed for the scallop surveys, a GLM with Poisson errors was used. In brief, the statistical power analysis relates the effect size (the measure of change the study design and modelling approach will be used to estimate), the power (the probability of rejecting the null hypothesis when the difference in the data exceeds a threshold effect size), alpha (the Type I error rate), and the sample size (the number of sites, replicates, and time periods sampled). Given, three of these elements, the fourth can be estimated. Thus, this power simulation study was used to explore various sample sizes within specified power and effect sizes.

Estimates of mean scallop density, standard error, coefficient of variation (CV) (%), and the number of stations sampled in 2012 within the New York Bight wind energy areas (i.e., wind energy area #4 was the Empire Wind Lease Area) were provided by Kevin Stokesbury (recently detailed in Stokesbury et al. 2022). These scallop data were collected using a drop camera approach as described in Bethoney and Stokesbury (2018), at stations located within a 5.6 km^2-grid systematic sampling design.

A symmetrical BACI design was tested in this power analysis, with the design variables, determined using Stokesbury data, specified in Table 3-8. Power curves were generated to evaluate how the power for the BACI interaction contrast within a saturated model varies as a function of the variation in scallop density (CV), the effect size (% change between Empire Wind Lease Area site relative to the reference site), the sample size (count of stations in each area during each survey time period), and using a two-tailed alpha of 0.10 (assuming two years of pre-construction and two-years of post-construction monitoring) (Figure 3-12). When analyzing for changes in relative density, achieving a statistical power of at least 0.8 is intended, which is generally considered to be the minimum standard for scientific monitoring (Cohen 1992). This ensures that the monitoring will have a probability of at least 80% of detecting an effect of the stated size when it is actually present.

A sample size of at most 60 stations for each area will be targeted per sampling event at the start of the monitoring. Given the lease area is 321 km^2, this sampling effort (60 stations) equates to about one station every 5.6 km (stations within a 5.6 km^2 grid). Based on the results of the power analysis (Figure 3-12), this level of sampling is expected to have at least 80% power to detect a 50% temporal and/or spatial change in scallop density for moderate coefficient of variation (CV) estimates (0.4 - 0.6). This power analysis will be re-visited after the first year of data collection at the Empire Wind Lease Area and reference area to assess intra-annual variability. The observed CV values will be evaluated to determine whether sampling intensity needs to be modified to achieve the desired level of statistical power. If a higher CV is observed (≥0.4) and a smaller change needs to be detected (15%-33%) then additional sampling will be required to maintain a statistical power of 0.8.

Table 3-8. Design Variables for Empire Wind Scallop Survey Power Simulation Study

Set study design variables
• Impact Areas = 1 impact area
• Reference Areas = 1 reference area
• Frequency = one season per year
• Number of years Before impact = 2 • Number of years After impact = 2
Variables used in the power analysis
• Number of station replicates (random) per season in each area (n): 20 to 110 (16 – 3 km^2 grid, for 325 km^2)
• Effect Sizes (ES): -15%, -33%, -40%, -50% and 0% (for Type I error*)
• CVs: 0.15, 0.4, 0.6, 0.8, 1.0
• A two-tailed α = 0.10

*Probability of rejecting the null hypothesis in error because the true difference is small (i.e., < Δ_M)

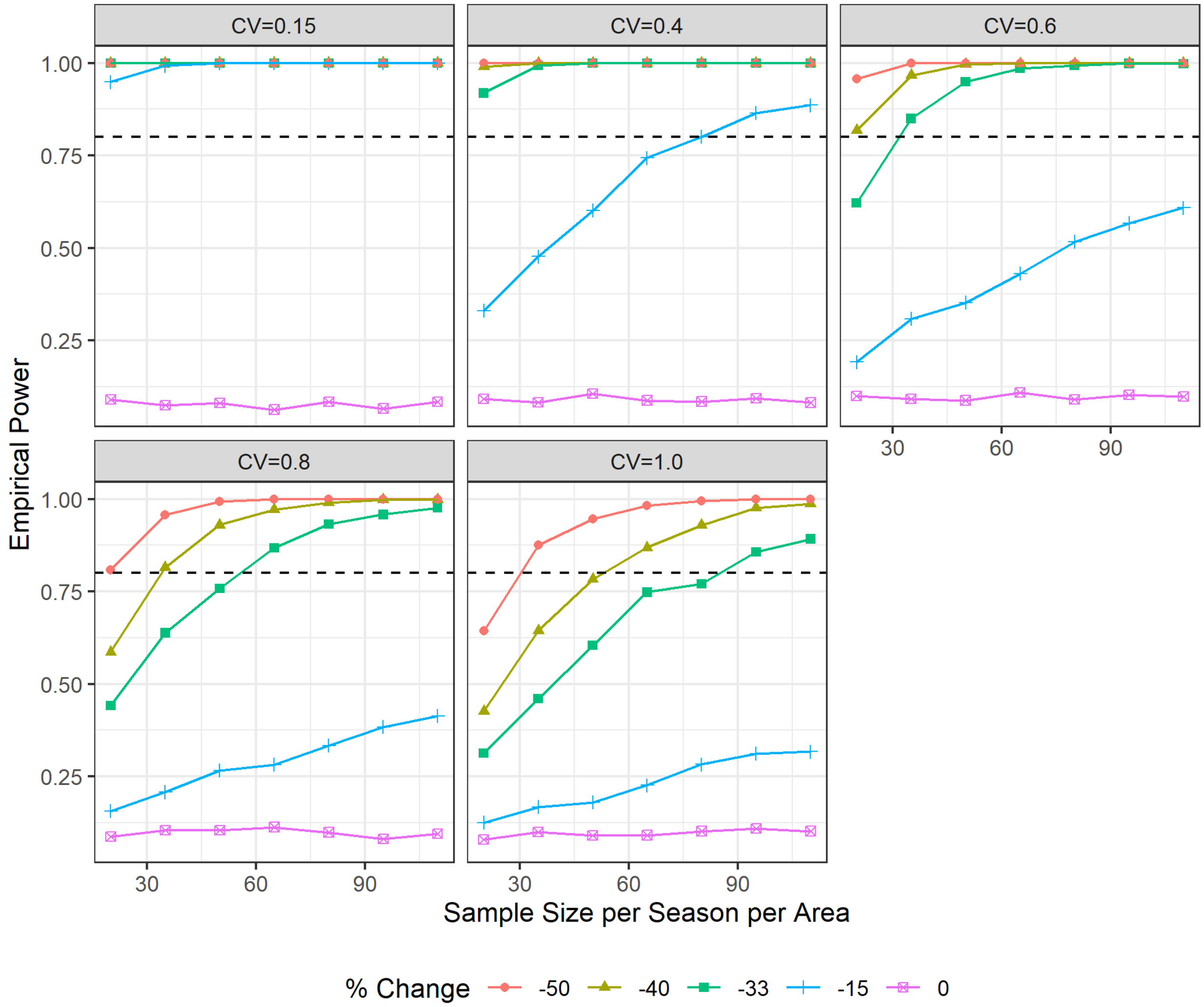


Figure 3-12. Power curves for the BACI interaction contrast within a saturated model for a range of variance (CV), effect sizes (negative % change) and sample sizes in each area per survey time point (n), and using a two-tailed alpha = 0.10. The 0% change illustrates the type I error.

3.4.5.2 Sampling Methods

At each station, a plan view camera system will be deployed to capture downward facing images of the seafloor. At least eight images will be collected at each station to capture within station variability given the narrower field of view (~0.5 to 1 m^2) relative to the field of view obtained from the drop camera surveys conducted by SMAST (0.6 m^2 to 2.5 m^2). An Ocean Imaging® Model DSC24000 plan view underwater camera system with two Ocean Imaging® Model 400-37 Deep Sea Scaling lasers attached to a steal frame will be used to collect plan view images of the seafloor surface. The PV underwater camera system consists of a Nikon® D7100 or D7200 DSLR camera encased in a pressure housing, a 24 VDC autonomous power pack, a 500 W strobe, and a bounce trigger. A weight is attached to the bounce trigger with a stainless-steel cable so that the weight hangs below the camera frame; the scaling lasers project two red dots that were separated by a constant distance (26 cm) regardless of the field of view of the PV system. The field of view can be changed by increasing or decreasing the length of the trigger wire and, thereby, the camera height above the bottom when the picture is taken. As the PV camera system is lowered to the seafloor, the weight attached to the bounce trigger contacts the seafloor prior to the camera frame reaching the seafloor and triggers the PV camera. Obtaining a clear image of the seafloor is dependent on the water column turbidity and the length of the trigger wire. A tradeoff exists between obtaining a larger field of view by using a longer trigger wire and a highly resolved image given the turbidity conditions, which may limit the distance from the seafloor that the camera can be to obtain a clear image. The PV camera system is a very effective way of capturing sea scallop presence and densities, an example image collected using this system is provided for illustrative purposes in Figure 3-13. Images will be annotated to reflect the presence and number of scallops; shell height will be manually measured for each scallop observed. Any scallops that are observed on the edge of the field of view of an image will be counted but the size measurements will be omitted.

Figure 3-13. Representative plan view imagery illustrating the use of the PV imaging system to document sea scallops on the seafloor.

3.4.5.3 Statistical Analysis

The BACI design for this survey plan allows for the scallop density to be compared between the before and after construction periods in the two treatment types (reference and Lease Area), using appropriate statistical modeling. Additionally, the spatial distribution and potential temporal shifts in that spatial distribution will be examined using spatial statistical approaches. The use of a reference area will ensure that larger regional changes in sea scallop populations will be captured and delineated from potential effects of the proposed project.

The first two years of the scallop PV survey will be used to characterize the pre-construction sea scallop abundance, density, and spatial distribution within the Lease Area and reference area. For the pre-construction monitoring, the results presented in annual reports will focus on descriptive and quantitative comparisons of the scallop abundance and spatial distribution. An exploratory analysis of spatial temporal changes in scallop density from baseline to post-construction years will be examined to determine if the scallop distribution within the Lease Area has changed between years. A surface trend analysis will be utilized to isolate broad patterns from local patterns, spatio-temporal kriging will be used to explore the spatial and temporal structure of data at baseline and post-construction periods. Lastly, the primary spatial autocorrelative process (clustering, repulsion patterns in scallop density) will be examined.

The primary monitoring objective to be addressed with the PV image scallop survey will be to determine whether scallop density or spatial distribution shifts over time. The monitoring objectives can be framed using the following hypotheses:

- $H_{Ø}$-Changes in scallop densities and scallop spatial distributions in both the reference and impact areas will be statistically indistinguishable between time periods (before and after).
- H_1-Changes in scallop densities and scallop spatial distributions will not be the same at the reference and impact areas between time periods (before and after; two-tailed).

In this BACI design, there are multiple years within each time period and a single site within each treatment (reference and Lease Area). A GLM framework will be used to describe the data and estimate the 90% CI on the BACI contrast. At a minimum, treatment type (reference and Lease Area) will be evaluated as a covariate in the model, but the modeling framework could be expanded to include other relevant covariates such as temperature, depth, salinity, the distance to the nearest turbine foundation. The interaction contrast that will be tested is the difference between the temporal change (i.e., average over the post-operation period minus the average over the pre-operation period) at the wind farm and the average temporal change at the reference area. A statistically significant impact would be indicated by a 90% CI for the estimated interaction contrast that excludes zero. Using a 90% CI allows 95% confidence statements for the lower or upper bound (e.g., if the lower bound of the 90% CI for the mean is greater than 0, this indicates 95% confidence that the mean exceeds 0).

4.0 BENTHIC MONITORING

4.1 EMPIRE WIND BENTHIC HABITAT OVERVIEW

The benthic habitat associated with the Empire Wind Project is described in detail in the COP (Volume 2b, Section 5.5, Equinor 2021) and COP Appendix T (Tetra Tech 2022). Several project-specific benthic and geophysical surveys have been conducted to support the benthic characterization across the Project Area including the two cable route corridors and the Lease Area. These surveys have used several sampling techniques to assess existing benthic habitat characteristics. These techniques span spatial scales, including benthic imagery and grab sampling surveys (described in the COP Appendix T, Tetra Tech 2022) and geophysical survey campaigns (synthesized in COP Appendix H, Marine Site Investigation Report, Gardline 2022). In addition, existing regional data were compiled, synthesized, and presented in the COP (Volume 2, Section 5.5; Equinor 2021), which includes the BOEM-funded benthic resources data collection, geophysical data collection, modeling, and technical report, Battista et al. 2019, which focused on the Empire Wind Lease Area. Here we provide a summary of the data and interpretations described in detail in the references cited above.

4.1.1 Empire Wind Lease Area

The Empire Wind Lease Area seafloor is predominantly flat with low rugosity and slope (COP Appendix H, Gardline 2022; Battista et al. 2019). The water depths range from about 26 m in the western portion of the Lease Area to about 43 m in the eastern portion of the Lease Area. Generally, the Lease Area exhibits little natural variability with regards to the benthic habitat, consisting mainly of softbottom habitat. The majority of the Lease Area is characterized as rippled sand or mega-rippled sand (in the eastern portion of the Lease) with high occurrence of faunal beds (Battista et al. 2019). The sediments in the Lease Area are composed primarily of sand with shell fragments and shell hash, with some areas of sand with small gravels (i.e., pebbles) and shell fragments (COP Appendix T, Tetra Tech 2022) (Figure 4-1 top panel).

The most commonly observed benthic taxa at the Lease Area during the image-based surveys were benthic-dwelling epifauna, and specifically the common sand dollar (*Echinarachnius parma*) (Battista et al. 2019; and project-specific benthic survey, COP Appendix T, Tetra Tech 2022) (Figure 4-1 bottom panel). Sand dollars were reported to be present at 90% of the 300 stations sampled, and often in high densities, particularly in the eastern portion of the Lease Area (Battista et al. 2019). The dominance of sand dollars in this region is consistent with reports from other regional benthic studies (Malek et al. 2014; Guida et al. 2017). Aside from sand dollars (echinoderms), other benthic groups observed were annelids, molluscs (e.g., moon snails), and crustaceans (e.g, hermit crabs and amphipods) (Figure 4-1 bottom panel). The project-specific benthic characterization survey in the Lease Area also reported high-occurrences of these benthic biota (COP Appendix T, Tetra Tech 2022). The majority of the stations sampled at the Lease Area during the project-specific benthic survey were characterized as Coastal and Marine Ecological Classification Standard (CMECS) Biotic Groups Small Surface-Burrowing Fauna and Mobile Crustaceans on Soft Sediments based on the sieved infauna samples, and Sand Dollar Beds based on the seafloor imagery data (COP Appendix T, Tetra Tech 2022).

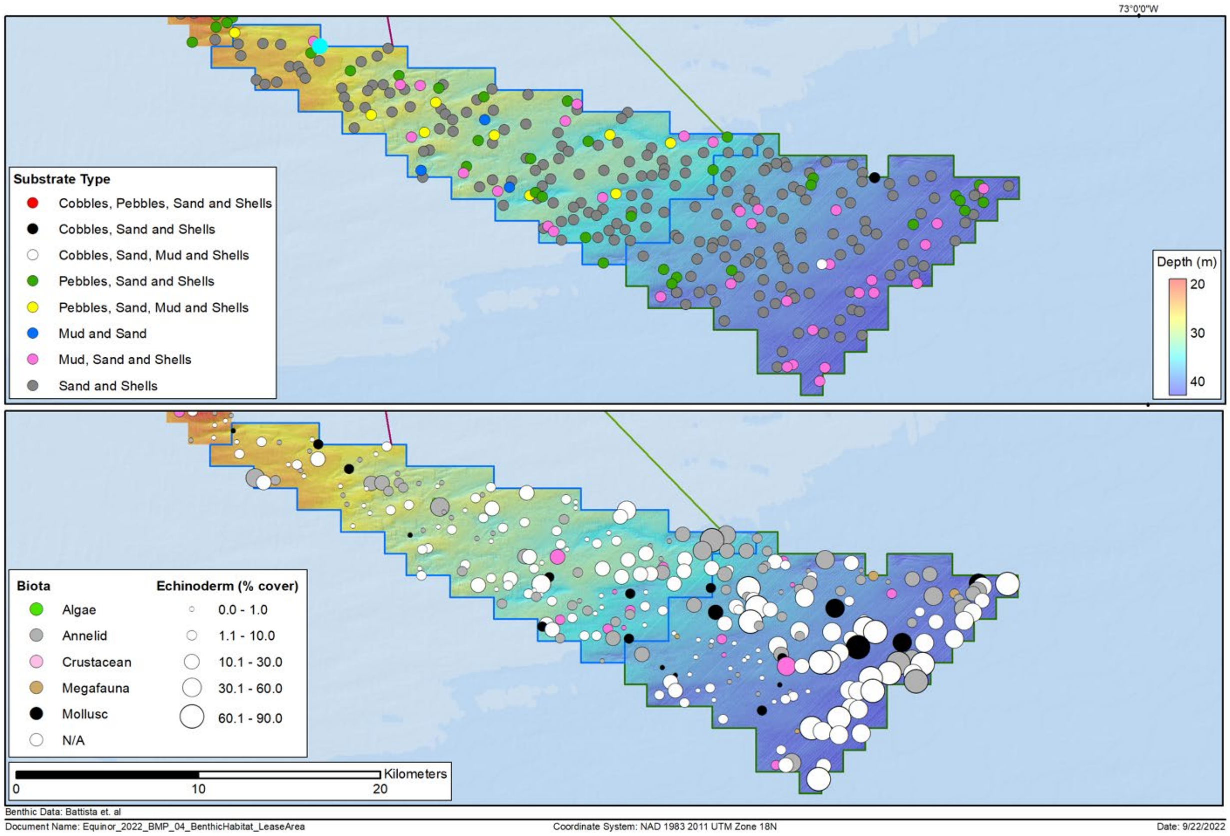


Figure 4-1. Summary of the benthic habitat at the Empire Wind Lease Area including bathymetry, substrate type (top), and biota (bottom), as originally described in Battista et al. 2019

4.1.2 Empire Wind Export Cables

The Empire Wind Project includes two separate export cables: EW 1 and EW 2 (Figure 1-1). The EW 1 export cable transits away from the Lease Area along its northeastern boundary and continues north-northwest across the Ambrose and Nantucket traffic separation schemes towards New York Harbor. The EW 1 runs parallel to the Ambrose Channel as it enters Lower New York Bay, transits through the narrows on the eastern side and makes landfall in Brooklyn, NY. The EW 2 export cable route extends away from the Lease Area at the center of northern boundary. This export cable route transits north-northwest towards Long Island, NY. There are several route alternatives currently being considered at the landfall in Oceanside, NY for the EW 2 route.

Two project-specific benthic characterization surveys were conducted along the export cable routes, which are summarized in the COP (Volume 2b, Section 5.5, Equinor 2021) and detailed results are provided in Appendix T (TetraTech, 2022 and INSPIRE 2019). Additionally high-resolution geophysical data were collected along the entirety of these two route corridors, results of which are reported in the COP (Appendix H, Marine Site Investigation Report, Gardline 2022). Here we provide a summary of the benthic conditions along both EW 1 and EW 2 cable routes (Figure 4-2).

The benthic habitat along EW 1 is generally characterized as softbottom with sediment types ranging from silt/clay to pebbles. The majority of the EW 1 within federal waters was characterized using sediment profile imagery as medium sand, fine sand, or very fine sand; fine-scale sediment layering with layers of coarser grains over finer sediments was frequently documented (Figure 4-2, left). One station located due north of the western-most corner of the Lease Area consisted of pebbles/granules over sand. The portion of the EW 1 export cable route in NY state waters transitioned from fine sand at the state waters boundary to an area of coarse and medium sand at the entrance of New York Bay. In lower New York Bay and through the narrows, the sediments along EW 1 corridor were silt/clay and very fine sand. The dominant CMECS Biotic Group observed in plan view imagery was mainly small and large tube-building fauna (Figure 4-2, right). Sand Dollar Beds, Attached Hydroids, and Mobile Crustaceans were observed in the area due north of the western-most portion of the Lease Area. Mussel Beds and Attached Mussels were observed at the stations within lower New York Bay and off Coney Island.

The benthic habitat along EW 2 is generally characterized as softbottom (Figure 4-2, left). Sediment types ranged from silt/clay to pebbles along EW 2, with fine-scale sediment layering consisting of coarser grains overlying finer grains observed in SPI imagery. High densities of sand dollar beds were observed along the offshore portion of the EW 2 (Figure 4-2, right). This benthic community transitioned to tube-building and surface burrowing infauna near shore along the EW 2 (Figure 4-2, right).

A separate monitoring plan will be developed that focuses on the cable corridors within New York State waters (Attachment B).

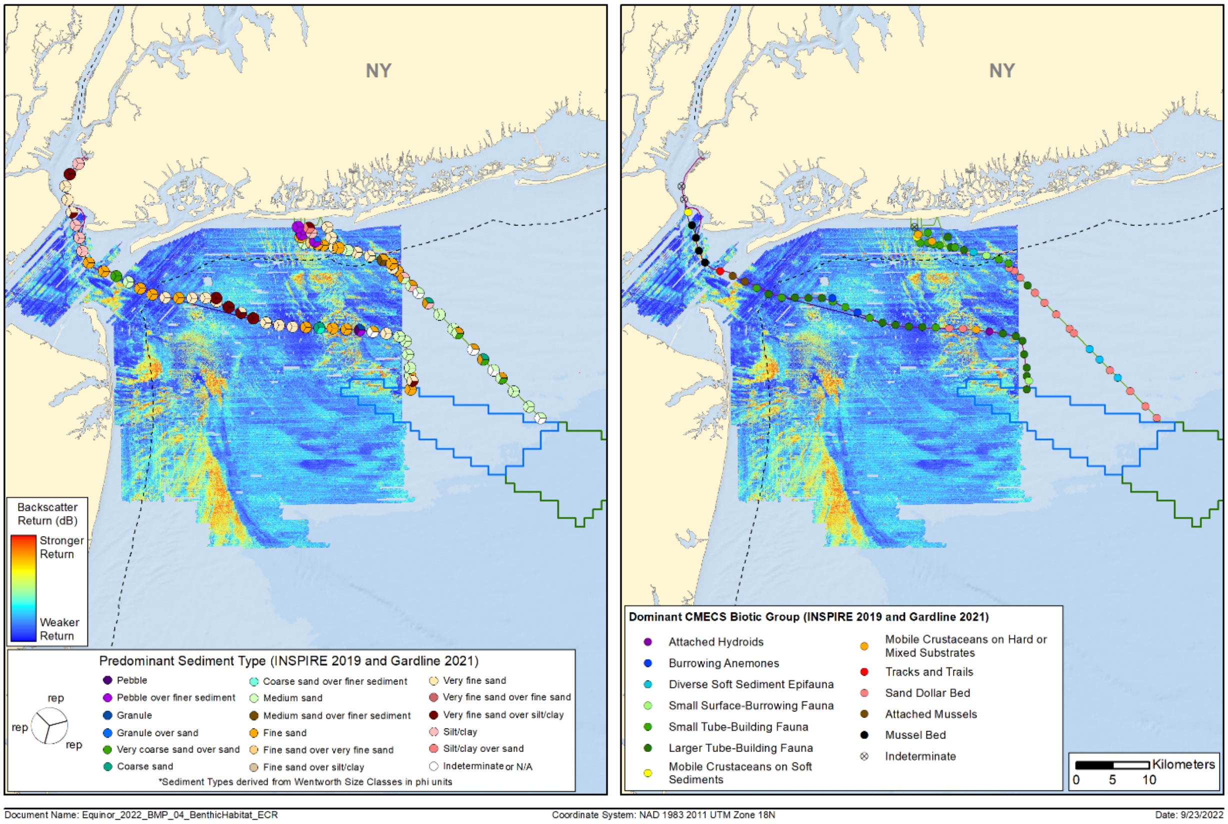


Figure 4-2. Summary of benthic habitat along the Empire Wind Export Cable corridors including sediment type (left), and CMECS Biotic Group (right), originally reported in INSPIRE 2019 and Gardline 2021 (both reports included in the COP Appendix T (TetraTech 2022)

4.2 BENTHIC MONITORING OBJECTIVES AND HYPOTHESES

Installation and operation of offshore wind projects can temporarily disturb existing benthic habitats and introduce new habitats. The level of impact and recovery from disturbance can vary depending on existing habitats at the site (Wilhelmsson and Malm 2008; HDR 2020). Physical disturbance associated with cable and foundation installation can temporarily affect sediments, resulting in mortality or injury of existing fauna. The introduction of novel hard substrata (wind turbine generator [WTG] foundations, scour protection layers, and cable protection layers) can lead to extensive biological growth on the introduced surfaces with complex patterns analogous to depth zonation as observed along shoreline intertidal to subtidal gradients (artificial reef effect, Petersen and Malm 2009; Reubens et al. 2013b; Degraer et al. 2020). Depending on the community composition and density, this biological epifaunal growth may lead to substantial shifts in the transfer of energy from the water column to other compartments of the ecosystem including the surrounding sediments and upper trophic levels.

Observations from existing offshore wind projects lead to three prevailing hypotheses related to benthic effects relevant to the proposed Empire Wind Project:

1. Introduction of novel surfaces (foundations, scour protection, and cable protection layers) will develop epifauna that vary with depth and change over time. *[Hard Bottom-Novel Surfaces]* (as reviewed in Langhamer 2012).
2. The artificial reef effect (epifaunal colonization) associated with the offshore wind structures will lead to enrichment (fining and higher organic content) of surrounding soft bottom habitats resulting in shifts in benthic function (increased organic matter processing). [*Structure-associated – Organic Enrichment*] (e.g., Lefaible et al. 2019 ; Ivanov et al. 2021).
3. Physical disturbance of soft sediments during cable installation will temporarily disrupt the function of the infaunal community, community function is expected to return to pre-disturbance conditions. [*Cable-associated – Physical Disturbance*] (e.g., Kraus and Carter 2018).

The consequences of these predicted effects may affect the role of soft and novel hard bottom habitats in providing food resources, refuge, and spawning habitat for fish and shellfish species (Reubens et al. 2014; Krone et al. 2017). The focus of the benthic monitoring will be on determining if there are unexpected changes to the benthic ecosystem associated with the development of the wind farm. Specifically, the monitoring will focus on documenting potential adverse outcomes associated with each of these three hypotheses including:

1. Dominance of non-native species relative to native species (Novel Hard Bottom Monitoring),
2. Evidence of impairment associated with organic enrichment on the seafloor surrounding the novel structures, and
3. Delayed recovery from physical disturbance along the export cable routes.

This operational monitoring plan is organized according to these three hypotheses (and potential adverse outcomes) associated with the Empire Wind Project. The plan describes the overall approach to tracking changes in both the novel hard bottom and soft bottom habitats associated with the Project development and operation. This monitoring plan is not designed to answer research questions about specific causes and effects on individual species but rather is aimed at monitoring potential changes associated with the benthic habitats of the Empire Wind Project. A comprehensive outline of the benthic monitoring plan, including the hypotheses, sampling schedule, and general approach for each monitoring component is provided in Table 4-1. The planned statistical analyses are summarized by survey type in Table 4-2.

Benthic monitoring surveys will provide count statistics, which determine estimates of occupancy assuming a known detection probability. MacKenzie et al (2002) developed a framework to estimate detection probabilities from replicate surveys based on a zero-inflated binomial model, thus making it possible to estimate occupancy from count statistics. This approach does not require additional, expensive sampling, so it is well-suited to large-scale monitoring. In these surveys, replicate images for each station or depth will determine the detection probabilities, yielding an occupancy estimate along the gradient (e.g., distance from monopile or depth). As suitable, the analysis will incorporate covariates and quantify goodness of fit. Covariates could include effort or dominant attached type; for example, detection could decrease when the site is colonized by many mussels that obstruct detection of other taxa. These analyses will be completed with the R Package ‘unmarked’ (Fisk and Chandler 2011).

Table 4-1. Summary of the Benthic Monitoring Plan Including Hypotheses, Approach, and Sampling Schedules for Each Component

Novel Hard Bottom

WTG/OSS Foundations, Scour and Cable Protection

Hypothesis: epifaunal community will vary with water depth (zonation with light and tide); successional development of epifaunal community over time

Approach: Use ROV/stereo camera to measure changes in % cover, identify key or dominant species, focus on documenting non-native species, estimate volume (biomass), compare across water depths

Design: stratified random selection of WTG foundations within water depth contour strata; both OSS foundations sampled [same foundations as Structure-associated Organic Enrichment Surveys]; selection of export cable protection areas to be determined following cable burial risk assessment

Y0 – late summer/early fall after construction
Y1- ROV/stereo camera late summer/early fall
Y2- ROV/stereo camera late summer/early fall
Y3- ROV/stereo camera late summer/early fall
Y5 – ROV/stereo camera late summer/early fall

Soft Bottom Habitats

Structure-associated Organic Enrichment

Hypothesis: epifaunal growth on foundations will result in sediment fining and higher organic content in surrounding soft bottom, this will support deposit feeding benthic invertebrates. Effects will decrease with increasing distance from structure foundation.

Approach: Use SPI/PV, sediment grab samples (organic matter characterization, grain size) to measure changes in benthic function over time and with distance from foundations, focus on documenting any evidence of impairment (Beggiatoa, methane, zero aRPD depth)

Design: stratified random selection of foundations within water depth contour strata [same foundations as Novel Hard Bottom surveys]; BAG design at each selected foundation:
2 radial transects at each foundation –

- 2 stations on scour protection (SPI/PV),
- 0-10m (SPI/PV + sediment samples)
- 15-25 m (SPI/PV)
- 40-50 m (SPI/PV + sediment samples)
- 90-100 m (SPI/PV)
- 190-200 m (SPI/PV)
- 900m (SPI/PV + sediment samples)

Pre seabed prep – within 6 mo prior to construction
Y0 – late summer/early fall after construction
Y1 – late summer/early fall
Y2 – late summer/early fall
Y3 – late summer/early fall
Y5 – late summer/early fall

Cable-associated Physical Disturbance

Hypothesis: After initial physical disturbance during construction, soft sediment community function is expected to return to pre-conditions; effects will decrease with increasing distance from cable

Approach: Use SPI/PV to measure changes in benthic function over time and with distance from cable centerline; focus on documenting any delayed recovery following disturbance.

Design: stratified random selection of cable segments within benthic habitat and depth strata; BAG at each selected cable segment, triplicate transects perpendicular from cable centerline – 16 stations along each transect with varying distances from cable

Pre seabed prep – within 6 mo prior to construction
Y0 – late summer/early fall after construction
Y1 – late summer/early fall
Y2 – late summer/early fall

Table 4-2. Summary of Planned Statistical Analyses for the Benthic Monitoring Surveys at Ocean Wind

Survey	Novel Hard Bottom Monitoring	Structure-associated Organic Enrichment	Cable-associated Physical Disturbance
Monitoring Plan Section	4.3	4.4	4.5
Area	Empire Wind Leases and Export Cable Segments with Cable Protection	Empire Wind Leases	Export Cable Routes
Design Type	Stratified Random	BAG	BAG
Design Overview	WTG foundations: random samples (WTGs) stratified by depth range; single season. Substation foundations will also be sampled. Segments of export cable where cable protection materials were used.	Impact only (no reference sites); stns at distances ranging from ~10 m to ~900 m from foundations; 2 directions from each foundation along prevailing current; single season	Impact only (no reference sites); stns at distances ranging from ~5 m to ~1 km from cable; ≥ 3 transects within each habitat stratum.
Number of Replicates	4 replicate WTGs per depth stratum; 2 OSS foundations; 4 replicate export cable segments with protection (locations TBD)	4 replicate WTGs per depth stratum; 2 OSS foundations;	3 replicate transects per habitat type
Sampling Effort	2 OSS jacket + [2 depth ranges x 4 WTGs] = **~10 structures** 4 segments of protected cable	~ 10 structures x 2 transects x 8 stations = **160 SPI/PV stations**	3 habitat strata x 3 transect replicates x 16 stations along each replicate transect = **144 SPI/PV stations**
Design details	**Sampling frame =** turbine foundations **Observational unit** = imaged quadrat (at systematically sampled depth intervals within frame) **Response variable** = macrobiotic cover, relative abundance of native vs non-native, presence of sensitive taxa and species of concern **Error variance** = among image quadrats at the same depth- and distance-direction (WTGs provide replication)	**Sampling frame** = turbine foundations with mobile sediment classes up/down current **Observational unit** = SPI/PV station (WTGs randomized first survey event, then fixed throughout study; stations randomized every survey; replicate images are subsamples) **Response variable** = mean or max per station depending on metric. **Error variance** = among stations at the same distance-direction (WTGs provide replication)	**Sampling frame** = soft bottom areas of export cable routes **Observational unit** = SPI/PV station (transects randomized first survey event, then fixed throughout study; stations randomized every survey; replicate images are subsamples) **Response variable** = mean or max per station depending on metric. **Error variance** = among stations at the same distance-direction (transects provide replication)

Survey	Novel Hard Bottom Monitoring	Structure-associated Organic Enrichment	Cable-associated Physical Disturbance
Metrics of Interest	**ROV/stereo-camera**: cover (macrobiota, relative abundance of native vs. invasive). **Photogrammetry***:* Estimate of biomass/biovolume	**SPI**: aRPD, Successional Stage, penetration, methane, grain size major mode, *Beggiatoa* **PV**: cover (macrobiota, shells, cobble), presence/absence of sensitive or invasive species **Sediment Grab:** percent organic matter, total organic carbon, total nitrogen, C:N	**SPI**: aRPD, Successional Stage, penetration **PV**: cover (macrobiota, shells, cobble), presence/absence of sensitive or invasive species
Hypothesis framework	Introduction of novel surfaces will develop epifauna (specifically focused on documenting non-native species, sensitive taxa, species of concern) that vary with depth and change over time.	The artificial reef effect associated with novel structures will lead to enrichment (fining and organic matter content) of surrounding seafloor leading to shifts in benthic function (differences in aRPD depths, bioturbation depths, infaunal successional stage, grain size)	Physical disturbance during cable installation will disrupt benthic function, effects expected to decrease with distance from export cable and over time
Post-Construction Statistical Methods	Fit a parametric generalized model (e.g., GLM, GLMM or GAM) or non-parametric regression tree that best describes the data. Quantify changes in the temporal profiles across spatial gradients. Calculate similarity between stations; graphically depict relationships between stations from different years, directions, or distances with nMDS.	Fit a parametric generalized model (e.g., GLM, GLMM or GAM) or non-parametric regression tree that best describes the data. Quantify changes in the temporal profiles across spatial gradients. Calculate similarity between stations; graphically depict relationships between stations from different years, directions, or distances with nMDS.	Fit a parametric generalized model (e.g., GLM, GLMM or GAM) or non-parametric regression tree that best describes the data. Quantify changes in the temporal profiles across spatial gradients. Calculate similarity between stations; graphically depict relationships between stations from different years, directions, or distances with nMDS.

4.3 NOVEL HARD BOTTOM MONITORING – WTG FOUNDATIONS AND CABLE PROTECTION

Hypothesis 1: Introduction of novel surfaces (foundations, scour protection, and cable protection layers) will develop epifauna that vary with depth and change over time. *[Hard Bottom – Novel Surfaces]* (as reviewed in Langhamer 2012).

The hard bottom monitoring will include an examination of three types of novel surfaces: WTG foundations (including associated scour protection layers), export cable protection layers, and the OSS foundations. The primary objective of the novel hard bottom survey is to measure changes (over time and water depths) to the nature and extent of macrobiotic cover of novel hard bottom associated with the Empire Wind Project. The focus of this monitoring will be to document the potential presence and relative dominance of non-native species within the epifaunal communities. Macrofaunal percent cover, identification of species (to the lowest possible taxonomic unit [LPIL]), and the relative abundance of native and non-native organisms will be documented using a Remotely Operated Vehicle (ROV) and stereo camera surveying approach. Distinguishing non-native organisms may require physical sampling for accurate identification, which will be facilitated by a sampling arm attached to the ROV or by validation with eDNA analyzed in samples collected as part of the Fisheries Monitoring Surveys.

It is expected that the epifaunal community that colonizes the WTG foundations will vary with water depth, dictated by the availability of light and tides, similar to zonation patterns commonly observed at coastal rocky intertidal habitats. Previous studies in Europe and at the Block Island Wind Farm (BIWF) found biological growth led to dense accumulations of filter feeding mussels on the turbine foundations, with amphipods, tunicates, sponges and sea anemones in the deeper segments of the structures (De Mesel et al. 2015; HDR 2020; Wilber et al. 2021; Hutchison et al. 2020). Other studies have also tracked and documented vertical zonation of epibenthic communities along the surface of wind turbine structures (Bouma and Lengkeek 2012; Hiscock et al. 2002; HDR 2020). At any given depth of the offshore wind structure, the epifaunal species composition is expected to develop successionally, with rapid opportunistic organisms pioneering the site and being replaced by more long-lived established species.

4.3.1 Technical Approach – Stereo Camera Imagery

To accomplish the objectives of the novel hard bottom monitoring, we will collect high-definition (HD) video imagery and ultra-high definition (UHD) stereo imagery using a compact ROV. This imagery will be used to document epifaunal community characteristics on the novel hard surfaces (WTG foundations and scour protection layers, OSS jacket, cable protection layers). The compact ROV will be equipped with a surface differential positioning system, an Ultra Short Baseline (USBL), and motion and depth sensors. The ROV will host 1) one downward facing UHD stereo camera to observe and capture high-resolution images of the seafloor surface, 2) one forward facing UHD stereo camera to collect data on vertical surfaces and avoid collisions, and 3) one HD video camera.

The focus of the UHD stereo imagery analysis will be biological features (e.g., percent cover of encrusting epifauna), identifying any non-native organisms, sensitive taxa, species of concern, presence of refuge, and quantifying the biomass of the dominant members of the epifaunal communities. The focus of the HD video will be to provide quantitative details of habitat characteristics and quality, including categorical levels for the presence of fish and decapods, and surrounding substrata (sediment type), and the percent cover of emergent fauna.

Images provide a data rich record of benthic communities. However, images flatten the landscape, which can introduce bias, limit identification, and distort quantitative analyses. By building 3D models from images, i.e., photogrammetry, we can overcome these challenges, which will allow for quantitative detection of changes at target sites (e.g., Bruno et al 2013). Photogrammetry is the process in which imagery is interpreted to provide detailed information about the physical objects observed in space. Specifically, photogrammetry generates high-resolution, photo-realistic 3D models from static images captured from multiple perspectives.

Although photogrammetry with single-camera systems cost less and integrate with low cost and free software (e.g., Agisoft Metashape and Meshromo), these systems require invasive and sometimes destructive methods including scene preparation for calibration (e.g., the placement of coded targets). Therefore, we will use a stereo-camera system. Stereo cameras do not require scene preparation because they are scaled by specific manufacturer's calibration of the two cameras with each other. Stereo-camera systems are not new. For example, Done reconstructed a habitat scale 3D model of a coral reef, using a stereo camera, over forty years ago (Done 1981). Compared to single camera systems, few researchers use stereo cameras to monitor ecological change because, until recently, commercial vendors did not offer these types of these systems for subtidal work. Now, commercial vendors manufacture stereo cameras systems and support their use in offshore, subtidal habitats to monitor equipment and environmental impacts for multiple energy industries.

We will collect UHD images at depth intervals along the turbine foundations and discrete areas of the cable protection layers will capture high-resolution images. The data will include the photographs, the calibrated 3D products, including a dense point cloud with color, a mesh, and a textured mesh. Preliminary tests yielded models with sub mm accuracy. We will use the point cloud and mesh in quantitative analysis, and we will use the textured mesh for communication.

By digitally reconstructing segments of the foundations and cable protection at predefined depth intervals, the resulting model can be analyzed for quantitative variables including percent cover, standing biomass, and abundance of individual taxa of interest (as reviewed in Marre et al. 2019). Collecting imagery and constructing spatial photogrammetric models of the structures soon after construction will provide initial reference conditions that can be used to track biological changes over time following subsequent years of data collection (i.e., change analysis).

Using the 3D model, we can also evaluate the abundance of refugia by calculating rugosity. We will evaluate the presence of refugia by quantifying three-dimensional complexity in the reconstructed 3D model. We will calculate three-dimensional complexity, i.e., rugosity (f_r), as $f_r = A_t/A_g$, where A_t is the true surface area of a complex object and A_g is the geometric surface area of a 3D convex hull wrapping the complex object. Larger values indicate more refugia, and values closer to 1 indicate fewer refugia. We will calculate A_t and A_g from the reconstructed 3D models from 10 sub-sampled chunks for each each replicate area, e.g., in python or meshlab. This analysis is comparable to the traditional field methods for rugosity using a transect tape and chain, however, using a virtual 3D model, we can collect more and better data in 3D versus in 2D.

Biological data obtained through photogrammetry can be used to estimate ecological functions including secondary production, and physiological rates such as biodeposition associated with the epifaunal community. These biological processes have implications to the transfer of energy to higher trophic levels and to the sediments at the base of the novel structures. This approach will provide an estimate of the increase in standing stock biomass at the basal trophic levels where filtering feeding epifauna (e.g., blue mussels, sea squirts) exist. This information can inform ecosystem models that seek to understand how these changes to the basal trophic level may alter food web dynamics, objectives that are beyond the scope of this monitoring plan.

The following parameters will be measured as part of the hard bottom analysis.

UHD stereo images:

- Community assemblages
    - Percent cover of encrusting or colonial taxa
    - Number of solitary taxa
- Species identification to the lowest possible taxonomic level
    - non-native species
    - species of concern (Guida et al. 2017)
    - sensitive species (e.g., slow growing species)
    - ecologically valuable taxa (e.g., biogenic structure-forming taxa such as emergent fauna)

HD Video:

- CMECS Substrate Group and Subgroup
- CMECS Biotic Subclass and Group
- Presence of fish, identified to lowest possible taxonomic level
- Presence of abandoned fishing gear

3D model reconstructed from UHD stereo images:

- Rugosity
- Volume

4.3.2 Survey Design

ROV stereo camera surveys will monitor novel hard bottom habitats within subareas of the Empire Wind Project. The selected WTG and OSSs foundations will be surveyed from the air-sea interface down to the seafloor and away from the structure to the edge of the scour protection layer using underwater image collection. For each selected foundation, we will collect UHD images with a stereo camera following vendor-specific protocol. For example, we will likely collect images with auxiliary lights, with at least 50% overlap for all survey lines, with ~1 m stand-off distance, in a lawnmower pattern. Furthermore, we will render a live sparse point cloud to identify and fill gaps in the model by collecting additional images, if this service is provided by the vendor.

Replicated WTG foundations will be selected using a stratified random design, as described below. Both OSS foundations will be selected for monitoring at the same intervals as described for the WTG foundation surveys. Selection of cable protection areas for monitoring will be dependent on where cable protection is used, information that is not currently known. Segments of the export cable that is armored using cable protection material, will be selected randomly considering environmental factors including water depth, natural benthic habitat of the surrounding seafloor, and distance from shore as explanatory variables. For analysis, we will analyze select images and sections of the 3D models as described below. Segments of the export cable that is armored using cable protection material, will be selected randomly considering environmental factors including water depth, natural benthic habitat of the surrounding seafloor, and distance from shore as explanatory variables.

For the WTG foundation monitoring program, a stratified random design, with water depth ranges as strata, will be used to select the novel WTG structures that will be monitored. The same WTG foundations selected for this novel hard bottom survey will be monitored as part of the soft sediment enrichment survey (see Section 4.4). This will help facilitate synthesis between the degree of enrichment in the surrounding soft sediments and the epifaunal community composition and density colonizing the novel structures at any given time and location. The same WTG foundations selected for this novel hard bottom survey will be monitored as part of the BRUV surveys (see Section 3.4.2). This will aid in drawing inferences between epifaunal colonization with habitat use by mobile vertebrates.

The Empire Wind Project Lease Area will be divided into two strata based on depth (<35 m [shallow] and >35 m [deep]). Four replicate WTGs will be randomly selected within each of the two depth strata for sampling. These replicate WTGs will be scanned and sampled during each survey event (Table 4-1). The hard bottom monitoring will occur in late summer/early fall for each survey. The initial baseline survey will occur during the first late summer/early fall following construction (Y0). The survey will then be repeated annually for the next three years (Y1, Y2, Y3) and again five years after construction (Y5).

4.3.3 Statistical Analyses

The planned statistical analyses are summarized by survey type in Table 4-2.

For the *Novel Hard Bottom Monitoring* dataset collected at WTG foundations and scour protection layers, OSS jacket, cable protection layers, data analysis will include exploratory multivariate approaches (e.g., non-metric Multidimensional Scaling [nMDS]) to identify patterns among responses (community composition; relative abundance of sensitive taxa, species of concern, non-native species, and ecologically valuable taxa; rugosity, and volume) and predictors (e.g., depth; distance from the turbine; time since construction). Covariates in the model for the turbine foundation dataset will include direction (categorical); variability among turbines will provide site-wide random error. For individual metrics that are consistently measured across tubines, parametric or non-parametric regression (e.g., generalized modeling such as GLM or GAM; or regression trees) will be applied if the data prove to be sufficient and appropriate for these tools.

Additionally, graphical methods and descriptive statistics will be used to assess changes in the community composition and relative abundance over time and as a function of depth, and distance and direction from the novel structures (e.g., turbines). These graphical techniques may help to elucidate the spatial scale at which the greatest changes in benthic habitat quality occur.

4.4 STRUCTURE-ASSOCIATED ORGANIC ENRICHMENT

Hypothesis 2: The artificial reef effect (epifaunal colonization) associated with the offshore wind structures will lead to enrichment (fining and higher organic content) of surrounding benthic habitats resulting in shifts in benthic function (increased organic matter processing). [*Soft Bottom – Structure-associated*] (e.g., Lefaible et al. 2019; Ivanov et al. 2021).

The *Structure-associated Organic Enrichment* monitoring will include an examination of two offshore wind components: WTG foundations and the OSS foundations. The overall objectives of this component of the benthic monitoring program are to measure potential changes in the benthic function of the benthic habitats surrounding these novel structures over time, and to assess whether benthic function changes with distance from the base of the foundations. The focus will be on monitoring for and documenting any evidence of impairment associated with organic enrichment on the seafloor surrounding the foundations (e.g., *Beggiatoa,* methane presence, zero aRPD depth [no oxygen penetrating into the sediment]).

It is expected that the epibenthic community that colonizes the novel structures will supply organic matter to the sediments below through filtration, biodeposition, and general deposition of detrital biomass. This organic material sourced from the biological activity of the epibenthic community on the novel structures will likely alter the infaunal community activity, increasing sediment oxygen demand (SOD) and promoting the activity of deep-burrowing infauna. Based on benthic monitoring results in other offshore wind farms, the effects of the foundation on the surrounding soft sediment habitat are expected to decrease with increasing distance from the foundation (as reviewed in Degraer et al. 2020 and modeled in De Borger et al. 2021).

Benthic functioning of the soft bottom habitats at the base of the novel foundations will be captured using sediment profile and plan view (SPI/PV) imagery, sediment grain size analysis, and organic matter characterization. These approaches will be employed at varying frequencies and spatial resolution as described below. The SPI/PV imagery will provide an overall integrated assessment of the physical parameters (grain size major mode) and biological factors (bioturbation depths, aRPD depths, methane production). At some stations, the SPI/PV imagery will be supplemented by sediment grab samples analyzed for grain size, percent bulk organic matter, and total organic carbon and nitrogen content, which will provide insight into shifts in the organic matter loading to the sediments and the quality of the organic matter in the sediments (carbon to nitrogen ratio).

4.4.1 Technical Approach – SPI/PV

SPI/PV will be used as the primary monitoring approach for the *Structure-associated Organic Enrichment* monitoring surveys. The SPI and PV cameras are state-of-the-art monitoring tools that capture benthic ecological functioning within the context of physical factors. The PV system captures high-resolution imagery over several meters of the seafloor, while the SPI system captures the typically unseen, sediment–water interface in the shallow seabed. Coupled SPI/PV imagery provides an integrated, multi-dimensional view of the benthic and geological condition of seafloor sediments and can be used to characterize the function of the benthic habitat, physical changes, and recovery from physical disturbance following the construction and during operation of the Empire Wind Project. Additionally, PV data will be used to characterize surficial geological and biotic (epifaunal) features of hard bottom areas within the sampling area (e.g., scour protection layers at the base of the foundations) but will not replace the dedicated novel hard bottom monitoring survey (Section 4.3).

SPI/PV imagery provides spatial and contextual information, such as oxygen penetration depths (apparent redox potential discontinuity [aRPD] depth), infaunal bioturbation depths, and small-scale grain size vertical layering that are critical pieces to assessing the ecological functioning of soft sediment habitats. Specifically, ecological functions related to organic matter processing, secondary production, and the forage-value of the benthic community are of particular importance when assessing impacts of offshore wind structures on soft sediment habitats (see Attachment C for more details). Taxonomic analysis of sediment grab samples provides information on the benthic community composition and infaunal abundances, but without making substantial inferences to relate presence and counts to biological activity and further ecological value or function, the sediment grab approach is severely limited in its ability to assess impacts of offshore wind development on soft sediment functioning. Further, given the inherently dynamic and patchy nature of infaunal populations, benthic species count data generally requires extensive replication, substantial transformations for normalization, and overextending inferences to relate species composition to function. SPI/PV imagery provides an effective snapshot of the overall ecological health and condition of the sediments as reflected and integrated over time and space by the continuous activity of the infaunal and epifaunal communities present (Germano et al. 2011). It is this holistic community activity, not necessarily the identity of community members, that requires careful assessment to determine impacts of offshore wind development on benthic habitats. Attachment C provides detailed justification for the use of SPI/PV imagery approach to meet these monitoring objectives and more detailed descriptions of several of the parameters that will be obtained during SPI/PV image analysis.

The SPI/PV system will collect quantitative data on measurements associated with physical and biological changes related to benthic function (bioturbation and utilization of organic material) that might result from construction and operation of the Empire Wind Project. SPI/PV and the parameters derived from these images are standard tools for assessing the response to disturbance and enrichment (Germano et al. 2011). Seafloor geological and biogenic substrates captured in SPI/PV imagery will be described using the Coastal and Marine Ecological Classification Standard (CMECS; FGDC 2012). Triplicate images will be collected and analyzed at each station.

The following parameters will be measured during SPI and PV image analysis:

- CMECS Substrate Group and Subgroup
- gravel size measurements (predominant, minimum, maximum), where applicable
- CMECS Biotic Class and Subclass
- aRPD depth (See Attachment C)
- maximum bioturbation depth
- infaunal successional stage (See Attachment C)
- methane presence/absence
- grain size major mode
- presence, frequency, size of surficial features such as bedforms (e.g., sand ripples)
- presence of sensitive taxa (e.g., slow growing species) and ecologically valuable taxa (e.g., biogenic structure-forming taxa such as emergent fauna) (See Attachment C)

Results from the three replicate images at each station will be aggregated to provide a summary value for each metric by station. Depending on the metric type, this will include mean, maximum, or predominant (categorical variables) (e.g., predominant CMECS Substrate Subgroup, maximum infaunal successional stage, maximum and median feeding void depth, and mean aRPD depths).

4.4.2 Technical Approach – Sediment Sampling

Sediment samples will be collected and analyzed for grain size distribution and organic matter characteristics. Sediments are expected to become more organically enriched over time and closer to the foundation structures as detrital material originating from the epifaunal community activity (e.g., biodeposition) falls to the surrounding seafloor. The level of organic enrichment and organic matter loading will be assessed by analyzing sediment samples for bulk percent organic matter and total organic carbon and nitrogen content. The percent organic matter of the sediments (measured as loss-on-ignition) is expected increase over time and decrease with distance from the structure. In addition to the quantity of organic matter in the sediments, the quality of sediment organic matter is important to consider when assessing shifts in benthic function. The quality of sediment organic matter will be assessed by analyzing sediment samples for organic carbon and total nitrogen content. The organic carbon to nitrogen ratio (C:N) of sediments provides insight into the quality or lability of the organic matter (i.e., how available it is to be decomposed or consumed). Finally, it is expected that the sediment grain size will become finer over time and closer to the foundation structures. This will be measured using both SPI/PV imagery (grain size major mode) and physical sediment samples analyzed for grain size distribution.

4.4.3 Survey Design

The *Structure-associated Organic Enrichment* monitoring will be conducted using a BAG survey design to determine the spatial scale of potential impacts on benthic habitats at the Empire Wind Lease Area. The same WTG foundations selected for the Novel Hard Bottom monitoring (Section 4.3) will be selected for the *Structure-associated Organic Enrichment* monitoring. The Empire Wind Project Lease Area will be divided into two strata based on depth (<35 m [shallow] and >35 m [deep]). Four replicate WTGs will be randomly selected within each of the two depth strata for sampling. The surrounding seafloor of these replicate WTG foundations will be surveyed during each survey event (Table 4-1).

At each replicate WTG foundation and the two OSS, a BAG survey design will be used for statistical evaluation of the spatial and temporal changes in the surrounding benthic habitat (Underwood 1994; Methratta 2020). Data will be collected before and after installation and operation of Empire Wind at stations oriented along a gradient from select foundations (Figure 4-3). Each transect will include stations that sample the edge of the scour protection layer and the surrounding soft sediment. This BAG design is based on an understanding of the complexities of habitat distribution at Empire Wind (COP Appendix T, Tetra Tech 2022), and an analysis of benthic monitoring results from European wind farms and the RODEO study at BIWF (HDR 2020; Coates et al. 2014; Dannheim et al. 2019; Degraer et al. 2018; Lefaible et al. 2019; Lindeboom et al. 2011). The proposed BAG survey design eliminates the need for a reference area, as this design is focused on sampling along a spatial gradient within the area of interest rather than using a control location that may not be truly representative of the conditions within the area of interest (Methratta 2020). This design also allows for the examination of spatial variation within the wind farm and does not assume homogeneity across sampling stations (Methratta 2020).

The pre-construction benthic survey will be conducted in late summer or early fall (August to October) prior to the start of construction to document benthic habitats prior to disturbance (baseline). The next survey will occur during the first late summer/early fall following construction (Y0). The survey will then be repeated annually for the next three years (Y1, Y2, Y3) and again five years after construction (Y5). All surveys will be conducted in the same seasonal time frame, which will be during late summer or early fall to capture peak biomass and diversity of benthic organisms in alignment with previous studies (Deepwater Wind South Fork 2020; HDR 2020; NYSERDA 2017; Stokesbury 2013, 2014; LaFrance et al. 2010, 2014). Benthic habitats in the northwest Atlantic are generally stable with little seasonality in the absence of physical disturbance or organic enrichment (Steimle 1982; Reid et al. 1991; Theroux and Wigley 1998; HDR 2020).

Data on the mean currents near Empire Wind Lease Areas will be used to establish up current and down current transects extending from each selected WTG foundation. Two belt transects (25 m wide) of benthic stations will be established, one up current and the other down current of the selected turbine locations (Figure 4-3). Pre-construction transects will begin at the center point of the planned foundation with two stations at equal intervals up to the maximum planned extent of the scour protection area and then at intervals of 0-10 m, 15-25 m, 40-50 m, 90-100 m, 190-200 m, and 900 m extending outward from the edge of the scour protection area (Figure 4-3). Post-construction transects will repeat this design at the same turbines and the same sampling distance intervals. These distances were chosen based on recent research indicating that effects of turbines on the benthic environment occur on a local scale (e.g., Lindeboom et al. 2011; Coates et al. 2014; Degraer et al. 2018; HDR 2019; Lefaible et al. 2019). SPI/PV imagery will be collected at every station. Physical sediment samples will be collected at the following stations beyond the scour protection layer (i.e., in soft sediments): 0-10 m, 40-50 m, and 900 m. The lower sampling effort for the physical sediment samples relative to the SPI/PV stations is due to the fact that the sediment sample data (organic matter content) will be ground truthing the information obtained from the SPI/PV imagery.

4.4.4 Statistical Analyses

The planned statistical analyses are summarized by survey type in Table 4-2.

For the *Structure-associated Organic Enrichment* dataset collected at the base of the selected WTG foundations (BAG design), data analysis will include exploratory multivariate approaches (e.g., non-metric Multidimensional Scaling [nMDS]) to identify patterns among responses (SPI/PV metrics, e.g., aRPD, successional stage, feeding voids, presence of methane or *Beggiatoa*) and predictors (e.g., quantitative or categorical epifaunal/epifloral cover estimates on the turbine foundations; and distance from the turbine). Covariates in the model for the turbine foundation dataset will include water depth (continuous) and direction (categorical); variability among turbines will provide site-wide random error. For individual metrics that are consistently measured across stations (e.g., aRPD depth, sediment organic matter content), parametric or non-parametric regression (e.g., generalized modeling such as GLM or GAM; or regression trees) will be applied if the data prove to be sufficient and appropriate for these tools.

Additionally, graphical methods and descriptive statistics will be used to assess changes in the SPI/PV metrics and sediment sample data over time and as a function of distance and direction from the novel structures (e.g., turbines). These graphical techniques may help to elucidate the spatial scale at which the greatest changes in benthic habitat quality occur.

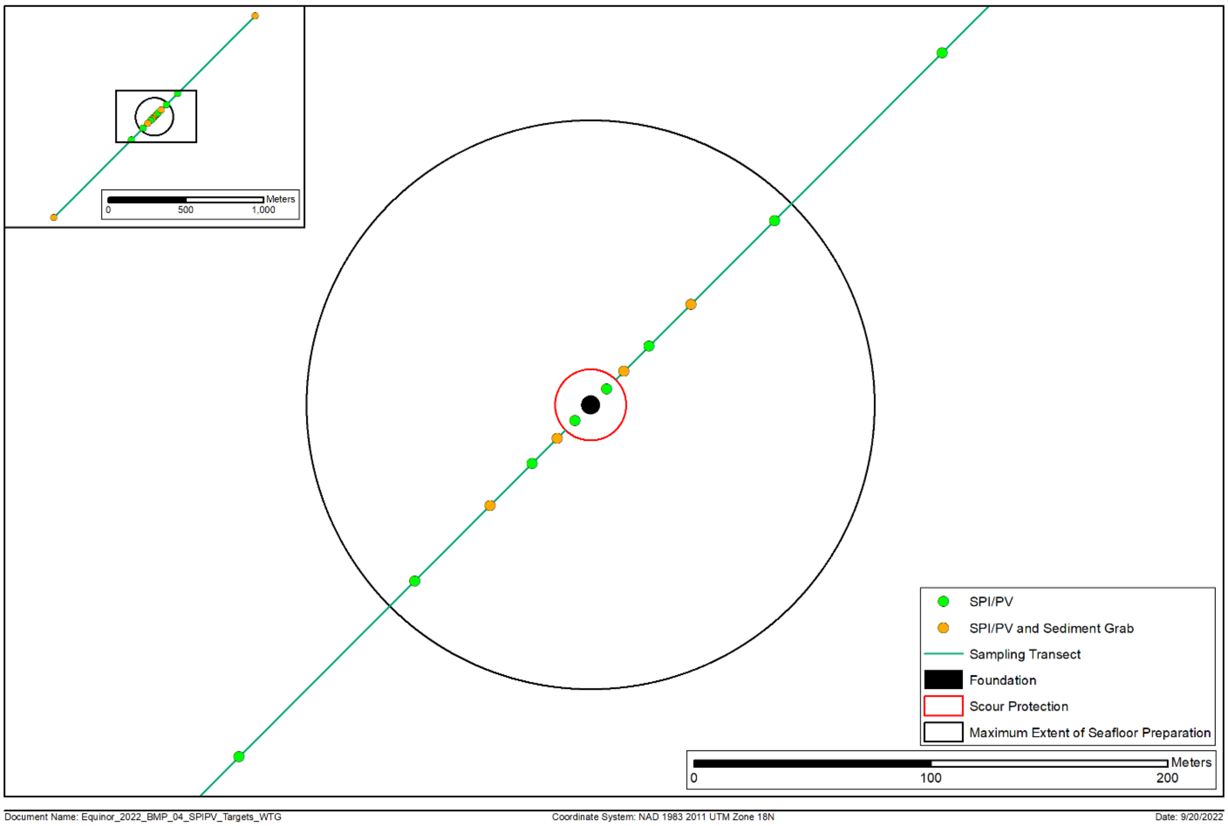


Figure 4-3. Conceptual diagram illustrating the Before-After Gradient design of the *Structure-associated Organic Enrichment* survey design, SPI/PV and sediment grab station locations on the seafloor surrounding each selected foundation. The transect orientation will be based on prevailing water currents in the area, to capture upstream and downstream effects.

4.5 CABLE-ASSOCIATED PHYSICAL DISTURBANCE – SOFT SEDIMENTS

Hypothesis 3: Physical disturbance of soft sediments from cable installation (including seafloor preparation) will temporarily disrupt the function of the infaunal community, community function is expected to return to pre-disturbance conditions. [*Soft Bottom – Cable-associated*] (e.g., Kraus and Carter 2018).

The objective for the *Cable-associated Physical Disturbance* monitoring along the Empire Wind export cables is to examine the effects of installation and operation of the export cables on the benthic habitat over time and along a spatial gradient with distance from the cable centerlines. This component of the benthic monitoring will include focused surveys along the export cable corridors. The focus of this monitoring will be on documenting any delayed recovery of the benthos following the physical disturbance associated with cable construction. Based on the review by Kraus and Carter 2018, biological and physical recovery following cable installation is expected to take up to two years, with several studies reporting much faster rates of recovery (weeks to one tyear). Note that monitoring epifaunal growth on any cable protection material along segments of the export cables is described within the novel hard bottom component of this monitoring plan (see Section 4.3). A separate monitoring plan will be developed that focuses on the cable corridors within New York State waters (Attachment B).

The primary effect of cable installation is physical disturbance of the sediment resulting in sediment resuspension and temporary loss of infauna. Effects of installation and operation of the cable are expected to be roughly equivalent along the length of the cable within similar benthic habitat types. Other independent variables that may influence the benthic effects of and recovery from cable installation include levels of fishing activity (e.g., bottom trawling, clam dredging), installation methodology, and natural bottom sediment transport from tides, waves, and currents. These variables will be considered during data analysis and interpretation. The sampling design is intended to estimate effects along a spatial gradient away from the cable and will not estimate mean changes along the entire export cable routes. Any potential impacts of the cable on soft bottom habitats are expected to decrease over time after installation and with distance from the export cable centerline.

4.5.1 Technical Approach – SPI/PV

SPI/PV will be the primary tool used to document any changes to the small-scale physical characteristics and benthic community function following cable installation. A general summary of the rationale and value of using SPI/PV is provided in Attachment C. Water temperature will be measured at each SPI/PV station.

4.5.2 Survey Design

A stratified random survey design will be used to select sampling frames along the export cables, stratified by habitat type. This monitoring plan provides a general overview of the design that can be adjusted when engineering and construction plans are finalized. Within each sampling frame, SPI/PV data will be collected using a BAG design, like that proposed for the seafloor surrounding the foundations (Section 4.4) (Underwood 1994; Methratta 2020). Details describing the BAG design approach and its value in evaluating potential temporal and spatial changes following construction are provided in the Section 4.4, above.

The soft bottom survey sample design will focus on sampling at representative sections of the export cables based on benthic habitat types as informed by the initial benthic characterization of the planned export cable corridors (INSPIRE 2019; COP Appendix T, Tetra Tech 2022). Sampling locations will be selected randomly, stratified by these habitats. At triplicate locations (each approximately 1 km apart) within each habitat type sampling stratum, a 25-m wide belt transect will be positioned perpendicular to the cable route (three replicate transects per habitat stratum) (Figure 4-4). Along each transect, a total of 16 stations will be sampled. At each station, triplicate SPI/PV images will be collected and analyzed. Near the centerline these stations will be distributed roughly 10 m apart and the distance intervals between stations will increase with distance from the centerline (Figure 4-4). The selected sampling locations and sampling intervals relative to the cable will remain fixed for the duration of the survey. The exact locations of the sampling frames will be selected after cable installation is completed; Figure 4-4 provides a conceptual diagram of the planned sampling design along the export cable corridors. Sampling along the export cables will occur prior to construction (within 6 months), within the first calendar year post installation (Y0), one year post-installation (Y1), and two years post-installation (Y2).

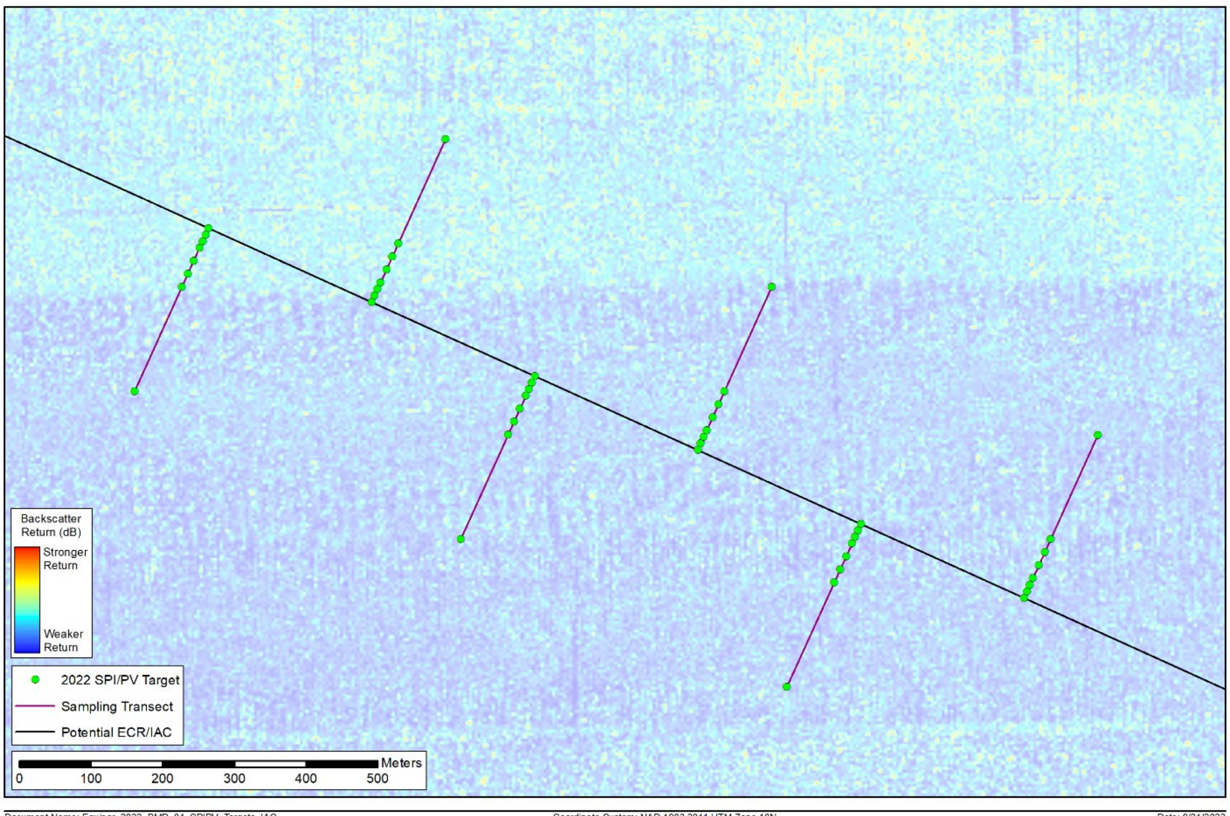


Figure 4-4. Conceptual diagram illustrating the Before-After Gradient design *of Cable-associated Physical Disturbance* survey design.

4.5.3 Statistical Analyses

The planned statistical analyses are summarized by survey type in Table 4-2.

For the *Cable-associated Physical Disturbance* dataset collected along the selected export cable segments (BAG design), data analysis will include exploratory multivariate approaches (e.g., nMDS) to identify patterns among responses (SPI/PV metrics, e.g., aRPD, successional stage, feeding voids, sediment grain size layering) and predictors (e.g., distance from the cable, water depth). Covariates in the model for the export cable dataset will include habitat type (categorical) and direction (categorical); variability among transects will provide site-wide random error. For individual metrics that are consistently measured across stations (e.g., aRPD), parametric or non-parametric regression (e.g., generalized modeling such as GLM or GAM; or regression trees) will be applied if the data prove to be sufficient and appropriate for these tools.

Additionally, graphical methods and descriptive statistics will be used to assess changes in the SPI/PV metrics over time and as a function of distance and direction from the export cable centerline. These graphical techniques may help to elucidate the spatial scale at which the greatest changes in benthic habitat condition occur.

5.0 DATA MANAGEMENT, REPORTING, AND DATA SHARING

The fisheries and benthic monitoring data will be managed by INSPIRE Environmental, with the exception of data described in Sections 3.3.3 and 3.3.4 which will be housed and maintained by Monmouth University. Data may be shared with state and federal agencies and other stakeholders upon request. Data will be prepared and disseminated annually and will undergo rigorous quality control and assurance audits prior to release.

Proper data management and traceability are integral to analysis and accurate interpretation and reporting. The surveys described in this monitoring plan will follow a rigorous system to inspect data throughout all stages of collection, processing, and analysis. This data management system will provide a high level of confidence in the accuracy of the data being reported. Data management will include methods for data collection, data storage and archiving, quality assurance/quality control (QA/QC) audits, distribution and dissemination protocols and best practices, and analyses. Metadata will be developed for each survey dataset which will include descriptions of data fields, data processing, QA/QC procedures, etc.

Annual reports will be prepared upon the conclusion of each year of sampling for each survey type. These reports will be shared with state and federal resource agencies. A final synthesis report will be prepared for each survey after the final year of sampling has concluded. This report will evaluate the survey findings during the pre- and post-construction survey time periods. The project team will disseminate annual results to agencies through an in-person meeting or webinar to solicit questions or feedback on the survey results, protocols, etc. The team will also host an in-person workshop to review results of monitoring efforts with members of the fishing industry.

In order to obtain data derived from this monitoring plan, stakeholders must submit a formal request to Empire Offshore Wind, LLC. A brief proposal will be required that states the purpose of the request, a description of the data requested (e.g., survey type, timeframe, species of interest), a list of collaborators and their affiliations, if applicable, and a description of the anticipated products of the work (e.g., manuscripts, fisheries stock assessments). Data access protocols will be developed to provide conditions for requesting monitoring data. Any data requested will be disseminated provided the criteria outlined in the data access protocols are met. Data will be sent to the requesting party electronically in most cases and any exceptions will be dealt with on a case-by-case basis with the party or parties seeking access. Empire Offshore Wind LLC will amend the above data sharing protocols as needed in accordance with current data sharing efforts and guidance being developed through ROSA.

6.0 REFERENCES

Afzali, S.F., H. Bourdages, M. Laporte, C. Merot, E. Normandeau, C. Audet, and L. Bernatchez. 2021. Comparing environmental metabarcoding and trawling survey of demersal fish communities in the Gulf of St. Lawrence, Canada. Environmental DNA 3:22-42.

Andersson, M.H. and M.C. Ohman. 2010. Fish and Sessile Assemblages Associated with Wind-Turbine Constructions in the Baltic Sea. Marine and Freshwater Research, 61, 642-650. http://dx.doi.org/10.1071/MF09117

Battista, T., W. Sautter, M. Poti, E. Ebert, L. Kracker, J. Kraus, A. Mabrouk, B. Williams, D.S. Dorfman, R. Husted, and C.J. Jenkins. 2019. Comprehensive Seafloor Substrate Mapping and Model Validation in the New York Bight. OCS Study BOEM 2019-069 and NOAA Technical Memorandum NOS NCCOS 255. 187 pp. doi:10.25923/yys0-aa98.

Bergström, L., F. Sundqvist, and U. Bergström. 2013. Effects of an Offshore Wind Farm on Temporal and Spatial Patterns in the Demersal Fish Community. Marine Ecology Progress Series 485 (June): 199–210. https://doi.org/10.3354/meps10344.

Bethoney, N.D. and K.D.E. Stokesbury. 2018. Methods for Image-based Surveys of Benthic Macroinvertebrates and Their Habitat Exemplified by the Drop Camera Survey for the Atlantic Sea Scallop. J Vis Exp. 2018; (137): 57493.

Bicknell, A.W.J., E.V. Sheehan, B.J. Godley, P.D. Doherty, and M.J. Witt. 2019. Assessing the impact of introduced infrastructure at sea with cameras: a case study for spatial scale, time, and statistical power, Marine Environmental Research, 147: 126-137.

Birt, M.J., T.J. Langlois, D. McLean, and E.S. Harvey. 2021. Optimal deployment durations of baited underwater video systems sampling temperate, subtropical and tropical reef fish assemblages. Journal of Experimental Marine Biology and Ecology 538: 151530

Bonzek, C.F., J. Gartland, R.A. Johnson, and J.D. Lange Jr. 2008. NEAMAP Near Shore Trawl Survey: Peer Review Documentation. A report to the Atlantic States Marine Fisheries Commission.

Bonzek, C.F., J. Gartland, D.J. Gauthier, and R.J. Latour. 2017 Northeast Area Monitoring and Assessment Program (NEAMAP) Data collection and analysis in support of single and multispecies stock assessments in the Mid-Atlantic: Northeast Area Monitoring and Assessment Program Near Shore Trawl Survey. Virginia Institute of Marine Science, College of William and Mary. https://doi.org/10.25773/ 7206-KM61.

Bouma S. and W. Lengkeek. 2012. Benthic communities on hard substrates of the offshore wind farm Egmond aan Zee (OWEZ). Bureau Waardenburg bv. Consultants for environment & ecology, Culemborg, The Netherlands, 84 pp.

Bruno, F., A. Gallo, F. De Filippo, M. Muzzupappa, B. Davidde Petriaggi and P. Caputo, "3D documentation and monitoring of the experimental cleaning operations in the underwater archaeological site of Baia (Italy)," 2013 Digital Heritage International Congress (DigitalHeritage), 2013, pp. 105-112, doi: 10.1109/DigitalHeritage.2013.6743719.

Bureau of Ocean Energy Management (BOEM) Office of Renewable Energy Programs. 2019. Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585. June 2019.

Callahan, B., P. McMurdie, M. Rosen, M. et al. 2016. DADA2: High-resolution sample inference from Illumina amplicon data. Nat Methods 13, 581–583. https://doi.org/10.1038/nmeth.3869

Closek, C.J., J.A. Santora, H.A. Starks, I.D. Schroder, E.A. Andruszkiewicz, K.M. Sakuma, S.J. Bogard, E.L. Hazen, J.C. Field, and A.B. Boehm. 2019. Marine vertebrate biodiversity and distribution within the

Central California Current ecosystem using environmental DNA (eDNA) metabarcoding and ecosystem survey. Frontiers in Marine Science, 6:732. doi: 10.3389/fmars.2019.00732.

Coates, D.A., Y. Deschutter, M. Vincx, and J. Vanaverbeke. 2014. Enrichment and shifts in macrobenthic assemblages in an offshore wind farm area in the Belgian part of the North Sea. Marine Environmental Research, 95: 1–12.

Cohen, J. 1992. A power primer. Psychological Bulletin. 112: 155-159.

Cole, V.J., D. Harasti, R. Lines, and M. Stat. 2022. Estuarine fishes associated with intertidal oyster reefs characterized using environmental DNA and baited remote underwater video. Environmental DNA 4: 50–62. https://doi.org/10.1002/edn3.190.

Collette, B.B. and G. Klein-MacPhee. 2002. Bigelow and Schroeder's Fishes of the Gulf of Maine. Third Edition. Smithsonian Institution Press. Washington D.C. 748 pp.

Collins, R.A., O.S. Wangensteen, E.J. O'Gorman, S. Mariani, D.W. Sims, and M.J. Genner. 2018. Persistence of environmental DNA in marine systems. Commun Biol 1, 185. https://doi.org/10.1038/s42003-018-0192-6.

Coonamesset Farm Foundation (CFF). 2022.Optical benthic surveys using the Habitat Mapping Camera (HabCam). Accessed August 2022. https://www.coonamessettfarmfoundation.org/habcam-surveys.

Cornell Cooperative Extension (CCE). 2022. Cornell Bottom Trawl Survey Notice. https://ehtrustees.com/wp-content/uploads/2022/07/JULY-Summer2022-Cornell-Bottom-Trawl-Survey-Notice-Final.pdf.

Currey-Randall, L.M., Cappo, M., Simpfendorfer, C.A., Farrabaugh, N.F., and Heupel, M.R. 2020. Optimal soak times for baited remote underwater video station surveys of reef-associated elasmobranchs. PLOS One, 15(5): e0231688.

Dannheim, J., L. Bergström, S.N.R. Birchenough, R. Brzana, A.R. Boon, J.W.P. Coolen, J. Dauvin, I. De Mesel, J. Derweduwen, A.B. Gill, Z.L. Hutchison, A.C. Jackson, U. Janas, G. Martin, A. Raoux, J.Reubens, L. Rostin, J. Vanaverbeke, T.A. Wilding, D. Wilhelmsson, and S. Degraer. 2019. Benthic effects of offshore renewables: identification of knowledge gaps and urgently needed research. ICES Journal of Marine Science 77: 1092–1108.

De Borger, E., E. Ivanov, A. Capet, U. Braeckman, J. Vanaverbeke, M. Grégoire, and K. Soetaert. 2021. Offshore Windfarm Footprint of Sediment Organic Matter Mineralization Processes. Frontiers in Marine Science 8. https://www.frontiersin.org/articles/10.3389/fmars.2021.632243. DOI=10.3389/fmars.2021.632243

Degraer, S., D.A. Carey, J.W.P. Coolen, Z.L. Hutchison, F. Kerckhof, B. Rumes, and J. Vanaverbeke. 2020. Offshore wind farm artificial reefs affect ecosystem structure and functioning: A synthesis. Oceanography 33(4):48–57, https://doi.org/10.5670/oceanog.2020.405.

Deepwater Wind South Fork 2020. South Fork Wind Research and Monitoring Plan. September 2020. Prepared by South Fork Wind, LLC and INSPIRE Environmental. 68pp.

Degraer, S., Brabant, R., Rumes, B., and Vigin, L. 2018. Environmental Impacts of Offshore Wind Farms in the Belgian Part of the North Sea: Assessing and Managing Effect Spheres of Influence. Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management, Brussels, Belgium. 136 pp.

Degraer, S., D.A. Carey, J.W.P. Coolen, Z.L. Hutchison, F. Kerckhof, B. Rumes, and J. Vanaverbeke. 2020. Offshore wind farm artificial reefs affect ecosystem structure and functioning: A synthesis. Oceanography 33(4):48–57, https://doi.org/10.5670/ oceanog.2020.405.

De Mesel, I., F. Kerckhof, A. Norro, B. Rumes, and S. Degraer. 2015. Succession and seasonal dynamics of the epifauna community on offshore wind farm foundations and their role as stepping stones for non-indigenous species. Hydrobiologia, 756(37):37–50.

Done, T.J. 1981. Photogrammetry in coral ecology: a technique for the study of change in coral communities. Proc. 4th International Coral Reef Symposium Volume 2

Dunton, K.J., A. Jordaan, K.A. McKown, D.O. Conover, and M.G. Frisk. 2010. Abundance and distribution of Atlantic sturgeon (*Acipenser oxyrinchus*) within the Northwest Atlantic Ocean, determined from five fishery-independent surveys. Fisheries Bulletin 108: 450-465.

Dunton, K.J., A. Jordaan, D.O. Conover, K.A. McKown, L.A. Bonacci, and M.G. Frisk. 2015. Marine Distribution and Habitat Use of Atlantic Sturgeon in New York Lead to Fisheries Interactions and Bycatch, Marine and Coastal Fisheries, 7:1, 18-32, DOI: 10.1080/19425120.2014.986348.

Ecology and Environment Engineering, P.C. 2017. New York State Offshore Wind Master Plan: Fish and Fisheries Study. NYSERDA Report 17-25l. 202 pp.

Equinor. 2021b. Empire Offshore Wind: Empire Wind Project (EW 1 and EW 2) Construction and Operations Plan. Volume 2b: Biological Resources. Prepared for Equinor by Tetra Tech. Submitted to the Bureau of Ocean Energy Management. July 2021.

Federal Geographic Data Committee (FGDC). 2012. Coastal and Marine Ecological Classification Standard. FGDC-STD-018-2012. Marine and Coastal Spatial Data Subcommittee. June 2012. 343 pp. Reston, VA.

Field, S.A., P.J. O'Connor, A. Tyre, and H.P. Possingham. 2007. Making monitoring meaningful. Austral Ecology, 32: 485-491.

Fiske I, Chandler R. 2011. "unmarked: An R Package for Fitting Hierarchical Models of Wildlife Occurrence and Abundance." *Journal of Statistical Software*, 43(10), 1–23. https://www.jstatsoft.org/v43/i10/.

Flescher, D.D. 1980. Guide to Some Trawl Caught Marine Fishes from Maine to Cape Hatteras, North Carolina. NOAA Technical Report NMFS Circular 431. March 1980.

Freiss, C., S.K. Lowerre-Barbieri, G. Poulakis, and 34 others. 2021. Regional-scale variability in movement ecology of marine fisheries revealed by an integrative acoustic tracking network. Marine Ecology Progress Series, 663: 157-177.

Friard, O. and M. Gamba. 2016. BORIS: a free, versatile open-source event-logging software for video/audio coding and live observations. Methods Ecol Evol, 7: 1325-1330. https://doi.org/10.1111/2041-210X.12584

Frisk M.G., M.C. Ingram, and K. Dunton. 2019. Monitoring Endangered Atlantic Sturgeon and Commercial Finfish Habitat Use in the New York Lease Area. Stony Brook (NY): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-074. 88 p

Gardline. 2022. Marine Site Investigation Report (MSIR) in Support of Construction and Operations Plan. Appendix H to the Empire Wind Project (EW 1 and EW 2) Construction and Operations Plan. Prepared for Equinor by Gardline. May 2022.

Gardline. 2021. EQ20547 – Empire Wind Extension – Barrett Route Habitat Characterization Report. Prepared for Equinor US Wind LLC. December 2021.

Germano, J.D., D.C. Rhoads, R.M. Valente, D. Carey, and M. Solan. 2011. The use of Sediment Profile Imaging (SPI) for environmental impact assessments and monitoring studies: Lessons learned from the past four decades. Oceanography and Marine Biology: An Annual Review 49: 247-310.

Gerrodette, T. 1987. A power analysis for detecting trends. Ecology 68(5): 1364-1372.

Glarou, M., M. Zrust, and J.C. Svendsen. 2020. Using artificial-reef knowledge to enhance the ecological function of offshore wind turbine foundations: implications for fish abundance and diversity. Journal of Marine Science and Engineering, 8: 332; doi:10.3390/jmse8050332.

Greene, J.K., M.G. Anderson, J. Odell, and N. Steinberg, eds. 2010. The Northwest Atlantic Marine Ecoregional Assessment: Species, Habitats and Ecosystems. Phase One. The Nature Conservancy, Eastern U.S. Division, Boston, MA.

Griffin, R.A., Robinson, G.J., West, A., Gloyne-Phillips, I.T., Unsworth, R.K.F. 2016. Assessing fish and motile fauna around offshore windfarms using stereo baited video. PLOS One, 11(3): e0149701.

Guida, V., A. Drohan, H. Welch, J. McHenry, D. Johnson, V. Kentner, J. Brink, D. Timmons, E. Estela-Gomez. 2017. Habitat Mapping and Assessment of Northeast Wind Energy Areas. Sterling, VA: US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-088. 312 p.

Hare, J.A., W.E. Morrison, M.W. Nelson, M.M. Stachura, E.J. Teeters, R.B. Griffis, M.A. Alexander, J.D. Scott, L. Alade, R.J. Bell, A.S. Chute, K.L. Curti, T.H. Curtis, D. Kircheis, J.F. Kocik, S.M. Lucey, C.T. McCandless, L.M. Milke, D.E. Richardson, E. Robillard, H.J. Walsh, M.C. McManus, K.E. Marancik, and C.A. Griswold. 2016. A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf. PLoS One, 11(2): e0146756. doi:10.1371/journal.pone.0146756.

Harrison, S. and M. Rousseau. 2020. Comparison of Artificial and Natural Reef Productivity in Nantucket Sound, MA, USA. Estuaries and Coasts 43, 2092–2105. https://doi.org/10.1007/s12237-020-00749-6.

Hart, D. 2015. Northeast Fisheries Science Center Scallop Dredge Surveys. Prepared for the Sea Scallop Survey Review, March 2015. Available online: https://www.cio.noaa.gov/services_programs/prplans/pdfs/ID321_Draft_Product_1-NEFSC_Dredge.pdf.

Harvey, E.S., D.L. McLean, J.S. Goetze, B.J. Saunders, T.J. Langlois, J. Monk, N. Barrett, S.K. Wilson, T.H. Holmes, D. Ierodiacinou, A.R. Jordan, M.G. Meekan, H.A. Malcolm, M.R. Heupel, D. Harasti, C. Huveneers, N.A. Knott, D.V. Fairclough, L.M. Currey-Randall, M.J. Travers, B.T. Radford, M.J. Rees, C.W. Speed, C.B. Wakefield, M. Cappo, and S.J. Newman. 2021. The BRUVs workshop – An Australia-wide synthesis of baited remote underwater video data to answer broad-scale ecological questions about fish, sharks and rays. Marine Policy 127: 104430.

HDR. 2019. Benthic Monitoring during Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island – Year 2. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019- 019. 318 pp.

HDR. 2020. Benthic and Epifaunal Monitoring During Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island – Project Report. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2020-044. Volume 1: 263 pp; Volume 2:380 pp.

Hilborn, R. and C.J. Walters. 1992 Quantitative fisheries stock assessment, choice, dynamics and uncertainty. Chapman and Hall, London. doi:10.1007/978-1-4615-3598-0

Hiscock, K., H. Tyler-Walters, and H. Jones. 2002. High Level Environmental Screening Study for Offshore Wind Farm Developments – Marine Habitats and Species Project. Report from the Marine Biological Association to The Department of Trade and Industry New & Renewable Energy Programme. (AEA Technology, Environment Contract: /35/00632/00/00.)

Hussey, N.E., S.T. Kessel, K. Aarestrup, S.J. Cooke, P.D. Cowley, A.T. Fisk, R.G. Harcourt, K.N. Holland, S.J. Iverson, J.F. Kocik, and J.E.M. Flemming. 2015. Aquatic animal telemetry: a panoramic window into the underwater world. Science, 348(6240), p.1255642.

Hutchison, Z.L., M. LaFrance Bartley, S. Degraer, P. English, A. Khan, J. Livermore, B. Rumes, and J.W. King. 2020. Offshore wind energy and benthic habitat changes: Lessons from Block Island Wind Farm. Oceanography 33(4):58–69, https://doi.org/10.5670/oceanog.2020.406.

Ingram, E.C., R.M. Cerrato, K.J. Dunton, and M.G. Frisk. 2019. Endangered Atlantic Sturgeon in the New York Wind Energy Area: implications of future development in an offshore wind energy site. Scientific Reports, 9:12432.

INSPIRE Environmental. 2019. Benthic Assessment Survey of Proposed Export Cable Routes in Support of the Equinor Wind OCS-A 0512 Offshore Wind Farm Project, Data Report. Prepared for Equinor Wind US LLC. November 2019.

Ivanov E., A. Capet, E. De Borger, S. Degraer, E.J.M. Delhez, K. Soetaert, J. Vanaverbeke, and M. Grégoire. 2021. Offshore Wind Farm Footprint on Organic and Mineral Particle Flux to the Bottom. Front. Mar. Sci. 8:631799.doi: 10.3389/fmars.2021.631799.

Kells, V. and K. Carpenter. 2011. A Field Guide to Coastal Fishes from Maine to Texas. Johns Hopkins University Press, 448 pp.

Kirtane, A., D. Wieczorek, T. Noji, L. Baskin, C. Ober et al. 2021. Quantification of environmental DNA (eDNA) shedding and decay rates for three commercially harvested fish species and comparison between eDNA detection and trawl catches. Environmental DNA DOI: 10.1002/edn3.236.

Knudsen, S.H., R.B. Ebert, M. Hesselsoe, F. Juntke, J. Hassignboe, P.B. Mortensen, P.F. Thomsen, E.E. Sigsgaard, B.K. Hansen, E.E. Nielsen, and P.R. Moller. 2019. Species-specific detection and quantification of environmental DNA from marine fishes in the Baltic Sea. Journal of Experimental Marine Biology and Ecology, 510: 31-45.

Kraus, C. and L. Carter. 2018. Seabed recovery following protective burial of subsea cables – Observations from the continental margin. Ocean Engineering, 157: 251-261.

Krone, R., G. Dederer, P. Kanstinger, P. Krämer, and C. Schneider. 2017. Mobile demersal megafauna at common offshore wind turbine foundations in the German Bight (North Sea) two years after deployment - increased production rate of Cancer pagurus. Marine Environmental Research, 123:53–61, https://doi.org/10.1016/j.marenvres.2016.11.011.

LaFrance, M., Shumchenia, E., King, J.W., Pockalny, R., Oakley, B. Pratt, S. & Boothroyd, J. 2010. Chapter 4. Benthic habitat distribution and subsurface geology in selected sites from the Rhode Island Ocean Special Area Management Study Area In: Rhode Island OCEAN SAMP. Volume 2. Coastal Resources Management Council, October 12, 2010.

LaFrance, M., King, J.W., Oakley, B.A. & Pratt, S. 2014. A comparison of top-down and bottom-up approaches to benthic habitat mapping to inform offshore wind energy development. Continental Shelf Research (2014). http://dx.doi.org/10.1016/j.cer.2014.007.

Langhamer, O. 2012. Artificial reef effect in relation to offshore renewable energy conversion: State of the Art. The Scientific World Journal. doi:10.1100/2012/386713.

Langlois T.J., E.S. Harvey, B. Fitzpatrick, J.J. Meeuwig, G. Shedrawi, and D.L. Watson. 2010. Cost-efficient sampling of fish assemblages: comparison of baited video stations and diver video transects. Aquat Biol 9:155–168.

Langlois, T., J. Williams, J. Monk, P. Bouchet, L. Currey-Randall, J. Goetze, D. David C. Huveneers, H. Malcolm, and S. Whitmarsh. 2018. Marine sampling field manual for benthic stereo-BRUVS (Baited Remote Underwater Videos).

Langlois, T., J. Goetze, T. Bond, et al. 2020. A field and video annotation guide for baited remote underwater stereo-video surveys of demersal fish assemblages. Methods Ecol Evol. 11: 1401– 1409. https://doi.org/10.1111/2041-210X.13470

Lefaible, N., L. Colson, U. Braeckman, and T. Moens. 2019. Evaluation of turbine-related impacts on macrobenthic communities within two offshore wind farms during the operational phase. In Degraer, S., Brabant, R., Rumes, B. & Vigin, L. (eds). 2019. Environmental Impacts of Offshore Wind Farms in the Belgian Part of the North Sea: Marking a Decade of Monitoring, Research and Innovation. Brussels: Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management, 134 p.

Liu, Y., G.H. Wikfors, J.M. Rose, R.S. McBride, L.M. Milke, and R. Mercaldo-Allen. 2019. Application of environmental DNA metabarcoding to spatiotemporal finfish community assessment in a temperate embayment. Frontiers in Marine Science 6:674. Doi: 10.3389/fmars.2019.00674.

Lindeboom, H.J., H.J. Kouwenhoven, M.J.N. Bergman, S. Bouma, S. Brasseur, R. Daan, R.C. Fijn, et al. 2011. Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environmental Research Letters, 6: 1-13.

MacKenzie, Darryl I., J.D. Nichols, G.B. Lachman, S. Droege, J.A. Royle, and C.A. Langtimm. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83.8 (2002): 2248-2255.

Maiello, G., L. Talarico, P. Carpentieri, F. De Angelis, S. Franceschini, et al. 2022. Little samplers, big fleet: eDNA metabarcoding from commercial trawlers enhances ocean monitoring. Fisheries Research 249: 106259.

Malek, A.J., J.S. Collie, and J. Gartland. 2014. Fine-scale spatial patterns in the demersal fish and invertebrate community in a northwest Atlantic ecosystem. Estuarine, Coastal and Shelf Science 147:1-10. doi: 10.1016/j.ecss.2014.05.028

Mallet D. and D. Pelletier. 2014. Underwater video techniques for observing coastal marine biodiversity: A review of sixty years of publications (1952–2012). Fish Res 154:44–62.

Marre, G., F. Holon, S. Luque, P. Boissery, and J. Deter. 2019. Monitoring Marine Habitats with Photogrammetry: A Cost-Effective, Accurate, Precise and High-Resolution Reconstruction Method. Front. Mar. Sci. 6:276. doi: 10.3389/fmars.2019.00276.

Massachusetts Division of Marine Fisheries (MADMF). 2018. Recommended regional scale studies related to fisheries in the Massachusetts and Rhode Island-Massachusetts offshore wind energy areas.

McCann, J. 2012. Developing Environmental Protocols and Modeling Tools to Support Ocean Renewable Energy and Stewardship. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA., OCS Study BOEM 2012-082, 626 pp.

Melnychuk, M. E. Peterson, M. Elliott, and R. Hilborn. 2016. Fisheries management impacts on target species status. Proceedings of the National Academy of Sciences. 114. 201609915. 10.1073/pnas.1609915114.

Mercaldo-Allen, R., P. Clark, Y. Liu, G. Phillips, D. Redman, et al. 2021. Exploring video and eDNA metabarcoding methods to assess oyster aquaculture cages as fish habitat. Aquaculture Environment Interactions 13: 277-294.

Methratta, E. 2020. Monitoring fisheries resources at offshore wind farms: BACI vs. BAG designs. ICES Journal of Marine Science. doi:10.1093/icesjms/fsaa026.

Mid-Atlantic Data Portal. 2022. Commercial Fishing – VMS. Accessed August 2022. https://portal.midatlanticocean.org/data-catalog/fishing/#layer-info-commercial-fishing-vms271.

National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries). 2022a. Socioeconomic Impacts of Atlantic Offshore Wind Development. Accessed August 2022. https://www.fisheries.noaa.gov/resource/data/socioeconomic-impacts-atlantic-offshore-wind-development.

New Jersey Department of Environmental Protection (NJDEP). 2022. Open Stock Assessment Program. Accessed August 2022. https://dep.nj.gov/njfw/fishing/marine/ocean-stock-assessment-program/.

New York State Department of Environmental Conservation NYSDEC). 2022.Ocean Monitoring Project; Nearshore Ocean Trawl Survey. Accessed August 2022. https://www.dec.ny.gov/lands/111178.html.

New York State Energy Research and Development Authority (NYSERDA). 2017. New York State Offshore Wind Master Plan: Fish and Fisheries Study. NYSERDA Report 17-25j. 140 pp.

Northeast Area Monitoring and Assessment Program (NEAMAP), Virginia Shark Monitoring & Assessment Program (VASMAP), R.J. Latour, J. Gartland, and C.F. Bonzek. 2021. Monitoring Living Marine Resources in the Mid-Atlantic Bight. Virginia Institute of Marine Science, William & Mary. doi: 10.25773/k5bv-pp81.

Northeast Ocean Data. 2022. Commercial Fishing. Accessed August 2022. https://www.northeastoceandata.org/data-explorer/?commercial-fishing|vessel-activity.

Northeast Fisheries Science Center (NEFSC). 2016. Fisheries Sampling Branch Observer On-Deck Reference Guide 2016. U.S. Department of Commerce, NOAA Fisheries Service. Woods Hole, MA.

Ocean Wind, LLC. 2021. Ocean Wind Offshore Wind Farm Fisheries Monitoring Plan. July 2021.

Petersen, J.K., and Malm, T. 2009. Offshore wind farms: threats to or possibilities for the marine environment. Ambio, 35(2): 75-80.

Reid, R.N., D.J. Radosh, A.B. Frame, and S.A. Fromm. 1991. Benthic macrofauna of the New York Bight, 1979-1989. NOAA Technical Report NMFS-103; 50 p.

Responsible Offshore Science Alliance (ROSA). 2021. Offshore wind project monitoring framework and guidelines. March 2021. Available online at Resources | ROSA 2021 Updated (rosascience.org).

Reubens, J.T., F. Pasotti, S. Degraer, and M. Vincx. 2013a. Residency, site fidelity and habitat use of Atlantic cod (*Gadus morhua*) at an offshore wind farm using acoustic telemetry. Marine Environmental Research, 50: 128-135.

Reubens, J.T., U. Braeckman, J. Vanaverbeke, C. Van Colen, S. Degraer, and M. Vincx. 2013b. Aggregation at windmill artificial reefs: CPUE of Atlantic cod (*Gadus morhua*) and pouting (*Trisopterus luscus*) at different habitats in the Belgian part of the North Sea. Fish. Res. 139:28-34.

Reubens, J.T., S. Degraer, and M. Vincx. 2014. The ecology of benthopelagic fishes at offshore wind farms: A synthesis of 4 years of research, Hydrobiologia 727:121-136,

Revolution Wind, LLC and INSPIRE Environmental. 2021. Revolution Wind Fisheries Research and Monitoring Plan. October 2021.

Rudders, D., 2015. Virginia Institute of Marine Science Dredge Survey Methods Report. From: http://www.cio.noaa.gov/services_programs/prplans/pdfs/ID310_Draft_Product_2-VIMS%20S_Methods%20Review.pdf.

Russo, T., Maiello, G., Talarico, L., Baillie, C., Colosimo, G., D'Andrea, L., Di Maio, F., Fiorentino, F., Franceschini, S., Garofalo, G., Scannella, D., Cataudella, S., Mariani, S., 2021. All is fish that comes to the net: metabarcoding for rapid fisheries catch assessment. Ecol. Appl. 31, 1–10. https://doi.org/10.1002/eap.2273.

Salter, I., M. Joensen, R. Kristiansen, P. Steingrund, and P. Vestergaard. 2019. Environmental DNA concentrations are correlated with regional biomass of Atlantic cod in oceanic waters. Communications Biology, https://doi/org/10.1038/s42003-019-0696-8.

Smith, E.P., D.R. Orvos, and J. Cairns. 1993. Impact assessment using the before-after-control- impact (BACI) model: comments and concerns. Canadian Journal of Fisheries and Aquatic Sciences, 50: 627-637.

Sokal, R.R. and F.J. Rohlf. 2001. Biometry. Third Edition. W.H. Freeman and Company. USA. 850 pp.

South Fork Wind, LLC and INSPIRE Environmental. 2022. South Fork Fisheries Research and Monitoring Plan. April 2022.

Stat, M., J. John, J.D. DiBattista, S.J. Newman, M. Bunce, and E.S. Harvey. 2018. Combined use of eDNA metabarcoding and video surveillance for the assessment of fish biodiversity. Conservation Biology, 33(1); 196-205.

Stenberg, C. J.G. Støttrup, M. van Deurs, C.W. Berg, G.E. Dinesen, H. Mosegaard, T.M. Grome, and S.B. Leonhard. 2015. Marine Ecology Progress Series 528:257-265. doi: 10.3354/meps11261.

Stoeckle B.C., S. Beggel, A.F. Cerwenka, E. Motivans, R. Kuehn, and J. Geist. 2017. A systematic approach to evaluate the influence of environmental conditions on eDNA detection success in aquatic ecosystems. PLoS ONE 12(12): e0189119. https://doi.org/10.1371/journal.pone.0189119

Stoeckle, M.Y., M.D. Mishu, and Z. Charlop-Powers. 2020a. Improved environmental DNA reference library detects overlooked marine fishes in New Jersey, United States. Frontiers in Marine Science, 7:226. doi: 10.3389/fmars.2020.00226.

Stoeckle, M., J. Adolf, Z. Charlop-Powers, K.J. Dunton, G. Hinks, and S.M. VanMorter. 2020b. Trawl and eDNA assessment of marine fish diversity, seasonality, and relative abundance in coastal New Jersey, USA. ICES Journal of Marine Science, 78(1): 293-304.

Stokesbury, K.D.E. 2013. MA Windfarm Survey, Final Report. School for Marine Science and Technology (SMAST), University of Massachusetts Dartmouth.

Stokesbury, K.D.E. 2014. MA Windfarm Survey, Final Report. School for Marine Science and Technology (SMAST), University of Massachusetts Dartmouth.

Stokesbury, K., G. Fay, and R. Griffin. 2022. A framework for categorizing the interactions of offshore windfarms and fisheries. ICES Journal of Marine Science. 79. 10.1093/icesjms/fsac118.

Sunrise Wind LLC. 2022. Sunrise Wind Fisheries and Benthic Research Monitoring Plan. April 2022.

Tetra Tech. 2022. Benthic Resource Characterization Reports. Appendix T to the Empire Wind Project (EW 1 and EW 2) Construction and Operations Plan. Prepared for Equinor by Tetra Tech. May 2022.

Theroux, R.B. and R.L. Wigley. 1998. Quantitative composition and distribution of the macrobenthic invertebrate fauna of the continental shelf ecosystems of the northeastern United States. U.S. Dep. Commer. NOAA Tech. Rep. NMFS 140, 240 pp.

Thomsen, P.F., P.R. Moller, E.E. Sigsgaard, S.W. Jundsen, O.A. Jorgensen, and E. Willerslev. 2016. Environmental DNA from seawater samples correlate with trawl catches of subarctic deepwater fishes. PLoS ONE, https://doi.org/10.1371/journal.pone.0165252

Thorne, L., J. Nye, J. Warren, and C. Flagg. 2020. Development and implementation of an ocean ecosystem monitoring program for New York Bight. Annual Report, MOU #AM10560 NYS DEC & SUNY Stony Brook for the period January 1, 2020 – December 31, 2020. New York State Environmental Protection Fund Ocean and Great Lakes Program and Stony Brook University School of Marine and Atmospheric Sciences. https://www.dec.ny.gov/docs/fish_marine_pdf/dmrsomasmonitoring.pdf.

Underwood, A.J. 1992. Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world. Journal of Experimental Marine Biology and Ecology, 161: 145-178.

Underwood, A.J. 1994. On beyond BACI: sampling designs that might reliably detect environmental disturbances. Ecol Appl 4: 3–15.

Wilber, D., L. Read, M. Griffin, and D. Carey. 2021. Block Island Wind Farm Demersal Fish Trawl Survey, Final Synthesis Report – Years 1 to 7, October 2012 through September 2019. Prepared by INSPIRE Environmental, Newport, RI for Deepwater Wind Block Island, LLC, Providence, RI. 103 pp. ++ Appendices.

Wilber, D. H., L. Brown, M. Griffin, G. R. DeCelles, and D. A. Carey. 2022. Demersal fish and invertebrate catches relative to construction and operation of North America's first offshore wind farm. ICES Journal of Marine Science 79:1274-1288.

Wilhelmsson, D., and Malm, T. 2008. Fouling assemblages on off- shore wind power plants and adjacent substrata. Estuarine Coastal and Shelf Science, 79: 459–466.

Winter, H.V., G. Aarts, and O.A. van Keeken. 2010. Residence time and behavior of sole and cod in the offshore wind farm Egmond aan Zee (OWEZ). IMARES Report number C038/10. 50 pp.

EMPIRE WIND FISHERIES AND BENTHIC MONITORING PLAN

ATTACHMENTS

Prepared for:

Empire Wind
Stamford Office
600 Washington Blvd
Suite 800
Stamford, CT 06901

Prepared by:

INSPIRE Environmental
Newport, Rhode Island 02840

May 2023

Attachment A - Power Analysis for Trawl Survey of Longfin Squid

1.0 Introduction

For the trawl survey, a symmetric BACI design is planned for the Empire Wind (EW) project area, with one impact and one control or reference area. The EW trawl survey will use NOAA-derived survey gear and NEAMAP sampling protocols and will focus primarily on longfin squid, though it is expected to also capture other benthic and pelagic fish and invertebrate species. This power analysis addresses only longfin squid catch.

This Attachment covers two topics:

1. A review of existing trawl survey datasets in the vicinity of EW project area, including data from the NEFSC trawl survey (Politis et al. 2014) and data collected in the reference areas during the BIWF trawl survey (Wilber et al. 2020). These datasets were evaluated to establish the proximate range of a meaningful effect size in measuring change over time, as well as reasonable ranges for inter-annual and intra-annual variability (i.e., the coefficient of variation [CV]) to use in the power analyses.

2. A power simulation study for a BACI design and analysis contrasting fish/invertebrate biomass between an impact area and control area. Effect sizes and CVs were derived from the NEFSC and BIWF trawl survey datasets (topic 1 above).

2.0 Power Analysis Elements

A statistical power analysis requires specification of the following:

- Study design specifics (e.g., number of replicates, number of sites, number of seasons/sampling events, sampling duration before and after construction), and their structure (e.g., random trawls as independent replicates within each site and sampling event, or fixed trawls nested within sites and repeatedly sampled over time).

- The statistical model, which is determined by the study design (previous bullet) and characteristics of the data (e.g., catch data as biomass might be modeled with a generalized linear or additive model with normal errors and a log-link; catch data as counts might be modeled with a generalized linear or additive model with Poisson errors, or with a negative binomial if the count data are over-dispersed; presence/absence data might be modeled with logistic regression and binomial errors).

A statistical power analysis relates the following four elements; given three of these elements, the fourth can be estimated:

- **Effect size (Δ)** is a measure of change in the data that the study design and modelling approach will be used to estimate. Statistical analysis of this OSW monitoring data from the BACI design will focus on the BACI interaction contrast between period and location, and is specified as a contrast between the temporal change at the Impact site to the temporal change at the Control site, with responses averaged across seasons and years within each period. The effect size herein is expressed as a proportional change between periods of the mean catch per tow at the Impact site relative to the mean catch per tow at the Control site. For example, an effect size of –0.33 (-33%) could represent a 33% decrease in catch at the impact site and no change at the control site (0.67/1 -1); or a 50% decrease at the impact site and a 25% decrease at the control site (0.5/0.75-1); or a 20% decrease at the impact site and 20% increase at the control (0.8/1.2-1); other similar combinations that yield a 67% ratio of relative change. In the context of statistical power analysis, a threshold effect size (Δ_M) is specified and the probability this difference would be statistically significant at the designated α, is the power (power = 1-β, where β is the type II error). Outside of statistical power analysis, observed effect size is simply a way of summarizing the metric of interest that can be compared across studies, and is not inherently tied to statistical significance or statistical power. In fact, the observed effect sizes for reference areas are used to establish what constitutes a meaningful threshold effect size (Δ_M) for impact studies.

- **Power (1-β**, where β is the Type II error**)** is the probability of rejecting the null hypothesis when the difference in the data exceeds a threshold effect size (Δ_M). In the BACI design setting, it is the probability of finding the interaction BACI contrast to be statistically significantly different from zero when an effect of size Δ_M is operating on the data.

- **Alpha (α)** is the Type I error, or the probability of rejecting the null hypothesis in error because the true difference is small (i.e., $< \Delta_M$). The value α is typically fixed, at 0.05 or 0.10 (95% or 90% confidence). For power estimated through simulations, α is estimated as the percent of significant outcomes when the effect size imposed on the data was 0. For this study, a target $\alpha = 0.10$ was used for the two-tailed null hypothesis which allows us to say whether results are significantly greater than or less than zero (the one-tailed hypotheses), with 95% confidence ($\alpha = 0.05$) on each side.

- **Sample size** encompasses the number of sites, replicates, and time periods that are sampled and determines the degrees of freedom for the statistical tests. In this analysis, the overall design was set (i.e., 1 impact site and 1 control site; 2 years of monitoring before and after construction, with sampling only in the fall of each year) and sample size refers to the number of tows per season in each area. Precision for the annual estimates can be improved by appropriate survey timing (i.e., surveys are timed to not miss the seasonal peaks in biomass/abundance), using consistent survey methods, and greater replication (tows per season, years per period, or areas per location). All else being equal, as replication increases, the precision estimates for the model parameters increase. This will result in higher power for a specific effect size, or a smaller detectable effect size for a specific level of power.

3.0 Review Existing Datasets

3.1 NEFSC

Station level catch data from the NEFSC trawl survey was provided by Phil Politis. The NEFSC (Politis et al. 2014) trawl dataset was used to establish 1) a proximate range of meaningful effect sizes that could be considered for measuring change over time, and 2) the expected distributional form for the longfin squid catch as biomass and reasonable variance estimates. The NEFSC dataset was screened to only include:

- tows from Stratum 1010, which includes the location for the EW project (Figure A1).
- Longfin squid catch.

This NEFSC survey design included seven to eight (random) 20-minute replicate tows in survey stratum 1010 in Fall (mid-September to early October) in the years 2010 to 2019, with replicate tows for each season generally occurring over two to four separate days which spanned a period of less than a week to 24 days, depending on the year. This dataset provides an adequate representation of the spatial variance among tows during each survey event (i.e., the within-season variability) for this approximately 8,750 km^2 stratum, and estimates of natural levels of inter-annual changes in catch. The survey planned for EW will be within a smaller area (322 km2) and limited to Fall with optimal timing informed by historical commercial landing information, examination of regional fisheries independent survey data, and stakeholder input. For comparison to the NEFSC trawl survey, monthly data from the Block Island Wind Farm (BIWF) otter trawl survey were also reviewed (Section 3.2) to determine the extent to which the seasonal NEFSC trawl survey captured intra-annual biomass peaks for longfin squid. Given that biomass and abundance can vary substantially throughout the course of the year within the proposed project area, it is important to ensure that this intra-annual variability is accounted for when estimating the expected variance for the species of interest in the seasonal trawl survey.

The tows in the NEFSC dataset are at a lower spatial density than what is planned for the EW trawl survey. We expect the NEFSC estimates of spatial variance to be conservatively high relative to the variance expected from the EW monitoring, because the EW survey will occur over a smaller spatial area, so less spatial heterogeneity may be expected amongst replicate tows. The EW trawl survey will maintain the same spatial sampling densities within the impact and the reference area (i.e., the two areas will be the same size, and predominantly within the boundaries of Stratum 1010).

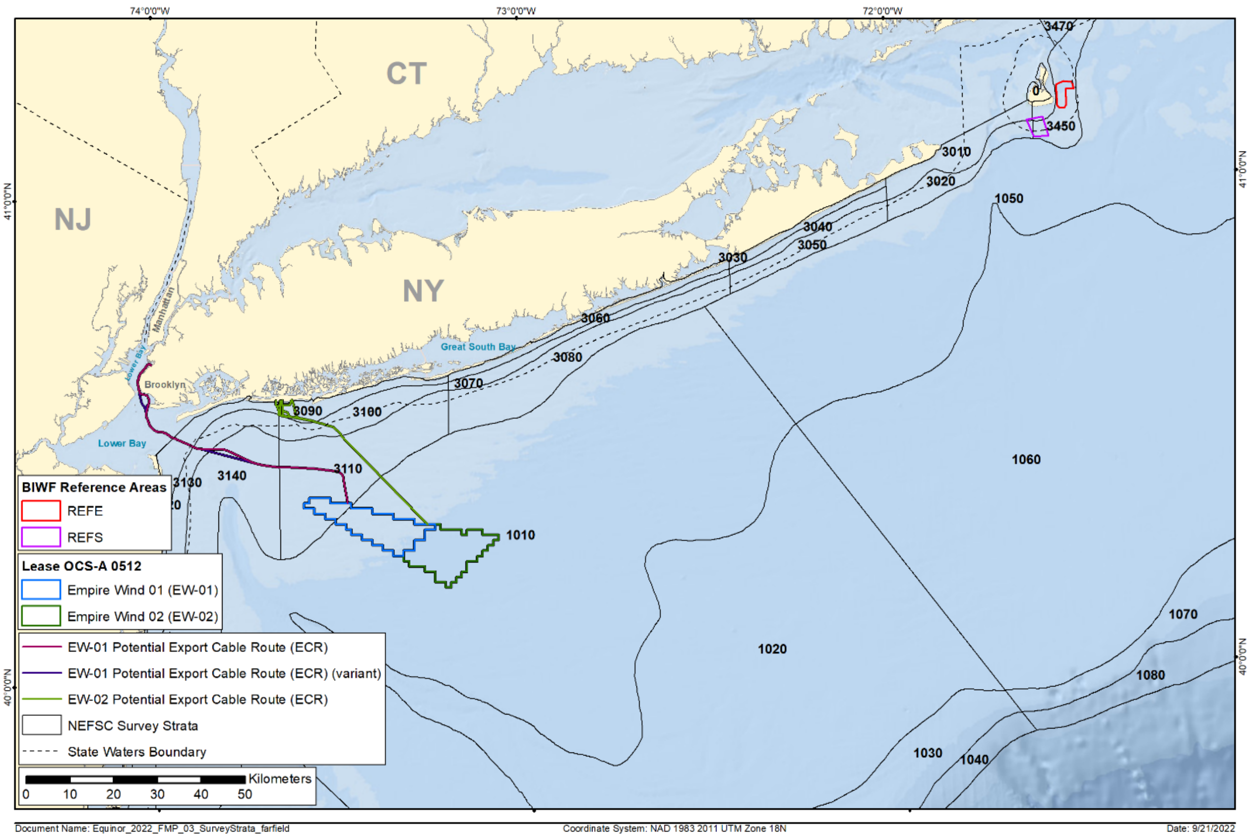


Figure A1. Map of NEFSC strata and the Empire Wind project area. Trawl survey data sampled in stratum 1010 from 2010-2019 were used in the analysis. The reference sites used in the BIWF Trawl survey (REFE and REFS) are also indicated for reference.

Table A1. Seasonal Summary by Year of Longfin Squid Catch (biomass, kg) in the NEFSC Trawl Survey (Politis et al., 2014) sampled in Stratum 1010

	Fall Survey			Spring Survey			
Year	**# of Tows**	**Mean Catch (kg/tow)**	**StDev of Catch (kg/tow)**	**# of Tows**	**Mean Catch (kg/tow)**	**StDev of Catch (kg/tow)**	**% of Annual Catch caught in Fall**
2010	8	18.6	19.0	8	0	0	100%
2011	7	4.6	4.0	7	0	0	100%
2012	7	16.6	22.9	7	3.2	2.5	84%
2013	7	3.5	2.3	7	0.02	0.03	100%
2014	7	33.7	11.2	6	0.03	0.05	100%
2015	7	17.1	10.8	7	0.01	0.04	100%
2016	7	9.9	8.0	7	1.2	1.3	89%
2017	0[1]	na	na	7	0.12	0.17	na
2018	7	7.7	9.0	5	0	0	100%
2019	7	10.9	9.3	7	0.43	0.81	96%

[1] There was no fall survey in 2017.

Fall was the dominant season for Longfin squid, both in the NEFSC survey (Table A1, Figure A2), and at BIWF (Figure A3).

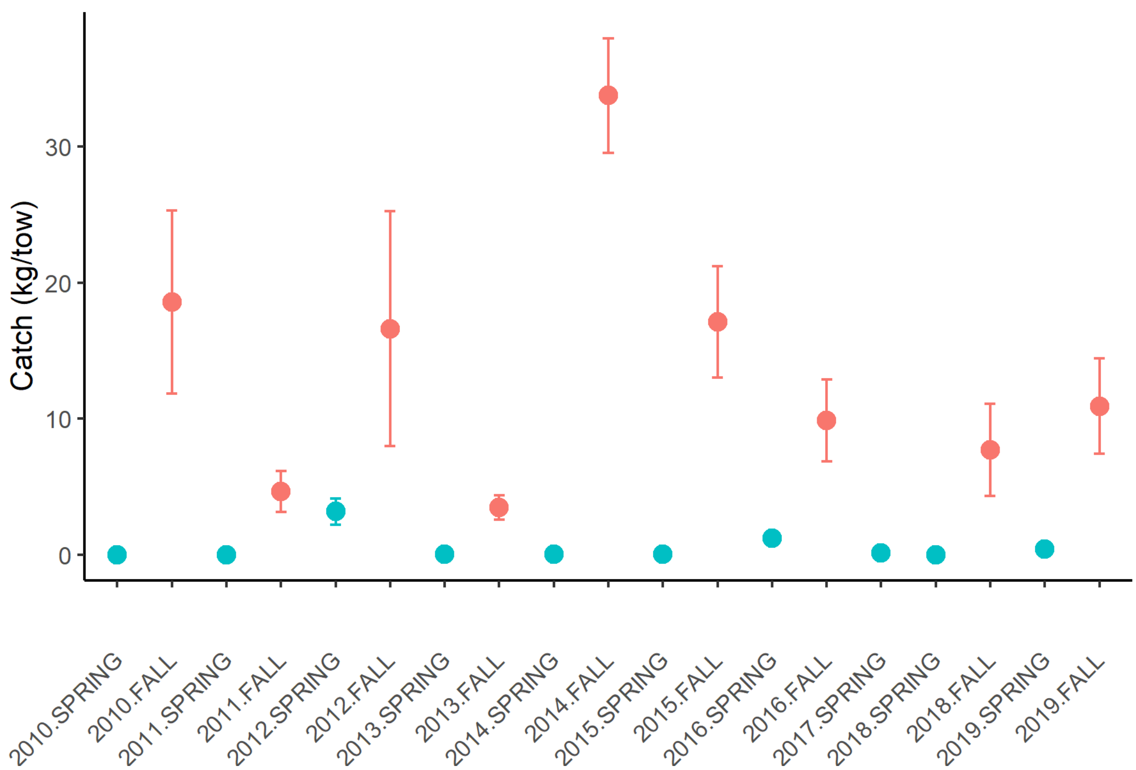


Figure A2. Mean and standard error of the seasonal longfin squid catch per tow (kg) sampled in stratum 1010 during the NEFSC seasonal trawl survey from 2010 through 2019. Blue represents spring surveys, and orange represents fall surveys.

3.2 Block Island Wind Farm Trawl Survey Data

Intra-annual variation in catch rates (kg/tow) were examined for longfin squid from the monthly trawl survey that occurred over seven years at the two reference areas used in the Block Island Wind Farm (BIWF) monitoring. The monthly BIWF trawl survey data were reviewed to determine the extent to which the NEFSC trawl survey data summaries, which are limited to a short window during fall, may miss intra-annual biomass peaks. The monthly mean longfin squid catch from seven years at the two reference areas are plotted in Figure A3 . September-October appeared to be the peak for REFE, while at REFS the much more muted peak occurred during November-December.

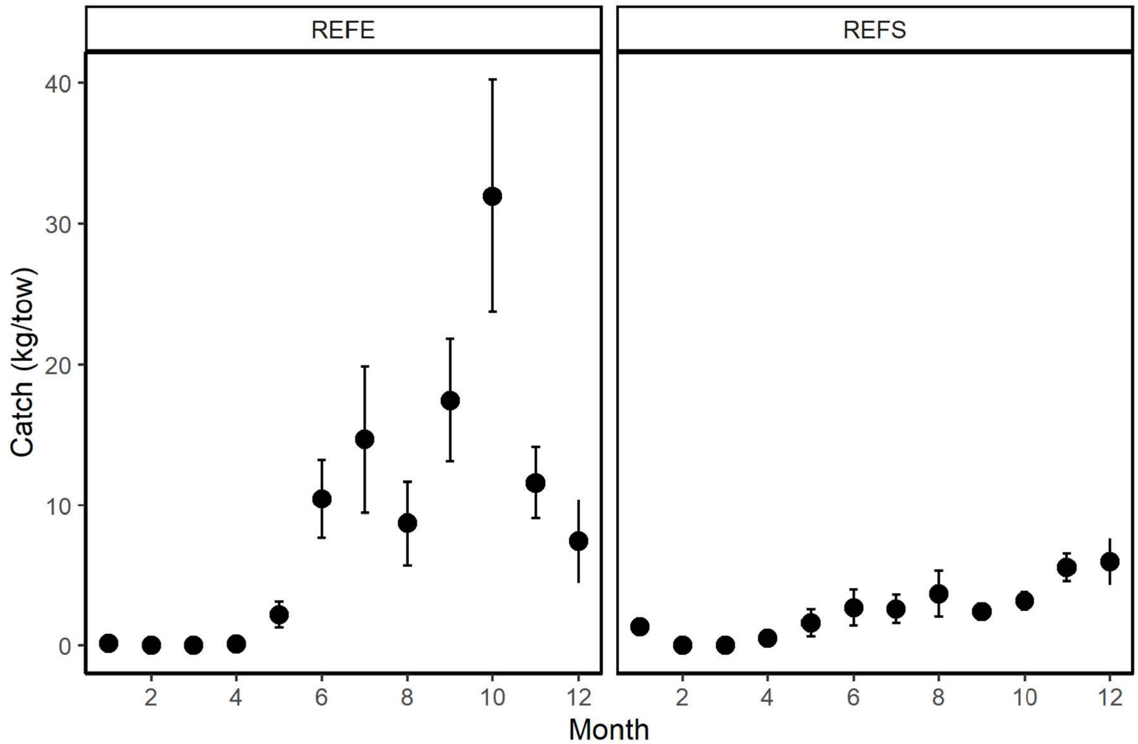


Figure A3. Monthly mean biomass (kg) averaged over seven years (from October 2012 to September 2019) for longfin squid from the eastern reference area (REFE) and southern reference area (REFS) from the BIWF trawl survey monitoring.

3.3 Effect Sizes

Using the NEFSC and BIWF reference datasets, the relative change in mean annual biomass (averaged across seasons) between subsequent 2-year time periods, was calculated as:

$$\%ES = \left(\bar{X}_{2,3} - \bar{X}_{0,1}\right)/\bar{X}_{0,1} \times 100 \qquad \text{[Eq. 1]}$$

where

$\bar{X}_{0,1}$ = The two year Fall mean in years i and $i+1$.

$\bar{X}_{2,3}$ = The two year Fall mean in years $i+2$ and $i+3$.

For [Eq. 1] in the NEFSC dataset $i=$ 2010 through 2015, and due to no fall sample results in 2017, 2014/2015 were compared to 2016/2018). This yields six contrasts of two adjacent two-year averages for fall. For the seven-year BIWF reference area datasets, the surveys run from October 2012 through September 2019. So $i=$ (Oct) 2012 through (Sept-Oct) 2015, and the annual means were calculated from data from September and/or October within each calendar year (the months were subsampled from the continuous time series). This yields five contrasts of two adjacent two-year running averages of September-October means (with only October used in year 1 and only September used in year 7).

The ranges of relative percent change from these extant datasets provide context for generating realistic effect sizes to be used in the power calculations. Results are summarized for longfin squid in the two datasets in Table A2 and Figure A4. The effect sizes [Eq. 1] have a natural lower bound of -100%, and an unlimited upper bound.

Table A2. Summary of relative effect sizes (Eq. 1) observed for longfin squid from NEFSC dataset and BIWF Reference area dataset.

	Longfin Squid				
Data Source	**Minimum**	**1st Quartile**	**Median**	**3rd Quartile**	**Maximum**
NEFSC (n=6 contrasts)	-65%	-30%	-21%	53%	153%
BIWF REFE (n=5 contrasts)	-65%	-40%	-20%	27%	29%
BIWF REFE (n=5 contrasts)	-50%	-48%	-6%	34%	39%

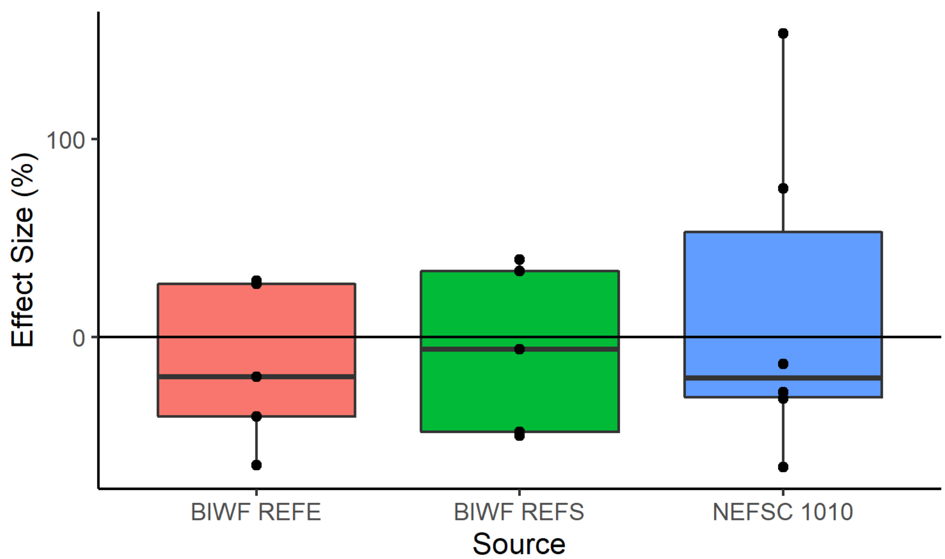


Figure A4. Boxplots showing the distribution of relative effect sizes (Eq. 1) for longfin squid for NEFSC dataset (2010 – 2018) and BIWF reference area datsets (October 2012 – September 2019).

The results shown in Figure 2 and Figure A4 demonstrate that substantial inter-annual sampling variability has occurred for longfin squid over the past 10-12 years, the sampling variability on a multi-year time scale may be larger when survey data are analyzed on a localized spatial scale due to spatial-temporal interactions. The data suggest that it may be meaningful to attempt to detect effect sizes on the order of ±40-50% or larger for longfin squid.

3.4 Coefficient of Variation

Catch (kg) per tow is naturally bounded by zero and the distribution tends to be skewed with most catches around the median value and large catches in a few tows, approximating a lognormal distribution. The NEFSC Stratum 1010 biomass data for fall catches of Longfin squid fit this description. For the lognormal distribution, the standard deviation (SD) is proportional to the mean and the coefficient of variation (CV = SD/mean) on the original scale is used to summarize variability in catch rates independent of the mean. A summary of the seasonal CV values for the NEFSC dataset is shown in Table A3. For conservative sample size estimates in the power analyses (Section 4.0), the CV values used captured approximately the median to maximum CV values across years (0.8 to 1.4).

Table A3. Summary of seasonal relative variance estimates for catch (biomass, kg) of longfin squid caught in the NEFSC fall trawl survey (Politis et al. 2014) in Stratum 1010 from 2010 to 2019

	Coefficients of Variation (CVs) among Fall Trawls Summarized across Years					
Source	**# of Years with Fall Catch**	**Minimum**	**1st Quartile**	**Median**	**3rd Quartile**	**Maximum**
NEFSC Stratum 1010	9	0.33	0.67	0.85	1.02	1.38

4.0 Power Analysis

4.1 The Study Design and Model

A symmetrical BACI design was tested in this power analysis, with the design variables as specified in Table A4. For a limited scenario (i.e., a single CV), power was simulated for a BACI design with one impact and one control area.

Table A4. Design for Empire Wind trawl survey power simulation study

Set study design variables
• Impact Areas = 1 impact area
• Control Areas = 1 control/reference area
• Habitat Strata = 1
• Frequency = one season per year
• Number of years Before impact = 2 • Number of years After impact = 2
Variables used in the power analysis
• Number of replicate (random) trawls per season in each area (n): 5 to 15
• Effect Sizes (ES): -33%, -40%, -50%, -70% (Section 3.3) and 0% (for Type I error)
• CVs: 0.6, 0.8, 1.0, 1.2, 1.4 (Section 3.4)
• A two-tailed α = 0.10

For a saturated model that estimates the mean catch (kg) for each season, year, and location, the BACI interaction contrast is described as

$$\left(\bar{X}_{Impact,Before} - \bar{X}_{Impact,After}\right) - \left(\bar{X}_{Control,Before} - \bar{X}_{Control,After}\right) \quad \text{[Eq. 2]}$$

where

$\bar{X}_{Impact,Period}$ = The two-year log-scale mean biomass per tow (kg) from the Impact area, for Fall season in all years of the *Period* (Before or After).

$\bar{X}_{Control,Period}$ = The two-year log-scale mean biomass per tow (kg) from the Control area, for Fall season in all years of the *Period* (Before or After).

4.2 Simulation methods

The power analysis used a simulation approach to generate significance values for a range of seasonal CV estimates and effect sizes, and a range of sample sizes (Table A4). The effect size, ES, was imposed on each year during the After period. Note that proportional changes on the original scale become additive changes on the log-scale; consequently, log-scale changes are a function only of the effect size and do not depend on the mean value. Calculations were scripted in R version 4.0.5 (R Core Team 2021), utilizing packages *dplyr* (Wickham et al. 2019), *lme4* (Bates et al, 2015), *emmeans* (Lenth 2021), and *EnvStats* (Millard 2013); figures were generated using *ggplot2* (Wickham 2016). The R code is included as an addendum to this Attachment.

For a given CV, ES, and sample size (n), the following steps were performed m=1000 times:

1. From a log-normal distribution with mean μ and CV, simulate *n* values of catch data for each year of the Before period, for both Impact and Control areas.
2. Repeat step 1 for each year of the After period for the control area.
3. Repeat step 1 for each year of the After period for the Impact area, but with a reduced mean equal to (1+ES)μ.
4. Fit a GLM to the simulated biomass data, where the dependent variable was the catch per trawl, coefficients were estimated for 8 groups (i.e., a saturated model, one estimate for each area-year), and a Gamma error distribution with a log-link was used. Based on residual diagnostics and model fit for a small set of simulated data sets, the Gamma error distribution was found to provide the best fit.
5. Calculate the BACI interaction contrast based on multi-year means, and save the p-value.
6. Repeat Steps 1-5 for 1000 simulation replicates.

7. Count the number of simulations for which the detection outcome from step 5 had a p-value < nominal alpha. The reported power results use a nominal alpha that achieves approximately a 10% rejection rate for no effect (ES=0).

Repeat Steps 1-7 for each combination of CV, ES, and n.

4.3 Results

Estimates of type I error (false positives) were calculated as the proportion of the simulated "no effect" datasets in which the BACI interaction contrast was rejected at $\alpha = 0.10$. For a nominal $\alpha = 0.10$, the empirical type I error rate had a tendency to be inflated (between 10% and 20% and 15% on average). When the empirical type I error was greater than 10%, this means that the test procedure was overly sensitive, i.e., rejecting more cases than it should. There was an inverse relationship between magnitude of CV and empirical type I error, with higher type I error rates occurring when relative variance of simulated data was lower. This may reflect a poorly specified model (e.g., inappropriate error distribution) for the simulated data sets with higher variance. For this approximation of power, the nominal alpha was adjusted to achieve an empirical type I error rate of approximately 10%, and this alpha level was applied to all test results to estimate both the type I error and the empirical power (Table A5, Figure A5).

Table A5. Simulated power for the BACI interaction contrast within a saturated GLM (see text) for a range of variance (CV), effect sizes (% change), and sample sizes (n) per area per year, using a design with one impact and one control area. Empirical power results are based on nominal two-tailed α levels which achieved an empirical type I error of approximately 10%. Results with power 80% and above are shaded.

% Change	Sample Size (n)	CV=0.6	CV=0.8	CV=1.0	CV=1.2	CV=1.4
Nominal alpha:		*0.08*	*0.07*	*0.06*	*0.05*	*0.04*
0	5	10%	11%	11%	10%	12%
0	7	11%	10%	11%	10%	11%
0	9	9%	12%	9%	11%	10%
0	11	10%	9%	10%	9%	8%
0	13	11%	10%	10%	7%	9%
0	15	9%	8%	7%	9%	8%
-33%	5	31%	23%	21%	20%	14%
-33%	7	36%	28%	22%	19%	17%
-33%	9	41%	30%	22%	20%	16%
-33%	11	46%	34%	23%	19%	18%
-33%	13	51%	36%	26%	23%	18%
-33%	15	56%	39%	29%	23%	20%
-40%	5	42%	31%	27%	21%	21%
-40%	7	48%	38%	29%	23%	20%
-40%	9	56%	42%	31%	24%	23%
-40%	11	65%	45%	33%	28%	22%
-40%	13	71%	50%	38%	29%	22%
-40%	15	75%	53%	40%	32%	24%
-50%	5	58%	46%	36%	28%	28%
-50%	7	73%	54%	39%	34%	29%
-50%	9	81%	58%	44%	37%	33%
-50%	11	83%	67%	51%	39%	34%
-50%	13	90%	71%	54%	45%	34%
-50%	15	94%	76%	58%	49%	38%
-70%	5	94%	81%	70%	59%	52%
-70%	7	98%	90%	78%	64%	59%
-70%	9	100%	95%	85%	75%	62%
-70%	11	100%	96%	89%	79%	68%
-70%	13	100%	99%	94%	83%	74%
-70%	15	100%	99%	95%	89%	79%

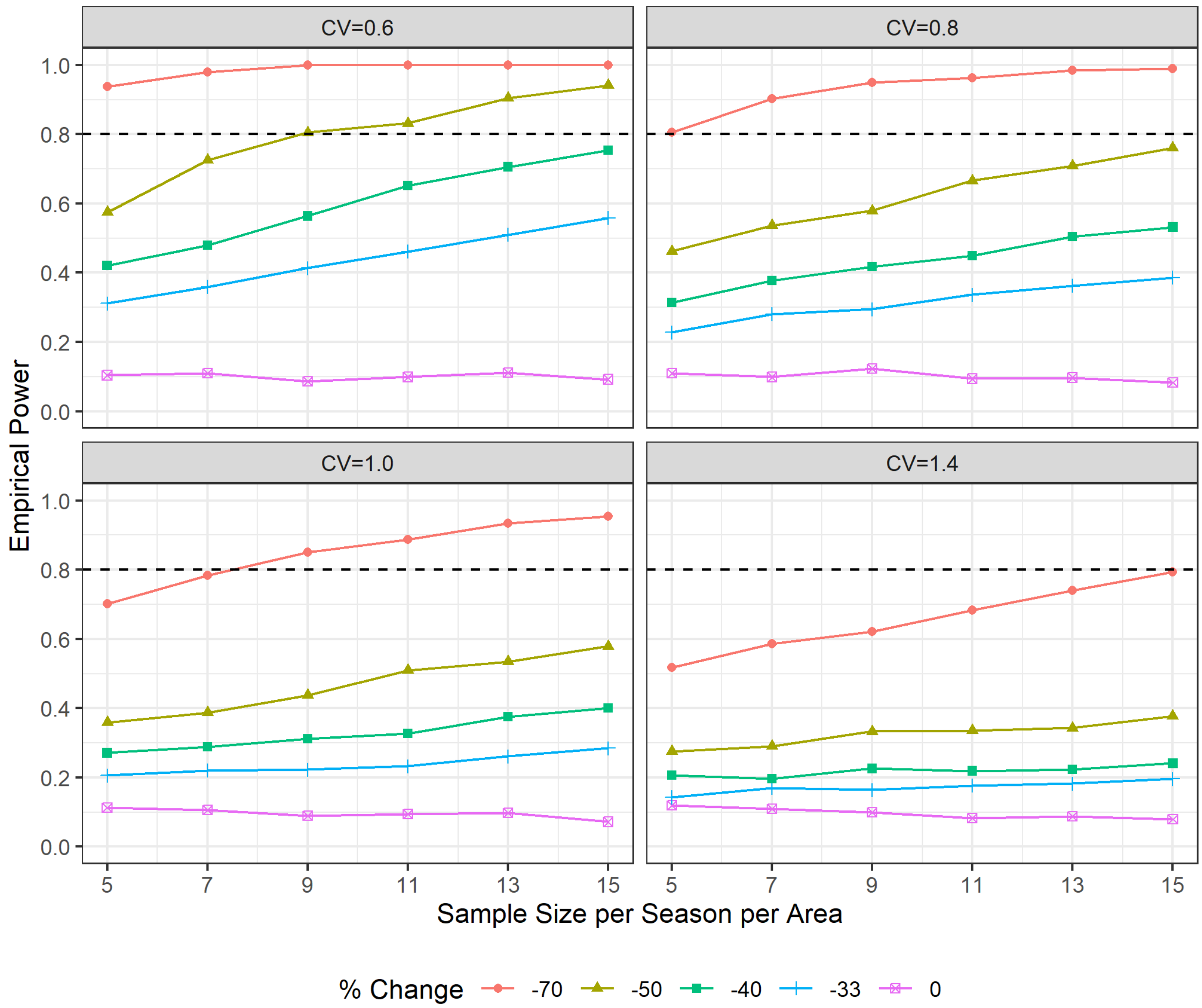


Figure A5. Power curves for the BACI interaction contrast within a saturated GLM (see text) for a range of variance (CV), effect sizes (% Change) and seasonal sample sizes in each area (n), using a nominal α that achieves a type I error rate of 0.10 where the results for 0% change illustrate the type I error.

5.0 Summary and Conclusions

- Data from regional trawl surveys indicate that longfin squid in the region have generally exhibited moderate to high levels of natural variability.
- Given the underlying variability (inter-annual and intra-annual) in catch rates that will likely be exhibited in the EW trawl survey, it does not appear to be practical to attempt to document effect sizes less than 50% for longfin squid.
- For moderate CV estimates for longfin squid (e.g., 0.6 – 0.8), a seasonal sampling intensity of more than 15 tows/area would yield > 80% power to detect an effect size of approximately 50% or greater.
- This power analysis will be re-visited after the first year of the EW trawl survey. The observed CV values will be evaluated to determine whether sampling intensity needs to be modified to achieve the desired level of statistical power.

6.0 References

Bates D., M. Mächler, B. Bolker, and S. Walker. 2015. Fitting Linear Mixed-Effects Models Using lme4. Journal of Statistical Software, 67(1), 1–48. doi: 10.18637/jss.v067.i01.

Lenth, R.V. 2021. emmeans: Estimated Marginal Means, aka Least-Squares Means. R package version 1.6.2-1. https://CRAN.R-project.org/package=emmeans.

Millard, S.P. 2013. _EnvStats: An R Package for Environmental Statistics. Springer, New York. ISBN 978-1-4614-8455-4, <URL: https://www.springer.com>.

Politis PJ, Galbraith JK, Kostovick P, Brown RW. 2014. Northeast Fisheries Science Center bottom trawl survey protocols for the NOAA Ship Henry B. Bigelow. Northeast Fish Sci Cent Ref Doc. 14-06; 138 p. Online at: https://doi.org/10.7289/V5C53HVS

R Core Team. 2021. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Wickham, H. 2016. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York. ISBN 978-3-319-24277-4, https://ggplot2.tidyverse.org.

Wickham et al. 2019. Welcome to the tidyverse. Journal of Open Source Software, 4(43), 1686, https://doi.org/10.21105/joss.01686

Wilber, D., L. Read, M. Griffin, and D. Carey. 2020. *Block Island Wind Farm Demersal Fish Trawl Survey Synthesis Report – Years 1 to 6, October 2012 through September 2018.* Technical report prepared for Deepwater Wind, Providence, RI. 80 pp.

Addendum – R Script for the Statistical Power Simulation.

```
########################################################################
# R code to simulate power for contrast-BACI approach for Empire Wind
## libraries
library(tidyverse)
library(EnvStats)          #for rlnormAlt
library(ggplot2)
library(emmeans)

################# SIMULATE BACI DESIGN AND TEST OF COMPLEX INTERACTION (planned contrast)
# Areas:
#          Two areas: 1 impact and 1 ref
# Population means and applying percent change:
#     pop1 = baseline distribution is lognormal(mean, CV); one season
#          - applies to both impact and reference in each of the BEFORE years
#          - applies to reference in each of the AFTER years (i.e., reference remains stable over time)
#     pop2 = distribution altered by the percent change (PC)
#          - mean.pop2 = (1-PC)*mean.pop1
#          - applies to impact area in each of the AFTER years
# Seasonality
#          - only 1 season is sampled
# Balanced design, i.e., n samples from each season, year, and area
# MODEL fit as glm(response ~ grp.pd.seas.yr, family=Gamma(link=log))
#          This is a fully saturated model; most conservative because it uses up most degrees of freedom
# LINEAR CONTRAST averages the logscale differences of means using emmeans function
#
# Notes about how this formulation of the problem is more generic than it appears:
#          - applying the same mean to each year within each period is equivalent to saying that
#            the assumed mean is the grand mean across years.
#          - if the reference is not stable over time, and instead changes between the BEFORE and
#            AFTER periods, then the % change applied to impact area is relative to the % change
#            at reference.
########################

## set up scenarios:
 PC.vec <- c(.7, .5, .4, .33, 0)       #these are % decreases
 cv.vec <- c(0.6, 0.8, 1, 1.2, 1.4)
n.vec <- seq(5,15,2)
n.sims <- 1000
foo.num <- as.numeric(rep(NA,n.sims*length(PC.vec)*length(cv.vec)*length(n.vec)*1))
baciContr.pwrsim <- data.frame(expand.grid(PC=PC.vec,
samp.size=n.vec, cv=cv.vec, mean=20, sim=1:n.sims),
baci1ref.p1=foo.num, baci1ref.p2=foo.num, baci2ref.p1=foo.num,
baci2ref.p2=foo.num, pit1ref.p1=foo.num, pit1ref.p2=foo.num, pit2ref.p1=foo.num,
pit2ref.p2=foo.num) %>% as_tibble()
#note p1 results are for glm(Gamma(log link)), p2 for lm(log(catch))
 baciContr.pwrsim <- arrange(baciContr.pwrsim, PC, samp.size, cv, mean, sim)
```

```
#set total number of seasons sampled before, each area (seasons/year * #years)
 b <- 1*2
#set total number of seasons sampled after, each area
 a <- 1*2
#set number of controls:          #calculate results for both 1 and 2 controls.
 n.c <- 2
my.mean <- 20          #does not affect outcome.
## loop it:
for (m in 1:length(cv.vec)) {                #alternative cv values
 this.cv <- cv.vec[m]
 for (k in 1:length(PC.vec)) {               #effect sizes
  this.PC <- PC.vec[k]
  for (j in 1:length(n.vec)) {               #sample sizes
   this.n <- n.vec[j]
   #create a design matrix:
   foo.data.df <- data.frame(expand.grid(location=c("CtrlA", "CtrlB","Impact"),
period=c("Before","After"), year=1:2, season=c("fall"),
rep=1:this.n), value=as.numeric(rep(NA,this.n*(b+a)*(n.c+1))))
   foo.data.df <- arrange(foo.data.df, location, period, year, season, rep)
   foo.data.df$grp.pd.seas.yr <- factor(with(foo.data.df,
        paste(substring(location,1,5),period,season,year)))
 ### SIMULATE DATA
  for (i in 1:n.sims){
    foo.data.df$value[foo.data.df$period=="Before"]  <-
rlnormAlt((n.c+1)*(b)*this.n, mean=my.mean, cv=this.cv)
    foo.data.df$value[foo.data.df$period=="After" & (foo.data.df$location=="CtrlA" |
        foo.data.df$location =="CtrlB")] <-
rlnormAlt(n.c*(a)*this.n, mean=my.mean, cv=this.cv)
    foo.data.df$value[foo.data.df$period=="After" & foo.data.df$location=="Impact" ] <-
rlnormAlt((a)*this.n, mean=my.mean*(1-this.PC), cv=this.cv)

### fit saturated glm
  #comparisons with 1 ref:
   foo1.glm <- glm(value ~ 0 + grp.pd.seas.yr, data=subset(foo.data.df, location!="CtrlB"),
family=Gamma(link="log"))
   foo1.t2 <- emmeans(foo1.glm, ~ grp.pd.seas.yr)
   #double check that contrast coefficients give the desired contrast!
   foo1.contr2 <- contrast(foo1.t2, list(baci.contrast=0.5*c(rep(c(rep(1,a), rep(-1,b)), 1), rep(-1,a),
        rep(1,b))))
  #comparisons with 2 ref:
   foo2.glm <- glm(value ~ 0 + grp.pd.seas.yr, data=foo.data.df, family=Gamma(link="log"))
   foo2.t2 <- emmeans(foo2.glm, ~ grp.pd.seas.yr)
   foo2.contr2 <- contrast(foo2.t2, list(baci.contrast=0.5*c(rep(c(rep(1/n.c,a), rep(-1/n.c,b)), n.c), rep(-
        1,a), rep(1,b))))
###grab p-value for interaction contrast and add to baciContr.pwrsim:
  baciContr.pwrsim$baci1ref.p2[baciContr.pwrsim$mean == my.mean & baciContr.pwrsim$cv == this.cv
        & baciContr.pwrsim$PC == this.PC & baciContr.pwrsim$samp.size == this.n &
        baciContr.pwrsim$sim==i] <- as.data.frame(foo1.contr2)$p.value
```

```
  baciContr.pwrsim$baci2ref.p2[baciContr.pwrsim$mean == my.mean & baciContr.pwrsim$cv == this.cv
        & baciContr.pwrsim$PC == this.PC & baciContr.pwrsim$samp.size == this.n &
        baciContr.pwrsim$sim==i] <- as.data.frame(foo2.contr2)$p.value
}}}}

finalBaci.pwrsim <- baciContr.pwrsim

#summarize simulated power (here alpha = 0.10)
baciContr.pwrsim.10.summ <- finalBaci.pwrsim %>% group_by(mean, cv, PC, samp.size) %>%
  summarize(count=n(), Power.1ref.glm = sum(baci1ref.p2 <= 0.1)/count,
   Power.2ref.glm = sum(baci2ref.p2 <= 0.1)/count)
 #separate factor variable for the facet labels (mean.cv):
 baciContr.pwrsim.10.summ$cv.factor <- factor(baciContr.pwrsim.10.summ$cv,
levels=c(0.6, 0.8, 1.0, 1.2, 1.4),
labels=c("CV=0.6", "CV=0.8", "CV=1.0", "CV=1.2", "CV=1.4"))

##### ADJUST NOMINAL ALPHA TO ACHIEVE EMPIRICAL ALPHA OF 10%
# observed alpha different from nominal alpha for the glms.
# recalibrate results to get observed closer to 0.1
 foo.nomalpha <- finalBaci.pwrsim %>% filter(PC==0) %>% group_by(mean, cv) %>%
summarize(nominal.alpha1ref.glm = quantile(baci1ref.p2, 0.1),
 nominal.alpha2ref.glm = quantile(baci2ref.p2, 0.1))
 foo.nomalpha
 #   mean    cv nominal.alpha1ref.glm nominal.alpha2ref.glm
 #1    20   0.6              0.0796              0.0816
 #2    20   0.8              0.0691              0.0672
 #3    20   1.0              0.0641              0.0597
 #4    20   1.2              0.0547              0.0581
 #5    20   1.4              0.0419              0.0447
 #note this summarizes across all samp.size values.
 # there is an inverse relationship between relative variance and empirical alpha.
 finalBaci.pwrsim <- left_join(finalBaci.pwrsim, foo.nomalpha)
# Apply adjusted nominal alpha to all glm results:
 baciContr.pwrsim.AlphaMOD.summ <- finalBaci.pwrsim %>%
  group_by(mean, cv, PC, samp.size) %>%
  summarize(count=n(), Power.1ref.glm = sum(baci1ref.p2 <= round(nominal.alpha1ref.glm,2))/count,
   Power.2ref.glm = sum(baci2ref.p2 <= round(nominal.alpha2ref.glm,2))/count)
 #separate factor variable for the facet labels:
 baciContr.pwrsim.AlphaMOD.summ$cv.factor <- factor(baciContr.pwrsim.AlphaMOD.summ$cv,
levels=c(0.6, 0.8, 1.0, 1.2, 1.4),
labels=c("CV=0.6", "CV=0.8", "CV=1.0", "CV=1.2", "CV=1.4"))

##plot power curves with modified nominal alpha
# skip 25% ES and CV=1.2
ggplot(subset(baciContr.pwrsim.AlphaMOD.summ,PC != 0.25 & cv.factor != "CV=1.2"),
   aes(x=samp.size, y=Power.1ref.glm, colour=factor(-PC*100),
shape=factor(-PC*100)), facets=~cv.factor) +
   facet_wrap(~cv.factor)+
```

```
  geom_point() + geom_line() +
  geom_hline(yintercept=0.8, colour="black",linetype="dashed")+
  theme_bw() + theme(legend.position="bottom") +
  scale_y_continuous(limits=c(0,1), breaks=seq(0,1,.2))+
  scale_x_continuous(limits=c(5,15), breaks=seq(5,15,2))+
  labs(colour="% Change", shape="% Change", x="Sample Size per Season per Area", y="Empirical
         Power")
ggsave("GLM power curves, MODified alpha , saturated baci.png", width=7, height=6, units="in")
####################################################

##output for appendix table
foo <- baciContr.pwrsim.AlphaMOD.summ %>% filter(PC != 0.25) %>%
 pivot_wider(id_cols=(PC:samp.size), names_from="cv", values_from="Power.1ref.glm")
write.csv(foo, "foo.csv")
```

Attachment B – Empire Wind Benthic Sampling Plan New York State Waters

EMPIRE WIND
Benthic Sampling Plan
New York State Waters

Prepared for:

equinor

Empire Offshore Wind LLC
Stamford Office
600 Washington Blvd
Suite 800
Stamford, CT 06901

Prepared by:

INSPIRE ENVIRONMENTAL

INSPIRE Environmental
Newport, Rhode Island 02840

May 2023

TABLE OF CONTENTS Page

LIST OF FIGURES

Page

LIST OF ACRONYMS

ac	acre(s)
aRPD	apparent redox potential discontinuity
BCA	benthic community analysis
BOEM	Bureau of Ocean Energy Management
cm	centimeter(s)
CMECS	Coastal and Marine Ecological Classification Standard
CTD	Conductivity Temperature Depth
DPS	Department of Public Service
Empire	Empire Offshore Wind LLC
EPA	Environmental Protection Agency
EW 1	Empire Wind 1
EW 2	Empire Wind 2
ft	feet
ha	hectare(s)
HDD	horizontal directional drilling
km	kilometer(s)
KP	kilometer point
MDD	minimum detectable difference
mi	mile(s)
nm	nautical mile(s)
NYSDEC	New York State Department of Environmental Conservation
OSS	offshore substation
PCB	polychlorinated biphenyl
POIs	Points of Interconnection
PV	Plan View
SPI	Sediment Profile Imaging
TOGS	Technical and Operational Guidance Series
WEA	Wind Energy Area

1.0 INTRODUCTION

Empire Offshore Wind LLC (Empire) proposes to construct and operate an offshore wind farm located in the designated Renewable Energy Lease Area OCS-A 0512 (Lease Area). The Lease Area covers approximately 79,350 acres (ac; 32,112 hectares [ha]) and is located approximately 14 statute miles (mi) (12 nautical miles [nm], 21 kilometers [km]) south of Long Island, New York and approximately 20 mi (17 nm, 31 km) east of Long Branch, New Jersey (Figure 1-1). The Lease Area was awarded through the Bureau of Ocean Energy Management (BOEM) competitive renewable energy lease auction of the Wind Energy Area (WEA) offshore of New York.

Empire proposes to develop the Lease Area in two wind farms, known as Empire Wind 1 (EW 1) and Empire Wind 2 (EW 2). EW 1 and EW 2 will be electrically isolated and independent from each other. Each wind farm will connect via offshore substations (OSS) to separate Points of Interconnection (POIs) at onshore locations by way of export cable routes and onshore substations. In this respect, the Project includes two onshore locations in New York where the renewable electricity generated will be transmitted to the electric grid.

The Project will include up to 66 nm (122 km) of submarine export cables, consisting of up to two routes to New York:

- Up to 40 nm (74 km) to the EW 1 landfall (Brooklyn, NY), of which 16 nm (30 km) are in state waters; and
- Up to 26 nm (48 km) to the EW 2 landfall (Oceanside, NY), of which 8 nm (15 km) are in state waters.

The EW 1 export cable transits away from the Lease Area along its northeastern boundary and continues north-northwest towards New York Harbor (Figure 1-1). The EW 1 runs parallel to the Ambrose Channel as it enters Lower New York Bay, transits through the narrows on the eastern side and makes landfall in Brooklyn, NY.

The EW 2 export cable route extends away from the Lease Area at the northwest corner of EW 2 boundary. This export cable route transits north-northwest towards Long Island, NY. There are several route alternatives currently being considered at the landfall in Oceanside, NY for the EW 2 route within New York state waters.

Benthic monitoring efforts that are planned for the federal waters portion of the project are described in the separate Fisheries and Benthic Monitoring Plan. This Benthic Sampling Plan focuses on the benthic sampling activities that will occur within New York state waters as agreed upon during the New York State Article VII joint proposal permitting process.

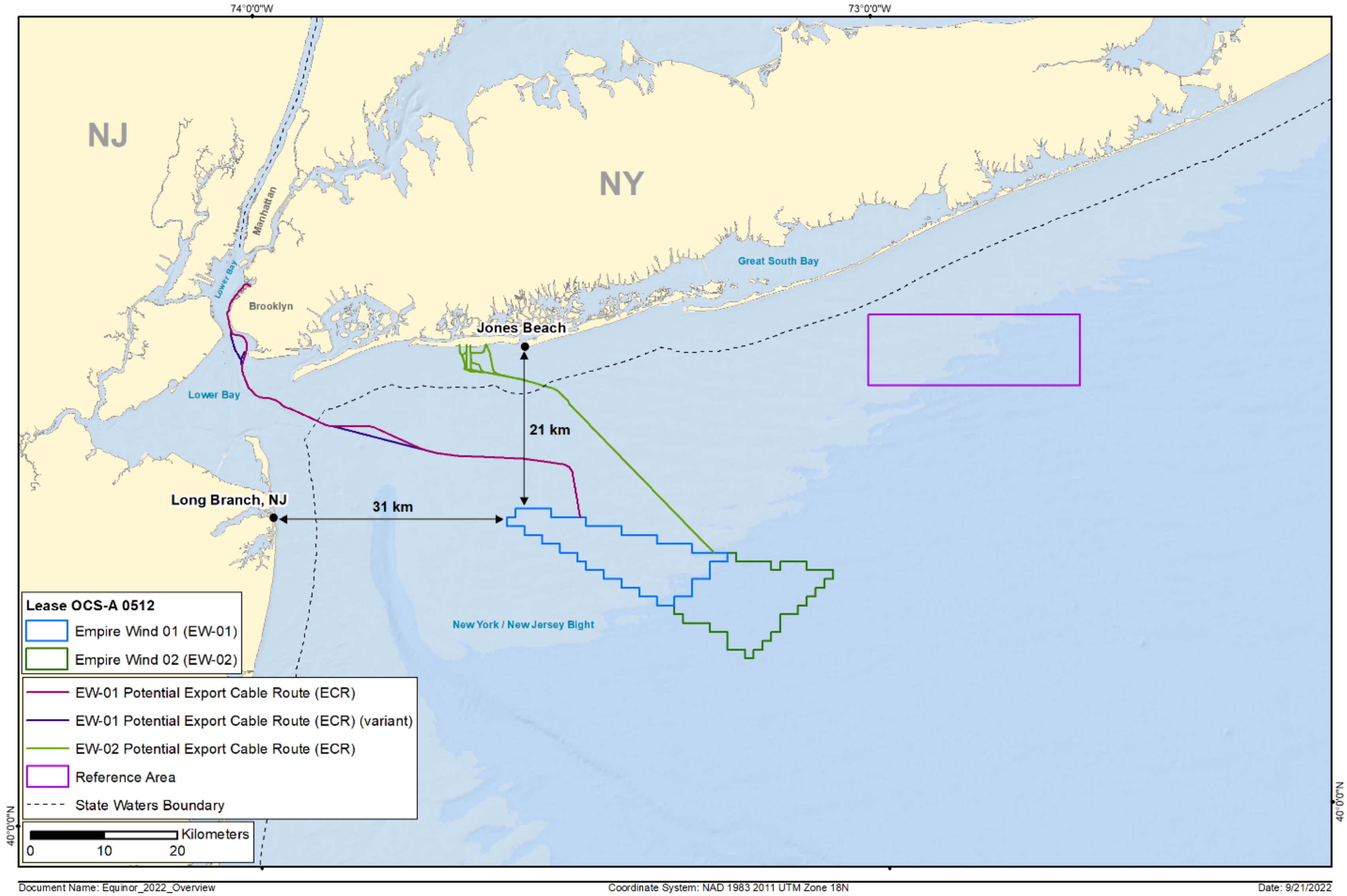


Figure 1-1. Map of the Project Area, including Export Cable Routes

2.0 OBJECTIVES

This benthic sampling plan is aimed at conducting benthic assessments in agreement with state and local agencies along the proposed EW 1 and EW 2 export cable corridors within New York state waters. Specifically, the objectives of these surveys are to characterize seafloor conditions, including the collection of geophysical and biological parameters, prior to and after the installation of the EW 1 and EW 2 export cables. This benthic sampling plan is designed to characterize and summarize baseline benthic conditions observed prior to cable installation within New York state waters, and subsequently monitor post-installation benthic conditions and chemical levels to assess any effects resulting from installation activities and operation of the EW 1 and EW 2 export cables. Sediment profile and plan view imaging (SPI/PV) in combination with sediment grab samples will be used to meet these benthic assessment goals.

3.0 OVERVIEW OF METHODOLOGICAL APPROACHES

This benthic sampling plan includes details of the pre-construction and post-construction surveying of soft sediment habitats that will occur along the EW 1 and EW 2 export cables. A combination of SPI/PV imaging and sediment grab sampling for benthic community analysis ("BCA"), grain size analysis, and, in some areas, chemistry analyses will be used to monitor these seafloor environments.

SPI/PV is a widely accepted approach to assess the seafloor as it provides an integrated, multi-dimensional view of the benthic and geological condition of the seafloor sediments (Germano et al., 2011). Specifically, SPI/PV imagery provides insight into benthic functioning such as organic matter remineralization (e.g., the depth of bioturbation, aRPD depth) and small-scale biogenic structures (low-relief tubes, burrows, and emergent fauna). Since this method preserves the organism-sediment relationship, it can accurately characterize benthic epifauna and infauna communities in relation to the local environmental context. Pairing SPI and PV images provides a comprehensive depiction of the seafloor that, through standardized analysis and interpretation (e.g., using the BOEM-recommended Coastal and Marine Ecological Classification Standard (CMECS); FGDC, 2012; BOEM, 2019) allows for accurate comparisons to be made before and after cable installation activity. SPI/PV provides real-time results that can be assessed onboard during the surveys, which allows for rapid adaptive sampling to target locations of interest.

Taxonomic BCA of sediment grab samples provides quantitative descriptions of soft sediment communities including community structure (beta diversity), abundances of taxa, and community diversity (species richness, alpha diversity). Populations of soft sediment taxa are often dynamic and patchy in nature. However, the natural spatial and temporal patchiness of these communities generally does not influence the overall benthic health or function (e.g., respiration, food provisioning, biogenic structure) of the benthic ecosystem at any given location or time. Drawing inferences about factors that influence changes in benthic community structure is challenging but perhaps obsolete given consistent benthic functioning (e.g., food provision, organic matter remineralization, benthic-pelagic coupling) across taxonomically distinct benthic communities (e.g., Belley and Snelgrove 2016). The BCA approach will provide an assessment of potential changes in quantitative community diversity metrics and particular species abundances.

In addition to BCA, sediment grab samples will be analyzed for physio-chemical parameters. Specifically, all sediment grab samples that will be collected for BCA will also be subsampled and analyzed for grain size distributions. In some specified areas along the EW 1 export cable route within New York state waters, sediment grab samples will also be collected and analyzed for a suite of chemical constituents, as described in more detail below.

In addition to SPI/PV and sediment grab collection, temperature and salinity profiles will be collected with a Conductivity, Temperature, Depth (CTD) sensor at each SPI/PV station on each survey. Sediment temperature will also be collected using a small temperature probe fastened to the SPI/PV system. The benthic sampling events within New York state waters are scoped below, including a pre-cable installation survey (EW 1 and EW 2) and two post-cable installation surveys (EW 1 and EW 2).

4.0 PRE-CONSTRUCTION BENTHIC SAMPLING

A pre-construction benthic survey is expected to occur between August 1 and October 31, 2024, prior to the start of cable installation activities in the area. This baseline survey will consist of a SPI/PV station every 1,000 feet (ft) along the proposed EW 1 and EW 2 export cable routes within New York state waters (Figures 4-1 and 4-2). At each SPI/PV station, a minimum of three SPI/PV image replicates will be collected and analyzed. At each SPI/PV station, a CTD sensor will be used to measure the salinity and temperature through the water column to the sediment surface. Additionally, the temperature of the surficial sediments will be measured at each SPI/PV station using a small temperature logger fastened to the SPI/PV camera system (e.g., STAR ODDI, DST milli-TD).

Sediment grab samples will be collected in triplicate every 2,000 ft along the proposed EW 1 and EW 2 export cable routes within New York state waters (Figures 4-1 and 4-2). Sediment subsamples will be collected from each acceptable grab sample for grain size analysis (with hydrometer ASTM D 422) and the remaining sediment will be sieved and preserved onboard the vessel for BCA. At each sediment grab station, a minimum of three replicate grab samples will be collected and analyzed for BCA and grain size analysis by standard Environmental Protection Agency (EPA) approved protocols (Swartz 2004).

Sediment samples will also be collected for chemistry analyses from kilometer point (KP) 15 north to the landfall during pre-construction sampling along the EW 1 export cable route within New York state waters (Figure 4-1). Sediment grab stations for chemistry analyses will be located along transects perpendicular to the cable route every 4,000 ft from KP 15 northward along the EW 1 export cable route. At each transect, one chemistry grab station will be sited as close as practicable to the proposed cable centerline (station co-located with every other 2,000 ft interval SPI/PV and BCA, grain size station) and two chemistry grab stations will be located approximately 100 ft on either side of the center grab sample (Figure 4-1). The exact locations of these stations for sediment chemistry analyses will be determined following consultation with Department of Public Service (DPS) staff in consultation with New York State Department of Environmental Conservation (NYSDEC). The top 2 centimeters (cm) will be collected from the acceptable sediment grab sample surface using a cut-off syringe corer marked to delineate a 2-cm depth. Several subsample cores will be collected from the grab sample to ensure sufficient sediment volume for the chemical analyses.

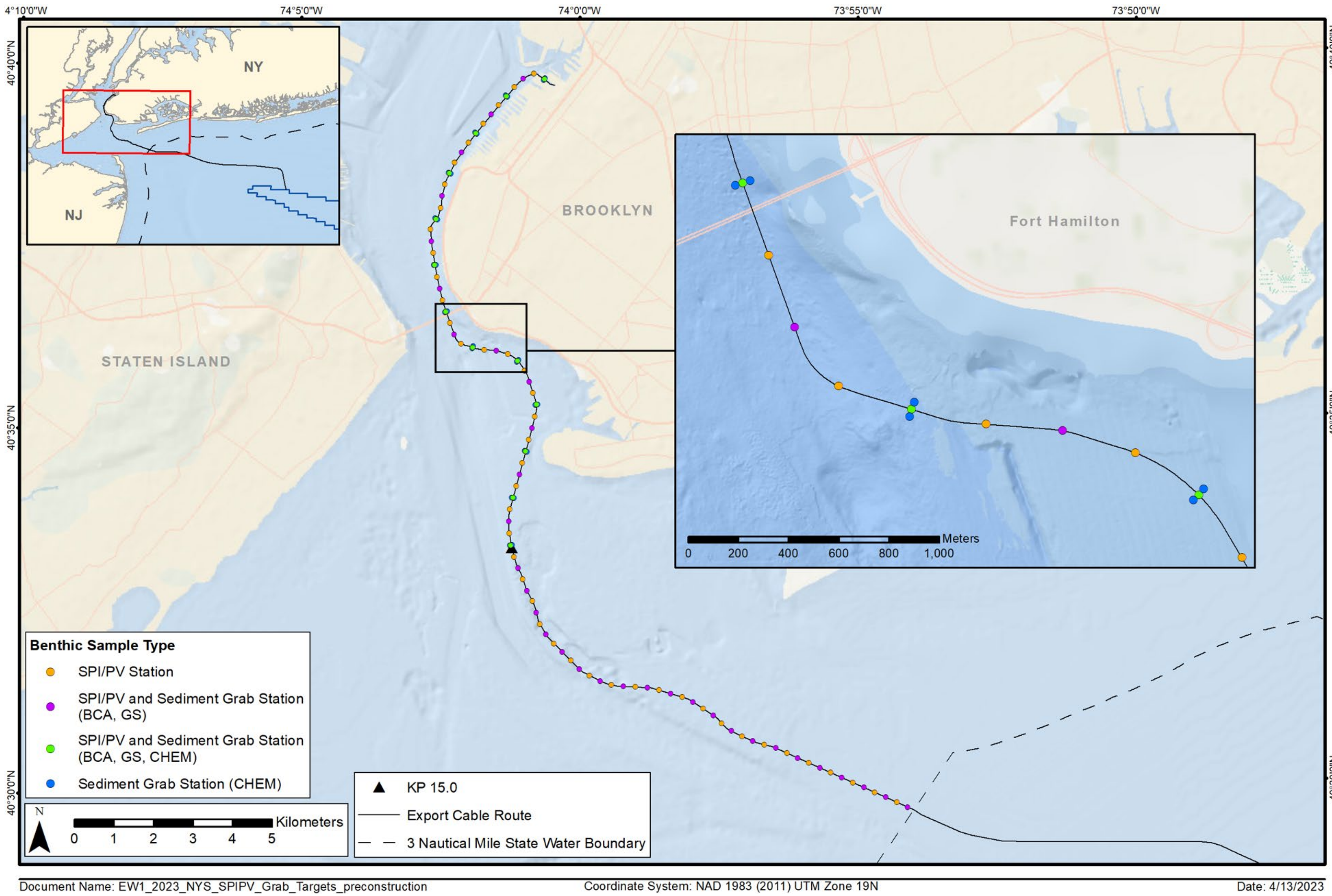


Figure 4-1. Representative Depiction of the Survey Design along the EW 1 Cable Route During the Pre-Construction Benthic Sampling Survey

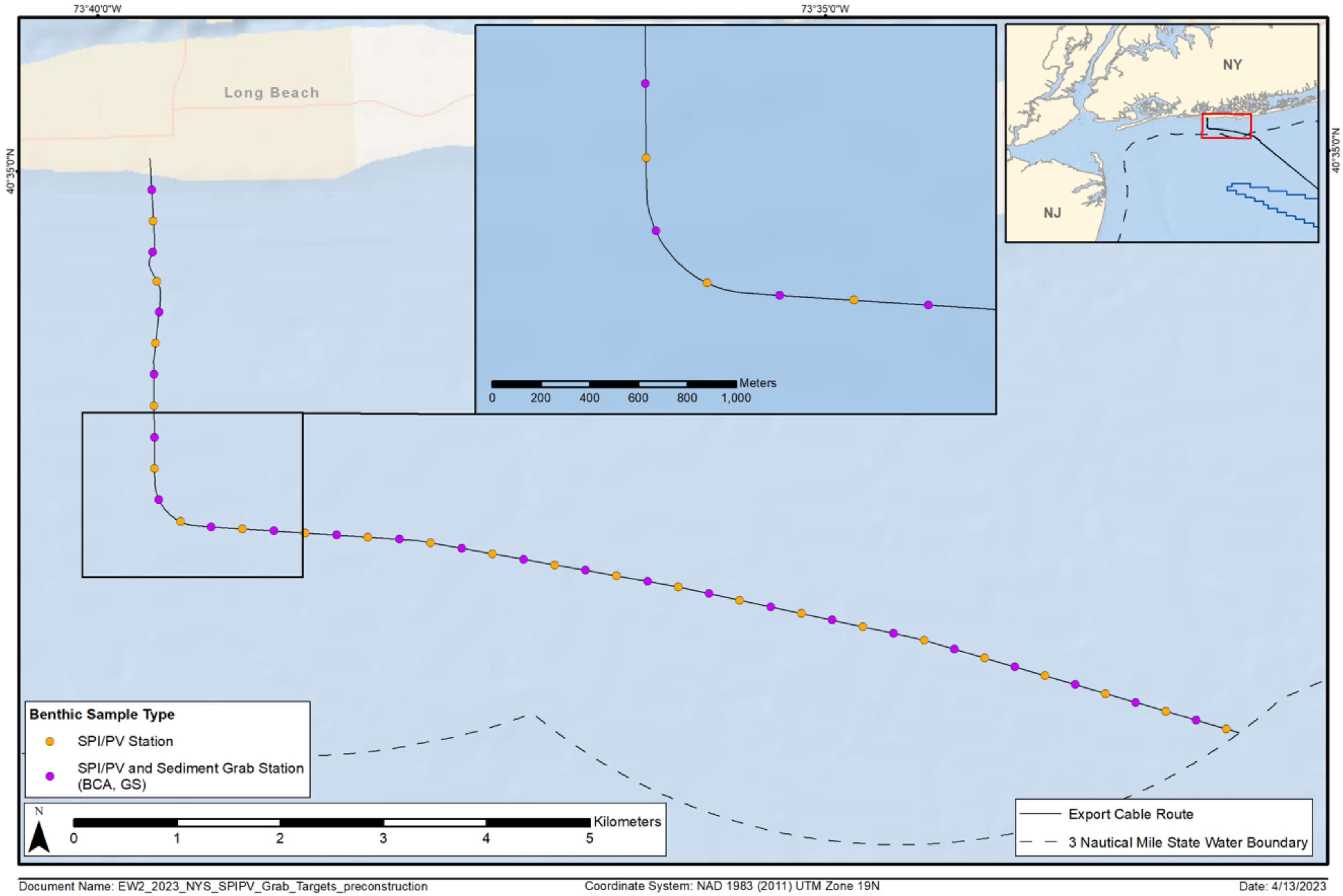


Figure 4-2. Representative Depiction of the Survey Design along the EW 2 Cable Route During the Pre-Construction Benthic Sampling Survey

5.0 POST-CONSTRUCTION BENTHIC SAMPLING

At least two field sampling surveys will occur after the proposed EW 1 and EW 2 export cables have been installed. Post-construction sampling will occur between August 1 and October 31 each year within 24 months of the Empire Wind Project's commercial operational date.

During the post-cable installation surveys, at each 1,000-ft interval, three stations will be sampled with SPI/PV in a transect perpendicular to the EW 1 and EW 2 export cables, with one station as close as practicable to the centerline and one station located approximately 100 ft on either side (Figures 5-1 and 5-2). These transects will repeat at 1,000-ft intervals from the horizontal directional drilling (HDD) exits offshore to the territorial limit of New York state waters. At each SPI/PV station a minimum of three replicate images shall be collected and analyzed. At each SPI/PV station, a CTD sensor will be used to measure the salinity and temperature through the water column to the sediment surface. Additionally, the temperature of the surficial sediments will be measured at each SPI/PV station using a small temperature logger fastened to the SPI/PV camera system (e.g., STAR ODDI, DST milli-TD).

The SPI/PV sampling will be supplemented with sediment grab stations located at transects every 2,000 ft along the EW 1 and EW 2 export cable centerlines (Figures 5-1 and 5-2). At each transect, one grab sample station will be sited as close as practicable to the centerline of the installed cable and one grab sample station will be sited approximately 100 ft on the right side of the cable while oriented towards shore. At each grab station three replicate grab samples will be collected, sieved onboard, and preserved. The number of replicate grab samples from each grab station that will be analyzed for BCA will be determined based on the outcome and review of the power analysis and the Maher and Cerrato (2006) method (see Section 6.1).

Sediment grab sampling for chemistry analyses will be collected at the same stations established during the pre-construction benthic sampling for chemistry analyses (Section 4.0). Along the EW 1 export cable route within New York state waters, sediment grab samples will be collected for chemistry analyses from KP 15 north to the landfall. The sampling design for chemistry grab sample collection will be the same as what was completed during the pre-construction survey (Figure 5-2). The exact locations of these stations for sediment chemistry analyses will be determined following consultation with DPS Staff in consultation with NYSDEC. The top 2 cm will be collected from the acceptable sediment grab sample surface using a cut-off syringe corer marked to delineate a 2-cm depth. Several subsample cores will be collected from the grab sample to ensure sufficient sediment volume for the chemical analyses.

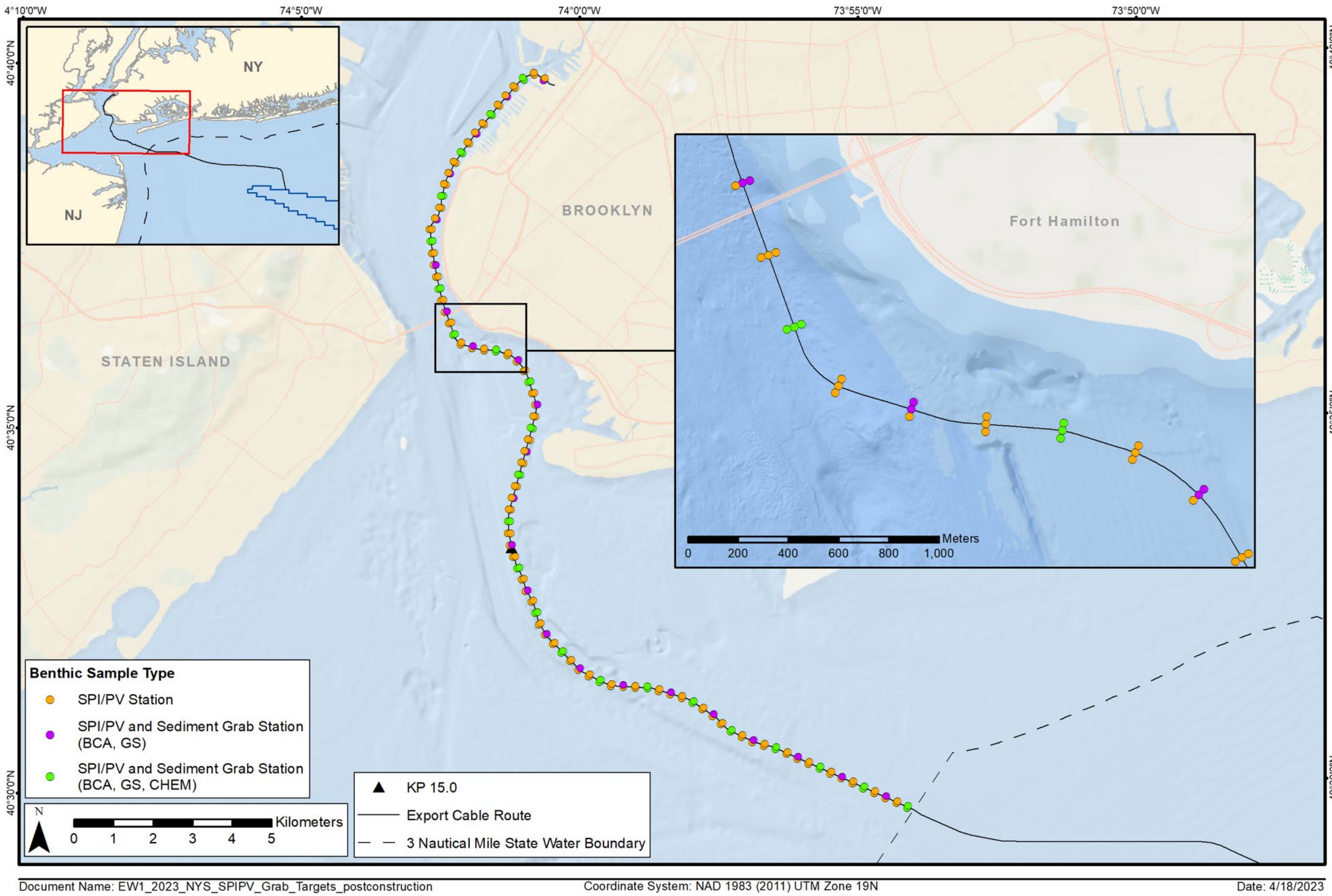
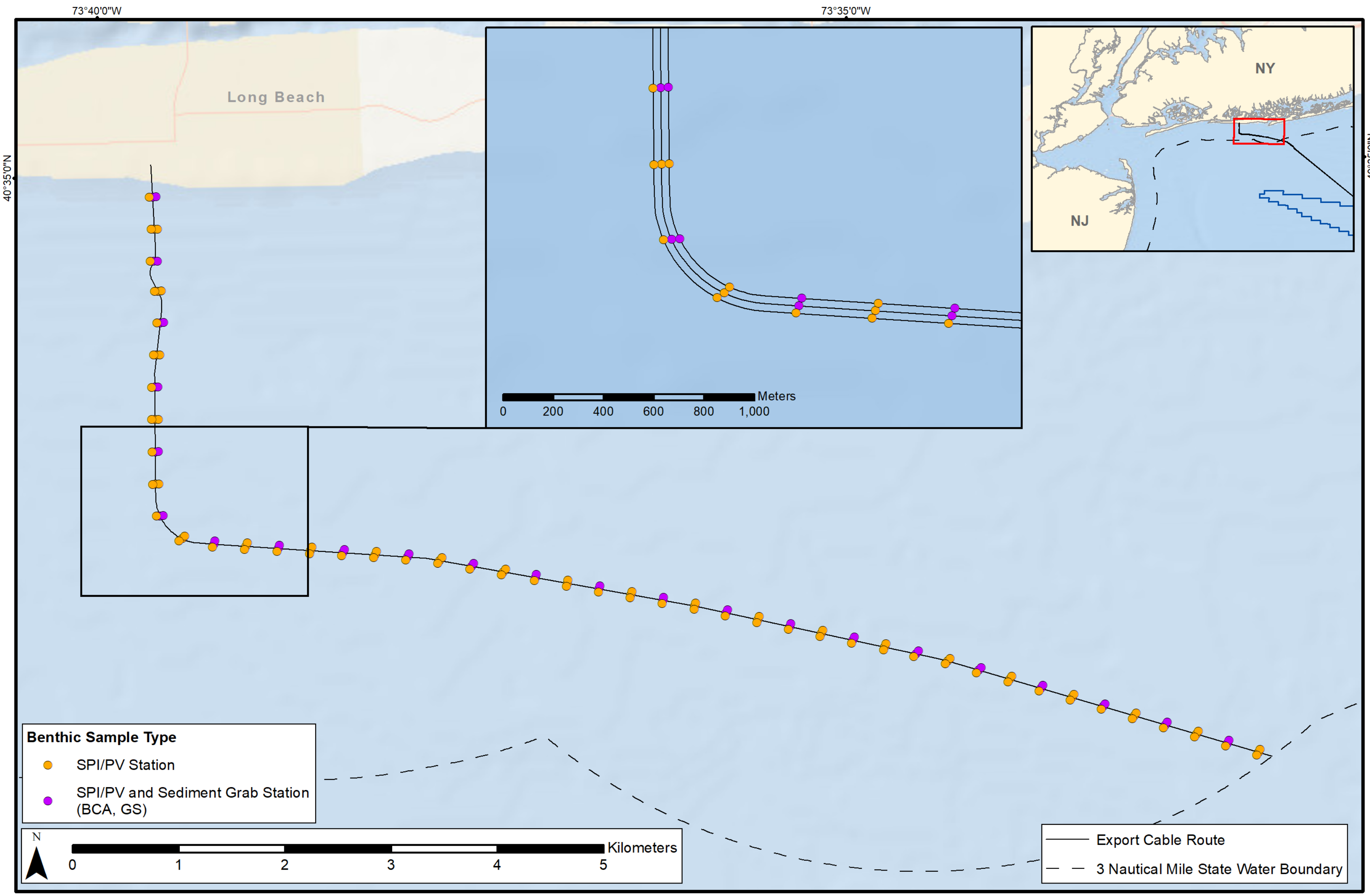


Figure 5-1. Representative Depiction of the Survey Design along the EW 1 Cable Route During Post-construction Benthic Sampling Surveys



Document Name: EW2_2023_NYS_SPIPV_Grab_Targets_postconstruction Coordinate System: NAD 1983 (2011) UTM Zone 19N Date: 4/13/2023

Figure 5-2. Representative Depiction of the Survey Design along the EW 2 Cable Route During Post-construction Benthic Sampling Surveys

6.0 IMAGE ANALYSIS, DATA ANALYSIS, AND STATISTICAL TESTS

6.1 SPI/PV IMAGE ANALYSIS

The SPI and PV cameras are state-of-the-art monitoring tools that capture benthic ecological functioning within the context of physical factors. The PV system captures high-resolution imagery over several meters of the seafloor, while the SPI system captures the typically unseen, sediment–water interface in the shallow seabed. Coupled SPI/PV imagery provides an integrated, multi-dimensional view of the benthic and geological condition of seafloor sediments and can be used to characterize the function of the benthic habitat, physical changes, and recovery from physical disturbance following the installation of the cables.

SPI/PV imagery provides spatial and contextual information, such as oxygen penetration depths (apparent redox potential discontinuity [aRPD] depth), infaunal bioturbation depths, and small-scale grain size vertical layering that are critical pieces to assessing the ecological functioning of soft sediment habitats. SPI/PV imagery provides an effective snapshot of the overall ecological health and condition of the sediments as reflected and integrated over time and space by the continuous activity of the infaunal and epifaunal communities present (Germano et al. 2011).

The SPI/PV system will collect qualitative and quantitative data associated with physical and biological changes related to benthic function (bioturbation and utilization of organic material) that might result from the installation of the cables. Seafloor geological and biogenic substrates captured in SPI/PV imagery will be described using the Coastal and Marine Ecological Classification Standard (CMECS; FGDC 2012). Triplicate paired images will be collected and analyzed at each station.

The following parameters will be measured during SPI and PV image analysis:

- CMECS Substrate Group and Subgroup
- gravel size measurements (predominant, minimum, maximum), where applicable
- CMECS Biotic Class and Subclass
- aRPD depth
- maximum bioturbation depth
- infaunal successional stage
- methane presence/absence
- grain size major mode
- presence, frequency, size of surficial features such as bedforms (e.g., sand ripples)
- presence of sensitive taxa (e.g., slow growing species) and ecologically valuable taxa (e.g., biogenic structure-forming taxa such as emergent fauna)

Results from the three replicate images at each station will be aggregated to provide a summary value for each metric by station. Depending on the metric type, this will include mean, maximum, or predominant (categorical variables) (e.g., predominant CMECS Substrate Subgroup, maximum infaunal successional stage).

6.2 SEDIMENT BCA

BCA results will be summarized with metrics for total abundance, total biomass, abundance of certain common species, species richness, and diversity indices (Shannon-Wiener, evenness). The variance estimated from these data obtained during the pre-construction sampling will be used in a statistical power analysis for the comparison of these metrics between pre- and post-installation time periods. In the power analysis the baseline mean and the variance will be used to estimate the minimum detectable difference (MDD) with 90% confidence and 80% power for a study design that utilizes one to three replicates. This MDD for the different study designs (i.e., one to three replicates) will be compared to an ecologically meaningful difference to estimate the number of replicates required for analysis in the post-installation surveys. To identify what constitutes an ecologically meaningful difference for this habitat, available regional data will be mined to quantify natural spatial/temporal variability in the area. The Maher and Cerrato (2006) method for estimating sampling effort (i.e., number of replicates) will also be conducted. Results of the statistical power analysis and estimation of ecologically meaningful difference will be presented to NYSDEC for review prior to the post-cable installation sampling surveys.

6.3 SEDIMENT CHEMISTRY ANALYSES

The sediment samples collected for chemistry analyses will be analyzed for

- Copper, using EPA Method 6020
- Lead, using EPA Method 6020
- Mercury, using EPA Method 7471
- Total polychlorinated biphenyls (PCBs), using congener-specific method (EPA Method 8082)
- Dioxin (Toxic Equivalency Total), using EPA Method 1613B (as described in NYSDEC Technical and Operational Guidance Series (TOGS) 5.1.9)

Concentrations of each analyte will be compared with the pre-construction survey results (pre-installation chemical concentrations).

7.0 DATA MANAGEMENT, REPORTING, AND DATA SHARING

Results of the post-cable installation benthic sampling events (including the collected water column CTD data and sediment temperature data) shall be submitted to the New York State Department Public Service, New York State Department of State, New York State Department of Agriculture and Markets, and the New York State Department of Environmental Conservation in a final written report within six months of the completion of each sampling event. The results of the BCA and chemistry analyses will be provided as a supplement of the report within nine months of the completion of each sampling event. All data collected under this plan will be made publicly available in shapefile and PDF format.

8.0 REFERENCES

Belley, R. and P.V.R Snelgrove. 2016. Relative contributions of biodiversity and environment to benthic ecosystem functioning.

Bureau of Ocean Energy Management (BOEM) Office of Renewable Energy Programs. 2019. Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585. June 2019.

Federal Geographic Data Committee (FGDC). 2012. Coastal and Marine Ecological Classification Standard. FGDC-STD-018-2012. Marine and Coastal Spatial Data Subcommittee. June 2012. 343 pp. Reston, VA.

Germano, J.D., D.C. Rhoads, R.M. Valente, D. Carey, and M. Solan. 2011. The use of Sediment Profile Imaging (SPI) for environmental impact assessments and monitoring studies: Lessons learned from the past four decades. Oceanography and Marine Biology: An Annual Review 49: 247-310.

Maher, N.P. and R.M. Cerrato. 2006. Using Species Richness to Estimate Sampling Effort, a report prepared for the Hudson River Estuary program, NYSDEC.

Swartz, R. 2004. Techniques for Sampling and Analyzing the Marine Macrobenthos. U.S. Environmental Protection Agency, Washington, D.C., EPA/600/3-78/030.

Attachment C - Sediment Profile and Plan View Imagery to Assess Shifts in Benthic Ecological Functions

Sediment Profile and Plan View Imagery to Assess Shifts in Benthic Ecological Functions

SPI/PV is an effective tool in assessing changes in benthic function of soft sediments in response to offshore wind development. Ecologically important benthic functions of soft sediment communities on the outer continental shelf of the northwest Atlantic include (1) the provision of biogenic structures as habitat, (2) the facilitation of organic matter processing (carbon and nutrient cycling), and (3) the provision of food to upper trophic levels (secondary production). These ecosystem functions are detectable using data obtained from SPI/PV imagery as described in more detail below.

Biogenic Habitats

SPI/PV is an effective means to assess the presence and relative distribution of biogenic structure-forming fauna in soft sediment environments. Common emergent fauna in this environment includes cerianthids (burrowing anemone). Other biogenic structure-forming organisms in this environmental context include mussels, tube-building amphipods and polychaetes including sabellid worms, that can serve to bind sediments and create reefs. Biogenic structure-forming organisms are often difficult to capture using traditional sediment grab sampling as they are able to effectively evade collection. Also, sediment grab collection is destructive sampling, which should be avoided in areas with sensitive benthic organisms. High-resolution SPI and PV imaging can non-invasively identify and quantify these emergent and structure-forming fauna. The presence and densities of these emergent and structure-forming fauna can be obtained using the SPI/PV approach, and any changes in spatial distributions in response to offshore wind development can be detected through this proposed monitoring survey design.

Benthic Organic Matter Processing

SPI/PV is an effective means to assess the degree of, and changes to, organic matter processing and cycling in soft sediments. Benthic communities in soft sediments serve an important role in facilitating organic matter processing and cycling. The ability of soft sediment communities to process organic matter delivered from the water column is highly dependent on the benthic community activity, specifically bioturbation, bioirrigation, and sediment mixing by shallow and deep-burrowing organisms. These infaunal activities deliver oxygenated water to the sediment column, facilitating aerobic respiration of organic matter. The degree of organic matter processing can be assessed by measuring the depth of oxygen penetration into the sediment column, which can be done through SPI analysis (apparent redox discontinuity [aRPD] depth). Other indicators of benthic organic matter processing include infaunal succession stage, feeding voids, methane, and presence of *Beggiatoa*. Of these, the successional stage and aRPD depth have the strongest predictive power for benthic functional response to physical disturbance and organic enrichment (Germano et al. 2011) and will be the key metrics used during the soft bottom surveys. Because the epifaunal growth on the novel wind turbine structures is likely to increase the delivery of organic matter to the sediments below, organic matter processing and sediment respiration is likely to increase in these adjacent soft sediments, causing a decrease in the depth of oxygen penetration into the sediment column (aRPD depth). SPI is an effective approach in assessing this change in organic matter processing with distance from the turbine as SPI analysis can accurately assess and detect changes in aRPD depths and bioturbation depths.

The aRPD depth is a measure of the depth within the sediment column where dissolved oxygen concentrations are depleted. This depth is dependent on several factors but is largely determined by the amount of organic matter load to the sediments (organic matter decomposition consumes oxygen) and the amount of bioturbation by macrofaunal organisms (bioturbation mixes oxygen from surface waters deep into the sediments). With SPI analysis, the aRPD depth is described as “apparent” because of the potential discrepancy between where the sediment color shifts and the complete depletion of dissolved oxygen concentration occurs. In sandy sediments that have very low sediment oxygen demand (SOD), the sediment may lack a visibly reduced layer even if a redox potential discontinuity (RPD) is present. Because the determination of the aRPD requires distinction of optical contrast between oxidized and reduced particles, it is difficult, if not impossible, to determine the depth of the aRPD in well-sorted sands of any size that have little to no silt or organic matter in them. When using SPI technology on sand bottoms, estimates of the mean aRPD depths are often indeterminate with conventional white light photography. It is expected that as sediments surrounding the WTGs will increase in organic enrichment and fines, the aRPD will become more ‘apparent’ and provide a quantitative measure of enrichment. The aRPD has been shown to be a sensitive and specific indicator of hypoxic conditions experienced over the preceding 1 day to 4 weeks (Shumchenia and King 2010), and to be correlated to concurrent *in situ* dissolved oxygen concentrations (Sturdivant et al. 2012).

There has been considerable research conducted on the effects of bioturbation on sediment geotechnical and geochemical properties as well as on sediment diagenesis (Ekman et al. 1981; Nowell et al. 1981; Rhoads and Boyer 1982; Grant et al. 1982; Boudreau 1986, 1994, 1998; Sturdivant and Shimizu 2017). Additional research has focused on the rates of contaminant flux in sediments (Reible and Thibodeaux 1999; François et al. 2002; Gilbert et al. 2003) and the two parameters that primarily affect the rate of benthic fluxes: erosion and bioturbation (Reible and Thibodeaux 1999). The depth to which sediments are bioturbated, or the biological mixing depth, can be an important parameter for understanding and predicting nutrient or contaminant flux from the sediments to the water column (and vice versa). The biological mixing depth is also a useful indicator for the degree of organic enrichment in sediments. Burrow depth has been shown to be reduced under hypoxic conditions and burrowing fauna respond quickly (within an hour) to sediment accretion and erosion (Sturdivant et al. 2012; Sturdivant and Shimizu 2017). While the aRPD depth is one potential measure of biological mixing depth, it is quite common in sediment profile images to see evidence of biological activity (burrows, voids, or actual animals) well below the mean aRPD. Biogenic particle mixing depths can be estimated by measuring the maximum and minimum depths of imaged fauna, burrows, or feeding voids in the sediment column. In this study, the minimum and maximum linear distances from the sediment surface to feeding voids and the maximum linear distance to the deepest feature of biological activity will be measured. The latter parameter represents the maximum observed particle mixing depth of head-down feeders, mainly polychaetes.

Benthic Secondary Production and Food Provisioning

Soft sediment benthic communities can be important prey to upper trophic levels. Although SPI/PV imagery does not provide estimates of biomass or detailed taxonomic identification, these measurements do not necessarily relate to the value of any given benthic community as prey resource. Regional and interannual variability in biomass and species composition does not reflect changes in prey availability or value in the ecosystem. This natural variability is not likely to be ecologically meaningful. SPI/PV imagery can provide information on the level of succession of benthic community present after a physical (or chemical) disturbance. SPI/PV provides a more holistic assessment of benthic functioning that captures the relationship between infauna and sediments compared with infaunal abundance assessments using sediment grab sampling (Germano et al. 2011). Although infaunal abundance and density measurements are not generated from SPI/PV analysis, other metrics that will be collected as part of the benthic biological assessment include lists of infaunal and epifaunal species, the percent cover of attached biota visible in PV images, presence of sensitive and non-native species, and the infaunal successional stage (Pearson and Rosenberg 1978; Rhoads and Germano 1982; Rhoads and Boyer 1982). The successional stage has a strong predictive power for benthic functional response to physical disturbance (Germano et al. 2011) and will be the key metrics used during this set of soft bottom monitoring surveys.

Infaunal successional stage describes the biological status of a benthic community and is useful in quantifying the biological recovery after a disturbance (physical or organic enrichment-related). Organism–sediment interactions in fine-grained sediments follow a predictable sequence of development after a major disturbance (Pearson and Rosenberg 1978; Rhoads and Germano 1982; Rhoads and Boyer 1982). This continuum is divided subjectively into four stages: Stage 0, indicative of a sediment column that is largely devoid of macrofauna, occurs immediately following a physical disturbance or in close proximity to an organic enrichment source; Stage 1 is the initial recolonizing by tiny, densely populated polychaete assemblages; Stage 2 is the start of the transition to head-down deposit feeders; and Stage 3 is the mature, equilibrium community of deep-dwelling, head-down deposit feeders. The presence of feeding voids in the sediment column is evidence of an active Stage 3 community. If the frequency of physical disturbance is high, which is generally the case in naturally dynamic benthic habitats such as the sandy environment of the outer continental shelf, the benthic community successional stage will remain low at Stage 1 or 2 (Germano et al. 2011).

Physical Benthic Characteristics and Dynamics

Evidence of physical sediment characteristics and dynamics, important factors associated with benthic functioning, can be readily gleaned from paired SPI and PV imagery. Specifically, parameters such as sediment grain size, CMECS Substrate Group and Subgroup, gravel sizes and distributions, presence and characteristics of small-scale bedforms (e.g., ripples) are measurements that can be obtained from SPI/PV. This imagery provides concurrent information about the physical conditions of the benthic habitat that directly relate to the species inhabiting the area and the community ecological function.

Coupling SPI and PV paired imagery allows for the assessment of benthic functioning over a spatial scale of several square meters at each station. PV images provide a larger field-of-view than SPI images, or sediment grab samples, and provide valuable information about the landscape ecology and sediment topography in the area where the pinpoint “optical core” of the SPI is taken. Distinct surface sediment layers, textures, or structures detected in SPI can be interpreted considering the larger context of surface sediment features captured in the PV images. The scale information provided by the underwater lasers allows for accurate organismal density counts and/or percent cover of attached epifaunal colonies, sediment burrow openings, larger macrofauna and/or fish which are missed in the SPI cross section. A field of view is calculated for each PV image and measurements are taken of specific parameters outlined in the survey workplan.

References

Boudreau, B.P. 1986. Mathematics of tracer mixing in sediment. I: Spatially-dependent, diffusive mixing. II: Non-local mixing and biological conveyor-belt phenomena. Am. J. Sci. 286: 161-238.

Boudreau, B.P. 1994. Is burial velocity a master parameter for bioturbation? Geochim. Cosmochim. Acta 58: 1243-1249.

Boudreau, B.P. 1998. Mean mixed depth of sediments: the wherefore and the why. Limnol. Oceanogr. 43: 524-526.

Ekman, J.E., A.R.M. Nowell, and P.A. Jumars. 1981. Sediment destabilization by animal tubes. J. Mar. Res. 39: 361-374.

François, F., M. Gerino, G. Stora, J.P. Durbec, and J.C. Poggiale. 2002. Functional approach to sediment reworking by gallery-forming macrobenthic organisms: modeling and application with the polychaete Nereis diversicolor. Mar. Ecol. Progr. 229: 127-136.

Germano, J.D., D.C. Rhoads, R.M. Valente, D. Carey, and M. Solan. 2011. The use of Sediment Profile Imaging (SPI) for environmental impact assessments and monitoring studies: lessons learned from the past four decades. Oceanogr. Mar. Biol. 49: 247-310.

Gilbert, F., S. Hulth, N. Strömberg, K. Ringdahl, and J.-C. Poggiale. 2003. 2-D optical quantification of particle reworking activities in marine surface sediments. J. Exp. Mar. Biol. Ecol. 285-286: 251-263.

Grant, W.D., Jr., L.F. Boyer, and L.P. Sanford. 1982. The effects of bioturbation on the initiation of motion of intertidal sands. J. Mar. Res. 40: 659-677.

Nowell, A.R.M., P.A. Jumars, and J.E. Ekman. 1981. Effects of biological activity on the entrainment of marine sediments. Mar. Geol. 42: 133-153.

Pearson, T.H. and R. Rosenberg. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanogr. Mar. Biol. 16: 229-311.

Reible, D. and L. Thibodeaux. 1999. Using natural processes to define exposure from sediments [Internet]. In: Sediment Management Work Group; Contaminated Sediment Management Technical Papers, Sediment Management Work Group. Available from: https://www.researchgate.net/publication/253029892_USING_NATURAL_PROCESSES_TO_DEFINE_EXPOSURE_FROM_SEDIMENTS

Rhoads, D.C. and L.F. Boyer. 1982. The effects of marine benthos on physical properties of sediments. In: McCall, P.L. and M.J.S. Tevesz, editors. Animal-sediment relations. New York (NY): Plenum Press. p. 3-52.

Rhoads, D.C. and J.D. Germano. 1982. Characterization of organism-sediment relations using sediment profile imaging: an efficient method of remote ecological monitoring of the seafloor (REMOTS System). Mar. Ecol. Progr. 8: 115-128.

Shumchenia, E. and J. King. 2010. Evaluation of sediment profile imagery as a tool for assessing water quality in Greenwich Bay, Rhode Island, USA. Ecol. Indic. 10: 818-825.

Sturdivant, S.K., R.J. Díaz., and G.R. Cutter. 2012. Bioturbation in a declining oxygen environment, in situ observations from Wormcam. PLoS ONE 7(4): e34539.

Sturdivant, S.K. and M.S. Shimizu. 2017. In situ organism-sediment interactions: bioturbation and biogeochemistry in a highly depositional estuary. PLoS ONE 12(11): e0187800.

Appendix I. Supplemental Information

I.1. Climate and Meteorology

Conditions that affect the weather and climate in an area include wind velocity, air temperature, and precipitation. Long-term averages of these conditions produce the regional climate. Extreme meteorological conditions are produced in the Mid-Atlantic region of the United States during tropical and extra-tropical storms. Over the open ocean, meteorological characteristics are fundamentally influenced by oceanographic conditions and are therefore sometimes jointly discussed as “metocean” conditions. In temperate regions such as the Mid-Atlantic, several metocean conditions are highly seasonal and driven by both atmospheric and oceanic circulation patterns. Daily variability in meteorological conditions will drive fluctuations in wind farm power production and associated stresses on the WTGs, while long-term performance may be estimated based on the climatic conditions.

I.1.1 Regional Climate Overview

The Atlantic seaboard is classified as a mid-latitude climate zone based on the Köppen Climate Classification System. This larger region, which encompasses the Mid-Atlantic region, is characterized by mostly moist subtropical conditions, generally warm and humid in the summer with relatively mild winters (BOEM 2021). Prevailing winds at the middle latitudes over North America occur mostly west to east (“westerlies”) and contribute to seasonal variability along the Atlantic seaboard (NJDEP 2010).

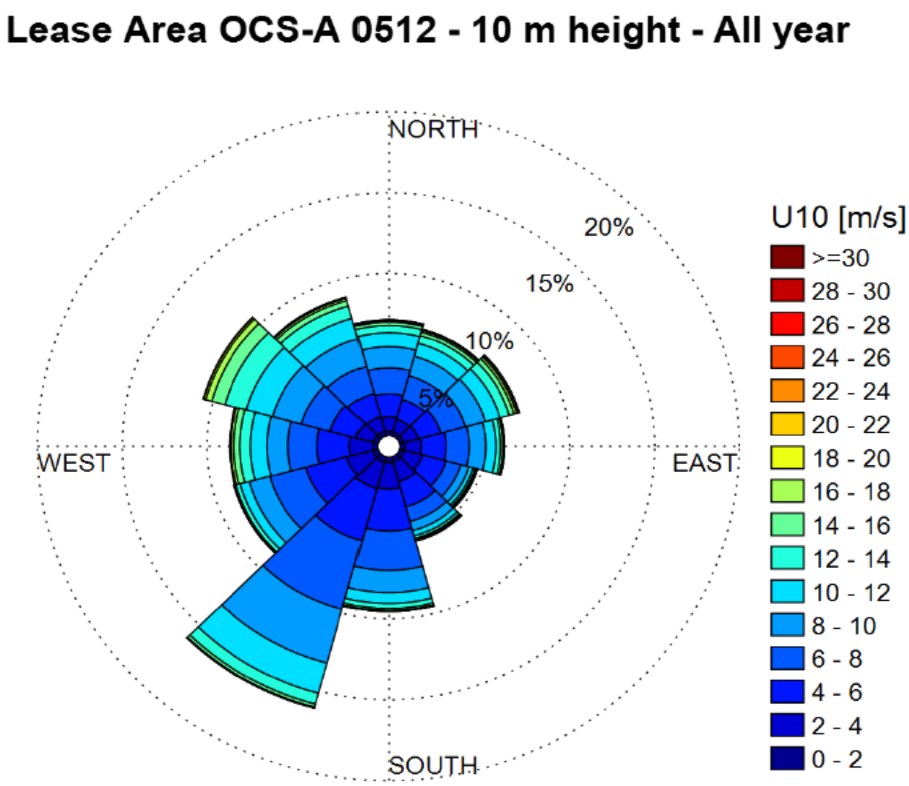
Consistent with the larger Mid-Atlantic region, the climate across New York state can be described as humid and continental (New York State Climate Action Council 2010). The New York Bight region along New York state’s southern coast experiences four distinct seasons with cold air temperatures during the winter months. Areas along the Atlantic coast, including the New York Bight, are especially prone to coastal storms and their associated effects, including heavy precipitation, high winds, and coastal flooding (New York State Climate Action Council 2010). Coastal storms are common in the vicinity of the Lease Area and include hurricanes and tropical storms during the warmer months (July to September), and northeasters or “nor’easters” (extratropical storms in which the winds in coastal areas blow from the northeast) during the cooler months (October to April). Extreme rainfall and flooding associated with storm events contribute to erosion of New York state’s coastal wetland areas and inland areas adjacent to the shoreline (New York State Climate Action Council 2010).

The North Atlantic Oscillation (NAO) also affects climate in the Northwest Atlantic on the scale of decades (NJDEP 2010; Townsend et al. 2004). The NAO is calculated as the wintertime pressure difference between the high-pressure system over the Azores Islands and the low-pressure system over Iceland (NJDEP 2010; Townsend et al. 2004). Shifts in the ratio of these pressures contribute to warmer or cooler average winters. Since the late 1970s, warmer NAO conditions have persisted on average (NJDEP 2010; Townsend et al. 2004). The NAO may be influenced by the El Niño-Southern Oscillation, which is a large-scale, multi-year fluctuation in sea surface temperatures in the Pacific Ocean (NJDEP 2010). The NAO may also be correlated with an 11-year solar cycle (IPCC 2021).

The U.S. Northeast region is currently subject to climate changes associated with global warming that are primarily attributed to human activities, especially the production of heat-trapping (i.e., “greenhouse”) gases (Dupigny-Giroux et al. 2018; Hayhoe et al. 2018; IPCC 2021). These regional changes include an average winter-spring increase in air temperature of 1.67 °F (increase of 0.93 °C) between 1940 and 2014. By 2035, the Northeast region is expected to be 3.6 °F (2 °C) warmer on average than during the pre-industrial era (Dupigny-Giroux et al. 2018). The Northeast region has also seen a 55 percent increase in the number of heaviest 1-percent precipitation events between 1958 and 2016 (Dupigny-Giroux et al. 2018). Severe storms have become more frequent and more intense. Storm flood heights driven by hurricanes in New York City have increased by more than 3.9 feet (1.2 meters) over the last thousand years (Dupigny-Giroux et al. 2018). Due to predicted increases in average global temperatures, the frequency and intensity of extreme regional weather events such as heat waves, strong winds, and heavy precipitation are expected to increase in the coming decades (New York State Climate Action Council 2010; Dupigny-Giroux et al. 2018).

I.1.2 Winds

Winds during the summer are typically from the southwest and flow parallel to the shore, while winds in the winter months are typically from the northwest and flow perpendicular to the shore. Spring and fall are more variable, with wind currents from either the southwest or northeast (Schofield et al. 2008). Empire has been collecting wind data, along with other directional wave and meteorological condition information, from a floating metocean buoy for 2 years. This metocean data will be used to inform final siting and design of the Projects (Empire 2023). Empire has also performed a preliminary metocean analysis using data from January 2000 through October 2019. This analysis shows that annual average wind speeds in the Lease Area at 33 feet (10 meters) AMSL range between 9.8 feet per second (3 meters per second [m/s]) and 23 feet per second (7 m/s) (Empire 2023 citing Kjeller Vindteknikk 2020). Winds in the Project area are predominantly from the south to southwest and the northwest (COP Appendix I; Empire 2023) as depicted on Figure I-1.



Source: COP Appendix I; Empire 2023
Note: Lease Area OCS-A 0512 is modeled at 40.28, -73.31 (latitude, longitude)

Figure I-1 All-Year Wind Rose at 33 Feet (10 Meters) AMSL for Lease Area OCS-A 0512 for the Period 2002–2019

In addition to the wind data presented above, representative data for wind speed and wind direction are publicly available from NOAA's National Data Buoy Center for the Long Island buoy (Buoy No. 44025) (NOAA 2021a) and the New York Harbor Entrance buoy (Buoy No. 44065) (NOAA 2021b). The Long Island buoy is within the Lease Area at coordinates of 40.251, -73.164 (latitude, longitude) and is 30 nm south of Islip, New York. The New York Harbor Entrance buoy is approximately 8 miles west of the Lease Area at coordinates of 40.369, -73.703.

The most recent data available from the New York Harbor Entrance buoy are for the period of January 2015 through December 2020. The maximum wind speed[1] recorded during this period was 47.4 miles per hour (mph) (21.2 m/s) in 2018, with average wind speeds from 11.2 to 15.7 mph (5 to 7 m/s) across these 6 years (Table I-1). Using 2017 as an example year to consider seasonal averages, the maximum wind speed was recorded in the spring of 2017 at 47.0 mph (21 m/s), although the highest average seasonal wind speed of 16.8 mph (7.5 m/s) occurred in the winter of 2017 (Table I-2). The average wind direction for all seasons between 2015 and 2020 was from the southwest. In other years, higher maximum wind speeds have occurred in summer and fall months due to tropical cyclones. For example, a maximum sustained wind speed of 51.4 mph (23.0 m/s) and gusts up to 70.5 mph (31.5 m/s) were recorded at the New York Harbor Entrance buoy on August 4, 2020, in association with Hurricane Isaias (NOAA 2021b).

Data from the Long Island buoy (Buoy No. 44025) in the Lease Area are available for the period of October 1975 through December 2008. The Long Island buoy measured similar conditions as the New York Harbor Entrance buoy with a maximum wind speed of 51.0 mph (22.8 m/s) in 1991, and average wind speeds from 11.2 to 18.9 mph (5.0 to 8.4 m/s) across the 34 years recorded (NOAA 2021a).

Table I-1 Annual Average and Maximum Wind Speed and Direction at New York Harbor Entrance Buoy (Buoy No. 44065) from January 2015 to December 2020

Year	Average Wind Speed		Maximum Wind Speed		Average Wind Direction
	mph	m/s	mph	m/s	Degrees from True North
2015	14.1	6.3	41.6	18.6	202 (Southwest)
2016	14.5	6.5	45.0	20.1	200 (Southwest)
2017	14.3	6.4	47.0	21.0	198 (Southwest)
2018	14.1	6.3	47.4	21.2	191 (Southwest)
2019	14.1	6.3	42.9	19.2	192 (Southwest)
2020	13.9	6.2	51.4	23.0	196 (Southwest)

Source: NOAA 2021b
Note: NOAA buoy measurements for wind speed are averaged over an 8-minute period.

Table I-2 Seasonal Average and Maximum Wind Speed and Direction at New York Harbor Entrance Buoy (Buoy No. 44065) in 2017

Season	Average Wind Speed		Maximum Wind Speed		Average Wind Direction
	mph	m/s	mph	m/s	Degrees from True North
Winter	16.8	7.5	44.3	19.8	223.9 (Southwest)
Spring	14.5	6.5	47.0	21.0	187.0 (South)
Summer	11.4	5.1	30.4	13.6	183.5 (South)

[1] NOAA buoy measurements for wind speed are averaged over an 8-minute period. Higher speeds are recorded for 5- to 8-second gusts.

Season	Average Wind Speed		Maximum Wind Speed		Average Wind Direction
	mph	m/s	mph	m/s	Degrees from True North
Fall	15.2	6.8	39.1	17.5	197.8 (Southwest)

Source: NOAA 2021b
Note: NOAA buoy measurements for wind speed are averaged over an 8-minute period.

I.1.3 Air Temperature and Precipitation

NOAA's National Centers for Environmental Information, formerly the National Climatic Data Center, defines distinct climatological divisions to represent areas that are nearly climatically homogeneous. Locations within the same climatic division are considered to share the same overall climatic features and influences. The site of the Proposed Action is within the New York coastal division or New York Climate Division 4 (NOAA National Centers for Environmental Information 2021a).

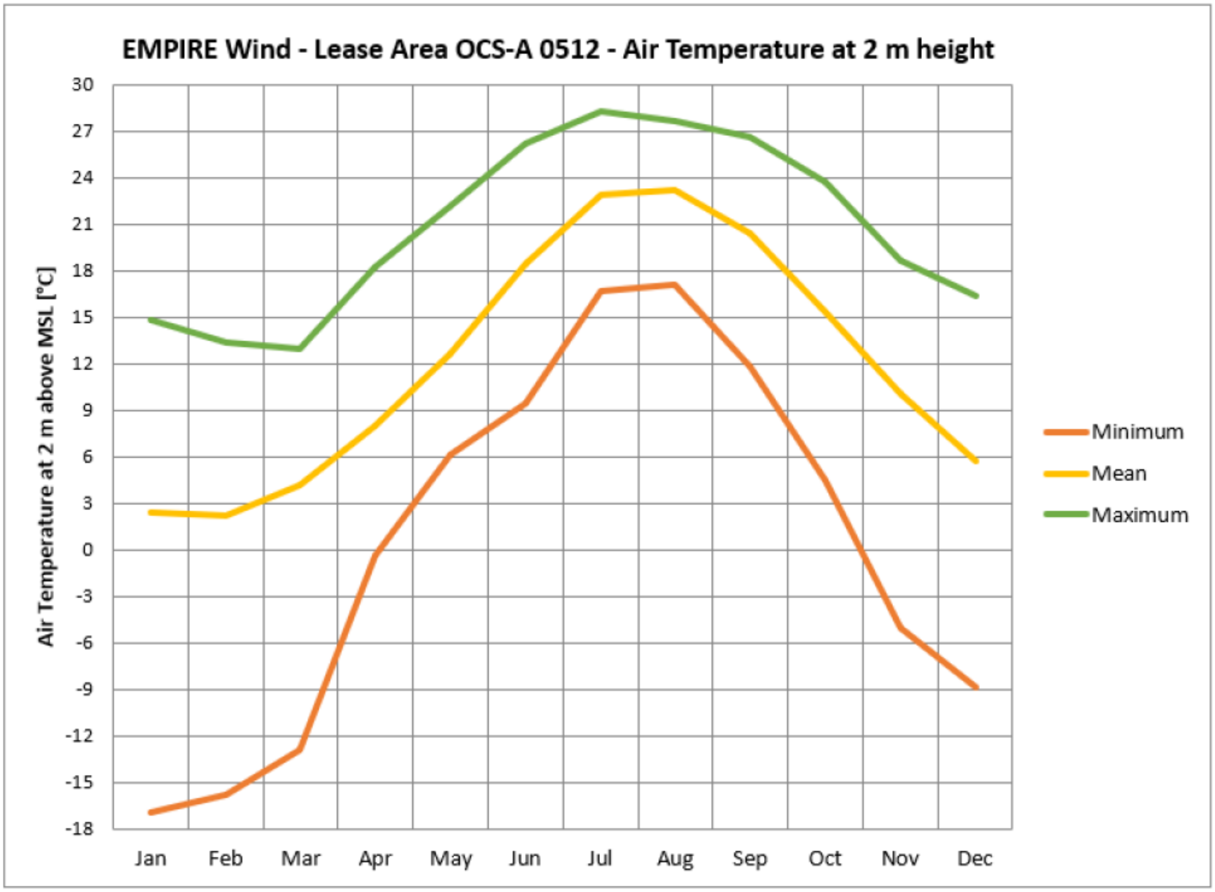
The mean average annual air temperature in the coastal division of New York was 51.4 °F (10.8 °C) between 1895 and 2021 (NOAA National Centers for Environmental Information 2021b). The seasonal mean ranged from 31.9 °F (-0.1 °C) in winter (December through February) to 70.8 °F (21.6 °C) in summer (June through August) (NOAA National Centers for Environmental Information 2021b).

Air temperature information is also available from NOAA's National Data Buoy Center Long Island buoy (Buoy No. 44025) and New York Harbor Entrance buoy (Buoy No. 44065). This information is presented in Table I-3 and shows air temperatures near the Lease Area ranging from 35 °F to 75 °F (1.67 °C to 23.90 °C), with the higher temperatures during the summer months (Empire 2023 citing NOAA 2018b, 2018c). Minimum, mean, and maximum air temperatures occurring over the Lease Area at 2 meters AMSL from the period between 2002 and 2019 are shown graphically on Figure I-2.

Table I-3 Average Air Temperature at NOAA Buoys in the Study Area

Month	Average Air Temperature in °F (°C)	
	Buoy Number 44065 (2008–2018)	Buoy Number 44025 (2007–2018)
January	35.01 (1.67)	37.98 (3.32)
February	36.66 (2.59)	38.70 (3.72)
March	39.58 (4.21)	41.49 (5.27)
April	46.65 (8.14)	47.03 (8.35)
May	56.71 (13.73)	55.33 (12.96)
June	66.04 (18.91)	65.46 (18.59)
July	73.92 (23.29)	73.29 (22.94)
August	75.02 (23.90)	73.98 (23.32)
September	69.69 (20.94)	68.61 (20.34)
October	59.94 (15.52)	60.53 (15.85)
November	49.10 (9.50)	51.06 (10.59)
December	42.13 (5.63)	43.77 (6.54)

Sources: Empire 2023 citing NOAA 2018b, 2018c



Source: Empire 2023 citing Kjeller Vindteknikk 2020

Figure I-2 Minimum, Mean, and Maximum Air Temperature at 2 Meters AMSL at Lease Area OCS-A 0512

Precipitation in the New York coastal region primarily takes the form of rain and snow. The mean annual precipitation for the coastal region of New York between 1895 and 2021 was 44.89 inches (114.0 centimeters) (NOAA National Centers for Environmental Information 2021c). During the same period, the mean monthly precipitation ranged from 3.40 inches (8.6 centimeters) in February to 4.19 inches (10.6 centimeters) in March (NOAA National Centers for Environmental Information 2021c). A summary of monthly and annual mean temperature and precipitation data collected for the New York coastal division between 1895 and 2021 is presented in Table I-4.

Table I-4 Mean Temperatures and Precipitation for New York Coastal Division, 1895 to 2021

Month	Average Mean Temperature		Maximum Mean Temperature		Minimum Mean Temperature		Total Mean Precipitation	
	°F	°C	°F	°C	°F	°C	Inches	cm
January	30.3	-0.9	38.0	3.3	22.6	-5.2	3.6	9.1
February	30.8	-0.7	38.7	3.7	22.8	-5.1	3.4	8.6
March	38.4	3.6	46.6	8.1	30.1	-1.1	4.2	10.7
April	47.9	8.8	57.0	13.9	38.8	3.8	3.9	9.9
May	58.1	14.5	67.6	19.8	48.7	9.3	3.8	9.7

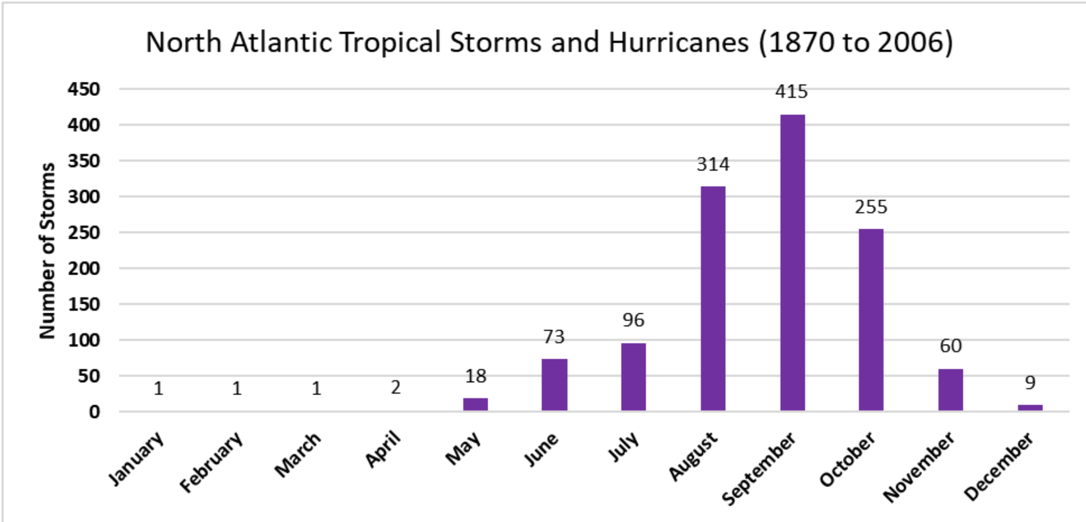
Month	**Average Mean Temperature**		**Maximum Mean Temperature**		**Minimum Mean Temperature**		**Total Mean Precipitation**	
	°F	**°C**	**°F**	**°C**	**°F**	**°C**	**Inches**	**cm**
June	67.4	19.7	76.6	24.8	58.2	14.6	3.5	8.9
July	73.1	22.8	81.9	27.7	64.3	17.9	3.7	9.4
August	71.8	22.1	80.3	26.8	63.2	17.3	4.1	10.4
September	65.3	18.5	74.2	23.4	56.4	13.6	3.6	9.1
October	54.8	12.7	63.8	17.7	45.7	7.6	3.6	9.1
November	44.4	6.9	52.4	11.3	36.3	2.4	3.8	9.7
December	34.6	1.4	42.0	5.6	27.1	-2.7	4.0	10.2
Annual	**51.4**	**10.8**	**59.9**	**15.5**	**42.9**	**6.0**	**44.9**	**114.0**

Source: NOAA National Centers for Environmental Information 2021b, 2021c
cm = centimeters

I.1.4 Extreme Storm Events

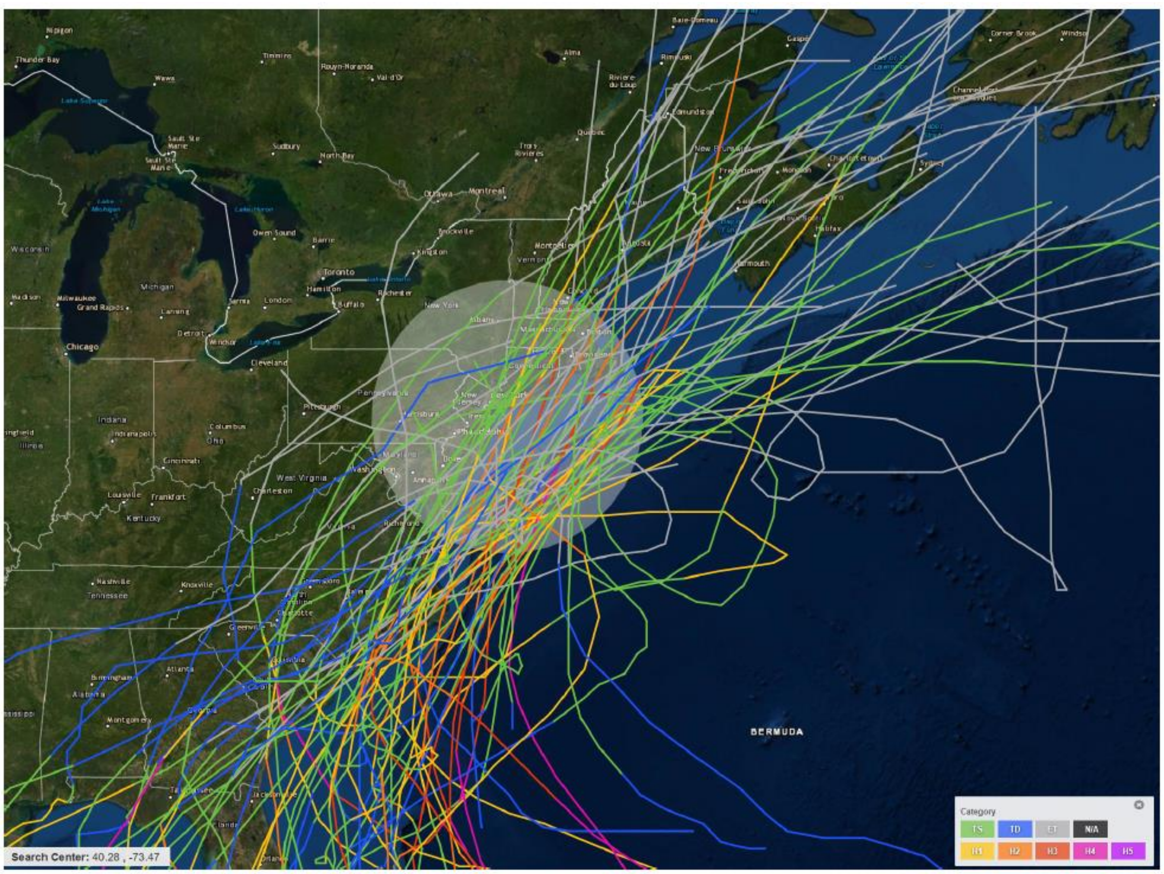
Strong weather events in the Lease Area include, but are not limited to, hurricanes and tropical storms in the warmer months and nor'easters during the winter months. The number of tropical storms, including hurricanes, generally reaches a peak during the period from August to early October (COP Appendix I; Empire 2023). This is consistent with the peak period for tropical cyclones throughout the North Atlantic basin (Figure I-3) (McAdie et al. 2009). Such storms that travel along the coastline of the eastern United States have the potential to affect the Project area with high winds and severe flooding.

Figure I-4 and Figure I-5 identify the hurricane tracks surrounding the Lease Area between 1950 and 2019 (COP Appendix I; Empire 2023). The category for each storm is designated by a color for each segment of its track on Figure I-4 and Figure I-5. Table I-5 lists each of the hurricanes affecting the Lease Area and the corresponding maximum storm categories as the hurricane occurred within 200 nm (370 kilometers) of the Lease Area for the corresponding period (NOAA 2021c). Most historical hurricanes affecting the Lease Area are Category 1, but storms as powerful as Category 3 hurricanes have passed nearby the Lease Area. The New York State ClimAID assessment determined that intense hurricanes are likely to increase in frequency over the 21st century for New York City and Long Island (New York State Climate Action Council 2010).



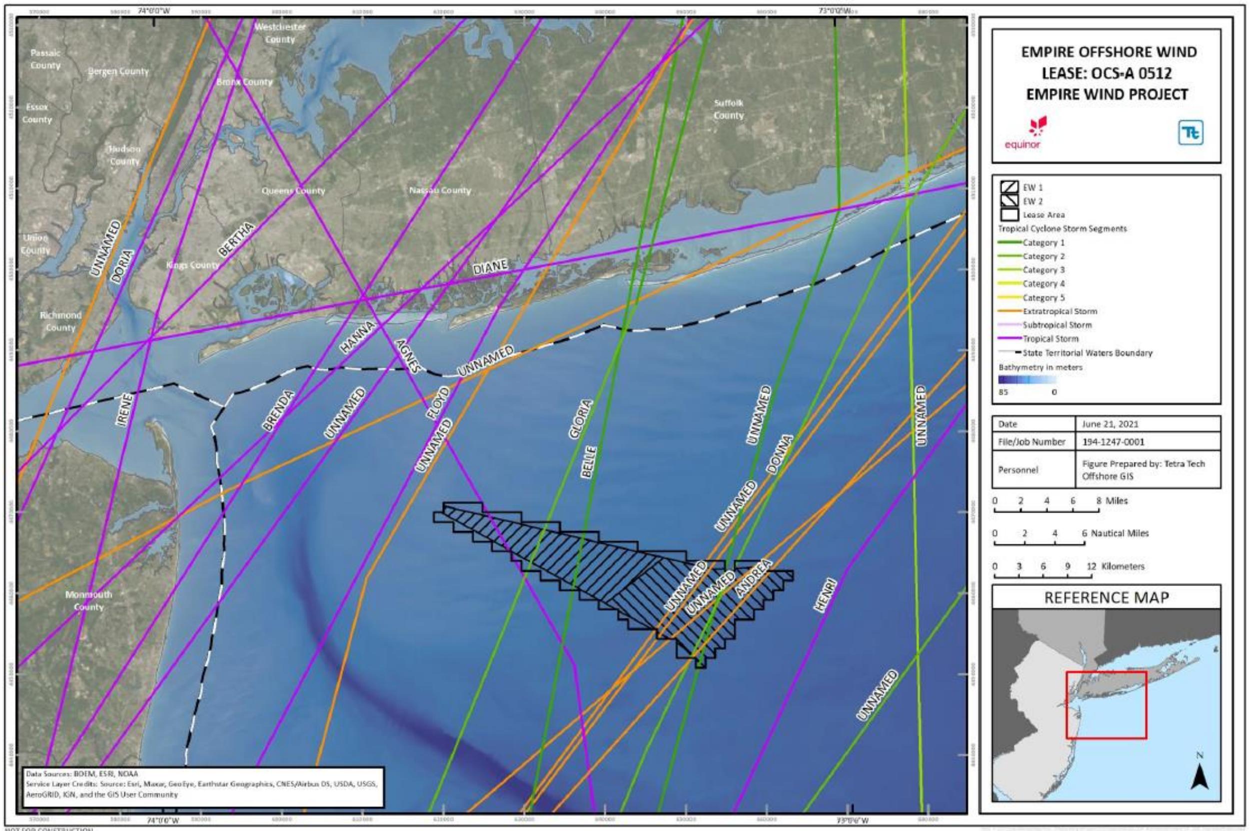
Source: McAdie et al. 2009

Figure I-3 Total Number of North Atlantic Basin Tropical Storms and Hurricanes per Month from 1870 to 2006



Source: COP Appendix I; Empire 2023

Figure I-4 Tracks of Hurricanes between 1950 and 2019 within a 200-nm (370-kilometer) Radius around Lease Area OCS-A 0512



Source: Empire 2023

Figure I-5 Hurricane Track Lines in the Project Area

Table I-5 Hurricanes with Tracks Passing within 200 nm of the Lease Area between 1950 and 2019

Storm Name	Year	Maximum Storm Category within 200 nm of Lease Area
Arthur	2014	Category 1 Hurricane
Sandy	2012	Category 2 Hurricane
Irene	2011	Category 1 Hurricane
Earl	2010	Category 1 Hurricane
Gustav	2002	Category 1 Hurricane
Floyd	1999	Category 1 Hurricane
Bonnie	1998	Category 1 Hurricane
Edouard	1996	Category 1 Hurricane
Emily	1993	Category 3 Hurricane
Bob	1991	Category 3 Hurricane
Charley	1986	Category 1 Hurricane
Gloria	1985	Category 2 Hurricane
Belle	1976	Category 2 Hurricane
Gerda	1969	Category 3 Hurricane
Doria	1967	Category 1 Hurricane

Storm Name	Year	Maximum Storm Category within 200 nm of Lease Area
Gladys	1964	Category 1 Hurricane
Alma	1962	Category 1 Hurricane
Esther	1961	Category 3 Hurricane
Donna	1960	Category 2 Hurricane
Daisy	1958	Category 2 Hurricane
Ione	1955	Category 1 Hurricane
Edna	1954	Category 3 Hurricane
Carol	1954	Category 3 Hurricane
Carol	1953	Category 1 Hurricane
Barbara	1953	Category 1 Hurricane
Dog	1950	Category 2 Hurricane
Able	1950	Category 2 Hurricane

Source: NOAA 2021c
Notes: The Lease Area was represented by a point with the following coordinates: latitude 40.28, longitude -73.47. Hurricane categories are identified as 1 through 5 based on the Saffir-Simpson scale.

Hurricane Sandy, which occurred in 2012, provides an example of extreme storm conditions that have occurred in the region. In coastal New York, the storm surge created by Hurricane Sandy was more severe than a 100-year extreme event (Empire 2023). In Bergen Point West Reach on the northern side of Staten Island, tide gauges measured a storm surge of 9.56 feet (2.91 meters) and estimated inundation of 9.53 feet (2.9 meters). At the Battery on the southern tip of Manhattan, tide gauges measured storm surges of 9.40 feet (2.87 meters) and estimated inundation of 9.00 feet (2.7 meters) (Blake et al. 2013). Marine observations at NOAA Buoy No. 44025 and NOAA Buoy No. 44065 recorded maximum sustained wind speeds of 49 knots (56.4 mph; 25.2 m/s) and 48 knots (55.2 mph; 24.7 m/s), respectively (Blake et al. 2013).

I.1.5 Potential General Impacts of Offshore Wind Facilities on Meteorological Conditions

A known impact of offshore wind facilities on meteorological conditions is the wake effect. A WTG extracts energy from the free flow of wind, creating turbulence downstream of the WTG. The resulting “wake effect” is the aggregated influence of the WTGs for the entire wind farm on the available wind resource and the energy production potential of any facility downstream. Christiansen and Hasager (2005) observed offshore wake effects from existing facilities via satellite with synthetic aperture radar to last anywhere from 1.2 to 12.4 miles (2 to 20 kilometers) depending on ambient wind speed, direction, degree of atmospheric stability, and the number of turbines within a facility. During stable atmospheric conditions, these offshore wakes can be longer than 43.5 miles (70 kilometers).

Under certain conditions, offshore wind farms can also affect temperature and moisture downwind of the facilities. For example, from September 2016 to October 2017, a study using aircraft observations accompanied by mesoscale simulations examined the spatial dimensions of micrometeorological impacts from a wind energy facility in the North Sea (Siedersleben et al. 2018). Measurements and associated modeling indicated that measurable redistribution of moisture and heat were possible up to 62 miles (100 kilometers) downwind of the wind farm. However, this occurred only when (a) there was a strong, sustained temperature inversion at or below hub height and (b) wind speeds were greater than approximately 13.4 mph (6 m/s) (Siedersleben et al. 2018). Typically, air temperature will decrease with height above the sea surface in the lower atmosphere (i.e., the troposphere), and air will freely rise and disperse up to a “mixing height” (Holzworth 1972; Ramaswamy et al. 2006). A temperature inversion occurs when a warmer overlying air mass causes temperatures to increase with height; a strong inversion inhibits the further rise of cooler surface air masses, thus limiting the mixing height (Ramaswamy et al. 2006). Therefore, the North Sea study suggests that rapidly spinning turbines with hub heights at or above a strong inversion may induce mixing between air masses that would otherwise remain separated, which can significantly affect temperature and humidity downwind of a wind farm.

The mixing height over open waters of the North Atlantic Ocean is typically greater than 1,640 feet (500 meters) AMSL, except over areas of upwelling, where the mixing height may be closer to the sea surface (Holzworth 1972; Fuhlbrügge et al. 2013). Table I-6 presents atmospheric mixing height data from the nearest measurement location to the Project area (Atlantic City, New Jersey). As shown in the table, the minimum average mixing height is 390 meters (1,279 feet), while the maximum average mixing height is 1,218 meters (3,996 feet).

Table I-6 Representative Seasonal Mixing Height Data

Season	Data Hours Included[1]	Atlantic City, NJ Average Mixing Height (meters)
Winter (December, January, February)	Morning: No-Precipitation Hours	624
	Morning: All Hours	617
	Afternoon: No-Precipitation Hours	774
	Afternoon: All Hours	390
Spring (March, April, May)	Morning: No-Precipitation Hours	545
	Morning: All Hours	640
	Afternoon: No-Precipitation Hours	1,196
	Afternoon: All Hours	499
Summer (June, July, August)	Morning: No-Precipitation Hours	511
	Morning: All Hours	566
	Afternoon: No-Precipitation Hours	1,218
	Afternoon: All Hours	695
Fall (September, October, November)	Morning: No-Precipitation Hours	484
	Morning: All Hours	649
	Afternoon: No-Precipitation Hours	988
	Afternoon: All Hours	476
Annual Average	Morning: No-Precipitation Hours	539
	Morning: All Hours	620
	Afternoon: No-Precipitation Hours	1,052
	Afternoon: All Hours	508

Source: USEPA 2021
[1] Missing values are not included.

Díaz et al. (2019) reported that measurements over the Atlantic Ocean between 1981 and 2010 indicated a trend of decreasing strength and thickness of inversion layers, accompanied by a general increase in the mixing height, which is correlated with an increase in sea surface temperatures. Therefore, WTG hub heights are expected to remain well below the typical mixing height and associated temperature inversions over the open ocean in the Mid-Atlantic region. As such, the redistribution of moisture and heat due to rotor-induced vertical mixing, and any associated shifts to the microclimate, would be limited to the immediate vicinity of a wind facility in this region.

Additionally, mixing height affects air quality by acting as a lid on the height to which air pollutants can vertically disperse. Lower mixing heights allow less air volume for pollutant dispersion and lead to higher ground-level pollutant concentrations than do higher mixing heights.

I.2. Demographics, Employment, and Economics

Table I-7 Demographic Trends: 2000, 2010, 2020

Jurisdiction	Population 2000	Population 2010	Population 2020	% Change 2000–2020	% Change 2010–2020
Village of Island Park	4,732	4,675	4,928	4.1%	5.4%
City of Albany	99,658	97,856	99,224	3.7%	1.4%
City of Long Beach	35,462	33,275	35,029	-1.2%	5.3%
Town of Hempstead	755,924	759,917	793,409	5.0%	4.4%
Albany County	294,565	304,204	314,848	6.9%	3.5%
Kings County	2,465,326	2,504,700	2,736,074	11.0%	9.2%
Nassau County	1,334,544	1,339,354	1,395,774	4.6%	4.2%
Nueces County, Texas	313,645	340,223	353,178	12.6%	3.8%
San Patricio County, Texas	67,138	64,804	68,755	2.4%	6.1%
State of New York	18,976,457	19,378,096	20,201,249	6.5%	4.2%

Source: U.S. Census Bureau 2000, 2020

Table I-8 Demographic Data: 2020

Jurisdiction	Population	Population Density (persons per square mile)	Population 18 Years and Over	% of Population 18 Years and Over	% of Population Under 18
Village of Island Park	4,928	11,081	3,983	80.8%	19.2%
City of Albany	99,224	4,636	81,589	82.2%	17.8%
City of Long Beach	35,029	15,796	29,730	84.9%	15.1%
Town of Hempstead	793,409	6,695	620,910	78.3%	21.7%
Albany County	314,848	602	255,875	81.3%	18.7%
Kings County	2,736,074	39,438	2,140,371	78.2%	21.8%
Nassau County	1,395,774	4,905	1,098,884	78.7%	21.3%
Nueces County, Texas	353,178	421	270,056	76.5%	23.5%
San Patricio County, Texas	68,755	99	51,377	74.7%	25.3%
State of New York	20,201,249	429	16,088,135	79.6%	20.4%

Source: U.S. Census Bureau 2020

Table I-9 Age Distribution

Jurisdiction	0–17	18–34	35–64	65+	Median Age
Village of Island Park	18.4%	22.5%	43.6%	15.6%	39
City of Albany	17.8%	37.9%	31.4%	12.9%	31
City of Long Beach	15.4%	23.6%	42.7%	18.4%	45
Town of Hempstead	22.1%	21.5%	40.1%	16.3%	40
Albany County	18.6%	27.8%	37.1%	16.5%	38
Kings County	23.0%	26.6%	36.9%	13.6%	35
Nassau County	21.7%	20.4%	40.5%	17.5%	42
Nueces County, Texas	24.8%	24.6%	36.6%	14.1%	36
San Patricio County, Texas	27.0%	22.4%	36.0%	14.6%	36
State of New York	21.0%	24.0%	39.0%	16.2%	39

Source: U.S. Census Bureau 2019a

Table I-10 Employment and Income Levels

Jurisdiction	Per Capita Income	Total Employment	Unemployment Rate	Percent of Population Living Below Poverty Level
Village of Island Park	$40,304	842	2.5%	2.6%
City of Albany	$29,174	124,954	7.1%	22.9%
City of Long Beach	$53,579	6,035	4.4%	6.7%
Town of Hempstead	$44,958	299,756	4.2%	6.0%
Albany County	$37,635	242,227	4.5%	11.9%
Kings County	$34,173	874,328	6.2%	20.0%
Nassau County	$51,422	647,469	3.9%	5.6%
Nueces County, Texas	$27,740	159,956	5.7%	16.5%
San Patricio County, Texas	$26,054	19,117	5.1%	15.9%
State of New York	$39,326	9,547,776	5.5%	14.1%

Sources: U.S. Census Bureau 2019a, 2019b

Table I-11 Housing Trends: 2020

Jurisdiction	Housing Units	Occupied (%)	Vacant (%)
Village of Island Park	1,851	93.2%	6.8%
City of Albany	48,031	87.8%	12.2%
City of Long Beach	16,771	91.6%	8.4%
Town of Hempstead	260,524	96.1%	3.9%
Albany County	146,131	90.9%	9.1%
Kings County	1,077,654	93.7%	6.3%
Nassau County	476,732	95.5%	4.5%
Nueces County, Texas	151,255	86.4%	13.6%
San Patricio County, Texas	29,424	84.3%	15.7%
State of New York	8,488,066	90.9%	9.1%

Source: U.S. Census Bureau 2020

Table I-12 Housing Vacancy and Value

Jurisdiction	Housing Units	Seasonal Vacant Units	Vacant Units (Non-Seasonal)	Non-Seasonal Vacancy Rate	Median Value (Owner-Occupied)	Median Monthly Rent (Renter-Occupied)
Village of Island Park	1,693	0	108	6.4%	$399,300	$1,689
City of Albany	48,813	153	7,405	15.2%	$179,100	$969
City of Long Beach	15,969	920	1,023	6.8%	$508,800	$1,874
Town of Hempstead	256,561	1,692	10,666	4.2%	$455,700	$1,678
Albany County	141,553	1,896	13,117	9.4%	$222,500	$1,022
Kings County	1,044,493	9,703	76,223	7.4%	$706,000	$1,426
Nassau County	472,572	3,971	21,624	4.6%	$493,500	$1,772
Nueces County, Texas	149,287	4,704	15,132	10.1%	$138,700	$1,017
San Patricio County, Texas	28,226	1,035	4,293	15.2%	$122,100	$975
State of New York	8,322,722	348,027	631,461	7.9%	$313,700	$1,280

Source: U.S. Census Bureau 2019a

Table I-13 Employment of Residents, by Industry

Industry	Village of Island Park	City of Albany	City of Long Beach	Town of Hempstead	Albany County	Kings County	Nassau County	Nueces County, Texas	San Patricio County, Texas	State of New York
Agriculture, Forestry, Fishing and Hunting, and Mining	0.0%	0.3%	0.2%	0.1%	0.3%	0.1%	0.2%	2.6%	5.7%	0.6%
Construction	11.4%	3.2%	6.6%	6.1%	4.3%	5.1%	5.7%	10.4%	13.8%	5.7%
Manufacturing	4.2%	2.8%	3.2%	4.0%	5.0%	3.2%	4.4%	6.3%	8.4%	6.0%
Wholesale Trade	2.5%	1.1%	3.0%	3.0%	1.8%	2.2%	3.3%	2.2%	2.7%	2.3%
Retail Trade	7.0%	10.1%	9.4%	10.1%	10.0%	9.2%	9.7%	11.5%	9.9%	10.2%
Transportation and Warehousing, and Utilities	5.6%	2.8%	4.6%	6.1%	3.4%	6.7%	5.6%	4.7%	5.9%	5.5%
Information	1.2%	2.3%	3.2%	2.8%	2.1%	4.6%	2.9%	1.3%	0.7%	2.9%
Finance and Insurance, and Real Estate and Rental and Leasing	12.7%	5.1%	11.6%	9.4%	7.7%	7.4%	10.5%	5.8%	5.3%	8.0%
Professional, Scientific, and Management, and Administrative and Waste Management Services	11.0%	10.9%	13.6%	11.9%	11.7%	14.1%	12.9%	9.0%	7.5%	12.0%
Educational Services, and Health Care and Social Assistance	19.3%	32.7%	29.2%	29.8%	27.6%	28.4%	29.0%	22.8%	23.0%	27.9%
Arts, Entertainment, and Recreation, and Accommodation and Food Services	15.1%	11.9%	7.5%	7.1%	9.1%	10.1%	7.0%	11.8%	8.7%	9.5%
Other Services, Except Public Administration	6.0%	4.5%	3.4%	4.4%	4.7%	5.1%	4.2%	5.7%	3.2%	4.9%
Public Administration	4.3%	12.3%	4.7%	5.3%	12.3%	3.8%	4.7%	5.9%	5.0%	4.6%

Source: U.S. Census Bureau 2019a

Table I-14 At-Place Employment, by Industry

Industry	Village of Island Park	City of Albany	City of Long Beach	Town of Hempstead	Albany County	Kings County	Nassau County	Nueces County, Texas	San Patricio County, Texas	State of New York
Agriculture, Forestry, Fishing and Hunting	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.3%	1.7%	0.3%
Mining, Quarrying, and Oil and Gas Extraction	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	2.4%	0.0%
Utilities	0.0%	0.1%	0.0%	0.8%	0.2%	0.5%	0.6%	0.9%	1.2%	0.4%
Construction	12.5%	2.2%	5.4%	4.9%	3.2%	3.9%	4.9%	11.1%	31.2%	4.1%
Manufacturing	0.2%	1.3%	0.2%	1.9%	3.2%	2.2%	2.5%	4.2%	4.4%	4.5%
Wholesale Trade	1.1%	1.4%	3.8%	2.3%	2.8%	2.8%	3.8%	3.3%	1.2%	3.4%
Retail Trade	5.5%	4.1%	13.7%	14.0%	8.2%	8.8%	12.0%	9.8%	10.6%	9.3%
Transportation and Warehousing	0.1%	2.2%	0.9%	3.4%	3.0%	8.8%	2.7%	3.0%	1.8%	3.6%
Information	3.6%	1.3%	1.5%	1.1%	2.1%	1.4%	1.4%	0.8%	0.8%	3.4%
Finance and Insurance	9.4%	5.6%	5.3%	3.7%	5.7%	1.9%	4.4%	2.6%	1.3%	5.4%
Real Estate and Rental and Leasing	1.0%	0.7%	3.3%	1.4%	1.4%	2.3%	1.6%	1.8%	0.7%	2.2%
Professional, Scientific, and Technical Services	1.3%	5.1%	4.1%	5.9%	6.4%	3.0%	6.4%	5.3%	2.9%	7.1%
Management of Companies and Enterprises	0.0%	1.8%	0.1%	0.7%	1.7%	0.3%	1.0%	0.4%	0.4%	1.6%
Administration & Support, Waste Management and Remediation	1.4%	3.3%	1.8%	5.6%	5.1%	4.3%	5.1%	5.2%	2.0%	5.5%
Educational Services	15.6%	6.9%	7.4%	14.2%	8.3%	11.6%	11.4%	10.2%	14.1%	11.0%
Health Care and Social Assistance	22.6%	19.3%	18.1%	18.7%	16.2%	31.4%	24.1%	20.8%	5.7%	18.3%
Arts, Entertainment, and Recreation	1.3%	0.5%	0.8%	2.2%	0.9%	1.2%	1.9%	1.6%	1.2%	1.9%
Accommodation and Food Services	10.6%	3.8%	16.1%	8.4%	6.1%	6.1%	7.6%	11.2%	11.3%	8.0%
Other Services (excluding Public Administration)	7.7%	2.4%	5.4%	5.0%	3.8%	3.4%	4.8%	2.7%	1.6%	3.9%
Public Administration	6.3%	37.9%	12.1%	6.1%	21.7%	6.0%	3.7%	2.5%	3.7%	6.0%

Source: U.S. Census Bureau 2019b

Table I-15 Number of Establishments, By Industry: 2021

Industry	Village of Island Park	City of Albany	City of Long Beach	Town of Hempstead	Albany County	Kings County	Nassau County	Nueces County, Texas	San Patricio County, Texas	State of New York
Agriculture, Forestry, Fishing and Hunting	0	7	2	23	36	83	65	57	18	2,983
Mining, Quarrying, and Oil and Gas Extraction	0	3	0	15	10	24	28	73	12	412
Utilities	0	4	0	23	22	33	67	27	6	839
Construction	11	193	54	1,909	804	3,813	3,876	933	131	43,963
Manufacturing	4	83	15	712	338	2,089	1,591	336	43	21,150
Wholesale Trade	5	104	13	865	422	2,290	1,813	462	43	21,469
Retail Trade	14	424	102	4,090	1,705	11,578	8,077	1,914	290	99,043
Transportation and Warehousing	4	67	17	625	243	1,346	1,052	262	33	13,294
Information	4	135	19	602	328	1,662	1,251	230	29	17,435
Finance and Insurance	7	190	50	1,445	679	2,056	3,118	744	96	31,484
Real Estate and Rental and Leasing	7	171	77	1,126	608	3,891	2,547	794	134	35,067
Professional, Scientific, and Technical Services	5	572	76	3,173	1,463	6,086	6,662	1,067	111	69,799
Management of Companies and Enterprises	0	7	2	91	15	301	198	50	4	1,838
Administration & Support, Waste Management and Remediation	4	112	24	1,181	430	2,291	2,308	437	30	24,670
Educational Services	3	162	22	775	378	1,866	1,478	325	63	18,637
Health Care and Social Assistance	8	497	93	2,424	1,222	6,128	5,166	1,023	120	59,382
Arts, Entertainment, and Recreation	6	107	25	635	298	1,228	1,329	270	31	16,173
Accommodation and Food Services	11	364	111	2,330	1,003	7,093	4,288	1,131	205	58,735
Other Services (excluding Public Administration)	23	693	106	3,608	1,866	9,226	6,726	1,485	256	86,344
Public Administration	5	344	15	383	661	372	683	321	101	18,436
Unclassified	5	342	97	2,390	802	11,815	5,236	890	89	67,253
Total (All Sectors)	126	4,581	920	28,425	13,333	75,271	57,559	12,831	1,845	708,406

Source: ArcGIS Business Analyst 2021

Table I-16 Annual Payroll by Industry ($1,000): 2020

Industry	Albany County	Kings County	Nassau County	New York State
Agriculture, Forestry, Fishing and Hunting	$10,653	$14,043	$6,552	$1,062,904
Mining, Quarrying, and Oil and Gas Extraction	$39,693	$0	$0	$322,656
Utilities	$69,215	$409,411	$469,906	$4,808,912
Construction	$637,392	$1,973,121	$2,418,144	$28,305,328
Manufacturing	$696,731	$849,682	$1,144,903	$29,188,387
Wholesale Trade	$520,212	$1,235,743	$2,054,761	$27,814,772
Retail Trade	$700,201	$2,893,401	$2,779,800	$33,464,878
Transportation and Warehousing	$284,904	$700,358	$972,615	$13,081,012
Information	$430,924	$1,169,921	$793,223	$41,332,226
Finance and Insurance	$1,286,324	$1,567,844	$3,035,636	$129,471,739
Real Estate and Rental and Leasing	$187,430	$961,500	$768,862	$15,449,702
Professional, Scientific, and Technical Services	$1,460,915	$1,986,058	$3,273,562	$85,762,955
Management of Companies and Enterprises	$310,587	$162,906	$763,359	$21,639,905
Administration & Support, Waste Management and Remediation	$446,112	$1,290,984	$1,602,593	$28,518,583
Educational Services	$603,361	$1,465,788	$936,646	$23,113,579
Health Care and Social Assistance	$1,810,463	$10,853,850	$9,491,509	$87,278,334
Arts, Entertainment, and Recreation	$32,836	$497,139	$428,020	$7,776,281
Accommodation and Food Services	$238,288	$1,125,952	$1,051,072	$15,647,467
Other Services (excluding Public Administration)	$366,789	$818,662	$943,867	$15,048,420
Unclassified	$9,916	$190,649	$126,294	$1,783,279
Total (All Private)	$10,142,947	$30,168,669	$33,061,428	$610,871,320

Source: New York State Department of Labor 2020
Note: Dollar value is in $1000s.

Table I-17 Ocean Economy Data

County	Ocean Economy GDP, All Ocean Sectors	Ocean Economy GDP, Tourism and Recreation Sector	Ocean Economy GDP, Living Resources Sector	Total County GDP (Coastal Economy, Employment Data) Total, All Industries	Ocean Economy GDP, as Percent of Total County GDP (%)
Albany	$32,689,00	$0	Suppressed	$34,550,146,168	0.1%
Kings	$2,052,466,000	$1,802,669,000	$167,428,000	$95,011,253,174	2.2%
Nassau	$1,065,093,000	$794,144,000	$55,065,000	$99,424,936,812	1.1%
Nueces	$1,529,501,000	$574,591,000	Suppressed	$20,523,787,223	7.5%
San Patricio	$588,635,000	$60,386,000	$0.00	$2,383,411,637	24.7%

Source: NOAA 2018

Table I-18 Ocean Economy Employment[1]

County	Marine Construction	Living Resources	Offshore Mineral Extraction	Tourism and Recreation	Marine Transportation	Total, All Sectors
Albany	Suppressed	Suppressed	Suppressed	0	594	594
Kings	Suppressed	1412	Suppressed	33,228	1,517	36,157
Nassau	142	493	43	17,392	1,286	19,356
Nueces	Suppressed	Suppressed	2,453	13,488	558	17,507
San Patricio	Suppressed	0	449	1,766	Suppressed	4,607

Source: NOAA 2018
[1] Data for ship and boat building are suppressed for all counties, so are not included in the table.

Table I-19 Race and Ethnicity: 2020[1]

Jurisdiction	Total Population	White (%)	Black (%)	Asian (%)	Other (%)	Hispanic (%)	Total Minority %
Village of Island Park	4,928	55.4%	3.0%	4.1%	4.1%	33.4%	44.6%
City of Albany	99,224	44.7%	29.5%	8.0%	6.2%	11.6%	55.3%
City of Long Beach	35,029	72.9%	5.2%	3.2%	3.5%	15.3%	27.1%
Town of Hempstead	793,409	50.7%	15.9%	7.5%	3.8%	22.0%	49.3%
Albany County	314,848	67.0%	12.9%	7.7%	5.6%	6.9%	33.0%
Kings County	2,736,074	35.4%	26.7%	13.6%	5.4%	18.9%	64.6%
Nassau County	1,395,774	55.8%	10.6%	11.7%	3.5%	18.4%	44.2%
Nueces County, Texas	353,178	30.1%	3.6%	2.2%	2.7%	61.5%	69.9%
San Patricio County, Texas	68,755	38.7%	1.4%	1.2%	3.0%	55.6%	61.3%
State of New York	20,201,249	52.5%	13.7%	9.5%	4.9%	19.5%	47.5%

Source: U.S. Census Bureau 2020
[1] The percentages of White, Black, Asian, and Other categories include Non-Hispanics only.

Table I-20 Educational Attainment for Population 25 Years and Over[1]

Highest Education Attainment	Less than High School	High School or GED	Some College	Bachelor's Degree	Advanced Degree
Village of Island Park	7.7%	41.6%	27.4%	9.9%	13.3%
City of Albany	12.2%	23.0%	25.3%	19.6%	20.0%
City of Long Beach	5.2%	22.8%	23.4%	25.7%	23.0%
Town of Hempstead	10.1%	24.4%	24.4%	23.1%	17.9%
Albany County	7.9%	23.0%	27.4%	21.4%	20.4%
Kings County	17.6%	25.7%	19.2%	22.5%	15.0%
Nassau County	8.6%	22.7%	22.8%	25.3%	20.7%
Nueces County, Texas	17.2%	29.3%	31.7%	14.2%	7.6%
San Patricio County, Texas	20.1%	32.7%	31.6%	11.2%	4.4%
State of New York	13.2%	26.0%	24.3%	20.5%	16.0%

Source: U.S. Census Bureau 2019a
[1] The percentages may not sum to 100 due to rounding.

Table I-21 Economic Value of the Tourism and Recreation Sector

Affected Area	Establishments	Employment	Wages (millions)	GDP (millions)
State of New York	**22,270**	**359,194**	**$12,628.4**	**$29,039.5**
Albany County	N/A	N/A	N/A	N/A
Kings County	3,759	33,229	$899.2	$1,802.7
Nassau County	1,396	17,392	$421.9	$794.1
New York County	9,621	217,305	$9,207.3	$22,187.7
Queens County	1,299	11,581	$277.4	$510.0
Suffolk County	2,741	36,385	$921.1	$1,916.7
State of New Jersey	**7,949**	**96,261**	**$2,201.6**	**$4,299.3**
Monmouth County	1,324	17,767	$369.0	$704.7
Ocean County	1,155	14,049	$288.2	$569.5

Source: National Ocean Economics Program 2018
N/A = not available

Table I-22 Empire's Projected Jobs and Economic Impacts during Construction

Economic Impact		Empire Wind 1	Empire Wind 2	Total
Jobs (FTE)[1]	Direct	180	269	449
	Indirect	60	96	156
	Induced	92	141	233
	Total	332	506	838
Gross State Product (Value added) (in millions of 2020 dollars)	Direct	$152.8	$273.9	$426.7
	Indirect	$54.6	$99.9	$154.5
	Induced	$75.6	$132.2	$207.8
	Total	$283.0	$506.0	$789.0

Economic Impact		Empire Wind 1	Empire Wind 2	Total
Personal Income (in millions of 2020 dollars)	Direct	$114.1	$197.9	$312.0
	Indirect	$37.8	$67.4	$105.2
	Induced	$43.0	$75.2	$118.2
	Total	$194.9	$340.5	$535.4

Source: COP Volume 1, Appendix O; Empire 2023
[1] One FTE job is the equivalent of one person working full time for 1 year (2,080 hours). Therefore, two half-time employees would equal one FTE. Only those jobs that Empire would perform in the designated area are included.

Table I-23 Projected Tax Revenues during Construction and Operations and Maintenance

Taxes	Construction		Operations and Maintenance	
	Empire Wind 1	Empire Wind 2	Empire Wind 1	Empire Wind 2
State and Local Taxes	$24.9	$42.6	$48.8	$74.1
Federal Taxes	$38.4	$67.1	$63.0	$95.7
Total Taxes	$63.4	$109.7	$111.8	$169.8

Source: COP Volume 1, Appendix O; Empire 2023

Table I-24 Empire's Projected Jobs and Economic Impacts during Operations and Maintenance

Economic Impact		Empire Wind 1	Empire Wind 2	Total
Jobs (FTE)[1]	Direct	53	80	133
	Indirect/Induced	67	101	168
	Total	120	181	301
Gross State Product (Value added) (in millions of 2020 dollars)	Direct	$215.8	$302.7	$518.5
	Indirect	$158.4	$140.1	$298.5
	Induced	$119.6	$151.7	$271.3
	Total	$493.8	$594.5	$1,088.3
Personal Income (in millions of 2020 dollars)	Direct	$137.9	$208.8	$346.7
	Indirect	$103.4	$96.8	$200.2
	Induced	$68.0	$86.3	$154.3
	Total	$309.3	$391.9	$701.2

Source: COP Volume 1, Appendix O; Empire 2023
[1] One FTE job is the equivalent of one person working full time for 1 year (2,080 hours). Therefore, two half-time employees would equal one FTE. Only those jobs that Empire would perform in the designated area are included.

I.3. Wetlands

Table I-25 NYSDEC-mapped Aquatic Features

Route Feature	NYSDEC Classification	Acres within Footprint/Cable Corridor
EW 2 Landfall A	No NYSDEC-mapped features in footprint[1]	--
EW 2 Landfall B	No NYSDEC-mapped features in footprint[1]	--

Route Feature	NYSDEC Classification	Acres within Footprint/Cable Corridor
EW 2 Landfall C	No NYSDEC-mapped features in footprint[1]	--
EW 2 Landfall E	No NYSDEC-mapped features in footprint[1]	--
EW 2 Route LB-A	No NYSDEC-mapped features in cable corridor	--
EW 2 Route LB-B	No NYSDEC-mapped features in cable corridor	--
EW 2 Route LB-C	No NYSDEC-mapped features in cable corridor	--
EW 2 Route LB-D	Littoral Zone	0.04
EW 2 Route LB-E	No NYSDEC-mapped features in cable corridor	--
EW 2 Route LB-Variant	No NYSDEC-mapped features in cable corridor	--
EW 2 Route LB-F	No NYSDEC-mapped features in cable corridor	--
EW Route 2 LB-G	No NYSDEC-mapped features in cable corridor	--
EW Route 2 LB-H	No NYSDEC-mapped features in cable corridor	
Reynolds Channel Crossing	Littoral Zone Coastal Shoals, Bars, and Mudflats	8.63 0.21
EW 2 Route IP-A	No NYSDEC-mapped features in cable corridor	--
EW 2 Route IP-B	No NYSDEC-mapped features in cable corridor	--
EW 2 Route IP-C	Littoral Zone Coastal Shoals, Bars, and Mudflats Intertidal Marsh	1.07 0.84 0.10
EW 2 Route IP-D	Littoral Zone	0.37
EW 2 Route IP-E	Littoral Zone Coastal Shoals, Bars, and Mudflats Intertidal Marsh	0.47 0.51 0.04
EW 2 Route IP-F	Littoral Zone Coastal Shoals, Bars, and Mudflats Intertidal Marsh	2.74 1.08 1.50
EW 2 Route IP-G	Littoral Zone Coastal Shoals, Bars, and Mudflats Intertidal Marsh High Marsh	3.27 3.99 2.44 0.16
EW 2 Route IP-H	No NYSDEC-mapped features in cable corridor	--
EW 2 Onshore Substation A	No NYSDEC-mapped features in footprint	--
EW 2 Onshore Substation C	No NYSDEC-mapped features[2]	--

Source: COP Volume 2, Table 5.2-3; Empire 2023

Note: The table presents wetland areas within the cable corridor that could be susceptible to potential impacts and not necessarily the area of wetland that would actually be affected during construction and operations. For example, segment IP-C could cross Reynolds Channel via open trench or trenchless (e.g., HDD) methods, which would have very different impacts on wetlands.

[1] The four landfalls have "Adjacent Areas" mapped within the footprint, which are land areas that are adjacent to any of the NYSDEC tidal wetland zone classifications. Adjacent Areas are generally not inundated by tidal waters and extend 300 feet landward of the most landward tidal wetland boundary or to an elevation of 10 feet (refer to New York State regulations Part 661, Tidal Wetlands Land Use Regulation).

[2] NYSDEC mapping indicates that Reynolds Channel extends into the Onshore Substation C site by a maximum of approximately 40 feet (12 meters); however, a review of aerial imagery indicates that historic alterations to the shoreline, including bulkheading, have resulted in a more artificial and linear bank than portrayed by NYSDEC-mapped boundaries. The result of these shoreline alterations is that the current bank of Reynolds Channel appears to approximately align with the boundary of the EW 2 Onshore Substation C site.

This page intentionally left blank.

I.4. Commercial and For-Hire Recreational Fisheries

Table I-26 Annual Number of Trips by Commercial Fishing Vessels to the EW 1 WEA for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Summer Flounder	1,418	1,488	1,532	1,679	1,673	1,119	1,072	1,044	1,076	858	905	838	861	675	1,160
Monkfish	1,904	1,361	850	870	797	643	838	769	636	582	509	513	503	324	793
Longfin Squid	708	766	811	1,009	1,216	557	704	573	622	705	594	524	600	485	705
Atlantic Sea Scallop	2,486	2,238	697	1,045	609	404	612	452	574	158	99	90	192	68	695
Black Sea Bass	541	489	794	757	679	580	627	616	610	617	546	577	537	496	605
Skate spp.	606	461	580	734	780	580	607	581	554	607	573	517	528	383	578
Scup	201	313	548	413	388	369	266	367	521	590	589	506	586	457	437
American Lobster	600	588	598	426	554	554	451	379	388	352	288	277	287	259	429
Bluefish	475	369	394	568	563	270	339	318	272	358	207	261	316	211	352
Silver Hake	355	414	309	355	317	359	351	243	178	261	297	310	343	243	310
Red Hake	404	406	314	275	356	421	335	247	144	232	215	311	321	161	296
Butterfish	234	232	231	237	409	234	249	174	220	233	239	220	245	166	237
Smooth Dogfish	236	221	318	406	278	222	228	213	155	190	150	145	137	124	216
Spiny Dogfish	97	211	192	284	171	122	113	149	144	182	121	97	139	151	155
Jonah Crab	46	103	138	106	166	187	132	170	152	141	111	132	168	102	132
Weakfish	231	113	147	87	142	158	62	59	157	132	93	103	136	120	124
Atlantic Mackerel	94	112	65	36	112	24	60	52	56	106	146	125	131	101	87
Tautog	78	92	101	127	78	69	55	58	85	71	52	67	31	96	76
Conger Eel	33	32	72	53	71	55	59	88	60	73	71	79	81	62	64
Atlantic Herring	135	189	137	91	58	35	30	36	21	19	58	37	7	0	61

Source: NMFS 2022

Table I-27 Annual Number of Commercial Fishing Vessels that Fished in the EW 1 WEA for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Monkfish	210	223	210	208	189	117	205	172	148	109	115	107	97	75	156
Atlantic Sea Scallop	189	218	229	250	166	121	226	149	171	89	54	57	127	51	150
Summer Flounder	105	113	104	133	145	105	128	141	119	106	111	107	96	87	114
Longfin Squid	74	89	81	96	115	85	102	114	90	100	96	93	79	74	92
Black Sea Bass	74	71	81	97	115	78	83	91	99	94	87	97	85	75	88
Scup	51	72	77	73	99	74	72	88	80	100	99	90	84	73	81
Bluefish	65	78	69	88	112	73	89	90	70	86	54	63	61	45	75
Skate spp.	61	65	63	74	68	43	59	61	53	64	72	55	44	35	58
Butterfish	48	52	45	51	65	51	61	48	39	57	64	57	48	43	52
Silver Hake	44	59	44	36	42	48	54	43	37	51	62	61	56	45	49
Red Hake	49	54	39	33	45	42	44	38	29	47	48	51	43	33	43
Weakfish	55	33	28	32	46	38	27	24	49	58	39	38	45	44	40
American Lobster	48	55	45	45	51	36	39	27	28	32	32	30	23	22	37
Smooth Dogfish	37	34	42	45	39	35	35	33	18	32	26	23	17	16	31

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Mackerel	30	41	34	17	30	13	22	26	24	32	45	43	33	34	30
Conger Eel	15	17	19	19	22	22	21	22	20	19	27	33	22	19	21
Spiny Dogfish	17	29	29	35	29	17	19	23	17	21	20	14	14	13	21
Atlantic Herring	30	29	31	18	17	12	10	14	11	12	14	12	5	0	15
Sea Robin spp.	11	14	13	18	13	12	19	20	14	20	14	16	11	7	14
Jonah Crab	10	10	10	14	14	11	12	14	11	13	14	12	10	10	12

Source: NMFS 2022

Table I-28 Annual Number of Trips by Commercial Fishing Vessels to the EW 2 WEA for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Sea Scallop	2,631	2,330	773	1,194	882	712	996	782	1,172	436	311	283	395	152	932
Monkfish	1,751	1,234	755	798	761	698	871	845	808	587	625	530	428	329	787
Summer Flounder	769	929	764	887	883	594	687	634	730	536	656	524	489	430	679
Longfin Squid	344	459	473	587	746	383	506	436	373	443	519	378	362	366	455
Black Sea Bass	231	245	337	466	445	326	398	412	417	431	446	421	391	390	383
Scup	73	211	302	264	320	275	223	338	378	388	510	401	385	358	316
Skate spp.	318	323	323	446	337	259	338	332	328	327	371	248	227	162	310
Bluefish	187	307	268	374	425	251	326	317	276	371	214	251	259	178	286
Silver Hake	171	250	127	146	165	215	196	148	131	166	249	238	180	191	184
American Lobster	157	236	160	147	196	121	173	158	131	123	115	154	128	155	154
Butterfish	88	116	119	130	212	155	190	107	149	178	216	144	120	134	147
Red Hake	136	165	106	87	119	185	128	114	106	120	162	158	134	109	131
Smooth Dogfish	150	118	148	206	123	89	120	96	65	94	94	64	49	53	105
Weakfish	86	75	56	62	93	114	79	113	148	176	124	98	81	132	103
Atlantic Mackerel	110	105	58	26	48	19	42	40	51	66	162	80	66	68	67
Spiny Dogfish	62	140	87	148	94	47	51	52	27	40	61	22	21	44	64
Atlantic Herring	90	98	56	30	29	24	12	30	21	21	63	41	7	0	37
Jonah Crab	5	22	20	18	5	18	32	66	33	49	44	73	37	87	36
Conger Eel	12	0	27	0	0	43	35	46	47	27	38	61	30	33	29
Sea Robin spp.	13	26	34	31	40	27	30	27	24	32	38	29	0	32	27

Source: NMFS 2022

Table I-29 Annual Number of Commercial Fishing Vessels that Fished in the EW 2 WEA for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Sea Scallop	215	247	267	286	217	155	272	182	254	188	91	97	192	83	196
Monkfish	242	249	247	236	221	162	253	202	204	155	151	139	120	100	192
Summer Flounder	118	120	131	136	157	123	152	152	152	134	129	130	114	110	133
Longfin Squid	80	96	87	94	121	106	110	123	113	103	106	104	85	92	101
Black Sea Bass	75	71	93	93	113	85	96	107	115	107	104	107	88	89	96
Scup	44	85	85	77	104	86	82	97	93	108	109	97	87	87	89

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Bluefish	59	81	74	86	111	85	93	99	90	89	56	68	64	50	79
Skate spp.	60	70	74	71	64	56	62	65	57	73	82	61	46	46	63
Butterfish	49	52	42	48	62	66	63	51	61	59	73	55	49	53	56
Silver Hake	49	65	50	35	42	61	59	52	57	60	69	67	55	57	56
Weakfish	49	37	35	35	46	51	35	49	55	65	47	37	35	51	45
Red Hake	47	53	42	35	37	54	43	44	44	50	47	48	43	38	45
American Lobster	39	52	46	36	46	39	44	23	23	27	29	31	20	21	34
Atlantic Mackerel	28	37	35	18	23	13	24	29	30	36	56	40	32	43	32
Smooth Dogfish	28	33	39	40	36	28	29	26	20	29	23	20	15	18	27
Spiny Dogfish	14	25	25	29	26	16	13	20	12	15	23	12	11	12	18
Conger Eel	10	0	17	0	0	25	20	24	25	20	26	32	21	18	17
King Whiting	10	9	10	9	13	10	17	19	20	25	23	9	12	20	15
John Dory	10	0	15	20	21	25	18	15	21	16	16	0	11	13	14
Atlantic Herring	26	25	25	15	14	9	9	13	9	14	14	11	5	0	14

Source: NMFS 2022

Table I-30 Annual Number of Trips by Commercial Fishing Vessels to the Lease Area for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Summer Flounder	1,490	1,655	1,638	1,757	1,818	1,283	1,254	1,213	1,406	1,063	1,113	999	989	789	1,319
Monkfish	2,217	1,658	1,075	1,048	1,035	951	1,192	1,113	1,035	848	806	732	668	444	1,059
Atlantic Sea Scallop	2,721	2,425	849	1,229	901	714	1,006	789	1,179	436	313	285	395	153	957
Longfin Squid	767	865	866	1,053	1,316	697	813	688	777	844	730	639	674	585	808
Black Sea Bass	560	545	840	791	774	661	730	731	751	745	675	668	617	595	692
Skate spp.	676	591	690	836	860	671	723	729	723	728	690	592	589	432	681
Scup	220	390	608	452	490	452	347	476	639	699	715	588	663	542	520
American Lobster	609	628	642	455	604	596	518	439	443	405	327	318	334	317	474
Bluefish	490	444	438	600	665	344	406	412	368	462	243	302	367	246	413
Silver Hake	398	514	344	378	380	460	409	283	243	319	376	386	388	299	370
Red Hake	423	463	343	296	383	504	364	275	206	290	272	356	371	220	340
Butterfish	253	276	252	258	437	310	294	201	280	294	295	257	273	207	278
Smooth Dogfish	248	236	326	422	295	234	251	232	183	217	169	160	145	134	232
Spiny Dogfish	98	235	201	295	195	131	128	157	152	194	135	97	142	152	165
Weakfish	240	137	169	99	184	206	95	127	197	201	145	133	166	166	162
Jonah Crab	47	107	148	112	167	192	144	191	167	166	129	152	173	146	146
Atlantic Mackerel	121	129	78	44	118	29	69	64	81	131	187	144	144	121	104
Tautog	79	93	101	129	78	70	59	58	85	71	52	67	31	96	76
Conger Eel	34	44	82	58	78	75	71	102	84	86	79	95	93	78	76
Atlantic Herring	155	201	141	95	61	36	35	39	24	24	63	42	7	0	66

Source: NMFS 2022

Table I-31 Annual Number of Commercial Fishing Vessels that Fished in the Lease Area for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Monkfish	253	263	260	247	237	168	265	211	214	161	157	146	127	105	201
Atlantic Sea Scallop	219	252	271	286	219	156	274	184	254	188	91	97	192	83	198
Summer Flounder	126	131	138	146	168	131	158	160	161	141	139	138	121	116	141
Longfin Squid	87	104	97	103	130	111	118	130	122	111	111	111	92	98	109
Black Sea Bass	87	88	103	105	126	95	104	114	129	119	116	119	97	96	107
Scup	62	96	94	84	114	93	91	104	103	118	116	105	97	93	98
Bluefish	72	91	83	94	127	91	103	107	95	98	61	72	70	54	87
Skate spp.	69	79	80	83	79	61	70	76	66	80	86	68	52	50	71
Butterfish	57	60	51	57	74	69	67	56	65	65	76	62	54	57	62
Silver Hake	56	71	53	43	50	67	66	54	61	64	73	72	64	60	61
Red Hake	56	65	50	41	51	62	50	50	51	59	57	60	54	45	54
Weakfish	64	42	40	39	56	56	38	51	59	68	53	45	51	56	51
American Lobster	53	62	55	48	58	48	52	31	35	41	40	37	27	27	44
Atlantic Mackerel	33	47	43	23	31	17	27	35	34	43	57	49	39	48	38
Smooth Dogfish	39	38	45	49	45	38	36	35	26	36	29	27	19	22	35
Conger Eel	16	25	25	21	25	34	27	30	30	28	32	40	30	26	28
Spiny Dogfish	18	30	32	37	34	20	20	24	20	22	24	14	16	13	23
King Whiting	12	9	13	12	18	12	18	19	20	28	26	12	16	25	17
Sea Robin spp.	11	17	14	21	16	14	20	21	18	21	15	19	12	11	16
Atlantic Herring	32	29	32	20	18	12	12	15	11	16	14	12	5	0	16

Source: NMFS 2022

Table I-32 Annual Number of Trips by Commercial Fishing Vessels to the EW 1 WEA by Gear Type, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Trawl-Bottom	3,276	3,133	1,836	2,258	2,109	1,318	1,344	1,140	1,206	1,045	965	877	885	693	1,578
Pots	456	431	449	315	417	545	381	339	367	330	253	260	248	241	359
Dredge-Scallop	376	349	344	444	295	176	373	333	319	104	64	67	170	49	247
Dredge-Clam	39	36	53	28	53	71	16	16	80	97	0	37	73	67	48
Gillnet-Sink	117	88	79	76	36	13	36	25	41	26	36	14	0	0	42
Trawl-Midwater	68	61	37	11	15	14	0	9	11	13	47	31	25	6	25

Source: NMFS 2022

Table I-33 Annual Number of Commercial Fishing Vessels that Fished in the EW 1 WEA by Gear Type, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Trawl-Bottom	132	155	115	138	157	120	136	136	118	127	119	108	96	92	125
Dredge-Scallop	132	154	193	205	136	86	178	127	142	68	46	45	124	40	120
Pots	24	20	16	17	19	22	14	15	16	14	16	16	10	13	17
Gillnet-Sink	26	28	24	22	11	5	11	12	6	8	9	4	0	0	12
Dredge-Clam	13	14	12	12	7	6	8	8	12	9	0	12	12	12	10

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Trawl-Midwater	15	15	14	5	9	7	0	4	6	7	9	9	8	4	8

Source: NMFS 2022

Table I-34 Annual Number of Trips by Commercial Fishing Vessels to the EW 2 WEA by Gear Type, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Trawl-Bottom	2,505	2,590	1,027	1,472	1,321	860	917	717	911	655	743	586	530	489	1,095
Dredge-Scallop	496	345	414	551	428	343	700	618	710	344	246	200	330	112	417
Pots	94	132	97	89	108	210	115	135	102	99	82	108	90	137	114
Dredge-Clam	66	24	57	43	75	104	61	75	151	166	137	116	136	91	93
Gillnet-Sink	186	151	166	130	51	43	52	66	0	38	84	24	0	26	73
Trawl-Midwater	88	71	39	12	18	15	0	9	14	13	50	36	26	6	28

Source: NMFS 2022

Table I-35 Annual Number of Commercial Fishing Vessels that Fished in the EW 2 WEA by Gear Type, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Dredge-Scallop	152	173	233	238	178	110	226	168	212	173	79	77	184	66	162
Trawl-Bottom	147	171	136	139	165	143	150	149	152	144	133	128	115	115	142
Gillnet-Sink	27	28	32	25	14	9	8	16	0	7	12	4	0	5	13
Pots	14	17	15	11	12	22	15	11	9	9	10	11	8	10	12
Dredge-Clam	9	8	12	13	9	10	13	12	16	11	9	13	13	14	12
Trawl-Midwater	15	15	14	5	10	7	0	4	6	7	9	9	8	4	8

Source: NMFS 2022

Table I-36 Annual Number of Trips by Commercial Fishing Vessels to the Lease Area by Gear Type, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Trawl-Bottom	3,381	3,359	1,959	2,388	2,366	1,577	1,523	1,322	1,579	1,247	1,142	1,045	1,004	818	1,765
Dredge-Scallop	531	414	441	561	444	344	705	619	712	344	246	201	330	112	429
Pots	457	468	483	346	450	626	443	392	414	374	283	293	284	294	401
Dredge-Clam	85	52	95	54	77	129	72	79	166	172	137	118	140	100	105
Gillnet-Sink	203	174	171	162	68	46	73	69	76	45	84	26	18	27	89
Trawl-Bottom	3,381	3,359	1,959	2,388	2,366	1,577	1,523	1,322	1,579	1,247	1,142	1,045	1,004	818	1,765

Source: NMFS 2022

Table I-37 Annual Number of Commercial Fishing Vessels that Fished in the Lease Area by Gear Type, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Dredge-Scallop	155	179	234	239	179	111	227	168	212	173	79	77	184	66	163
Trawl-Bottom	153	176	139	149	176	148	156	156	159	153	139	135	122	119	149

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Pots	25	31	19	23	21	26	26	16	18	18	18	19	12	14	20
Gillnet-Sink	33	34	35	31	17	9	13	18	8	9	12	6	3	6	17
Dredge-Clam	15	17	17	17	10	11	15	13	16	11	9	13	14	15	14
Trawl-Midwater	15	15	14	5	10	7	0	4	6	7	9	9	8	4	8

Source: NMFS 2022

Table I-38 Annual Number of Commercial Fishing Vessel Trips to the EW 1 WEA for the Top 20 Landing Ports, 2008–2021

Port and State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Point Pleasant, NJ	1,090	952	625	635	779	702	649	602	454	374	378	346	426	293	593
Belford, NJ	0	638	629	691	0	504	458	0	556	0	359	0	367	307	322
Freeport, NY	781	569	378	389	318	237	199	206	206	198	157	147	150	149	292
Point Lookout, NY	797	1,053	219	434	324	121	152	0	0	0	0	0	0	0	221
New Bedford, MA	110	120	180	138	87	39	130	55	84	63	56	43	114	25	89
Cape May, NJ	69	77	79	151	101	60	84	96	75	46	51	29	51	24	71
Point Judith, RI	8	66	45	68	74	57	105	86	49	42	106	55	53	33	61
Barnegat, NJ	27	56	83	85	58	77	62	99	75	44	43	0	0	32	53
Montauk, NY	15	27	25	66	50	10	19	18	0	25	37	24	10	14	24
Newport News, VA	27	34	26	56	44	38	24	16	16	11	9	10	11	16	24
Atlantic City, NJ	12	16	8	0	8	4	6	6	38	44	0	10	44	24	16
Hampton, VA	0	0	0	0	32	0	0	28	36	30	0	19	23	20	13
Shark River, NJ	0	0	123	32	17	0	0	0	0	0	12	0	0	0	13
Shinnecock, NY	33	29	22	21	5	11	6	6	0	0	0	7	0	0	10
Long Beach, NY	133	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Beaufort, NC	0	0	0	0	4	0	5	17	16	20	17	16	14	20	9
Islip, NY	91	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Brooklyn, NY	0	0	0	90	0	0	0	0	0	0	0	0	0	0	6
Stonington, CT	13	10	13	0	0	0	0	6	5	0	0	8	10	0	5
Chincoteague, VA	0	0	0	0	0	16	9	0	0	13	10	7	0	0	4

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-39 Annual Number of Commercial Fishing Vessels that Fished in the EW 1 WEA for the Top 20 Landing Ports, 2008–2021

Port and State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Bedford, MA	55	71	106	79	57	30	93	42	63	45	32	28	78	20	57
Point Pleasant, NJ	64	74	57	77	55	49	63	49	49	38	37	32	39	29	51
Cape May, NJ	35	42	60	65	52	31	47	44	35	21	12	14	28	14	36
Point Judith, RI	8	28	22	29	26	27	40	31	28	24	34	28	30	18	27
Newport News, VA	17	20	16	37	29	24	20	13	14	9	7	10	8	13	17
Barnegat, NJ	13	20	24	26	20	19	19	27	19	17	14	0	0	9	16
Belford, NJ	0	21	18	18	0	16	14	0	14	0	16	0	14	12	10

Port and State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Hampton, VA	0	0	0	0	20	0	0	19	22	24	0	14	16	15	9
Montauk, NY	10	11	10	9	13	6	7	7	0	8	10	8	7	5	8
Beaufort, NC	0	0	0	0	4	0	4	13	14	18	16	12	11	18	8
Point Lookout, NY	22	26	11	17	17	7	10	0	0	0	0	0	0	0	8
Freeport, NY	16	17	13	8	8	5	7	4	6	6	4	5	4	4	8
Shinnecock, NY	14	11	13	10	4	6	5	3	0	0	0	3	0	0	5
Atlantic City, NJ	8	8	4	0	4	3	5	4	5	3	0	3	7	5	4
Chincoteague, VA	0	0	0	0	0	11	6	0	0	9	6	7	0	0	3
Stonington, CT	7	6	6	0	0	0	0	3	3	0	0	3	3	0	2
Wanchese, NC	6	5	0	3	0	0	6	0	6	3	0	0	0	0	2
Long Beach, NY	27	0	0	0	0	0	0	0	0	0	0	0	0	0	2
New London, CT	6	5	4	5	4	0	0	0	0	0	0	0	0	0	2
Hampton Bay, NY	0	0	0	3	0	0	3	0	0	3	4	4	0	0	1

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-40 Annual Number of Commercial Fishing Vessel Trips to the EW 2 WEA for the Top 20 Landing Ports, 2008–2021

Port and State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Point Pleasant, NJ	1,000	803	444	536	626	632	665	700	694	491	493	462	472	384	600
Point Lookout, NY	768	1,040	186	407	303	130	125	0	0	0	0	0	0	0	211
New Bedford, MA	139	148	224	176	127	57	199	88	164	153	84	63	162	46	131
Freeport, NY	567	412	194	196	156	83	0	45	0	0	0	0	0	50	122
Barnegat, NJ	61	120	161	147	85	123	117	170	144	75	132	0	69	51	104
Cape May, NJ	80	86	95	179	148	97	171	114	115	72	58	43	68	32	97
Point Judith, RI	13	99	61	84	84	109	132	120	116	81	140	97	80	76	92
Belford, NJ	0	118	64	120	0	50	72	0	87	0	75	0	29	30	46
Montauk, NY	20	39	30	76	61	27	24	28	16	39	53	35	18	22	35
Atlantic City, NJ	8	10	26	18	9	22	74	59	61	72	41	24	45	18	35
Newport News, VA	32	41	36	66	58	49	39	29	20	23	11	17	19	20	33
Shinnecock, NY	67	122	58	28	11	20	10	15	13	5	4	16	4	4	27
Hampton, VA	0	0	0	0	45	0	14	43	47	36	11	27	27	23	20
Beaufort, NC	5	0	0	0	4	0	13	30	25	20	30	23	23	31	15
Hampton Bay, NY	0	0	0	4	0	3	17	0	48	9	40	18	15	9	12
Long Beach, NY	153	0	0	0	0	0	0	0	0	0	0	0	0	0	11
Islip, NY	118	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Stonington, CT	17	10	16	5	12	0	0	7	8	5	0	11	15	10	8
Chincoteague, VA	0	0	0	0	27	19	14	10	0	14	12	9	0	0	8
New London, CT	14	11	11	11	9	8	0	3	7	0	0	0	0	0	5

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-41 Annual Number of Commercial Fishing Vessels that Fished in the EW 2 WEA for the Top 20 Landing Ports, 2008–2021

Port and State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Bedford, MA	67	85	128	101	78	40	123	62	103	103	45	39	108	37	80
Point Pleasant, NJ	67	76	69	79	62	57	68	54	48	45	47	43	47	39	57
Cape May, NJ	36	47	63	72	69	40	55	47	48	36	18	20	41	21	44
Point Judith, RI	12	31	27	30	27	38	44	37	46	42	38	38	36	32	34
Newport News, VA	21	24	24	37	36	27	23	22	17	21	9	16	12	16	22
Barnegat, NJ	15	22	33	28	25	24	24	30	24	22	24	0	15	12	21
Hampton, VA	0	0	0	0	24	0	10	27	25	28	9	19	19	18	13
Beaufort, NC	4	0	0	0	4	0	11	22	23	18	27	19	17	27	12
Montauk, NY	11	14	9	11	13	11	7	8	6	7	11	9	8	8	10
Belford, NJ	0	15	16	13	0	13	12	0	9	0	13	0	6	8	8
Shinnecock, NY	17	18	16	11	4	6	7	3	4	3	3	5	4	3	7
Point Lookout, NY	20	24	9	14	15	7	8	0	0	0	0	0	0	0	7
Atlantic City, NJ	5	5	4	6	4	6	8	9	5	3	4	3	7	5	5
Chincoteague, VA	0	0	0	0	14	11	9	7	0	10	8	9	0	0	5
Stonington, CT	8	6	6	4	6	0	0	4	6	3	0	5	5	6	4
Freeport, NY	12	11	8	5	6	4	0	3	0	0	0	0	0	3	4
Wanchese, NC	8	9	6	5	0	0	8	0	10	4	0	0	0	0	4
New London, CT	7	5	6	6	5	4	0	3	4	0	0	0	0	0	3
Hampton Bay, NY	0	0	0	3	0	3	4	0	6	4	5	6	5	3	3
Long Beach, NY	29	0	0	0	0	0	0	0	0	0	0	0	0	0	2

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-42 Annual Number of Commercial Fishing Vessel Trips to the Lease Area for the Top 20 Landing Ports, 2008–2021

Port and State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Point Pleasant, NJ	1,258	1,048	710	713	930	983	883	901	826	623	596	561	621	435	792
Belford, NJ	0	652	632	704	0	512	462	0	567	0	367	0	367	310	327
Freeport, NY	788	575	386	393	318	237	199	206	206	198	157	147	150	150	294
Point Lookou, NYt	804	1,059	222	473	432	166	164	0	0	0	0	0	0	0	237
New Bedford, MA	139	148	225	176	128	57	201	88	164	153	84	63	162	46	131
Barnegat, NJ	61	124	163	159	94	124	121	171	150	79	142	0	76	52	108
Cape May, NJ	82	86	96	180	149	97	171	114	116	72	58	43	68	32	97
Point Judith, RI	14	99	62	85	85	110	132	122	117	81	141	97	80	76	93
Atlantic City, NJ	13	19	30	19	11	23	76	61	67	74	41	26	49	25	38
Montauk, NY	21	40	31	76	62	27	25	28	16	40	53	36	18	22	35
Newport News, VA	32	41	36	66	58	49	39	29	20	23	11	17	19	20	33
Shinnecock, NY	71	127	58	28	12	20	10	16	13	5	4	21	8	4	28
Hampton, VA	0	0	0	0	45	0	14	43	47	36	11	27	27	23	20
Shark River, NJ	0	0	126	33	27	0	46	0	0	0	12	0	0	0	17
Beaufort, NC	5	0	0	0	4	0	13	30	25	21	30	23	23	31	15
Hampton Bay, NY	0	0	10	6	0	3	20	0	49	9	42	19	15	9	13

Port and State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Long Beach, NY	155	0	0	0	0	0	0	0	0	0	0	0	0	0	11
Islip, NY	119	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Stonington, CT	17	10	16	5	12	0	0	7	8	5	0	12	16	10	8
Chincoteague, VA	0	0	0	0	27	19	14	10	0	14	12	9	0	0	8

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-43 Annual Number of Commercial Fishing Vessels that Fished in the Lease Area for the Top 20 Landing Ports, 2008–2021

Port and State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Bedford, MA	67	85	128	101	79	40	124	62	103	103	45	39	108	37	80
Point Pleasant, NJ	71	82	71	84	66	59	74	59	54	48	48	45	49	39	61
Cape May, NJ	38	47	64	72	69	40	55	47	49	36	18	20	41	21	44
Point Judith, RI	13	31	28	30	27	38	44	39	47	42	38	38	36	32	35
Barnegat, NJ	15	25	33	30	27	24	24	31	25	23	25	0	15	12	22
Newport News, VA	21	24	24	37	36	27	23	22	17	21	9	16	12	16	22
Hampton, VA	0	0	0	0	24	0	10	27	25	28	9	19	19	18	13
Beaufort, NC	4	0	0	0	4	0	11	22	23	19	27	19	17	27	12
Belford, NJ	0	21	18	18	0	17	14	0	14	0	16	0	14	12	10
Montauk, NY	11	14	10	11	14	11	8	8	6	8	11	9	8	8	10
Point Lookout, NY	22	26	11	17	18	8	10	0	0	0	0	0	0	0	8
Shinnecock, NY	17	19	16	11	5	6	7	4	4	3	3	6	4	3	8
Freeport, NY	16	17	13	8	8	5	7	4	6	6	4	5	4	4	8
Atlantic City, NJ	9	10	6	6	5	7	9	9	6	4	4	3	8	6	7
Chincoteague, VA	0	0	0	0	14	11	9	7	0	10	8	9	0	0	5
Stonington, CT	8	6	6	4	6	0	0	4	6	3	0	5	5	6	4
Wanchese, NC	8	9	6	5	0	0	8	0	10	4	0	0	0	0	4
Hampton Bay, NY	0	0	3	4	0	3	5	0	6	4	5	6	5	3	3
New London, CT	7	5	6	6	5	4	0	3	4	0	0	0	0	0	3
Long Beach, NY	30	0	0	0	0	0	0	0	0	0	0	0	0	0	2

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-44 Annual Commercial Landings (pounds) in the EW 1 WEA for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Herring	83,578	119,521	98,718	54,966	68,840	39,836	10,991	13,628	25,731	6,204	61,823	21,717	344	0	43,278
Atlantic Mackerel	117,033	91,506	170,078	53	84,578	460	113	6,781	735	7,480	58,843	20,431	18,461	9,573	41,866
Longfin Squid	4,465	40,121	11,933	87,093	126,160	47,676	134,042	12,703	807	3,173	16,383	8,042	14,146	2,746	36,392
Atlantic Sea Scallop	97,533	62,974	80,539	113,727	43,851	24,198	28,543	14,751	12,656	8,787	2,753	2,131	6,649	989	35,720
Atlantic Surf Clam	4,751	3,168	7,103	1,259	0	0	0	1,691	27,599	24,911	0	7,124	64,872	31,784	12,447
Summer Flounder	6,647	5,645	19,135	9,122	7,719	4,463	6,065	6,742	2,824	3,299	3,028	4,201	4,333	4,795	6,287
Skate spp.	1,934	2,425	4,822	2,959	4,279	3,507	4,034	4,227	3,480	3,790	4,212	6,169	4,953	8,550	4,239

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Menhaden	736	12,311	10,596	0	0	0	11	6	1,802	1,613	16,677	9	1,783	1,990	3,395
Scup	330	417	929	892	1,001	1,007	1,037	2,549	1,818	2,267	12,874	4,531	3,785	4,119	2,683
Spiny Dogfish	650	2,035	2,063	3,834	1,003	994	757	946	1,124	2,101	1,298	3,713	918	1,161	1,614
Silver Hake	1,702	5,759	2,059	3,620	2,242	1,097	1,733	501	123	160	266	539	404	134	1,453
Monkfish	4,961	3,143	2,010	2,052	1,301	634	838	1,121	1,025	333	407	298	130	94	1,311
Black Sea Bass	165	236	299	349	317	359	368	640	442	1,813	1,628	2,210	1,728	1,232	842
American Lobster	812	605	507	890	649	791	841	893	481	352	294	354	352	963	627
Smooth Dogfish	430	996	1,693	1,993	543	336	222	256	108	159	363	145	181	184	544
Bluefish	394	637	369	1,168	853	288	365	265	171	132	139	200	196	107	377
Illex Squid	0	95	70	183	3,155	27	5	16	68	0	3	0	53	0	263
Red Hake	382	452	246	371	535	195	334	268	54	63	45	251	229	67	249
Butterfish	110	116	231	332	777	224	353	195	171	88	67	574	149	104	249
Jonah Crab	6	733	21	19	23	33	67	351	301	70	151	339	172	315	186
All Species[1]	**328,397**	**355,574**	**422,682**	**293,067**	**356,899**	**162,914**	**204,585**	**75,563**	**92,890**	**116,016**	**205,348**	**86,415**	**126,545**	**76,762**	**207,404**

Source: NMFS 2022
[1] Includes 65 species and taxonomic groups that were landed in the EW 1 WEA

Table I-45 Annual Commercial Revenue (2021 dollars) in the EW 1 WEA for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Sea Scallop	$797,669	$481,919	$784,774	$1,344,285	$511,705	$329,882	$401,123	$212,032	$165,379	$79,173	$26,213	$21,774	$67,671	$14,600	$374,157
Longfin Squid	$5,338	$47,855	$18,738	$134,536	$159,471	$63,142	$156,041	$18,336	$1,194	$5,245	$28,818	$14,151	$17,483	$4,627	$48,213
Summer Flounder	$20,459	$14,321	$61,256	$25,318	$24,883	$13,426	$19,712	$24,271	$14,035	$16,120	$15,117	$13,891	$12,867	$20,151	$21,131
Atlantic Mackerel	$22,357	$20,285	$30,576	$49	$41,689	$254	$74	$1,722	$220	$1,825	$13,221	$4,730	$4,866	$2,197	$10,290
Atlantic Surf Clam	$3,713	$2,085	$5,801	$1,029	$0	$0	$0	$923	$20,971	$19,116	$0	$6,212	$46,264	$23,795	$9,279
Atlantic Herring	$8,275	$12,352	$12,177	$6,405	$9,476	$9,925	$1,387	$2,051	$3,330	$1,127	$11,540	$5,163	$78	$0	$5,949
American Lobster	$4,648	$2,924	$2,506	$4,935	$3,031	$3,959	$4,567	$4,772	$2,789	$1,932	$1,591	$2,123	$1,919	$7,194	$3,492
Monkfish	$13,039	$6,386	$5,691	$5,706	$4,131	$1,541	$1,975	$2,473	$2,078	$489	$540	$418	$194	$129	$3,199
Black Sea Bass	$779	$869	$1,261	$1,425	$1,409	$1,567	$1,463	$3,101	$1,943	$4,518	$8,218	$9,690	$3,486	$4,222	$3,139
Scup	$353	$362	$813	$603	$582	$682	$1,055	$1,876	$1,781	$1,492	$8,490	$4,051	$3,208	$4,545	$2,135
Silver Hake	$1,381	$1,948	$1,695	$4,270	$1,777	$802	$1,337	$379	$76	$177	$350	$578	$452	$240	$1,105
Skate spp.	$358	$513	$1,220	$1,078	$780	$542	$821	$640	$469	$531	$779	$732	$753	$1,210	$745
Tautog	$258	$244	$181	$186	$108	$330	$119	$234	$638	$170	$73	$208	$215	$6,800	$697
Atlantic Menhaden	$112	$1,448	$1,305	$0	$0	$0	$2	$1	$212	$252	$2,911	$1	$195	$548	$499
Spiny Dogfish	$228	$621	$458	$1,190	$249	$215	$155	$201	$266	$490	$305	$1,132	$237	$287	$431
Smooth Dogfish	$297	$567	$1,111	$1,051	$368	$212	$186	$153	$94	$132	$252	$119	$132	$176	$346
Bluefish	$388	$404	$254	$924	$592	$226	$284	$171	$134	$104	$154	$153	$276	$130	$299
Winter Flounder	$2,075	$558	$0	$78	$4	$274	$38	$39	$3	$0	$7	$0	$0	$0	$220
Butterfish	$119	$126	$179	$255	$523	$161	$278	$126	$142	$67	$53	$513	$118	$127	$199
Conch spp.	$1,188	$29	$9	$0	$1	$1,444	$19	$6	$6	$0	$0	$0	$0	$0	$193
All Species[1]	**$884,005**	**$598,183**	**$938,331**	**$1,540,512**	**$771,412**	**$463,099**	**$601,548**	**$281,958**	**$229,107**	**$188,080**	**$136,910**	**$89,924**	**$163,904**	**$98,530**	**$498,965**

Source: NMFS 2022
[1] Includes 65 species and taxonomic groups that were landed in the EW 1 WEA

Table I-46 Annual Commercial Landings (pounds) in the EW 2 WEA for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Sea Scallop	345,910	153,170	172,472	428,891	277,440	88,879	166,082	86,083	72,533	35,478	13,518	12,061	32,906	4,670	135,007
Atlantic Herring	230,113	274,246	164,314	59,027	281,781	160,608	36,814	23,406	166,343	17,373	84,268	48,578	820	0	110,549
Atlantic Mackerel	186,725	298,824	215,697	37	135,327	1,255	130	13,301	1,343	16,692	106,421	48,006	52,307	37,094	79,511
Atlantic Surf Clam	1,573	0	0	0	0	0	0	0	48,254	49,697	0	24,125	77,798	60,113	18,683
Longfin Squid	3,880	12,517	8,263	32,054	34,305	13,643	45,636	17,804	2,618	2,942	14,598	10,120	19,656	3,995	15,859
Scup	426	1,055	1,053	1,202	2,268	2,712	2,078	4,438	4,885	6,440	58,059	19,056	17,209	16,502	9,813
Monkfish	24,992	10,240	8,504	8,480	6,433	2,801	3,737	7,506	12,868	4,198	9,193	1,124	569	193	7,203
Summer Flounder	8,141	6,004	6,097	6,882	6,332	4,613	7,378	6,558	4,088	3,166	6,396	6,043	6,192	4,668	5,897
Atlantic Menhaden	710	0	12,327	0	0	0	16	16	20,175	1,396	7,330	0	1,424	6,569	3,569
Black Sea Bass	288	331	117	234	330	496	788	1,460	1,376	5,165	11,621	5,460	8,780	3,799	2,875
Skate spp.	1,775	1,675	2,789	2,216	2,120	884	3,724	3,524	3,157	1,946	6,148	2,147	1,292	2,991	2,599
Spiny Dogfish	1,491	1,300	978	2,314	924	518	358	819	301	310	963	928	195	432	845
American Lobster	595	702	233	474	540	279	1,585	1,110	463	314	221	379	411	1,828	652
Smooth Dogfish	527	395	853	838	287	107	221	165	53	146	1,681	895	1,322	440	566
Waved Whelk	0	0	0	0	0	7,680	0	0	0	0	0	0	0	0	549
Silver Hake	464	1,036	1,186	1,859	523	293	651	191	115	153	220	166	268	51	513
Bluefish	247	352	238	662	493	209	221	296	210	364	997	356	929	377	425
Ocean Quahog	0	0	5,646	0	0	0	0	0	0	0	0	0	0	0	403
Jonah Crab	1	7	5	4	7	68	165	749	161	143	158	720	118	549	204
Butterfish	72	157	183	101	336	75	415	83	135	100	65	779	196	84	199
All Species[1]	**822,679**	**808,745**	**602,520**	**585,877**	**774,590**	**294,060**	**281,693**	**178,977**	**377,632**	**209,069**	**358,311**	**196,917**	**256,210**	**183,276**	**423,611**

Source: NMFS 2022
[1] Includes 68 species and taxonomic groups that were landed in the EW 2 WEA

Table I-47 Annual Commercial Revenue (2021 dollars) in the EW 2 WEA for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Sea Scallop	$2,837,134	$1,175,191	$1,623,699	$5,056,463	$3,282,030	$1,225,772	$2,353,044	$1,236,877	$978,516	$344,112	$134,165	$129,052	$338,888	$72,934	$1,484,848
Longfin Squid	$4,276	$15,308	$11,951	$49,982	$43,729	$17,547	$53,283	$25,386	$3,653	$4,900	$25,721	$17,469	$24,172	$6,001	$21,670
Summer Flounder	$24,735	$13,676	$18,371	$16,553	$16,903	$12,354	$22,539	$21,662	$18,766	$13,767	$29,576	$17,310	$15,973	$14,464	$18,332
Atlantic Mackerel	$28,643	$66,954	$46,020	$27	$44,998	$623	$84	$3,248	$402	$4,251	$22,797	$10,638	$13,686	$8,269	$17,903
Monkfish	$64,285	$19,399	$21,966	$24,208	$20,125	$6,159	$9,279	$15,079	$24,146	$6,399	$11,171	$1,601	$739	$286	$16,060
Atlantic Surf Clam	$1,390	$0	$0	$0	$0	$0	$0	$0	$38,799	$41,703	$0	$23,576	$74,489	$43,861	$15,987
Atlantic Herring	$26,799	$26,581	$21,677	$8,103	$34,551	$41,329	$4,220	$3,199	$21,642	$3,585	$15,478	$11,097	$181	$0	$15,603
Black Sea Bass	$1,481	$1,091	$537	$1,158	$1,584	$2,155	$3,245	$6,716	$6,249	$12,894	$64,015	$24,490	$22,281	$14,275	$11,584
Scup	$546	$826	$965	$796	$1,434	$2,015	$1,960	$3,516	$5,130	$4,981	$44,576	$22,472	$13,766	$19,871	$8,775
American Lobster	$2,550	$3,176	$1,181	$2,790	$2,722	$1,430	$8,890	$6,376	$2,701	$1,803	$1,175	$2,150	$2,476	$12,431	$3,704
Skate spp.	$622	$717	$1,609	$1,436	$721	$386	$845	$1,156	$1,081	$670	$2,490	$373	$387	$539	$931
Conch spp.	$1,717	$70	$0	$0	$0	$6,272	$209	$15	$101	$0	$0	$0	$0	$0	$599
Silver Hake	$347	$502	$940	$2,969	$443	$201	$484	$153	$63	$174	$259	$132	$276	$60	$500
Atlantic Menhaden	$112	$0	$1,475	$0	$0	$0	$3	$2	$2,229	$218	$1,340	$0	$163	$1,245	$485
Bluefish	$190	$199	$183	$482	$384	$166	$171	$221	$174	$294	$1,126	$265	$1,143	$447	$389

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Smooth Dogfish	$321	$259	$677	$450	$189	$78	$166	$99	$65	$129	$1,124	$747	$807	$293	$386
Waved Whelk	$0	$0	$0	$0	$0	$5,025	$0	$0	$0	$0	$0	$0	$0	$0	$359
Ocean Quahog	$0	$0	$4,333	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$309
Spiny Dogfish	$554	$347	$221	$674	$221	$102	$72	$153	$65	$68	$231	$262	$99	$112	$227
Jonah Crab	$1	$5	$4	$4	$5	$51	$159	$570	$122	$136	$168	$615	$110	$641	$185
All Species[1]	**$3,006,201**	**$1,344,704**	**$1,757,632**	**$5,191,043**	**$3,467,691**	**$1,329,837**	**$2,470,263**	**$1,334,810**	**$1,148,459**	**$514,058**	**$388,115**	**$282,682**	**$552,565**	**$237,483**	**$1,644,682**

Source: NMFS 2022
[1] Includes 68 species and taxonomic groups that were landed in the EW 2 WEA

Table I-48 Annual Commercial Landings (pounds) in the Lease Area for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Sea Scallop	443,443	216,143	253,010	542,618	321,290	113,077	194,625	100,834	85,189	44,265	16,271	14,192	39,555	5,660	170,727
Atlantic Herring	313,690	393,767	263,032	113,994	350,621	200,445	47,805	37,034	192,073	23,577	146,091	70,294	1,164	0	153,828
Atlantic Mackerel	303,757	390,330	385,775	90	219,905	1,715	243	20,082	2,078	24,172	165,265	68,437	70,769	46,666	121,377
Longfin Squid	8,345	52,638	20,197	119,147	160,464	61,318	179,678	30,507	3,425	6,114	30,981	18,162	33,802	6,741	52,251
Surf Clam	6,324	12,525	7,418	2,043	0	0	0	7,197	75,853	74,608	0	31,249	142,670	91,897	32,270
Scup	757	1,472	1,981	2,094	3,269	3,719	3,115	6,986	6,703	8,706	70,933	23,587	20,994	20,622	12,496
Summer Flounder	14,788	11,650	25,232	16,004	14,051	9,075	13,442	13,300	6,912	6,465	9,424	10,244	10,524	9,463	12,184
Angler	29,953	13,383	10,515	10,532	7,734	3,435	4,574	8,627	13,893	4,531	9,600	1,422	699	287	8,513
Menhaden	1,446	24,789	22,922	0	0	0	28	22	21,977	3,009	24,007	11	3,206	8,559	7,855
Skates	3,709	4,100	7,610	5,175	6,400	4,391	7,758	7,751	6,637	5,736	10,360	8,315	6,245	11,541	6,838
Black Sea Bass	453	567	416	583	647	855	1,156	2,100	1,817	6,978	13,249	7,670	10,509	5,031	3,717
Dogfish Spiny	2,141	3,335	3,041	6,149	1,926	1,512	1,115	1,764	1,425	2,411	2,261	4,641	1,113	1,593	2,459
Silver Hake	2,166	6,795	3,245	5,479	2,765	1,390	2,384	692	239	313	487	705	672	185	1,966
American Lobster	1,407	1,307	740	1,364	1,190	1,070	2,426	2,003	944	665	516	733	763	2,791	1,280
Dogfish Smooth	958	1,391	2,547	2,831	830	443	443	420	161	304	2,044	1,040	1,503	624	1,110
Ocean Quahog	0	0	14,028	0	0	0	0	0	0	0	0	0	0	0	1,002
Bluefish	641	990	607	1,830	1,346	497	586	562	382	496	1,136	556	1,125	483	803
Waved Whelk	0	0	0	0	0	9,090	0	0	0	0	0	0	0	0	649
Butterfish	182	273	414	433	1,113	299	769	278	306	188	132	1,353	346	188	448
Jonah Crab	7	740	26	23	31	101	232	1,100	462	213	309	1,058	290	864	390
All Species[1]	**1,151,074**	**1,164,328**	**1,025,214**	**878,947**	**1,131,490**	**456,977**	**486,279**	**254,541**	**470,525**	**325,086**	**563,669**	**283,338**	**382,762**	**260,041**	**631,019**

Source: NMFS 2022
[1] Includes 72 species and taxonomic groups that were landed in the Lease Area

Table I-49 Annual Commercial Revenue (2021 dollars) in the Lease Area for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Sea Scallop	$3,634,804	$1,657,110	$2,408,472	$6,400,749	$3,793,735	$1,555,654	$2,754,167	$1,448,909	$1,143,894	$423,285	$160,379	$150,827	$406,559	$87,534	$1,859,006
Longfin Squid	$9,615	$63,163	$30,688	$184,519	$203,200	$80,689	$209,324	$43,722	$4,849	$10,146	$54,540	$31,619	$41,654	$10,629	$69,883
Summer Flounder	$45,194	$27,997	$79,626	$41,870	$41,786	$25,780	$42,250	$45,934	$32,800	$29,887	$44,693	$31,200	$28,839	$34,615	$39,462
Atlantic Mackerel	$51,001	$87,239	$76,596	$75	$86,686	$878	$158	$4,970	$621	$6,076	$36,018	$15,368	$18,551	$10,467	$28,193

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Surf Clam	$5,104	$6,168	$6,058	$1,655	$0	$0	$0	$5,265	$59,769	$60,819	$0	$29,789	$120,753	$67,656	$25,931
Atlantic Herring	$35,074	$38,932	$33,854	$14,508	$44,027	$51,254	$5,608	$5,251	$24,971	$4,712	$27,019	$16,259	$259	$0	$21,552
Angler	$77,324	$25,784	$27,659	$29,914	$24,256	$7,700	$11,253	$17,552	$26,224	$6,888	$11,710	$2,019	$934	$414	$19,259
Black Sea Bass	$2,260	$1,960	$1,798	$2,583	$2,993	$3,722	$4,708	$9,817	$8,192	$17,411	$72,234	$34,180	$25,767	$18,497	$14,723
Scup	$899	$1,189	$1,778	$1,401	$2,017	$2,698	$3,016	$5,393	$6,911	$6,473	$53,066	$26,522	$16,975	$24,417	$10,911
American Lobster	$7,198	$6,100	$3,687	$7,726	$5,752	$5,389	$13,457	$11,149	$5,492	$3,735	$2,766	$4,273	$4,394	$19,625	$7,196
Skates	$980	$1,230	$2,829	$2,514	$1,501	$927	$1,668	$1,796	$1,549	$1,202	$3,269	$1,105	$1,140	$1,749	$1,676
Silver Hake	$1,730	$2,449	$2,635	$7,239	$2,220	$1,003	$1,820	$534	$138	$352	$609	$710	$728	$300	$1,605
Menhaden	$225	$2,927	$2,780	$0	$0	$0	$6	$3	$2,441	$470	$4,251	$2	$357	$1,793	$1,090
Ocean Quahog	$0	$0	$11,585	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$828
Conchs	$2,903	$99	$58	$70	$2	$7,717	$228	$21	$107	$0	$0	$0	$0	$0	$800
Tautog	$309	$296	$214	$202	$112	$347	$127	$247	$663	$176	$75	$212	$227	$7,315	$752
Dogfish Smooth	$619	$826	$1,788	$1,501	$557	$290	$352	$252	$159	$261	$1,376	$866	$939	$469	$732
Bluefish	$579	$603	$437	$1,404	$976	$392	$455	$392	$307	$397	$1,280	$418	$1,419	$576	$688
Dogfish Spiny	$782	$968	$679	$1,862	$470	$317	$227	$354	$332	$559	$536	$1,392	$336	$399	$658
Waved Whelk	$0	$0	$0	$0	$0	$5,945	$0	$0	$0	$0	$0	$0	$0	$0	$425
All Species	**$3,890,211**	**$1,942,893**	**$2,695,963**	**$6,731,547**	**$4,239,108**	**$1,792,933**	**$3,071,813**	**$1,616,776**	**$1,377,580**	**$702,154**	**$525,042**	**$372,606**	**$716,471**	**$336,024**	**$2,143,652**

Source: NMFS 2022
[1] Includes 72 species and taxonomic groups that were landed in the Lease Area

Table I-50 Commercial Landings in the EW 1 WEA as a Percentage of Landings in the Geographic Analysis Area for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Tautog	0.062%	0.055%	0.037%	0.044%	0.028%	0.073%	0.041%	0.056%	0.159%	0.050%	0.017%	0.076%	0.086%	1.934%	0.194%
Atlantic Mackerel	0.242%	0.187%	0.780%	0.004%	0.696%	0.005%	0.001%	0.054%	0.006%	0.048%	0.304%	0.180%	0.101%	0.077%	0.192%
Longfin Squid	0.016%	0.193%	0.072%	0.397%	0.467%	0.196%	0.519%	0.049%	0.002%	0.018%	0.066%	0.030%	0.070%	0.012%	0.150%
Northern Puffer	0.000%	0.000%	0.000%	0.000%	0.000%	0.090%	0.000%	0.000%	0.000%	0.000%	0.000%	1.419%	0.000%	0.000%	0.108%
Atlantic Sea Scallop	0.180%	0.108%	0.143%	0.195%	0.077%	0.060%	0.086%	0.042%	0.032%	0.017%	0.005%	0.004%	0.014%	0.002%	0.069%
Summer Flounder	0.063%	0.059%	0.155%	0.060%	0.066%	0.040%	0.061%	0.070%	0.040%	0.065%	0.056%	0.052%	0.053%	0.050%	0.064%
Chub Mackerel	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.001%	0.009%	0.000%	0.000%	0.000%	0.000%	0.040%	0.684%	0.052%
Sea Robin spp.	0.023%	0.039%	0.152%	0.044%	0.022%	0.014%	0.034%	0.026%	0.020%	0.021%	0.076%	0.018%	0.045%	0.184%	0.051%
Smooth Dogfish	0.054%	0.074%	0.087%	0.111%	0.043%	0.028%	0.020%	0.029%	0.016%	0.019%	0.042%	0.019%	0.030%	0.022%	0.042%
Cobia	0.000%	0.000%	0.000%	0.331%	0.171%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.059%	0.040%
Atlantic Surf Clam	0.010%	0.007%	0.018%	0.003%	0.000%	0.000%	0.000%	0.004%	0.069%	0.067%	0.000%	0.021%	0.238%	0.114%	0.039%
Black Drum	0.000%	0.017%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.513%	0.000%	0.038%
Black Sea Bass	0.010%	0.025%	0.024%	0.026%	0.024%	0.020%	0.020%	0.037%	0.022%	0.058%	0.062%	0.083%	0.055%	0.035%	0.036%
Weakfish	0.042%	0.018%	0.030%	0.025%	0.113%	0.029%	0.015%	0.009%	0.044%	0.026%	0.022%	0.028%	0.043%	0.046%	0.035%
Atlantic Herring	0.048%	0.055%	0.068%	0.031%	0.036%	0.019%	0.005%	0.008%	0.019%	0.006%	0.064%	0.076%	0.002%	0.000%	0.031%
Scup	0.008%	0.007%	0.011%	0.007%	0.009%	0.007%	0.008%	0.019%	0.014%	0.017%	0.120%	0.042%	0.035%	0.041%	0.025%
Skate spp.	0.007%	0.010%	0.020%	0.014%	0.019%	0.017%	0.019%	0.020%	0.017%	0.023%	0.022%	0.033%	0.028%	0.064%	0.022%
Red Hake	0.023%	0.026%	0.015%	0.026%	0.028%	0.016%	0.023%	0.024%	0.004%	0.007%	0.004%	0.026%	0.032%	0.013%	0.019%

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
American Eel	0.000%	0.000%	0.000%	0.008%	0.065%	0.000%	0.006%	0.000%	0.000%	0.022%	0.015%	0.013%	0.019%	0.118%	0.019%
Bluefish	0.010%	0.016%	0.008%	0.039%	0.033%	0.015%	0.014%	0.014%	0.008%	0.007%	0.019%	0.020%	0.027%	0.017%	0.018%

Source: NMFS 2022

Table I-51 Commercial Revenue in the EW 1 WEA as a Percentage of Revenue in the Geographic Analysis Area for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Tautog	0.051%	0.056%	0.041%	0.040%	0.032%	0.076%	0.036%	0.070%	0.152%	0.046%	0.027%	0.070%	0.089%	1.925%	0.194%
Atlantic Mackerel	0.274%	0.184%	0.605%	0.008%	0.829%	0.013%	0.002%	0.040%	0.006%	0.040%	0.280%	0.162%	0.090%	0.020%	0.182%
Longfin Squid	0.016%	0.199%	0.085%	0.425%	0.442%	0.204%	0.531%	0.052%	0.002%	0.019%	0.070%	0.031%	0.066%	0.014%	0.154%
Northern Puffer	0.000%	0.000%	0.000%	0.000%	0.000%	0.055%	0.000%	0.000%	0.000%	0.000%	0.000%	1.402%	0.000%	0.000%	0.104%
Summer Flounder	0.068%	0.063%	0.204%	0.077%	0.079%	0.045%	0.064%	0.077%	0.051%	0.068%	0.064%	0.053%	0.059%	0.074%	0.075%
Atlantic Sea Scallop	0.167%	0.101%	0.141%	0.190%	0.077%	0.061%	0.083%	0.043%	0.031%	0.014%	0.005%	0.004%	0.013%	0.002%	0.066%
Sea Robin spp.	0.041%	0.028%	0.108%	0.070%	0.030%	0.010%	0.034%	0.025%	0.014%	0.024%	0.067%	0.036%	0.101%	0.192%	0.056%
Cobia	0.000%	0.000%	0.000%	0.443%	0.214%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.079%	0.053%
Chub Mackerel	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.001%	0.045%	0.000%	0.000%	0.000%	0.000%	0.019%	0.638%	0.050%
American Eel	0.000%	0.000%	0.000%	0.009%	0.018%	0.000%	0.002%	0.000%	0.000%	0.218%	0.002%	0.112%	0.223%	0.088%	0.048%
Black Sea Bass	0.012%	0.025%	0.025%	0.026%	0.026%	0.023%	0.020%	0.045%	0.023%	0.043%	0.082%	0.099%	0.044%	0.045%	0.038%
Weakfish	0.062%	0.022%	0.035%	0.024%	0.112%	0.030%	0.009%	0.007%	0.048%	0.021%	0.031%	0.035%	0.043%	0.041%	0.037%
Atlantic Surf Clam	0.009%	0.006%	0.017%	0.003%	0.000%	0.000%	0.000%	0.003%	0.060%	0.058%	0.000%	0.022%	0.200%	0.106%	0.035%
Smooth Dogfish	0.025%	0.050%	0.075%	0.085%	0.035%	0.022%	0.020%	0.022%	0.015%	0.019%	0.034%	0.018%	0.024%	0.023%	0.033%
Scup	0.007%	0.006%	0.013%	0.008%	0.006%	0.007%	0.012%	0.018%	0.017%	0.016%	0.098%	0.052%	0.042%	0.060%	0.026%
Atlantic Herring	0.032%	0.044%	0.052%	0.022%	0.030%	0.028%	0.004%	0.007%	0.010%	0.004%	0.046%	0.050%	0.001%	0.000%	0.024%
Black Drum	0.000%	0.023%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.261%	0.000%	0.020%
Red Hake	0.026%	0.028%	0.018%	0.023%	0.024%	0.017%	0.023%	0.026%	0.006%	0.009%	0.007%	0.030%	0.021%	0.018%	0.020%
Bluefish	0.017%	0.019%	0.012%	0.043%	0.028%	0.013%	0.015%	0.010%	0.008%	0.007%	0.019%	0.014%	0.037%	0.019%	0.019%
Conger Eel	0.015%	0.009%	0.007%	0.009%	0.011%	0.008%	0.011%	0.005%	0.005%	0.006%	0.012%	0.038%	0.060%	0.015%	0.015%

Source: NMFS 2022

Table I-52 Commercial Landings in the EW 2 WEA as a Percentage of Landings in the Geographic Analysis Area for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Mackerel	0.386%	0.611%	0.989%	0.003%	1.113%	0.014%	0.001%	0.106%	0.010%	0.107%	0.549%	0.424%	0.287%	0.299%	0.350%
Atlantic Sea Scallop	0.640%	0.263%	0.306%	0.734%	0.489%	0.219%	0.503%	0.245%	0.182%	0.070%	0.024%	0.020%	0.069%	0.011%	0.269%
Chub Mackerel	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.001%	0.009%	0.000%	0.000%	0.000%	0.000%	0.192%	2.073%	0.163%
Black Sea Bass	0.017%	0.036%	0.009%	0.017%	0.025%	0.028%	0.042%	0.084%	0.068%	0.165%	0.442%	0.204%	0.277%	0.107%	0.109%
Scup	0.011%	0.017%	0.013%	0.010%	0.020%	0.019%	0.016%	0.032%	0.037%	0.050%	0.539%	0.175%	0.160%	0.163%	0.090%
Atlantic Herring	0.132%	0.126%	0.113%	0.033%	0.146%	0.077%	0.018%	0.013%	0.122%	0.016%	0.088%	0.171%	0.004%	0.000%	0.076%
Monkfish	0.204%	0.103%	0.102%	0.085%	0.060%	0.031%	0.043%	0.082%	0.137%	0.041%	0.092%	0.011%	0.008%	0.003%	0.072%
Longfin Squid	0.014%	0.060%	0.050%	0.146%	0.127%	0.056%	0.177%	0.069%	0.007%	0.017%	0.059%	0.037%	0.098%	0.017%	0.067%
Summer Flounder	0.078%	0.062%	0.050%	0.045%	0.054%	0.041%	0.074%	0.068%	0.057%	0.062%	0.119%	0.075%	0.076%	0.049%	0.065%
Smooth Dogfish	0.066%	0.029%	0.044%	0.047%	0.023%	0.009%	0.019%	0.019%	0.008%	0.017%	0.197%	0.119%	0.222%	0.054%	0.062%

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Surf Clam	0.003%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.120%	0.134%	0.000%	0.072%	0.286%	0.216%	0.059%
Bluefish	0.006%	0.009%	0.005%	0.022%	0.019%	0.011%	0.008%	0.015%	0.010%	0.020%	0.137%	0.036%	0.130%	0.061%	0.035%
Sea Robin spp.	0.012%	0.027%	0.052%	0.020%	0.039%	0.014%	0.019%	0.024%	0.023%	0.015%	0.088%	0.027%	0.000%	0.101%	0.033%
Weakfish	0.022%	0.010%	0.010%	0.023%	0.012%	0.017%	0.019%	0.042%	0.046%	0.043%	0.050%	0.013%	0.032%	0.102%	0.031%
Conger Eel	0.006%	0.000%	0.004%	0.000%	0.000%	0.019%	0.042%	0.004%	0.016%	0.002%	0.002%	0.033%	0.303%	0.008%	0.031%
Thresher Shark	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.020%	0.000%	0.000%	0.007%	0.403%	0.000%	0.000%	0.000%	0.031%
Northern Puffer	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.373%	0.000%	0.000%	0.027%
Clearnose Skate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.057%	0.301%	0.000%	0.000%	0.000%	0.000%	0.026%
Conch spp.	0.143%	0.008%	0.000%	0.000%	0.000%	0.176%	0.015%	0.001%	0.010%	0.000%	0.000%	0.000%	0.000%	0.000%	0.025%
Waved Whelk	0.000%	0.000%	0.000%	0.000%	0.000%	0.350%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.025%

Source: NMFS 2022

Table I-53 Commercial Revenue in the EW 2 WEA as a Percentage of Revenue in the Geographic Analysis Area for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Mackerel	0.351%	0.606%	0.911%	0.004%	0.895%	0.031%	0.002%	0.075%	0.010%	0.094%	0.483%	0.363%	0.253%	0.075%	0.297%
Atlantic Sea Scallop	0.595%	0.246%	0.291%	0.715%	0.491%	0.225%	0.489%	0.249%	0.180%	0.062%	0.023%	0.021%	0.068%	0.011%	0.262%
Chub Mackerel	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.001%	0.041%	0.000%	0.000%	0.000%	0.000%	0.114%	1.885%	0.146%
Black Sea Bass	0.023%	0.031%	0.011%	0.021%	0.029%	0.031%	0.045%	0.097%	0.075%	0.123%	0.643%	0.251%	0.281%	0.153%	0.130%
Scup	0.011%	0.014%	0.015%	0.010%	0.015%	0.021%	0.022%	0.034%	0.050%	0.054%	0.513%	0.291%	0.178%	0.263%	0.107%
Longfin Squid	0.013%	0.064%	0.055%	0.158%	0.121%	0.057%	0.181%	0.072%	0.007%	0.018%	0.063%	0.038%	0.091%	0.018%	0.068%
Summer Flounder	0.083%	0.060%	0.061%	0.050%	0.054%	0.041%	0.074%	0.069%	0.068%	0.058%	0.126%	0.066%	0.073%	0.053%	0.067%
Monkfish	0.206%	0.086%	0.100%	0.080%	0.067%	0.031%	0.046%	0.073%	0.114%	0.033%	0.074%	0.011%	0.008%	0.003%	0.067%
Atlantic Surf Clam	0.003%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.112%	0.127%	0.000%	0.082%	0.322%	0.195%	0.060%
Atlantic Herring	0.104%	0.094%	0.093%	0.028%	0.108%	0.117%	0.013%	0.011%	0.066%	0.012%	0.062%	0.108%	0.003%	0.000%	0.058%
Smooth Dogfish	0.027%	0.023%	0.046%	0.037%	0.018%	0.008%	0.018%	0.014%	0.010%	0.018%	0.151%	0.112%	0.148%	0.038%	0.048%
Conger Eel	0.009%	0.000%	0.007%	0.000%	0.000%	0.021%	0.024%	0.003%	0.014%	0.002%	0.001%	0.029%	0.399%	0.006%	0.037%
Bluefish	0.008%	0.010%	0.008%	0.023%	0.018%	0.009%	0.009%	0.013%	0.010%	0.019%	0.142%	0.023%	0.153%	0.066%	0.037%
Sea Robin spp.	0.020%	0.014%	0.048%	0.026%	0.030%	0.010%	0.023%	0.019%	0.027%	0.016%	0.067%	0.071%	0.000%	0.115%	0.035%
Weakfish	0.030%	0.011%	0.008%	0.022%	0.009%	0.013%	0.026%	0.042%	0.049%	0.044%	0.061%	0.015%	0.033%	0.099%	0.033%
Thresher Shark	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.027%	0.000%	0.000%	0.012%	0.413%	0.000%	0.000%	0.000%	0.032%
Conch spp.	0.130%	0.005%	0.000%	0.000%	0.000%	0.187%	0.020%	0.003%	0.032%	0.000%	0.000%	0.000%	0.000%	0.000%	0.027%
Waved Whelk	0.000%	0.000%	0.000%	0.000%	0.000%	0.347%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.025%
King Whiting	0.012%	0.135%	0.109%	0.013%	0.002%	0.002%	0.002%	0.001%	0.001%	0.002%	0.006%	0.001%	0.004%	0.029%	0.023%
Northern Puffer	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.280%	0.000%	0.000%	0.020%

Source: NMFS 2022

Table I-54 Commercial Landings in the Lease Area as a Percentage of Landings in the Geographic Analysis Area for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Mackerel	0.628%	0.799%	1.768%	0.007%	1.809%	0.019%	0.002%	0.161%	0.016%	0.156%	0.852%	0.605%	0.389%	0.376%	0.542%
Atlantic Sea Scallop	0.820%	0.371%	0.449%	0.928%	0.566%	0.278%	0.589%	0.287%	0.214%	0.087%	0.028%	0.024%	0.083%	0.013%	0.338%

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Longfin Squid	0.030%	0.253%	0.122%	0.543%	0.594%	0.252%	0.696%	0.118%	0.009%	0.035%	0.124%	0.067%	0.168%	0.029%	0.217%
Chub Mackerel	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.002%	0.018%	0.000%	0.000%	0.000%	0.001%	0.232%	2.737%	0.214%
Tautog	0.074%	0.066%	0.047%	0.048%	0.029%	0.078%	0.043%	0.059%	0.166%	0.051%	0.017%	0.077%	0.091%	2.081%	0.209%
Black Sea Bass	0.026%	0.061%	0.033%	0.044%	0.049%	0.048%	0.062%	0.120%	0.090%	0.224%	0.503%	0.287%	0.332%	0.142%	0.144%
Northern Puffer	0.000%	0.000%	0.000%	0.000%	0.000%	0.090%	0.000%	0.000%	0.000%	0.000%	0.000%	1.792%	0.000%	0.000%	0.134%
Summer Flounder	0.141%	0.121%	0.205%	0.105%	0.121%	0.081%	0.135%	0.139%	0.097%	0.127%	0.175%	0.127%	0.128%	0.099%	0.129%
Scup	0.019%	0.023%	0.024%	0.017%	0.028%	0.026%	0.024%	0.051%	0.051%	0.067%	0.659%	0.217%	0.195%	0.204%	0.115%
Atlantic Herring	0.181%	0.181%	0.180%	0.063%	0.182%	0.097%	0.023%	0.021%	0.140%	0.022%	0.152%	0.247%	0.006%	0.000%	0.107%
Smooth Dogfish	0.120%	0.103%	0.130%	0.158%	0.065%	0.037%	0.039%	0.048%	0.023%	0.036%	0.239%	0.138%	0.253%	0.076%	0.105%
Atlantic Surf Clam	0.013%	0.028%	0.019%	0.005%	0.000%	0.000%	0.000%	0.017%	0.189%	0.202%	0.000%	0.093%	0.524%	0.331%	0.101%
Sea Robin spp.	0.035%	0.065%	0.205%	0.063%	0.063%	0.027%	0.053%	0.051%	0.043%	0.036%	0.165%	0.046%	0.051%	0.286%	0.085%
Monkfish	0.244%	0.135%	0.126%	0.106%	0.073%	0.038%	0.052%	0.094%	0.148%	0.044%	0.096%	0.014%	0.010%	0.005%	0.085%
Cobia	0.000%	0.000%	0.000%	0.404%	0.236%	0.000%	0.000%	0.000%	0.000%	0.000%	0.066%	0.000%	0.000%	0.078%	0.056%
Bluefish	0.017%	0.025%	0.014%	0.062%	0.052%	0.026%	0.022%	0.029%	0.019%	0.027%	0.156%	0.056%	0.157%	0.078%	0.053%
Conger Eel	0.018%	0.010%	0.012%	0.008%	0.011%	0.027%	0.062%	0.007%	0.022%	0.009%	0.012%	0.069%	0.357%	0.021%	0.046%
Thresher Shark	0.000%	0.000%	0.000%	0.006%	0.010%	0.012%	0.109%	0.000%	0.000%	0.012%	0.440%	0.000%	0.000%	0.000%	0.042%
Black Drum	0.000%	0.017%	0.009%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.513%	0.000%	0.038%
Weakfish	0.034%	0.014%	0.020%	0.024%	0.062%	0.023%	0.018%	0.026%	0.045%	0.034%	0.036%	0.041%	0.085%	0.075%	0.038%

Source: NMFS 2022

Table I-55 Commercial Revenue in the Lease Area as a Percentage of Revenue in the Geographic Analysis Area for the Top 20 Species, 2008–2021

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Atlantic Mackerel	0.624%	0.789%	1.515%	0.012%	1.724%	0.044%	0.004%	0.115%	0.016%	0.134%	0.763%	0.525%	0.343%	0.094%	0.479%
Atlantic Sea Scallop	0.763%	0.347%	0.432%	0.904%	0.568%	0.286%	0.572%	0.292%	0.211%	0.076%	0.028%	0.025%	0.081%	0.013%	0.328%
Longfin Squid	0.029%	0.263%	0.140%	0.582%	0.563%	0.261%	0.713%	0.124%	0.009%	0.037%	0.133%	0.070%	0.157%	0.032%	0.222%
Tautog	0.061%	0.068%	0.048%	0.044%	0.033%	0.080%	0.039%	0.074%	0.158%	0.048%	0.027%	0.072%	0.094%	2.070%	0.208%
Chub Mackerel	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.002%	0.086%	0.000%	0.000%	0.000%	0.001%	0.134%	2.522%	0.196%
Black Sea Bass	0.036%	0.056%	0.036%	0.047%	0.054%	0.054%	0.066%	0.142%	0.099%	0.165%	0.725%	0.350%	0.325%	0.198%	0.168%
Summer Flounder	0.151%	0.123%	0.266%	0.127%	0.133%	0.086%	0.138%	0.146%	0.118%	0.127%	0.190%	0.119%	0.132%	0.128%	0.142%
Scup	0.018%	0.021%	0.028%	0.018%	0.021%	0.029%	0.033%	0.051%	0.067%	0.071%	0.611%	0.344%	0.220%	0.324%	0.132%
Northern Puffer	0.000%	0.000%	0.000%	0.000%	0.000%	0.109%	0.000%	0.000%	0.000%	0.000%	0.000%	1.683%	0.000%	0.000%	0.128%
Atlantic Surf Clam	0.013%	0.017%	0.018%	0.005%	0.000%	0.000%	0.000%	0.015%	0.172%	0.185%	0.000%	0.104%	0.523%	0.301%	0.097%
Sea Robin spp.	0.041%	0.056%	0.156%	0.105%	0.060%	0.010%	0.057%	0.045%	0.041%	0.048%	0.150%	0.089%	0.101%	0.307%	0.090%
Atlantic Herring	0.136%	0.137%	0.146%	0.050%	0.138%	0.146%	0.017%	0.018%	0.076%	0.016%	0.107%	0.158%	0.004%	0.000%	0.082%
Smooth Dogfish	0.052%	0.073%	0.121%	0.122%	0.053%	0.030%	0.038%	0.037%	0.026%	0.037%	0.185%	0.130%	0.172%	0.060%	0.081%
Monkfish	0.248%	0.114%	0.126%	0.099%	0.080%	0.039%	0.056%	0.085%	0.124%	0.036%	0.078%	0.014%	0.010%	0.004%	0.080%
Cobia	0.000%	0.000%	0.000%	0.535%	0.292%	0.000%	0.000%	0.000%	0.000%	0.000%	0.038%	0.000%	0.000%	0.108%	0.070%
American Eel	0.000%	0.000%	0.061%	0.009%	0.018%	0.000%	0.002%	0.000%	0.000%	0.228%	0.002%	0.118%	0.303%	0.148%	0.063%
Bluefish	0.025%	0.029%	0.020%	0.066%	0.047%	0.022%	0.024%	0.024%	0.018%	0.026%	0.162%	0.037%	0.190%	0.086%	0.055%
Conger Eel	0.024%	0.009%	0.010%	0.009%	0.011%	0.029%	0.035%	0.008%	0.019%	0.008%	0.013%	0.064%	0.459%	0.021%	0.051%

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Thresher Shark	0.000%	0.000%	0.000%	0.004%	0.011%	0.013%	0.146%	0.000%	0.000%	0.018%	0.452%	0.000%	0.000%	0.000%	0.046%
Weakfish	0.046%	0.016%	0.021%	0.023%	0.060%	0.022%	0.018%	0.028%	0.048%	0.033%	0.044%	0.034%	0.092%	0.070%	0.040%

Source: NMFS 2022

Table I-56 Annual Commercial Landings (pounds) in the EW 1 WEA by Fishing Gear, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Trawl-Bottom	63,245	83,852	55,905	117,641	212,343	87,458	151,325	32,669	12,050	17,284	69,214	32,162	32,685	26,717	71,039
Trawl-Midwater	163,337	176,684	249,382	51,256	87,677	14,094	0	9,289	16,967	14,615	107,039	39,651	18,972	7,165	68,295
Dredge-Scallop	62,971	49,552	80,476	112,214	42,736	23,727	26,288	14,944	11,669	8,700	2,646	2,131	6,578	961	31,828
Dredge-Clam	5,221	5,018	15,531	8,858	5,163	34,326	13,179	8,189	38,701	73,771	0	10,189	67,338	37,480	23,069
Other Gear	30,677	36,810	19,371	150	7,199	254	12,192	8,398	11,895	870	25,559	1,208	280	2,952	11,273
Pots	876	1,428	591	1,020	775	2,854	1,011	1,369	838	499	543	930	700	1,493	1,066
Gillnet-Sink	2,099	2,444	1,431	1,935	1,007	208	592	710	782	280	353	149	0	0	856
All Gear	**328,426**	**355,788**	**422,687**	**293,074**	**356,900**	**162,921**	**204,587**	**75,568**	**92,902**	**116,019**	**205,354**	**86,420**	**126,553**	**76,768**	**207,426**

Source: NMFS 2022

Table I-57 Annual Commercial Revenue (2021 dollars) in the EW 1 WEA by Fishing Gear, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Dredge-Scallop	$540,776	$393,139	$777,064	$1,321,637	$494,625	$319,329	$366,117	$210,255	$151,755	$77,985	$25,012	$21,384	$66,690	$13,993	$341,411
Trawl-Bottom	$293,791	$162,500	$104,521	$196,272	$247,115	$99,583	$196,171	$52,194	$34,300	$28,546	$68,685	$44,593	$39,715	$35,852	$114,560
Dredge-Clam	$6,249	$4,692	$13,400	$7,245	$5,984	$32,346	$10,005	$8,403	$33,859	$73,796	$0	$9,484	$49,272	$29,514	$20,303
Trawl-Midwater	$19,075	$22,132	$33,430	$5,790	$15,319	$2,021	$0	$1,333	$2,246	$2,917	$19,726	$9,093	$4,331	$1,494	$9,922
Other Gear	$15,836	$8,382	$5,277	$506	$2,969	$2,130	$23,504	$3,487	$2,736	$2,339	$21,151	$2,183	$1,449	$9,829	$7,270
Pots	$4,727	$3,602	$2,572	$5,192	$3,232	$7,379	$4,794	$5,363	$3,197	$2,171	$1,975	$3,025	$2,450	$7,864	$4,110
Gillnet-Sink	$3,551	$3,734	$2,069	$3,869	$2,170	$311	$968	$934	$1,040	$338	$368	$165	$0	$0	$1,394
All Gear	**$884,006**	**$598,180**	**$938,334**	**$1,540,511**	**$771,414**	**$463,100**	**$601,558**	**$281,968**	**$229,134**	**$188,092**	**$136,917**	**$89,927**	**$163,908**	**$98,546**	**$498,971**

Source: NMFS 2022

Table I-58 Annual Commercial Landings (pounds) in the EW 2 WEA by Fishing Gear, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Trawl-Midwater	374,048	454,985	322,039	46,713	385,026	48,861	0	19,141	133,577	31,736	165,381	92,154	50,910	28,394	153,783
Dredge-Scallop	224,274	130,227	173,555	425,160	270,163	88,979	144,382	86,694	70,724	35,796	13,366	12,187	32,804	4,627	122,353
Trawl-Bottom	170,426	86,611	61,322	65,439	88,966	137,757	74,962	38,831	17,681	23,545	128,920	50,112	59,693	47,464	75,124
Dredge-Clam	15,702	33,872	6,061	39,665	4,873	6,265	10,122	10,270	86,428	112,269	35,858	39,227	110,836	98,212	43,547
Other Gear	26,484	94,141	31,766	268	21,157	291	48,581	14,148	68,574	795	1,536	1,212	1,147	1,700	22,271
Gillnet-Sink	11,343	8,705	7,517	8,160	3,867	1,480	1,775	7,933	0	4,423	12,752	797	0	231	4,927
Pots	597	719	265	479	540	10,431	1,877	1,967	656	510	506	1,239	829	2,651	1,662
All Gear	**822,874**	**809,260**	**602,525**	**585,884**	**774,592**	**294,064**	**281,699**	**178,984**	**377,640**	**209,074**	**358,319**	**196,928**	**256,219**	**183,279**	**423,667**

Source: NMFS 2022

Table I-59 Annual Commercial Revenue (2021 dollars) in the EW 2 WEA by Fishing Gear, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Dredge-Scallop	$1,913,494	$1,024,989	$1,616,347	$4,997,780	$3,171,860	$1,205,849	$2,030,473	$1,213,703	$934,861	$343,815	$130,879	$126,875	$335,251	$71,069	$1,365,517
Trawl-Bottom	$960,997	$199,455	$72,252	$141,152	$191,475	$93,268	$249,015	$77,915	$80,516	$39,282	$177,902	$85,583	$80,573	$59,304	$179,192
Dredge-Clam	$19,621	$24,176	$5,366	$23,830	$3,195	$5,472	$10,196	$8,904	$83,049	$115,326	$31,953	$42,674	$116,889	$83,973	$41,044
Trawl-Midwater	$46,433	$61,976	$40,930	$5,595	$69,457	$6,981	$0	$2,772	$17,219	$6,487	$29,248	$20,381	$12,199	$5,820	$23,250
Other Gear	$44,290	$17,129	$8,206	$656	$20,664	$660	$168,558	$12,820	$29,980	$1,596	$4,094	$3,234	$4,645	$3,389	$22,851
Gillnet-Sink	$18,862	$13,846	$13,379	$19,257	$8,402	$2,191	$2,883	$11,614	$0	$5,572	$12,451	$877	$0	$526	$7,847
Pots	$2,503	$3,140	$1,154	$2,775	$2,644	$15,418	$9,141	$7,095	$2,877	$1,993	$1,599	$3,066	$3,016	$13,407	$4,988
All Gear	**$3,006,199**	**$1,344,712**	**$1,757,635**	**$5,191,044**	**$3,467,697**	**$1,329,838**	**$2,470,265**	**$1,334,823**	**$1,148,501**	**$514,072**	**$388,127**	**$282,689**	**$552,573**	**$237,488**	**$1,644,690**

Source: NMFS 2022

Table I-60 Annual Commercial Landings (pounds) in the Lease Area by Fishing Gear, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Trawl-Midwater	537,385	631,669	571,421	97,969	472,703	62,956	0	28,430	150,544	46,352	272,419	131,804	69,882	35,559	222,078
Dredge-Scallop	287,246	179,780	254,032	537,375	312,899	112,828	170,670	101,637	82,392	44,605	16,012	14,318	39,382	5,589	154,198
Trawl-Bottom	233,671	170,463	117,227	183,279	301,338	225,215	226,287	71,500	29,781	40,942	198,134	82,900	92,404	74,181	146,237
Dredge-Clam	20,923	38,889	21,592	48,522	10,036	40,591	23,300	18,459	125,129	186,039	59,641	49,416	178,174	135,691	68,314
Other Gear	57,161	130,931	51,137	181	28,329	424	60,757	22,545	66,292	1,442	3,312	1,794	935	4,252	30,678
Gillnet-Sink	13,442	11,148	8,948	10,095	4,875	1,688	2,367	8,644	14,908	4,703	13,105	946	466	633	6,855
Pots	1,473	2,167	855	1,536	1,315	13,284	2,905	3,336	1,495	1,009	1,050	2,169	1,529	4,144	2,733
All Gear	**1,151,301**	**1,165,047**	**1,025,212**	**878,957**	**1,131,495**	**456,986**	**486,286**	**254,551**	**470,541**	**325,092**	**563,673**	**283,347**	**382,772**	**260,049**	**631,094**

Source: NMFS 2022

Table I-61 Annual Commercial Revenue (2021 dollars) in the Lease Area by Fishing Gear, 2008–2021

Gear	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Dredge-Scallop	$2,454,270	$1,418,130	$2,393,411	$6,319,417	$3,666,486	$1,526,890	$2,396,589	$1,423,957	$1,086,614	$422,893	$155,889	$148,259	$401,941	$85,061	$1,707,129
Trawl-Bottom	$1,254,788	$361,958	$176,773	$337,790	$438,702	$192,851	$445,185	$130,110	$114,888	$67,956	$246,587	$131,272	$120,340	$95,156	$293,883
Dredge-Clam	$25,870	$28,869	$18,767	$31,075	$9,179	$37,818	$20,201	$17,307	$116,908	$189,121	$49,544	$52,157	$166,161	$113,487	$62,604
Trawl-Midwater	$65,507	$84,107	$74,360	$11,384	$84,777	$9,002	$0	$4,106	$19,465	$9,404	$48,973	$29,474	$16,530	$7,314	$33,172
Other Gear	$60,127	$25,468	$13,483	$640	$23,522	$1,079	$191,995	$16,307	$10,097	$2,716	$7,656	$4,322	$5,550	$12,372	$26,810
Gillnet-Sink	$22,413	$17,580	$15,449	$23,126	$10,570	$2,502	$3,851	$12,547	$23,589	$5,909	$12,819	$1,042	$492	$1,372	$10,947
Pots	$7,230	$6,787	$3,726	$8,121	$5,876	$22,798	$14,002	$12,457	$6,074	$4,164	$3,575	$6,091	$5,467	$21,270	$9,117
All Gear	**$3,890,206**	**$1,942,898**	**$2,695,970**	**$6,731,553**	**$4,239,112**	**$1,792,940**	**$3,071,821**	**$1,616,791**	**$1,377,634**	**$702,164**	**$525,044**	**$372,616**	**$716,482**	**$336,032**	**$2,143,662**

Source: NMFS 2022

Table I-62 Annual Commercial Landings (pounds) in the EW 1 WEA for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Bedford, MA	117,982	74,500	119,720	95,378	92,473	17,075	21,086	5,011	15,660	9,684	30,745	13,350	11,522	4,381	44,898
Cape May, NJ	51,876	100,950	117,584	37,103	59,921	15,450	19,182	19,172	12,864	10,460	67,173	16,363	11,304	6,375	38,984
Point Judith, RI	29	19,766	2,377	28,335	45,268	25,126	101,369	7,266	670	865	16,150	4,647	10,244	3,394	18,965
Point Pleasant, NJ	16,618	23,493	36,110	31,706	18,134	8,418	14,410	10,531	13,470	5,208	15,562	9,934	34,645	13,359	17,971
Atlantic City, NJ	1,977	2,059	464	0	1,495	10,072	623	7,473	23,390	48,333	0	3,000	42,439	19,130	11,461
Montauk, NY	469	12,731	2,618	33,541	17,785	4,172	8,780	4,452	0	698	3,466	670	708	1,091	6,513
Point Lookout, NY	14,418	9,481	6,994	12,682	20,344	8,582	5,946	0	0	0	0	0	0	0	5,603
Belford, NJ	0	8,125	9,655	15,575	0	6,660	7,555	0	6,792	0	6,355	0	7,155	6,983	5,347
Newport News, VA	9,767	6,107	16,245	14,452	7,133	1,763	2,620	348	393	728	315	257	285	290	4,336
Freeport, NY	13,951	4,743	2,865	3,361	1,318	537	322	411	372	294	118	179	351	4,436	2,376
Barnegat, NJ	271	2,688	5,326	4,538	3,644	3,569	2,364	4,598	1,752	1,680	709	0	0	1,575	2,337
North Kingstown, RI	0	0	16,812	769	0	0	0	0	0	0	0	0	0	0	1,256
New London, CT	4,983	1,984	550	1,304	3,094	0	0	0	0	0	0	0	0	0	851
Shinnecock, NY	927	1,255	250	1,154	58	7,385	286	198	0	0	0	53	0	0	826
Stonington, CT	2,604	685	1,225	0	0	0	0	508	78	0	0	2,788	1,793	0	692
Fall River, MA	0	0	8,047	0	0	0	0	0	0	0	0	0	0	0	575
Long Beach, NY	7,081	0	0	0	0	0	0	0	0	0	0	0	0	0	506
Hampton, VA	0	0	0	0	677	0	0	686	941	926	0	481	664	515	349
Newport, RI	0	2,797	0	0	0	0	0	0	0	0	0	0	0	0	200
Hampton Bay, NY	0	0	0	416	0	0	50	0	0	284	941	657	0	0	168
All Ports[1]	**328,428**	**355,791**	**422,685**	**293,075**	**356,907**	**162,920**	**204,591**	**75,567**	**92,898**	**116,017**	**205,353**	**86,420**	**126,556**	**76,763**	**207,427**

Source: NMFS 2022
[1] Includes 34 ports that reported landings in the EW 1 WEA
State Abbreviations: CT = Connecticut, MA = Massachusetts, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-63 Annual Commercial Revenue (2021 dollars) in the EW 1 WEA for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Bedford, MA	$282,552	$219,416	$308,234	$555,870	$208,281	$86,378	$172,672	$38,658	$52,354	$52,727	$17,142	$10,760	$43,594	$4,833	$146,676
Point Pleasant, NJ	$88,016	$103,992	$169,531	$223,094	$94,224	$54,081	$58,575	$71,736	$52,278	$17,243	$28,224	$23,389	$37,290	$21,041	$74,480
Cape May, NJ	$62,156	$45,930	$163,389	$303,403	$148,758	$120,166	$80,963	$32,411	$30,377	$5,072	$17,035	$5,715	$7,359	$5,225	$73,426
Newport News, VA	$84,278	$43,517	$160,525	$164,701	$75,103	$18,550	$36,025	$3,333	$4,653	$6,053	$2,603	$1,032	$502	$1,831	$43,050
Point Judith, RI	$38	$22,857	$3,937	$44,313	$58,388	$34,201	$138,815	$10,840	$3,390	$2,261	$18,263	$5,909	$13,069	$4,357	$25,760
Barnegat, NJ	$591	$10,199	$31,095	$28,894	$32,966	$26,402	$25,369	$54,716	$14,315	$9,226	$3,158	$0	$0	$8,128	$17,504
Point Lookout, NY	$86,870	$50,739	$13,851	$31,838	$27,764	$15,320	$12,158	$0	$0	$0	$0	$0	$0	$0	$17,039
Atlantic City, NJ	$3,461	$6,032	$440	$0	$1,622	$11,725	$324	$7,901	$21,862	$53,869	$0	$3,146	$30,754	$15,274	$11,172
Montauk, NY	$668	$16,994	$4,249	$53,227	$26,254	$5,628	$10,431	$6,562	$0	$1,155	$6,010	$1,045	$1,149	$1,646	$9,644
Freeport, NY	$85,278	$13,900	$7,116	$6,427	$3,154	$2,202	$1,253	$1,882	$1,429	$1,286	$562	$756	$1,241	$3,092	$9,256
Belford, NJ	$0	$10,673	$16,474	$20,307	$0	$7,227	$9,236	$0	$9,747	$0	$6,212	$0	$5,582	$6,869	$6,595
New London, CT	$41,862	$14,598	$4,817	$14,608	$4,096	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,713
Stonington, CT	$22,211	$5,212	$6,766	$0	$0	$0	$0	$6,071	$932	$0	$0	$4,591	$2,775	$0	$3,468
Long Beach, NY	$47,924	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,423

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Hampton, VA	$0	$0	$0	$0	$4,540	$0	$0	$1,673	$8,994	$2,474	$0	$1,633	$4,077	$2,324	$1,837
Shinnecock, NY	$2,800	$1,620	$538	$2,055	$119	$10,011	$302	$346	$0	$0	$0	$84	$0	$0	$1,277
North Kingstown, RI	$0	$0	$9,677	$1,295	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$784
Islip, NY	$10,367	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$740
Beaufort, NC	$0	$0	$0	$0	$88	$0	$636	$409	$324	$1,238	$1,236	$837	$426	$920	$437
Hampton Bay, NY	$0	$0	$0	$513	$0	$0	$172	$0	$0	$479	$1,690	$1,176	$0	$0	$288
All Ports[1]	**$884,008**	**$598,179**	**$938,335**	**$1,540,507**	**$771,410**	**$463,101**	**$601,557**	**$281,965**	**$229,128**	**$188,088**	**$136,916**	**$89,922**	**$163,907**	**$98,537**	**$498,969**

Source: NMFS 2022
[1] Includes 34 ports that reported landings in the EW 1 WEA
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-64 Annul Commercial Landings (pounds) in the EW 2 WEA for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Bedford, MA	204,740	187,412	292,807	271,276	420,177	48,514	72,545	17,490	85,776	40,250	44,546	32,396	43,923	15,347	126,943
Cape May, NJ	65,710	290,149	61,899	119,720	130,449	38,277	42,937	49,892	57,694	22,580	100,818	48,178	25,924	27,733	77,283
Point Pleasant, NJ	56,900	42,008	26,103	39,397	67,140	33,330	32,943	37,322	28,823	19,395	80,537	39,244	115,292	83,951	50,170
Newport News, VA	24,415	20,970	16,803	53,895	40,818	4,635	18,555	1,137	1,139	6,737	1,232	742	921	708	13,765
Barnegat, NJ	3,490	9,602	15,053	14,418	27,261	24,531	11,417	17,820	22,707	6,525	6,394	0	5,069	1,714	11,857
Point Judith, RI	123	7,142	3,207	12,442	13,401	9,562	53,090	12,141	2,902	1,825	15,297	7,613	14,008	5,827	11,327
Atlantic City, NJ	1,534	1,009	1,581	2,468	362	2,747	8,422	4,642	37,575	43,664	9,090	7,901	28,517	4,081	10,971
Point Lookout, NY	57,338	16,067	3,559	8,558	5,652	3,135	10,334	0	0	0	0	0	0	0	7,475
New London, CT	37,050	11,771	3,121	11,389	779	471	0	255	209	0	0	0	0	0	4,646
Montauk, NY	797	3,401	3,581	12,304	8,755	1,268	5,942	4,207	579	1,237	6,094	2,385	1,959	10,613	4,509
North Kingstown, RI	8,822	0	48,821	1,727	0	0	0	0	0	0	0	0	0	0	4,241
Stonington, CT	18,891	2,013	9,669	682	3,846	0	0	7,108	435	510	0	3,526	2,940	147	3,555
Freeport, NY	38,238	3,898	856	1,039	299	41	0	17	0	0	0	0	0	2,384	3,341
Long Beach, NY	35,478	0	0	0	0	0	0	0	0	0	0	0	0	0	2,534
Belford, NJ	0	2,800	2,574	5,102	0	1,200	2,337	0	3,950	0	3,917	0	890	1,005	1,698
Newport, RI	0	3,326	0	10,375	0	2,042	0	0	0	0	0	0	0	0	1,125
Fall River, MA	0	0	15,675	0	0	0	0	0	0	0	0	0	0	0	1,120
Hampton, VA	0	0	0	0	1,915	0	278	2,419	2,363	2,054	206	1,020	2,170	1,249	977
Islip, NY	10,572	0	0	0	0	0	0	0	0	0	0	0	0	0	755
Hampton Bay, NY	0	0	0	112	0	52	18	0	62	280	8,805	290	331	205	725
All Ports[1]	**822,873**	**809,256**	**602,525**	**585,886**	**774,592**	**294,067**	**281,698**	**178,982**	**377,640**	**209,076**	**358,321**	**196,926**	**256,218**	**183,282**	**423,667**

Source: NMFS 2022
[1] Includes 32 ports that reported landings in the EW 2 WEA
State Abbreviations: CT = Connecticut, MA = Massachusetts, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-65 Annual Commercial Revenue (2021 dollars) in the EW 2 WEA for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Bedford, MA	$822,339	$494,937	$861,238	$2,441,911	$1,141,754	$228,465	$729,580	$162,664	$360,583	$154,036	$57,002	$41,013	$200,995	$21,952	$551,319
Point Pleasant, NJ	$319,775	$222,859	$163,928	$295,365	$703,494	$337,679	$364,464	$431,687	$326,565	$91,889	$159,966	$120,112	$179,750	$109,243	$273,341
Cape May, NJ	$87,585	$145,955	$280,554	$1,303,048	$605,831	$294,088	$286,678	$288,377	$79,465	$25,288	$32,738	$19,629	$24,919	$16,677	$249,345
Newport News, VA	$207,304	$152,679	$163,772	$597,202	$451,294	$50,878	$263,236	$10,408	$13,134	$62,972	$10,993	$3,568	$2,308	$6,425	$142,584
Barnegat, NJ	$6,380	$33,785	$92,432	$103,217	$289,445	$222,147	$139,450	$160,099	$138,290	$30,600	$24,740	$0	$46,197	$19,186	$93,284
Point Lookout, NY	$382,736	$82,400	$7,507	$47,766	$22,757	$13,904	$110,980	$0	$0	$0	$0	$0	$0	$0	$47,718
New London, CT	$309,904	$85,007	$25,693	$133,963	$2,612	$5,449	$0	$2,635	$1,462	$0	$0	$0	$0	$0	$40,480
Point Judith, RI	$166	$8,091	$6,726	$23,485	$18,329	$19,281	$312,550	$18,801	$14,431	$9,410	$15,369	$9,186	$20,529	$9,991	$34,739
Stonington, CT	$165,017	$15,061	$65,192	$5,462	$39,527	$0	$0	$88,586	$5,207	$4,891	$0	$5,698	$5,884	$589	$28,651
Freeport, NY	$245,709	$17,501	$2,241	$1,638	$611	$150	$0	$83	$0	$0	$0	$0	$0	$1,272	$19,229
Long Beach, NY	$241,660	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$17,261
Atlantic City, NJ	$2,323	$4,035	$1,295	$2,508	$549	$2,846	$8,995	$4,967	$42,186	$48,397	$9,766	$8,168	$28,096	$3,165	$11,950
Montauk, NY	$1,128	$5,440	$8,215	$22,087	$16,576	$1,658	$7,350	$7,394	$821	$1,912	$8,981	$3,517	$2,826	$14,117	$7,287
Islip, NY	$74,553	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,325
Hampton, VA	$0	$0	$0	$0	$13,246	$0	$506	$6,183	$21,520	$5,552	$465	$3,606	$15,775	$6,673	$5,252
Belford, NJ	$0	$4,196	$6,516	$10,892	$0	$1,988	$3,599	$0	$8,574	$0	$4,305	$0	$974	$1,513	$3,040
North Kingstown, RI	$4,058	$0	$28,063	$5,640	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,697
Newport, RI	$0	$2,058	$0	$5,940	$0	$29,306	$0	$0	$0	$0	$0	$0	$0	$0	$2,665
Shinnecock, NY	$7,227	$2,142	$1,620	$6,270	$1,567	$1,312	$456	$478	$140	$45	$168	$44	$23	$412	$1,565
Beaufort, NC	$281	$0	$0	$0	$330	$0	$4,285	$1,456	$1,654	$2,888	$1,577	$1,718	$1,056	$2,560	$1,272
All Ports[1]	**$3,006,201**	**$1,344,712**	**$1,757,633**	**$5,191,050**	**$3,467,694**	**$1,329,834**	**$2,470,263**	**$1,334,824**	**$1,148,500**	**$514,073**	**$388,124**	**$282,692**	**$552,572**	**$237,490**	**$1,644,690**

Source: NMFS 2022
[1] Includes 32 ports that reported landings in the EW 2 WEA
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-66 Annual Commercial Landings (pounds) in the Lease Area for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Bedford, MA	322,721	261,912	412,528	366,654	512,650	65,589	93,631	22,501	101,436	49,933	75,291	45,746	55,445	19,727	171,840
Cape May, NJ	117,586	391,099	179,484	156,824	190,369	53,726	62,119	69,064	70,558	33,041	167,991	64,541	37,228	34,108	116,267
Point Pleasant, NJ	73,518	65,501	62,213	71,103	85,274	41,748	47,353	47,854	42,293	24,603	96,099	49,178	149,938	97,311	68,142
Point Judith, RI	153	26,908	5,584	40,776	58,669	34,688	154,460	19,407	3,572	2,690	31,447	12,260	24,252	9,221	30,292
Atlantic City, NJ	3,511	3,067	2,045	2,622	1,856	12,820	9,045	12,115	60,965	91,997	11,251	10,901	70,956	23,211	22,597
Newport News, VA	34,182	27,076	33,048	68,347	47,951	6,397	21,176	1,485	1,532	7,465	1,547	999	1,206	998	18,101
Barnegat, NJ	3,761	12,290	20,379	18,956	30,905	28,099	13,781	22,418	24,460	8,205	7,103	0	6,153	3,290	14,271
Point Lookout, NY	71,756	25,548	10,553	21,241	25,995	11,717	16,280	0	0	0	0	0	0	0	13,078
Montauk, NY	1,265	16,132	6,199	45,846	26,539	5,440	14,722	8,659	709	1,934	9,559	3,055	2,668	11,704	11,031
Belford, NJ	0	10,925	12,229	20,677	0	7,860	9,892	0	10,742	0	10,272	0	8,044	7,988	7,045
North Kingstown, RI	13,264	0	65,634	2,496	0	0	0	0	0	0	0	0	0	0	5,814
Freeport, NY	52,190	8,641	3,720	4,400	1,617	578	336	428	379	302	120	182	361	6,820	5,720
New London, CT	42,033	13,755	3,671	12,693	3,873	489	0	326	209	0	0	0	0	0	5,504
Stonington, CT	21,496	2,698	10,894	1,295	4,819	0	0	7,616	513	602	0	6,314	4,732	149	4,366

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Long Beach, NY	42,559	0	0	0	0	0	0	0	0	0	0	0	0	0	3,040
Fall River, MA	0	0	23,723	0	0	0	0	0	0	0	0	0	0	0	1,695
Newport, RI	0	6,124	0	11,982	0	3,404	0	0	0	0	0	0	0	0	1,536
Hampton, VA	0	0	0	0	2,592	0	420	3,105	3,304	2,980	308	1,501	2,834	1,764	1,343
Shinnecock, NY	2,180	2,299	788	2,907	336	8,402	668	411	55	45	134	66	37	211	1,324
Hampton Bay, NY	0	0	97	528	0	53	68	0	67	564	9,746	947	560	257	921
All Ports[1]	**1,151,299**	**1,165,046**	**1,025,215**	**878,959**	**1,131,494**	**456,984**	**486,290**	**254,549**	**470,542**	**325,092**	**563,676**	**283,345**	**382,772**	**260,046**	**631,094**

Source: NMFS 2022
[1] Includes 36 ports that reported landings in the Lease Area
State Abbreviations: CT = Connecticut, MA = Massachusetts, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-67 Annual Commercial Revenue (2021 dollars) in the Lease Area for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Bedford, MA	$1,104,891	$714,353	$1,169,472	$2,997,781	$1,350,034	$314,844	$902,252	$201,322	$412,938	$206,763	$74,145	$51,774	$244,588	$26,785	$697,996
Point Pleasant, NJ	$407,791	$326,851	$333,459	$518,459	$797,718	$391,759	$423,039	$503,423	$378,843	$109,131	$188,190	$143,501	$217,040	$130,284	$347,821
Cape May, NJ	$149,740	$191,885	$443,942	$1,606,451	$754,589	$414,254	$367,640	$320,789	$109,842	$30,361	$49,773	$25,344	$32,277	$21,902	$322,771
Newport News, VA	$291,581	$196,195	$324,297	$761,902	$526,397	$69,428	$299,261	$13,741	$17,787	$69,025	$13,597	$4,600	$2,810	$8,255	$185,634
Barnegat, NJ	$6,970	$43,984	$123,527	$132,110	$322,411	$248,550	$164,819	$214,816	$152,605	$39,826	$27,898	$0	$54,875	$27,314	$111,408
Point Lookout, NY	$469,606	$133,139	$21,358	$79,603	$50,521	$29,223	$123,137	$0	$0	$0	$0	$0	$0	$0	$64,756
Point Judith, RI	$204	$30,948	$10,663	$67,798	$76,718	$53,481	$451,365	$29,641	$17,820	$11,671	$33,633	$15,096	$33,599	$14,348	$60,499
New London, CT	$351,767	$99,605	$30,510	$148,571	$6,708	$5,605	$0	$2,999	$1,464	$0	$0	$0	$0	$0	$46,231
Stonington, CT	$187,228	$20,272	$71,958	$7,471	$43,790	$0	$0	$94,658	$6,139	$5,935	$0	$10,288	$8,659	$593	$32,642
Freeport, NY	$330,987	$31,401	$9,357	$8,064	$3,765	$2,351	$1,312	$1,965	$1,455	$1,321	$570	$766	$1,283	$4,364	$28,497
Atlantic City, NJ	$5,784	$10,067	$1,735	$2,803	$2,171	$14,571	$9,320	$12,870	$64,046	$102,267	$12,111	$11,314	$58,851	$18,439	$23,311
Long Beach, NY	$289,584	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,685
Montauk, NY	$1,796	$22,435	$12,464	$75,314	$42,829	$7,286	$17,782	$13,957	$1,008	$3,068	$14,991	$4,563	$3,977	$15,763	$16,945
Belford, NJ	$0	$14,869	$22,989	$31,199	$0	$9,215	$12,836	$0	$18,321	$0	$10,516	$0	$6,556	$8,382	$9,634
Hampton, VA	$0	$0	$0	$0	$17,786	$0	$747	$7,857	$30,514	$8,026	$665	$5,239	$19,852	$8,996	$7,120
Islip, NY	$84,921	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$6,066
Newport, RI	$0	$2,911	$0	$7,049	$0	$49,228	$0	$0	$0	$0	$0	$0	$0	$0	$4,228
North Kingstown, RI	$6,065	$0	$37,740	$6,934	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,624
Shinnecock, NY	$10,027	$3,762	$2,158	$8,323	$1,686	$11,323	$759	$824	$163	$64	$257	$128	$82	$412	$2,855
Beaufort, NC	$350	$0	$0	$0	$418	$0	$4,922	$1,865	$1,978	$4,126	$2,813	$2,555	$1,482	$3,480	$1,713
All Ports[1]	**$3,890,205**	**$1,942,892**	**$2,695,966**	**$6,731,551**	**$4,239,109**	**$1,792,936**	**$3,071,822**	**$1,616,789**	**$1,377,632**	**$702,164**	**$525,042**	**$372,619**	**$716,481**	**$336,031**	**$2,143,660**

Source: NMFS 2022
[1] Includes 36 ports that reported landings in the Lease Area
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-68 Annual Commercial Landings in the EW 1 WEA as a Percentage of Landings in the Geographic Analysis Area for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Freeport, NY	3.017%	0.945%	0.747%	0.751%	0.781%	0.740%	0.403%	0.508%	0.352%	0.461%	0.216%	0.309%	0.408%	0.919%	0.754%
Point Lookout, NY	1.256%	0.860%	0.492%	0.741%	1.422%	0.451%	1.328%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.468%
Belford, NJ	0.000%	0.156%	0.132%	0.151%	0.000%	0.093%	0.117%	0.000%	0.184%	0.000%	0.129%	0.000%	0.264%	0.249%	0.105%
Point Pleasant, NJ	0.081%	0.125%	0.161%	0.158%	0.095%	0.053%	0.101%	0.070%	0.081%	0.032%	0.091%	0.068%	0.231%	0.087%	0.102%
Newport News, VA	0.096%	0.076%	0.223%	0.190%	0.127%	0.041%	0.097%	0.011%	0.012%	0.036%	0.014%	0.009%	0.012%	0.017%	0.069%
Montauk, NY	0.005%	0.123%	0.021%	0.253%	0.124%	0.032%	0.075%	0.042%	0.000%	0.008%	0.035%	0.007%	0.008%	0.013%	0.053%
Atlantic City, NJ	0.006%	0.006%	0.002%	0.000%	0.005%	0.036%	0.002%	0.028%	0.095%	0.195%	0.000%	0.013%	0.241%	0.111%	0.053%
Cape May, NJ	0.056%	0.117%	0.167%	0.042%	0.066%	0.035%	0.039%	0.034%	0.023%	0.014%	0.076%	0.022%	0.017%	0.006%	0.051%
Belmar, NJ	0.000%	0.000%	0.000%	0.000%	0.629%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.045%
Barnegat, NJ	0.032%	0.039%	0.080%	0.063%	0.061%	0.050%	0.044%	0.097%	0.029%	0.027%	0.014%	0.000%	0.000%	0.065%	0.043%
Point Judith, RI	0.000%	0.050%	0.007%	0.081%	0.109%	0.052%	0.196%	0.018%	0.001%	0.002%	0.037%	0.011%	0.026%	0.008%	0.043%
New Bedford, MA	0.087%	0.048%	0.095%	0.080%	0.071%	0.014%	0.016%	0.004%	0.016%	0.010%	0.029%	0.012%	0.011%	0.004%	0.035%
New London, CT	0.208%	0.089%	0.024%	0.040%	0.066%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.030%
Islip, NY	0.401%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.029%
Shinnecock, NY	0.024%	0.032%	0.008%	0.032%	0.001%	0.255%	0.013%	0.013%	0.000%	0.000%	0.000%	0.004%	0.000%	0.000%	0.027%
Shark River, NJ	0.000%	0.000%	0.122%	0.096%	0.006%	0.000%	0.000%	0.000%	0.000%	0.000%	0.036%	0.000%	0.000%	0.000%	0.019%
Stonington, CT	0.017%	0.006%	0.016%	0.000%	0.000%	0.000%	0.000%	0.010%	0.001%	0.000%	0.000%	0.059%	0.039%	0.000%	0.011%
Fall River, MA	0.000%	0.000%	0.147%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.010%
Long Beach, NY	0.144%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.010%
Hampton Bay, NY	0.000%	0.000%	0.000%	0.029%	0.000%	0.000%	0.002%	0.000%	0.000%	0.014%	0.043%	0.030%	0.000%	0.000%	0.008%

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-69 Annual Commercial Revenue in the EW 1 WEA as a Percentage of Revenue in the Geographic Analysis Area for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Freeport, NY	3.865%	1.089%	1.039%	0.890%	0.902%	0.950%	0.615%	0.696%	0.507%	0.667%	0.541%	0.653%	0.769%	0.770%	0.997%
Point Lookout, NY	2.447%	1.371%	0.754%	0.840%	0.902%	0.335%	0.973%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.544%
Point Pleasant, NJ	0.295%	0.353%	0.545%	0.558%	0.244%	0.178%	0.195%	0.220%	0.136%	0.046%	0.086%	0.077%	0.118%	0.062%	0.222%
Belford, NJ	0.000%	0.323%	0.459%	0.508%	0.000%	0.223%	0.253%	0.000%	0.237%	0.000%	0.149%	0.000%	0.265%	0.297%	0.194%
Newport News, VA	0.163%	0.093%	0.289%	0.280%	0.201%	0.080%	0.183%	0.011%	0.016%	0.042%	0.015%	0.006%	0.003%	0.017%	0.100%
Belmar, NJ	0.000%	0.000%	0.000%	0.000%	1.209%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.086%
Cape May, NJ	0.066%	0.050%	0.154%	0.231%	0.157%	0.250%	0.111%	0.041%	0.031%	0.006%	0.022%	0.006%	0.008%	0.008%	0.081%
Islip, NY	1.054%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.075%
New London, CT	0.604%	0.184%	0.057%	0.120%	0.035%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.071%
Barnegat, NJ	0.016%	0.037%	0.099%	0.071%	0.097%	0.087%	0.095%	0.201%	0.051%	0.037%	0.013%	0.000%	0.000%	0.035%	0.060%
Atlantic City, NJ	0.010%	0.020%	0.002%	0.000%	0.006%	0.043%	0.001%	0.033%	0.097%	0.251%	0.000%	0.017%	0.226%	0.083%	0.056%
Point Judith, RI	0.000%	0.060%	0.011%	0.107%	0.135%	0.075%	0.257%	0.023%	0.006%	0.004%	0.029%	0.009%	0.030%	0.007%	0.054%
Montauk, NY	0.004%	0.095%	0.019%	0.213%	0.100%	0.025%	0.051%	0.037%	0.000%	0.007%	0.033%	0.006%	0.008%	0.010%	0.043%
New Bedford, MA	0.093%	0.071%	0.082%	0.122%	0.042%	0.019%	0.045%	0.010%	0.014%	0.012%	0.004%	0.002%	0.011%	0.001%	0.038%
Stonington, CT	0.180%	0.048%	0.054%	0.000%	0.000%	0.000%	0.000%	0.076%	0.009%	0.000%	0.000%	0.043%	0.025%	0.000%	0.031%
Shinnecock, NY	0.047%	0.028%	0.010%	0.036%	0.002%	0.227%	0.009%	0.013%	0.000%	0.000%	0.000%	0.004%	0.000%	0.000%	0.027%

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Shark River, NJ	0.000%	0.000%	0.122%	0.125%	0.007%	0.000%	0.000%	0.000%	0.000%	0.000%	0.042%	0.000%	0.000%	0.000%	0.021%
Long Beach, NY	0.203%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.014%
Hampton, VA	0.000%	0.000%	0.000%	0.000%	0.029%	0.000%	0.000%	0.011%	0.041%	0.012%	0.000%	0.012%	0.028%	0.022%	0.011%
Neptune, NJ	0.000%	0.000%	0.000%	0.000%	0.122%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.009%

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-70 Annual Commercial Landings in the EW 2 WEA as a Percentage of Landings in the Geographic Analysis Area for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Freeport, NY	8.270%	0.776%	0.223%	0.232%	0.177%	0.056%	0.000%	0.021%	0.000%	0.000%	0.000%	0.000%	0.000%	0.494%	0.732%
Point Lookout, NY	4.993%	1.457%	0.251%	0.500%	0.395%	0.165%	2.308%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.719%
Point Pleasant, NJ	0.276%	0.223%	0.116%	0.196%	0.353%	0.209%	0.232%	0.247%	0.172%	0.119%	0.471%	0.269%	0.770%	0.544%	0.300%
Belmar, NJ	0.000%	0.000%	0.000%	0.000%	3.609%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.258%
Newport News, VA	0.241%	0.262%	0.231%	0.710%	0.726%	0.107%	0.685%	0.035%	0.035%	0.331%	0.053%	0.027%	0.040%	0.043%	0.252%
Barnegat, NJ	0.418%	0.138%	0.227%	0.199%	0.455%	0.342%	0.211%	0.378%	0.380%	0.104%	0.128%	0.000%	0.108%	0.071%	0.226%
New London, CT	1.544%	0.526%	0.134%	0.347%	0.017%	0.011%	0.000%	0.004%	0.003%	0.000%	0.000%	0.000%	0.000%	0.000%	0.185%
Islip, NY	2.351%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.168%
New Bedford, MA	0.151%	0.121%	0.232%	0.228%	0.320%	0.039%	0.056%	0.015%	0.087%	0.040%	0.042%	0.030%	0.040%	0.015%	0.101%
Cape May, NJ	0.071%	0.338%	0.088%	0.134%	0.144%	0.087%	0.088%	0.089%	0.102%	0.030%	0.114%	0.066%	0.039%	0.024%	0.101%
Long Beach, NY	0.723%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.052%
Atlantic City, NJ	0.004%	0.003%	0.006%	0.008%	0.001%	0.010%	0.028%	0.017%	0.153%	0.176%	0.036%	0.034%	0.162%	0.024%	0.047%
Stonington, CT	0.126%	0.018%	0.130%	0.006%	0.057%	0.000%	0.000%	0.140%	0.006%	0.011%	0.000%	0.074%	0.064%	0.004%	0.045%
Montauk, NY	0.008%	0.033%	0.029%	0.093%	0.061%	0.010%	0.051%	0.040%	0.005%	0.014%	0.061%	0.024%	0.023%	0.126%	0.041%
Neptune, NJ	0.000%	0.000%	0.042%	0.000%	0.489%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.038%
Hampton Bay, NY	0.000%	0.000%	0.000%	0.008%	0.000%	0.004%	0.001%	0.000%	0.004%	0.014%	0.406%	0.013%	0.016%	0.009%	0.034%
Belford, NJ	0.000%	0.054%	0.035%	0.050%	0.000%	0.017%	0.036%	0.000%	0.107%	0.000%	0.080%	0.000%	0.033%	0.036%	0.032%
Point Judith, RI	0.000%	0.018%	0.010%	0.036%	0.032%	0.020%	0.103%	0.030%	0.006%	0.005%	0.035%	0.018%	0.036%	0.014%	0.026%
Hampton, VA	0.000%	0.000%	0.000%	0.000%	0.044%	0.000%	0.009%	0.066%	0.054%	0.039%	0.005%	0.019%	0.053%	0.036%	0.023%
Beaufort, NC	0.006%	0.000%	0.000%	0.000%	0.009%	0.000%	0.061%	0.025%	0.030%	0.042%	0.021%	0.031%	0.021%	0.061%	0.022%

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-71 Annual Commercial Revenue in the EW 2 WEA as a Percentage of Revenue in the Geographic Analysis Area for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Point Lookout, NY	10.779%	2.226%	0.409%	1.260%	0.740%	0.304%	8.882%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	1.757%
Freeport, NY	11.135%	1.371%	0.327%	0.227%	0.175%	0.065%	0.000%	0.031%	0.000%	0.000%	0.000%	0.000%	0.000%	0.317%	0.975%
Point Pleasant, NJ	1.073%	0.756%	0.527%	0.739%	1.824%	1.112%	1.216%	1.325%	0.852%	0.247%	0.488%	0.393%	0.571%	0.321%	0.817%
Belmar, NJ	0.000%	0.000%	0.000%	0.000%	8.423%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.602%
Islip, NY	7.581%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.541%
New London, CT	4.470%	1.073%	0.305%	1.103%	0.023%	0.081%	0.000%	0.032%	0.024%	0.000%	0.000%	0.000%	0.000%	0.000%	0.508%
Newport News, VA	0.401%	0.326%	0.295%	1.016%	1.209%	0.218%	1.339%	0.033%	0.044%	0.433%	0.062%	0.020%	0.015%	0.059%	0.391%

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Barnegat, NJ	0.168%	0.124%	0.293%	0.253%	0.850%	0.736%	0.522%	0.588%	0.494%	0.121%	0.099%	0.000%	0.209%	0.083%	0.324%
Cape May, NJ	0.093%	0.157%	0.265%	0.991%	0.640%	0.611%	0.392%	0.362%	0.080%	0.029%	0.042%	0.022%	0.028%	0.026%	0.267%
Stonington, CT	1.339%	0.140%	0.525%	0.043%	0.320%	0.000%	0.000%	1.114%	0.052%	0.045%	0.000%	0.054%	0.052%	0.005%	0.263%
New Bedford, MA	0.272%	0.160%	0.230%	0.534%	0.233%	0.051%	0.192%	0.044%	0.098%	0.036%	0.012%	0.009%	0.052%	0.004%	0.138%
Belford, NJ	0.000%	0.127%	0.182%	0.272%	0.000%	0.061%	0.099%	0.000%	0.209%	0.000%	0.103%	0.000%	0.046%	0.065%	0.083%
Long Beach, NY	1.023%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.073%
Point Judith, RI	0.000%	0.021%	0.019%	0.057%	0.042%	0.042%	0.579%	0.040%	0.025%	0.016%	0.025%	0.014%	0.048%	0.015%	0.067%
Atlantic City, NJ	0.007%	0.013%	0.006%	0.009%	0.002%	0.010%	0.034%	0.021%	0.186%	0.226%	0.047%	0.044%	0.206%	0.017%	0.059%
Neptune, NJ	0.000%	0.000%	0.048%	0.000%	0.774%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.059%
Montauk, NY	0.006%	0.030%	0.037%	0.088%	0.063%	0.007%	0.036%	0.042%	0.004%	0.012%	0.050%	0.020%	0.021%	0.089%	0.036%
Hampton, VA	0.000%	0.000%	0.000%	0.000%	0.083%	0.000%	0.008%	0.042%	0.098%	0.028%	0.004%	0.025%	0.108%	0.063%	0.033%
Shinnecock, NY	0.121%	0.037%	0.031%	0.111%	0.030%	0.030%	0.014%	0.018%	0.005%	0.002%	0.008%	0.002%	0.002%	0.014%	0.030%
Chincoteague, VA	0.000%	0.000%	0.000%	0.000%	0.019%	0.024%	0.092%	0.016%	0.000%	0.089%	0.044%	0.053%	0.000%	0.000%	0.024%

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-72 Annual Commercial Landings in the Lease Area as a Percentage of Landings in the Geographic Analysis Area for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Freeport, NY	11.287%	1.721%	0.969%	0.983%	0.958%	0.796%	0.421%	0.529%	0.358%	0.474%	0.219%	0.314%	0.420%	1.413%	1.490%
Point Lookout, NY	6.249%	2.316%	0.743%	1.241%	1.817%	0.615%	3.636%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	1.187%
Point Pleasant, NJ	0.356%	0.348%	0.278%	0.354%	0.449%	0.262%	0.333%	0.316%	0.253%	0.151%	0.562%	0.338%	1.002%	0.630%	0.402%
Newport News, VA	0.338%	0.338%	0.455%	0.901%	0.852%	0.148%	0.782%	0.045%	0.047%	0.367%	0.066%	0.037%	0.053%	0.060%	0.321%
Belmar, NJ	0.000%	0.000%	0.000%	0.000%	4.238%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.303%
Barnegat, NJ	0.451%	0.176%	0.307%	0.261%	0.516%	0.392%	0.255%	0.475%	0.410%	0.130%	0.143%	0.000%	0.131%	0.137%	0.270%
New London, CT	1.752%	0.614%	0.158%	0.387%	0.082%	0.011%	0.000%	0.005%	0.003%	0.000%	0.000%	0.000%	0.000%	0.000%	0.215%
Islip, NY	2.752%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.197%
Cape May, NJ	0.127%	0.455%	0.255%	0.176%	0.210%	0.122%	0.127%	0.123%	0.125%	0.044%	0.190%	0.088%	0.056%	0.030%	0.152%
Belford, NJ	0.000%	0.210%	0.167%	0.201%	0.000%	0.110%	0.153%	0.000%	0.291%	0.000%	0.209%	0.000%	0.297%	0.285%	0.137%
New Bedford, MA	0.239%	0.169%	0.327%	0.308%	0.391%	0.053%	0.072%	0.019%	0.103%	0.050%	0.070%	0.042%	0.051%	0.020%	0.137%
Atlantic City, NJ	0.010%	0.009%	0.008%	0.009%	0.007%	0.046%	0.030%	0.046%	0.248%	0.371%	0.045%	0.047%	0.403%	0.134%	0.101%
Montauk, NY	0.013%	0.155%	0.051%	0.346%	0.186%	0.042%	0.126%	0.082%	0.006%	0.022%	0.096%	0.031%	0.031%	0.138%	0.095%
Point Judith, RI	0.000%	0.069%	0.017%	0.117%	0.141%	0.071%	0.299%	0.047%	0.007%	0.007%	0.073%	0.028%	0.063%	0.023%	0.069%
Neptune, NJ	0.000%	0.000%	0.364%	0.000%	0.563%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.066%
Long Beach, NY	0.868%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.062%
Stonington, CT	0.144%	0.024%	0.146%	0.012%	0.071%	0.000%	0.000%	0.150%	0.007%	0.013%	0.000%	0.133%	0.103%	0.004%	0.058%
Hampton Bay, NY	0.000%	0.000%	0.019%	0.037%	0.000%	0.004%	0.003%	0.000%	0.004%	0.028%	0.449%	0.043%	0.026%	0.011%	0.045%
Shinnecock, NY	0.056%	0.059%	0.025%	0.081%	0.008%	0.290%	0.031%	0.026%	0.004%	0.003%	0.011%	0.005%	0.003%	0.013%	0.044%
Shark River, NJ	0.000%	0.000%	0.148%	0.103%	0.061%	0.000%	0.139%	0.000%	0.000%	0.000%	0.036%	0.000%	0.000%	0.000%	0.035%

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-73 Annual Commercial Revenue in the Lease Area as a Percentage of Revenue in the Geographic Analysis Area for the Top 20 Landing Ports, 2008–2021

Port	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Point Lookout, NY	13.226%	3.597%	1.163%	2.100%	1.642%	0.640%	9.855%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	2.302%
Freeport, NY	14.999%	2.460%	1.366%	1.117%	1.077%	1.014%	0.644%	0.727%	0.516%	0.686%	0.549%	0.662%	0.795%	1.087%	1.978%
Point Pleasant, NJ	1.369%	1.108%	1.071%	1.297%	2.068%	1.290%	1.412%	1.546%	0.988%	0.293%	0.574%	0.470%	0.689%	0.382%	1.040%
Belmar, NJ	0.000%	0.000%	0.000%	0.000%	9.632%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.688%
Islip, NY	8.635%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.617%
New London, CT	5.074%	1.257%	0.362%	1.224%	0.058%	0.083%	0.000%	0.037%	0.024%	0.000%	0.000%	0.000%	0.000%	0.000%	0.580%
Newport News, VA	0.565%	0.419%	0.584%	1.297%	1.410%	0.298%	1.523%	0.044%	0.060%	0.474%	0.076%	0.025%	0.018%	0.075%	0.491%
Barnegat, NJ	0.183%	0.161%	0.392%	0.324%	0.947%	0.823%	0.617%	0.789%	0.545%	0.158%	0.112%	0.000%	0.248%	0.119%	0.387%
Cape May, NJ	0.159%	0.207%	0.419%	1.222%	0.798%	0.861%	0.503%	0.402%	0.111%	0.035%	0.063%	0.028%	0.037%	0.034%	0.349%
Stonington, CT	1.519%	0.188%	0.579%	0.058%	0.355%	0.000%	0.000%	1.190%	0.061%	0.055%	0.000%	0.097%	0.077%	0.005%	0.299%
Belford, NJ	0.000%	0.450%	0.641%	0.780%	0.000%	0.284%	0.351%	0.000%	0.446%	0.000%	0.252%	0.000%	0.312%	0.362%	0.277%
New Bedford, MA	0.365%	0.231%	0.312%	0.656%	0.275%	0.070%	0.237%	0.055%	0.112%	0.048%	0.016%	0.011%	0.063%	0.005%	0.175%
Point Judith, RI	0.000%	0.081%	0.030%	0.164%	0.177%	0.117%	0.837%	0.062%	0.031%	0.019%	0.054%	0.023%	0.078%	0.022%	0.121%
Atlantic City, NJ	0.017%	0.033%	0.008%	0.010%	0.008%	0.053%	0.035%	0.054%	0.283%	0.477%	0.058%	0.061%	0.432%	0.101%	0.116%
Neptune, NJ	0.000%	0.000%	0.358%	0.000%	0.896%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.090%
Long Beach, NY	1.226%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.088%
Montauk, NY	0.009%	0.125%	0.056%	0.301%	0.163%	0.033%	0.087%	0.079%	0.005%	0.020%	0.083%	0.026%	0.029%	0.100%	0.080%
Shinnecock, NY	0.168%	0.064%	0.041%	0.147%	0.032%	0.257%	0.023%	0.032%	0.006%	0.003%	0.012%	0.006%	0.005%	0.014%	0.058%
Hampton, VA	0.000%	0.000%	0.000%	0.000%	0.112%	0.000%	0.012%	0.053%	0.139%	0.040%	0.006%	0.037%	0.136%	0.084%	0.044%
Shark River, NJ	0.000%	0.000%	0.152%	0.133%	0.057%	0.000%	0.144%	0.000%	0.000%	0.000%	0.042%	0.000%	0.000%	0.000%	0.038%

Source: NMFS 2022
State Abbreviations: CT = Connecticut, MA = Massachusetts, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia

Table I-74 Annual Commercial Landings (pounds) in the EW 1 WEA for States with Landings in the EW 1 WEA, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Jersey	89,994	138,039	171,560	90,367	98,929	46,024	47,107	48,340	58,763	73,391	92,422	42,230	96,809	51,779	81,840
Massachusetts	182,909	133,380	192,428	95,609	94,884	17,441	21,106	5,526	22,301	10,640	42,528	24,727	12,960	4,730	61,512
Rhode Island	4,539	44,627	19,189	30,711	108,411	52,547	101,901	11,213	727	1,556	28,739	6,151	11,793	3,479	30,399
New York	33,060	29,554	20,536	53,193	41,252	42,904	27,768	5,919	8,786	25,667	25,263	3,681	1,500	15,186	23,876
Virginia	10,196	6,662	16,994	20,948	9,205	3,804	5,079	3,395	1,784	2,297	851	1,389	1,240	812	6,047
Connecticut	7,587	2,669	1,775	1,917	4,067	0	0	578	78	0	585	3,193	1,806	2	1,733
All Others	5	0	0	43	124	137	1,059	2	0	1,647	14,437	4,595	56	346	1,604
North Carolina	136	857	204	286	35	63	569	391	230	575	529	456	302	434	362
Maryland	0	0	0	0	0	0	0	203	229	245	0	0	89	0	55
All States	**328,426**	**355,788**	**422,686**	**293,074**	**356,907**	**162,920**	**204,589**	**75,567**	**92,898**	**116,018**	**205,354**	**86,422**	**126,555**	**76,768**	**207,427**

Source: NMFS 2022

Table I-75 Annual Commercial Revenue (2021 dollars) in the EW 1 WEA for States with Landings in the EW 1 WEA, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Jersey	$249,795	$179,171	$391,378	$581,561	$300,033	$223,447	$184,241	$175,809	$131,177	$94,772	$58,473	$45,311	$90,936	$65,016	$197,937
Massachusetts	$291,282	$227,425	$320,738	$558,573	$211,620	$86,726	$172,695	$39,202	$59,073	$53,671	$19,662	$15,931	$44,206	$5,206	$150,429
Virginia	$87,702	$46,911	$166,473	$239,359	$94,572	$39,289	$67,533	$36,113	$18,179	$12,083	$4,920	$6,879	$7,263	$4,295	$59,398
New York	$188,082	$86,923	$33,777	$96,785	$59,963	$50,431	$33,963	$9,958	$14,964	$21,564	$22,966	$4,975	$3,268	$18,097	$46,122
Rhode Island	$2,573	$36,024	$13,615	$46,717	$96,314	$62,411	$139,066	$12,543	$3,479	$2,552	$23,170	$6,747	$14,007	$4,450	$33,119
Connecticut	$64,073	$19,811	$11,582	$16,616	$8,358	$0	$0	$6,436	$934	$0	$1,781	$5,315	$2,793	$5	$9,836
North Carolina	$454	$1,920	$772	$796	$165	$259	$1,701	$1,021	$688	$1,589	$1,845	$1,167	$808	$1,072	$1,018
All Others	$43	$0	$0	$103	$391	$537	$2,358	$8	$0	$1,344	$4,102	$3,599	$497	$404	$956
Maryland	$0	$0	$0	$0	$0	$0	$0	$879	$638	$514	$0	$0	$130	$0	$154
All States	**$884,004**	**$598,183**	**$938,334**	**$1,540,511**	**$771,416**	**$463,100**	**$601,558**	**$281,968**	**$229,132**	**$188,089**	**$136,920**	**$89,925**	**$163,908**	**$98,545**	**$498,971**

Source: NMFS 2022

Table I-76 Annual Commercial Landings (pounds) in the EW 2 WEA for States with Landings in the EW 2 WEA, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Massachusetts	446,834	337,245	401,151	271,894	427,507	50,294	72,680	17,833	165,354	44,285	60,387	62,728	51,962	16,072	173,302
New Jersey	175,098	345,986	108,287	182,215	229,589	100,406	102,158	111,961	152,102	95,164	201,608	100,874	176,208	119,033	157,192
Rhode Island	9,145	62,017	52,110	24,544	45,108	124,573	54,433	17,216	3,412	5,664	36,855	9,797	17,592	5,963	33,459
New York	109,827	25,615	9,560	25,202	16,248	6,353	16,760	9,758	49,842	46,568	35,467	4,055	2,354	37,553	28,226
Virginia	25,441	22,754	17,918	69,277	51,173	11,447	32,432	13,185	5,025	11,458	2,222	4,297	3,895	2,073	19,471
Connecticut	55,941	13,785	12,790	12,071	4,625	699	0	7,363	646	511	927	4,020	2,958	160	8,321
All Others	32	0	0	15	218	169	1,037	0	0	3,320	20,025	10,290	135	1,173	2,601
North Carolina	555	1,856	711	668	124	125	2,200	1,187	876	1,592	827	866	743	1,253	970
Maryland	0	0	0	0	0	0	0	480	386	511	0	0	372	0	125
All States	**822,873**	**809,258**	**602,527**	**585,886**	**774,592**	**294,066**	**281,700**	**178,983**	**377,643**	**209,073**	**358,318**	**196,927**	**256,219**	**183,280**	**423,668**

Source: NMFS 2022

Table I-77 Annual Commercial Revenue (2021 dollars) in the EW 2 WEA for States with Landings in the EW 2 WEA, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Jersey	$731,784	$413,279	$552,194	$1,722,987	$1,617,339	$859,987	$836,716	$893,934	$610,589	$210,862	$240,606	$160,414	$284,426	$152,990	$663,436
Massachusetts	$854,227	$514,805	$883,485	$2,448,150	$1,163,281	$229,571	$730,895	$162,906	$383,300	$156,908	$60,195	$61,819	$205,929	$22,726	$562,728
Virginia	$215,539	$165,051	$172,566	$763,338	$560,410	$129,431	$456,683	$147,990	$50,175	$86,022	$15,955	$27,649	$25,571	$14,958	$202,238
New York	$722,192	$113,082	$21,647	$79,864	$44,685	$17,736	$118,942	$12,717	$78,642	$37,857	$32,705	$5,045	$3,494	$31,619	$94,302
Connecticut	$474,921	$100,067	$90,885	$139,424	$42,141	$8,086	$0	$91,221	$6,672	$4,893	$6,028	$6,579	$5,912	$623	$69,818
Rhode Island	$5,764	$34,631	$34,795	$35,066	$38,165	$83,954	$313,280	$21,267	$15,222	$11,586	$23,803	$10,420	$23,562	$10,576	$47,292
North Carolina	$1,506	$3,797	$2,062	$2,181	$963	$528	$8,627	$2,798	$2,863	$4,254	$2,743	$2,388	$1,916	$2,945	$2,826
All Others	$265	$0	$0	$37	$715	$548	$5,123	$0	$0	$641	$6,092	$8,380	$1,208	$1,052	$1,719
Maryland	$0	$0	$0	$0	$0	$0	$0	$1,990	$1,037	$1,048	$0	$0	$553	$0	$331
All States	**$3,006,198**	**$1,344,713**	**$1,757,633**	**$5,191,047**	**$3,467,698**	**$1,329,839**	**$2,470,267**	**$1,334,823**	**$1,148,501**	**$514,071**	**$388,127**	**$282,693**	**$552,572**	**$237,489**	**$1,644,691**

Source: NMFS 2022

Table I-78 Annual Commercial Landings (pounds) in the Lease Area for States with Landings in the Lease Area, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Jersey	265,091	484,025	279,846	272,582	328,517	146,429	149,265	160,301	210,865	168,555	294,031	143,103	273,016	170,812	239,031
Massachusetts	629,744	470,625	593,579	367,503	522,391	67,735	93,785	23,358	187,655	54,925	102,915	87,455	64,922	20,802	234,814
Rhode Island	13,684	106,644	71,300	55,254	153,519	177,120	156,334	28,429	4,139	7,220	65,594	15,948	29,385	9,442	63,858
New York	142,887	55,169	30,096	78,396	57,500	49,257	44,528	15,677	58,628	72,235	60,730	7,736	3,854	52,739	52,102
Virginia	35,637	29,416	34,912	90,225	60,378	15,251	37,511	16,580	6,809	13,755	3,073	5,685	5,136	2,885	25,518
Connecticut	63,529	16,454	14,565	13,988	8,692	717	0	7,942	724	604	1,512	7,212	4,763	162	10,062
All Others	37	0	0	58	342	289	2,096	2	0	4,874	34,463	14,884	191	1,519	4,197
North Carolina	691	2,713	915	954	159	188	2,769	1,577	1,107	2,167	1,356	1,322	1,045	1,687	1,332
Maryland	0	0	0	0	0	0	0	683	615	757	0	0	461	0	180
All States	**1,151,300**	**1,165,046**	**1,025,213**	**878,960**	**1,131,498**	**456,986**	**486,288**	**254,549**	**470,542**	**325,092**	**563,674**	**283,345**	**382,773**	**260,048**	**631,094**

Source: NMFS 2022

Table I-79 Annual Commercial Revenue (2021 dollars) in the Lease Area for States with Landings in the Lease Area, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New Jersey	$981,580	$592,450	$943,572	$2,304,548	$1,917,372	$1,083,433	$1,020,956	$1,069,743	$741,766	$305,635	$299,080	$205,725	$375,362	$218,006	$861,373
Massachusetts	$1,145,510	$742,229	$1,204,222	$3,006,723	$1,374,900	$316,298	$903,589	$202,108	$442,375	$210,580	$79,857	$77,749	$250,135	$27,931	$713,158
Virginia	$303,241	$211,962	$339,040	$1,002,697	$654,982	$168,719	$524,216	$184,103	$68,354	$98,105	$20,876	$34,528	$32,833	$19,253	$261,636
New York	$910,273	$200,003	$55,422	$176,649	$104,648	$68,166	$152,906	$22,675	$93,606	$59,421	$55,670	$10,022	$6,763	$49,716	$140,424
Rhode Island	$8,337	$70,654	$48,410	$81,781	$134,479	$146,365	$452,345	$33,809	$18,702	$14,139	$46,973	$17,167	$37,569	$15,026	$80,411
Connecticut	$538,995	$119,878	$102,467	$156,042	$50,498	$8,242	$0	$97,657	$7,607	$5,936	$7,809	$11,894	$8,704	$628	$79,740
North Carolina	$1,961	$5,717	$2,834	$2,977	$1,128	$787	$10,327	$3,821	$3,551	$5,843	$4,588	$3,555	$2,725	$4,017	$3,845
All Others	$309	$0	$0	$140	$1,105	$930	$7,482	$8	$0	$941	$10,194	$11,979	$1,706	$1,456	$2,589
Maryland	$0	$0	$0	$0	$0	$0	$0	$2,870	$1,675	$1,562	$0	$0	$683	$0	$485
All States	**$3,890,206**	**$1,942,893**	**$2,695,967**	**$6,731,556**	**$4,239,111**	**$1,792,939**	**$3,071,822**	**$1,616,795**	**$1,377,636**	**$702,163**	**$525,046**	**$372,619**	**$716,481**	**$336,033**	**$2,143,662**

Source: NMFS 2022

Table I-80 Annual Commercial Landings in the EW 1 WEA as a Percentage of Landings in the Geographic Analysis Area for States with Landings in the EW 1 WEA, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New York	0.167%	0.141%	0.098%	0.240%	0.177%	0.214%	0.160%	0.038%	0.050%	0.181%	0.177%	0.027%	0.012%	0.114%	0.128%
New Jersey	0.057%	0.091%	0.128%	0.057%	0.063%	0.044%	0.044%	0.044%	0.054%	0.056%	0.064%	0.034%	0.089%	0.033%	0.061%
Rhode Island	0.006%	0.056%	0.027%	0.044%	0.140%	0.065%	0.125%	0.017%	0.001%	0.002%	0.040%	0.009%	0.018%	0.006%	0.040%
Virginia	0.049%	0.035%	0.095%	0.098%	0.053%	0.023%	0.038%	0.025%	0.013%	0.017%	0.007%	0.008%	0.009%	0.007%	0.034%
Connecticut	0.149%	0.047%	0.028%	0.025%	0.051%	0.000%	0.000%	0.007%	0.001%	0.000%	0.008%	0.039%	0.033%	0.000%	0.028%
Massachusetts	0.063%	0.043%	0.078%	0.043%	0.038%	0.008%	0.009%	0.002%	0.011%	0.005%	0.022%	0.013%	0.007%	0.003%	0.025%
North Carolina	0.000%	0.005%	0.001%	0.002%	0.000%	0.001%	0.005%	0.003%	0.002%	0.004%	0.006%	0.005%	0.004%	0.008%	0.003%
Maryland	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.004%	0.005%	0.006%	0.000%	0.000%	0.004%	0.000%	0.001%

Source: NMFS 2022

Table I-81 Annual Commercial Revenue in the EW 1 WEA as a Percentage of Revenue in the Geographic Analysis Area for States with Landings in the EW 1 WEA, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New York	0.524%	0.253%	0.096%	0.237%	0.147%	0.141%	0.112%	0.038%	0.049%	0.087%	0.088%	0.019%	0.016%	0.073%	0.134%
New Jersey	0.127%	0.095%	0.191%	0.227%	0.143%	0.154%	0.109%	0.099%	0.064%	0.051%	0.034%	0.025%	0.055%	0.043%	0.101%
Virginia	0.090%	0.052%	0.169%	0.212%	0.109%	0.066%	0.132%	0.050%	0.024%	0.022%	0.010%	0.013%	0.015%	0.011%	0.070%
Connecticut	0.392%	0.121%	0.062%	0.072%	0.037%	0.000%	0.000%	0.043%	0.007%	0.000%	0.012%	0.037%	0.025%	0.000%	0.058%
Rhode Island	0.004%	0.055%	0.022%	0.059%	0.126%	0.079%	0.181%	0.018%	0.004%	0.003%	0.025%	0.007%	0.021%	0.005%	0.044%
Massachusetts	0.067%	0.053%	0.062%	0.092%	0.033%	0.015%	0.034%	0.008%	0.012%	0.010%	0.003%	0.003%	0.009%	0.001%	0.029%
North Carolina	0.001%	0.010%	0.004%	0.004%	0.001%	0.002%	0.007%	0.003%	0.001%	0.003%	0.009%	0.005%	0.005%	0.009%	0.005%
Maryland	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.010%	0.009%	0.009%	0.000%	0.000%	0.002%	0.000%	0.002%

Source: NMFS 2022

Table I-82 Annual Commercial Landings in the EW 2 WEA as a Percentage of Landings in the Geographic Analysis Area for States with Landings in the EW 2 WEA, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New York	0.556%	0.122%	0.045%	0.114%	0.070%	0.032%	0.097%	0.062%	0.285%	0.328%	0.249%	0.029%	0.020%	0.281%	0.163%
Connecticut	1.099%	0.244%	0.200%	0.159%	0.059%	0.010%	0.000%	0.091%	0.007%	0.010%	0.012%	0.049%	0.055%	0.003%	0.143%
New Jersey	0.110%	0.228%	0.081%	0.115%	0.146%	0.097%	0.095%	0.102%	0.139%	0.073%	0.139%	0.082%	0.162%	0.076%	0.118%
Virginia	0.122%	0.121%	0.100%	0.323%	0.297%	0.070%	0.245%	0.096%	0.036%	0.082%	0.017%	0.026%	0.028%	0.017%	0.113%
Massachusetts	0.154%	0.108%	0.164%	0.121%	0.172%	0.023%	0.031%	0.008%	0.082%	0.023%	0.031%	0.033%	0.028%	0.010%	0.071%
Rhode Island	0.013%	0.078%	0.074%	0.035%	0.058%	0.153%	0.067%	0.026%	0.005%	0.008%	0.051%	0.014%	0.027%	0.009%	0.044%
North Carolina	0.002%	0.012%	0.004%	0.004%	0.002%	0.002%	0.019%	0.010%	0.006%	0.011%	0.009%	0.010%	0.010%	0.024%	0.009%
Maryland	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.010%	0.008%	0.012%	0.000%	0.000%	0.015%	0.000%	0.003%

Source: NMFS 2022

Table I-83 Annual Commercial Revenue in the EW 2 WEA as a Percentage of Revenue in the Geographic Analysis Area for States with Landings in the EW 2 WEA, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Connecticut	2.904%	0.610%	0.483%	0.607%	0.185%	0.052%	0.000%	0.613%	0.047%	0.039%	0.041%	0.046%	0.053%	0.006%	0.406%
New Jersey	0.372%	0.218%	0.270%	0.674%	0.771%	0.591%	0.497%	0.505%	0.297%	0.114%	0.139%	0.089%	0.171%	0.101%	0.344%
New York	2.013%	0.329%	0.061%	0.195%	0.110%	0.050%	0.392%	0.048%	0.256%	0.152%	0.125%	0.020%	0.017%	0.127%	0.278%
Virginia	0.220%	0.182%	0.175%	0.676%	0.649%	0.217%	0.891%	0.206%	0.067%	0.158%	0.031%	0.054%	0.053%	0.037%	0.258%
Massachusetts	0.196%	0.119%	0.172%	0.403%	0.181%	0.040%	0.144%	0.033%	0.075%	0.028%	0.010%	0.010%	0.041%	0.003%	0.104%
Rhode Island	0.008%	0.053%	0.056%	0.044%	0.050%	0.106%	0.409%	0.031%	0.018%	0.013%	0.026%	0.011%	0.035%	0.012%	0.062%
North Carolina	0.003%	0.020%	0.010%	0.012%	0.007%	0.004%	0.037%	0.009%	0.005%	0.008%	0.013%	0.011%	0.011%	0.024%	0.013%
Maryland	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.023%	0.015%	0.019%	0.000%	0.000%	0.009%	0.000%	0.005%

Source: NMFS 2022

Table I-84 Annual Commercial Landings in the Lease Area as a Percentage of Landings in the Geographic Analysis Area for States with Landings in the Lease Area, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
New York	0.723%	0.263%	0.143%	0.353%	0.247%	0.246%	0.257%	0.100%	0.335%	0.508%	0.426%	0.056%	0.032%	0.395%	0.292%
New Jersey	0.167%	0.319%	0.208%	0.171%	0.209%	0.141%	0.139%	0.147%	0.193%	0.130%	0.203%	0.116%	0.250%	0.109%	0.179%
Connecticut	1.248%	0.291%	0.228%	0.184%	0.110%	0.011%	0.000%	0.098%	0.008%	0.011%	0.020%	0.087%	0.088%	0.003%	0.171%
Virginia	0.170%	0.156%	0.195%	0.420%	0.350%	0.093%	0.283%	0.121%	0.048%	0.099%	0.024%	0.035%	0.037%	0.024%	0.147%
Massachusetts	0.218%	0.150%	0.242%	0.164%	0.211%	0.030%	0.040%	0.011%	0.093%	0.028%	0.052%	0.046%	0.035%	0.013%	0.095%
Rhode Island	0.019%	0.133%	0.102%	0.079%	0.198%	0.218%	0.191%	0.044%	0.006%	0.010%	0.091%	0.023%	0.045%	0.015%	0.084%
North Carolina	0.002%	0.017%	0.005%	0.006%	0.002%	0.003%	0.024%	0.013%	0.008%	0.015%	0.015%	0.015%	0.014%	0.033%	0.012%
Maryland	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.014%	0.013%	0.018%	0.000%	0.000%	0.019%	0.000%	0.005%

Source: NMFS 2022

Table I-85 Annual Commercial Revenue in the Lease Area as a Percentage of Revenue in the Geographic Analysis Area for States with Landings in the Lease Area, 2008–2021

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average
Connecticut	3.296%	0.730%	0.544%	0.680%	0.222%	0.053%	0.000%	0.656%	0.053%	0.047%	0.053%	0.084%	0.078%	0.006%	0.464%
New Jersey	0.499%	0.313%	0.461%	0.901%	0.915%	0.745%	0.606%	0.605%	0.361%	0.165%	0.173%	0.114%	0.226%	0.144%	0.445%
New York	2.537%	0.581%	0.157%	0.432%	0.257%	0.190%	0.504%	0.086%	0.305%	0.239%	0.213%	0.039%	0.033%	0.200%	0.412%
Virginia	0.310%	0.234%	0.344%	0.888%	0.758%	0.283%	1.023%	0.256%	0.091%	0.181%	0.041%	0.067%	0.068%	0.048%	0.328%
Massachusetts	0.263%	0.172%	0.235%	0.494%	0.214%	0.055%	0.178%	0.041%	0.087%	0.038%	0.014%	0.013%	0.050%	0.004%	0.133%
Rhode Island	0.012%	0.108%	0.078%	0.103%	0.175%	0.186%	0.590%	0.049%	0.022%	0.015%	0.051%	0.018%	0.056%	0.017%	0.106%
North Carolina	0.004%	0.031%	0.014%	0.016%	0.008%	0.007%	0.044%	0.012%	0.007%	0.011%	0.022%	0.016%	0.016%	0.033%	0.017%
Maryland	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.033%	0.024%	0.028%	0.000%	0.000%	0.012%	0.000%	0.007%

Source: NMFS 2022

Table I-86 Annual For-Hire Recreational Fishing Effort in the EW 1 WEA, 2008–2021

Year	Angler Trips			Vessel Trips		
	New York Ports	New Jersey Ports	All Ports	New York Ports	New Jersey Ports	All Ports
2008	33	0	33	1	0	1
2009	19	0	19	2	0	2
2010	191	5	196	42	1	43
2011	156	12	168	6	1	7
2012	5	74	79	2	3	5
2013	48	0	48	2	0	2
2014	276	27	303	9	1	10
2015	106	32	138	4	2	6
2016	185	10	195	7	1	8
2017	193	22	215	7	2	9
2018	1,476	116	1,592	54	6	60
2019	2,729	59	2,788	84	3	87
2020	1,891	16	1,907	47	2	49
2021	2,659	0	2,659	79	0	79
Average	**712**	**27**	**739**	**25**	**2**	**27**

Source: NMFS 2022
Notes: Angler trips is the number of passengers reported on Vessel Trip Reports for party and charter vessels.

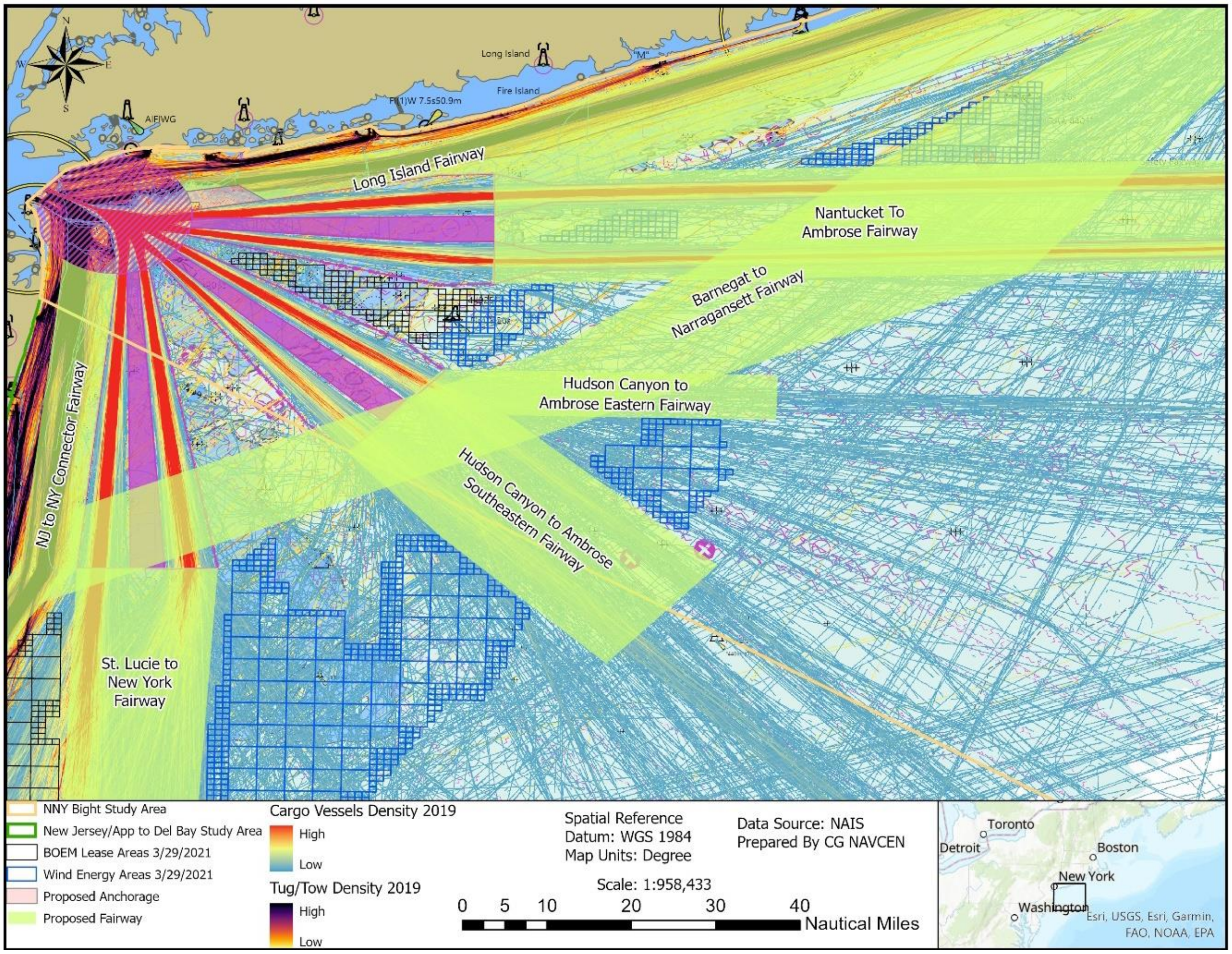
Table I-87 Annual For-Hire Recreational Fishing Effort in the EW 2 WEA, 2008–2021

Year	Angler Trips			Vessel Trips		
	New York Ports	New Jersey Ports	All Ports	New York Ports	New Jersey Ports	All Ports
2008	0	0	0	0	0	0
2009	4	0	4	1	0	1
2010	32	144	176	1	4	5
2011	204	0	204	12	0	12
2012	0	0	0	0	0	0
2013	202	241	443	6	13	19
2014	94	7	101	2	1	3
2015	78	14	92	6	1	7
2016	94	0	94	4	0	4
2017	22	93	115	1	4	5
2018	399	23	422	10	3	13
2019	27	0	27	1	0	1
2020	1,353	0	1,353	40	0	40
2021	192	0	192	7	0	7
Average	**193**	**37**	**230**	**7**	**2**	**9**

Source: NMFS 2022
Notes: Angler trips is the number of passengers reported on Vessel Trip Reports for party and charter vessels.

I.5. Navigation and Vessel Traffic

The recently published *Northern New York Bight Port Access Route Study: Final Report* (USCG 2021) analyzed an area that includes the approaches to the Port of New York and New Jersey and based on Marine Planning Guidelines and recommended that multiple shipping fairways and one federal anchorage be established within the PARS area. USCG is pursuing a rulemaking to establish the shipping safety fairways and the Northern New York Bight PARS final report will be considered during that process.



Source: USCG 2021

Figure I-6 U.S. Coast Guard Proposed Fairways and Anchorage Area

I.6. References Cited

I.6.1 Climate and Meteorology

Blake, E. S., T. B. Kimberlain, R. J. Berg, J. P. Cangialosi, and J. L. Beven II. 2013. Tropical cyclone report Hurricane Sandy (AL182012). February 12, 2013. Available: https://www.nhc.noaa.gov/data/tcr/AL182012_Sandy.pdf. Accessed: November 8, 2021.

Bureau of Ocean Energy Management (BOEM). 2021. *Vineyard Wind 1 Offshore Wind Energy Project Final Environmental Impact Statement*. OCS EIS/EA BOEM 2021-0012. Available: https://www.boem.gov/vineyard-wind. Accessed: November 8, 2021.

Christiansen, M. B., and C. Hasager. 2005. Wake Effects of Large Offshore Wind Farms Identified from Satellite SAR. *Remote Sensing of Environment* 98:251–268. doi: 10.1016/j.rse.2005.07.009. Available: https://www.sciencedirect.com/science/article/abs/pii/S0034425705002476. Accessed: October 20, 2020.

Díaz, Juan P., Francisco J. Expósito, Juan C. Pérez, and Albano González. 2019. Long-Term Trends in Marine Boundary Layer Properties over the Atlantic Ocean. *Journal of Climate* 34(22):2991–3004. Available: https://journals.ametsoc.org/view/journals/clim/32/10/jcli-d-18-0219.1.xml. Accessed: November 8, 2021.

Dupigny-Giroux, L. A., E. L. Mecray, M. D. Lemcke-Stampone, G. A. Hodgkins, E. E. Lentz, K. E. Mills, E. D. Lane, R. Miller, D. Y. Hollinger, W. D. Solecki, G. A. Wellenius, P. E. Sheffield, A. B. MacDonald, and C. Caldwell. 2018. Chapter 18: Northeast. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, Volume II [Reidmiller, D. R., C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 669–742. Chapter 18. doi: 10.7930/NCA4.2018.CH18. Available: https://nca2018.globalchange.gov/chapter/northeast. Accessed: November 8, 2021.

Empire Offshore Wind, LLC (Empire). 2023. *Empire Offshore Wind: Empire Wind Project (EW1 and EW2), Construction and Operations Plan*. Available: https://www.boem.gov/renewable-energy/empire-wind-construction-and-operations-plan.

Empire Offshore Wind, LLC (Empire). 2023. Citing Kjeller Vindteknikk. 2020. Northeast coast, USA – Hindcast simulation of offshore wind conditions.

Empire Offshore Wind, LLC (Empire). 2023. Citing National Oceanic and Atmospheric Administration (NOAA). 2018b. National Data Buoy Center, Station 44065. 2008–2018. Available: https://www.ndbc.noaa.gov/station_history.php?station=44065. Accessed: September 4, 2019.

Empire Offshore Wind, LLC (Empire). 2023. Citing National Oceanic and Atmospheric Administration (NOAA). 2018c. National Data Buoy Center, Station 44025. 2007–2018. Available: https://www.ndbc.noaa.gov/station_history.php?station=44025. Accessed: September 11, 2019.

Fuhlbrügge, S., K. Krüger, B. Quack, E. Atlas, H. Hepach, and F. Ziska. 2013. Impact of the marine atmospheric boundary layer conditions on VSLS abundances in the eastern tropical and subtropical North Atlantic Ocean. *Atmos. Chem. Phys.* 13:6345–6357. Available: https://acp.copernicus.org/articles/13/6345/2013/acp-13-6345-2013.pdf. Accessed: November 8, 2021.

Hayhoe, K., D. J. Wuebbles, D. R. Easterling, D. W. Fahey, S. Doherty, J. Kossin, W. Sweet, R. Vose, and M. Wehner. 2018. Chapter 2: Our Changing Climate. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, Volume II [Reidmiller, D. R., C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 72–144. Chapter 2 doi: 10.7930/ NCA4.2018.CH2. Available: https://nca2018.globalchange.gov/chapter/climate. Accessed: November 8, 2021.

Holzworth, George C. 1972. *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution throughout the Contiguous United States*. U.S. Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina. January 1972. Available: https://www.nrc.gov/docs/ML1408/ML14084A177.pdf. Accessed: November 8, 2021.

International Panel on Climate Change (IPCC). 2021. Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis*. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. Available: https://www.ipcc.ch/report/ar6/wg1/#SPM. Accessed: November 8, 2021.

McAdie, C. J., C. W. Landsea, C. J. Neumann, J. E. David, E. S. Blake, and G. R. Hammer. 2009. *Tropical cyclones of the north Atlantic Ocean, 1851–2006* (with 2007 and 2008 track maps included). Historical Climatology Series 6-2. Prepared by the National Climatic Data Center, Asheville, NC, in cooperation with the National Hurricane Center, Miami, FL. Available: https://www.nhc.noaa.gov/pdf/TC_Book_Atl_1851-2006_lowres.pdf. Accessed: November 8, 2021.

National Oceanic and Atmospheric Administration (NOAA). 2021a. “Station 44025 (LLNR 830) – Long Island – 30 NM South of Islip, NY.” National Oceanic and Atmospheric Administration’s National Data Buoy Center. Page last modified: August 10, 2021. Available: https://www.ndbc.noaa.gov/station_page.php?station=44025. Accessed: November 5, 2021.

National Oceanic and Atmospheric Administration (NOAA). 2021b. “Station 44065 (LLNR 725) – New York Harbor Entrance – 15 NM SE of Breezy Point, NY.” National Oceanic and Atmospheric Administration’s National Data Buoy Center. Page last modified: August 10, 2021. Available: https://www.ndbc.noaa.gov/station_page.php?station=44065. Accessed: November 5, 2021.

National Oceanic and Atmospheric Administration (NOAA). 2021c. “Historical Hurricane Mapper.” Page last modified: May 21, 2021. Available: https://coast.noaa.gov/hurricanes/. Accessed: November 5, 2021.

National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information. 2021a. “Climate at a Glance: Divisional Mapping.” Published November 2021. Available: https://www.ncdc.noaa.gov/cag/divisional/mapping. Accessed: November 8, 2021.

National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information. 2021b. “Climate at a Glance: Divisional Time Series Temperature.” Published October 2021. Available: https://www.ncdc.noaa.gov/cag/divisional/time-series. Accessed: November 5, 2021.

National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information. 2021c. "Climate at a Glance: Divisional Time Series Precipitation." Published October 2021. Available: https://www.ncdc.noaa.gov/cag/divisional/time-series. Accessed: November 5, 2021.

New Jersey Department of Environmental Protection (NJDEP). 2010. Ocean/Wind Power Ecological Baseline Studies. Available: https://www.nj.gov/dep/dsr/ocean-wind/Ocean%20Wind%20Power%20Ecological%20Baseline%20Studies_Volume%20One.pdf. Accessed: November 8, 2021.

New York State Climate Action Council. 2010. *Climate Action Plan Interim Report*. Chapter 2: Climate Projections and Vulnerabilities. November 2010. Available: https://www.dec.ny.gov/docs/administration_pdf/irchap2.pdf. Accessed: November 8, 2021.

Ramaswamy, V., J. W. Hurrell, and G. A. Meehl. 2006. Why do temperatures vary vertically (from the surface to the stratosphere) and what do we understand about why they might vary and change over time? In: *Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences*. [T. R. Karl, S. J. Hassol, C. D. Miller, and W. L. Murray, editors.] A Report by the Climate Change Science Program and the Subcommittee on Global Change Research, Washington, DC. Available: https://downloads.globalchange.gov/sap/sap1-1/sap1-1-final-all.pdf. Accessed: November 8, 2021.

Schofield, O., R. Chant, B. Cahill, R. Castelao, D. Gong, A. Kahl, J. Kohut, M. Montes-Hugo, R. Ramadurai, P. Ramey, X. Yi, and S. Glenn. 2008. The Decadal View of the Mid-Atlantic Bight from the COOLroom: Is our Coastal System Changing? *Oceanography* 21, No. 4:109–117. Available: https://tos.org/oceanography/assets/docs/21-4_schofield.pdf. Accessed: November 8, 2021.

Siedersleben, S. K., J. K. Lundquist, A. Platis, J. Bange, K. Bärfuss, A. Lampert, B. Cañadillas, T. Neumann, and S. Emeis. 2018. Micrometeorological impacts of offshore wind farms as seen in observations and simulations. *Environ. Res. Lett.* 13 (2018) 124012. Available: https://iopscience.iop.org/article/10.1088/1748-9326/aaea0b. Accessed: November 8, 2021.

Townsend, D. W., A. C. Thomas, L. M. Mayer, M.A. Thomas, and J. A. Quinlan. 2004. Oceanography of the northeast Atlantic continental shelf. In: *The Sea: The Global Coastal Ocean: Interdisciplinary Regional Studies and Syntheses*. Harvard University Press. Available: https://www.researchgate.net/publication/240641612_Oceanography_of_the_northwest_Atlantic_continental_shelf_1_W. Accessed: November 8, 2021.

U.S. Environmental Protection Agency (USEPA). 2021 [index page date]. SCRAM Mixing Height Data. Index page: https://www.epa.gov/scram/scram-mixing-height-data. Data file: https://gaftp.epa.gov/Air/aqmg/SCRAM/met_files/mixing_hghts/njmix.zip. Accessed: November 8, 2021.

I.6.2 Demographics, Employment, and Economics

ArcGIS Business Analyst. 2021. ESRI Business Summary Reports.

National Ocean Economics Program. 2018. Market Data: Ocean Economy Data. Available: http://www.oceaneconomics.org/Market/ocean/oceanEcon.asp?IC=N&dataSource=E.

National Oceanic and Atmospheric Administration (NOAA). 2018. Quick Report Tool for Socioeconomic Data. Available: https://coast.noaa.gov/quickreport/#/index.html. Accessed: January 6, 2022.

New York State Department of Labor. 2020. Quarterly Census of Employment and Wages. Available: https://statistics.labor.ny.gov/lsqcew.shtm. Accessed: November 3, 2021.

U.S. Census Bureau. 2000. 2000 Census. Available: http://socialexplorer.com. Accessed: October 27, 2021.

U.S. Census Bureau. 2019a. American Community Survey 5-year Estimates. Available: http://socialexplorer.com. Accessed: October 29, 2021.

U.S. Census Bureau. 2019b. OnTheMap Application and LEHD Origin-Destination Employment Statistics (Beginning of Quarter Employment, 2nd Quarter of 2002–2019), All Jobs, Where Workers Work, 2019.

U.S. Census Bureau. 2020. 2020 Census. Available: http://socialexplorer.com. Accessed: November 3, 2021.

I.6.3 Wetlands

Empire Offshore Wind, LLC (Empire). 2023. *Empire Offshore Wind: Empire Wind Project (EW1 and EW2), Construction and Operations Plan*. Available: https://www.boem.gov/renewable-energy/empire-wind-construction-and-operations-plan.

I.6.4 Commercial and For-Hire Recreational Fishing

National Marine Fisheries Service (NMFS). 2022. Socioeconomic Impacts of Atlantic Offshore Wind Development. Available: https://www.fisheries.noaa.gov/resource/data/socioeconomic-impacts-atlantic-offshore-wind-development. Accessed: December 2022.

I.6.5 Navigation and Vessel Traffic

U.S. Coast Guard (USCG). 2021. *Northern New York Bight Port Access Route Study: Final Report.* USCG-2020-0278. December 2021. Available: https://www.regulations.gov/document/USCG-2020-0278-0067. Accessed: January 8, 2022.

Appendix J. Overview of Acoustic Modeling Reports

J.1. Introduction

This appendix is focused on providing an overview of the methods, assumptions, and results of the technical acoustic modeling reports prepared for the Projects (COP Appendices M-1 and M-2; Empire 2023). Readers who may be less familiar with acoustic terminology are recommended to refer to Section M-1.1.1, *Acoustic Concepts and Terminology*, in Appendix M-1 of the COP (Empire 2023), Appendix A, *Glossary*, to Appendix M-2 of the COP (Empire 2023), and Appendix D, *Underwater Acoustics*, to Appendix M-2 of the COP (Empire 2023).

The 2,076-MW Projects, which encompass EW 1 and EW 2, would consist of up to 147 WTGs, up to two OSS, and interarray and export cables. The Projects would be on the OCS offshore New York in BOEM's Lease Area OCS-A 0512. The primary underwater noise-producing activity for the Projects would be impact pile driving during construction. Other modeled noise-producing activities include drilling during WTG foundation installation and vibratory pile driving during cofferdam installation. This appendix focuses on the quantitative underwater noise modeling conducted for Project activities (i.e., impact pile driving and vibratory pile driving). Qualitative assessments of lower noise-level activities, including cable laying (i.e., operation of dynamic positioning thrusters by the cable-laying vessel), WTG operation, and marina activities (including bulkhead repairs and the removal of berthing piles) are also provided in Appendices M-1 and M-2 of the COP (Empire 2023).

For the quantitative modeling assessment for impact pile driving for foundation installation, predicted sound fields were generated for 31.5-foot (9.6-meter) diameter[1] monopiles, 36.1-foot (11-meter) diameter R3 monopiles, 36.1-foot (11-meter) diameter T1 monopiles, and 36.1-foot (11-meter) diameter U3 monopiles for WTG foundations and 8.2-foot (2.5-meter) diameter pin piles for jacketed OSS foundations. Modeling scenarios included two representative locations each for the R3, T1, and U3 monopile foundations; three representative locations for the 31.5-foot (9.6-meter) monopile foundations; and two locations for the jacket foundations with pin piles to represent the types of piles and range of water depths in the Project area (COP Appendix M-2, Figure 2; Empire 2023). For each of their respective monopile foundation locations, modeling was conducted at a maximum hammer energy of 2,000 kJ for R3 monopiles, 2,500 kJ for the T1 monopiles, and 1,300 kJ for the U3 monopiles. At each 31.5-foot (9.6-meter) monopile location, modeling was conducted for a typical scenario, with a maximum hammer energy of 2,300 kJ, and a difficult-to-drive scenario, with a maximum hammer energy of 5,225 kJ. Modeling scenarios included one or two monopiles driven per day, two to three pin piles driven per day, and all possible combinations of monopiles and pin piles driven per day. Sound field predictions were made for both summertime and wintertime conditions to account for variation in sound propagation caused by water temperature, as well as different levels of noise attenuation, including 0 (i.e., no mitigation), 6, 10, and 15 dB. In addition to impact pile driving for foundation installation, predicted sound fields for impact pile driving for goal post installation (as an alternative to the use of cofferdams for cable landfalls) at one representative location were also calculated.

For the quantitative modeling assessment for vibratory pile driving associated with cofferdam installation, predicted sound fields were generated for five locations: the anticipated EW 1 export cable landfall site, three representative locations for the EW 2 export cable landfall site, and one representative location for the western approach to EW 2 Landfall C. The representative locations for EW 2 export cable landfall sites include a location representative of EW 2 Landfalls A, B, and E; a location representative of a

[1] The diameter provided for tapered monopiles is the diameter at the expected waterline.

shallow-water option for EW 2 Landfall C; and a location representative of a deep-water option for EW 2 Landfall C. Additional predicted sound fields were generated for vibratory pile driving associated with marina activities: one representative location for sheetpile installation at the EW 2 Onshore Substation C, and one representative location for berthing pile removal at the EW 2 Onshore Substation C marina. Sound field predictions were made for the conditions that resulted in the greatest sound propagation (i.e., maximum underwater noise impacts).

The predicted sound fields for impact pile driving and vibratory pile driving were used to predict ranges to isopleths associated with acoustic criteria for injury and behavioral impacts. These ranges were then used to estimate the number of marine animals that could be exposed to sound levels exceeding acoustic criteria for each modeled noise source.

J.2. Acoustic Models and Assumptions

The quantitative assessments of noise-producing activities rely upon a variety of acoustic models to predict the potential effect of Project activities on marine animals. The models used in the quantitative analyses include:

1. GRL Wave Equation Analysis Program (GRLWEAP) Model: to model the force applied to the pile by the impact hammer
2. Finite Difference Model: to compute pile vibration and near-field sound radiation after the impact hammer strikes the pile to calculate source levels
3. Full Waveform Range-dependent Acoustic Model (FWRAM): to calculate the time-dependent sound field, SPL, and SEL metrics for impact pile driving
4. dBSea Parabolic Equation (dBSeaPE) Method: to calculate one-third octave band noise levels for drilling and vibratory pile driving in the 12.5- to 800-Hz frequency range
5. dBSea Ray Tracing (dBSeaRay) Method: to calculate one-third octave band noise levels for drilling and vibratory pile driving in the 1,000- to 20,000-Hz frequency range
6. JASMINE Model: the JASCO Applied Sciences animat[2] movement and exposure model used to estimate the number of animals exposed to sound levels exceeding regulatory criteria (Section J.5)

FWRAM, dBSeaPE, and dBSeaRay predict the propagation of the source signal through the physical environment. As such, these models require accurate descriptions of ocean bathymetry, seafloor sediment properties, and sound speed profile (SSP) in the water column. The assumptions of these models and their inputs are critical to the accuracy of the model output.

J.2.1 Physical Environment

The bathymetry information used to model impact pile driving was compiled from the Shuttle Radar Topography Mission data (Becker et al. 2009). Bathymetry data used to model drilling and vibratory pile driving were obtained from the National Geographic Data Center’s U.S. Coastal Relief Model. A simplified geoacoustic profile of the sediment properties for modeling was developed based on site-specific geotechnical data collected by Empire. SSPs used to model impact pile driving were extracted from the U.S. Navy’s Generalized Digital Environmental Model (Naval Oceanographic Office 2003). SSPs used to model vibratory pile driving were obtained using the NOAA Sound Speed Manager software, which incorporates the World Ocean Atlas 2009 extension algorithms (World Ocean Atlas 2009). Water temperatures and density change seasonally and vertically within the water column; therefore, representative summer and winter SSPs were used for modeling. For the impact pile driving assessment, seasonal SSPs were calculated by averaging monthly SSPs for the summer months (i.e., May

[2] Animat = simulated animal

through September) and the winter months (i.e., December through March). For the goal post installation and vibratory pile driving assessments, a seasonal monthly SSP was selected to represent the maximum underwater noise impacts. A sensitivity analysis identified the December SSP as having the greatest sound propagation. Therefore, the December SSP was used for assessment of these activities.

J.2.2 Sound Source Details

J.2.2.1. Impact Pile Driving for Foundation Installation

Pile dimensions, hammer energy, and number of strikes are required inputs for the modeling of impact pile driving for foundation installation (Table J-1).

Typical installation of the 78.5-meter-long WTG foundation 9.6-meter diameter monopiles with an IHC S-5500 hammer was expected to begin with 450-kJ hammer strikes that would be scaled up to 2,300 kJ at the end of the pile installation. A total of 5,497 strikes were expected per pile, and the strike rate was estimated at 30 strikes per minute. Spectral source levels for the 9.6-meter monopiles under a typical installation were estimated at up to approximately 200 dB re 1 $\mu Pa^2 s$. A difficult installation of the 78.5-meter-long WTG foundation 9.6-meter diameter monopiles with an IHC S-5500 hammer was expected to begin with 450-kJ hammer strikes that would be scaled up to 5,225 kJ at the end of the pile installation. A total of 7,165 strikes were expected per pile, and the strike rate was estimated at 30 strikes per minute. Installation of the 75.3-meter-long WTG foundation 11-meter diameter R3 monopiles with an IHC S-5500 hammer was expected to begin with 500-kJ hammer strikes that would be scaled up to 2,000 kJ at the end of the pile installation. A total of 4,025 strikes were expected per pile, and the strike rate was estimated at 30 strikes per minute. Spectral source levels for the 11-meter R3 monopiles under were estimated at up to approximately 195 dB re 1 $\mu Pa^2 s$. Installation of the 84.1-meter-long WTG foundation 11-meter diameter T1 monopiles with an IHC S-5500 hammer was expected to begin with 500-kJ hammer strikes that would be scaled up to 2,500 kJ at the end of the pile installation. A total of 4,919 strikes were expected per pile, and the strike rate was estimated at 30 strikes per minute. Spectral source levels for the 11-meter T1 monopiles under a typical installation were estimated at up to approximately 195 dB re 1 $\mu Pa^2 s$. Installation of the 97.5-meter-long WTG foundation 11-meter diameter U3 monopiles with an IHC S-5500 hammer was expected to begin with 450-kJ hammer strikes that would be scaled up to 1,300 kJ at the end of the pile installation. A total of 7,335 strikes were expected per pile, and the strike rate was estimated at 30 strikes per minute. Spectral source levels for the 11-meter U3 monopiles were estimated at up to approximately 190 dB re 1 $\mu Pa^2 s$. Installation of the 57- to 66-meter-long pin piles for the OSS jacket foundations with an IHC S-4000 hammer was expected to scale from 500 to 3,200 kJ during pile installation. For the EW 1 OSS, 4,340 strikes were predicted for each pin pile, with a strike rate of 30 strikes per minute. For the EW 2 OSS, 3,711 strikes were predicted for each pin pile, with a strike rate of 30 strikes per minute. Spectral source levels for the pin piles were estimated at up to approximately 185 dB re 1 $\mu Pa^2 s$. No simultaneous pile driving was included in the modeling assumptions.

J.2.2.2. Impact Pile Driving for Goal Post Installation

The source level of the impact pile driver for goal post installation was assumed to be 200 dB re 1 µPa peak SPL and 174 dB re 1 $\mu Pa^2 s$ SEL. A total of 2,000 strikes are expected per pile, and anticipated drive time is 2 hours per pile.

Table J-1 Key Assumptions Used in the Underwater Acoustic Modeling of Impact Pile Driving

Foundation type	Scenario	Modeled maximum impact hammer energy (kJ)	Number of Strikes	Strike Rate (min^{-1})	Pile diameter (m)	Pile wall thickness (mm)	Maximum Seabed penetration (m)	Piles per day
Monopile	Typical	2,300	5,497	30	9.6	73–101	38	1–2
Monopile	Difficult-to-Drive	5,225	7,165	30	9.6	73–101	38	1-2
R3 Monopile	Typical	2,000	4,025	30	11	8.5	55	1-2
T1 Monopile	Typical	2,500	4,919	30	11	8.5	55	1-2
U3 Monopile	Typical	1,300	7,335	30	11	8.5	55	1-2
Jacket	Typical	3,200	3,711/4,340[1]	30	2.5	50	56	2–3

[1] Number of strikes for OSS2/OSS1
min = minute; m = meter; mm = millimeter

J.2.2.3. Vibratory Pile Driving

The source level of the vibratory pile driver was assumed to be 189 dB re 1 μPa^2s SEL with an 1,800-kilonewton vibratory force over a 24-hour assessment period for cofferdam installation; for vibratory pile driving associated with sheetpile installation, the source level was assumed to be 160 dB re 1 μPa^2s SEL; and for pile driving associated with berthing pile removal, the source level was assumed to be 165 dB re 1 μPa^2s SEL.

J.2.3 Noise Attenuation

No specific noise-attenuation system was identified for the assessment of impact pile-driving noise associated with foundation installation. However, a minimum sound-source attenuation of 10 dB was assumed to model impact pile driving. This level of attenuation was selected as an achievable reduction in sound levels when one noise-attenuation system is in use (Empire 2023 citing Austin and Li 2016; Empire 2023 citing Bellman 2014; Empire 2023 citing Buehler et al. 2015; Empire 2023 citing Koschinski and Lüdemann 2013). An attenuation of 10 dB produces a 90-percent reduction in sound levels. Additional levels of attenuation (0, 6, and 15 dB) were also modeled for comparison. These results are presented in Appendix H, *Acoustic Ranges*, and Appendix I, *Animal Movement and Exposure* Modeling, to Appendix M-2 of the COP (Empire 2023).

The use of noise attenuation is not anticipated for vibratory pile driving associated with cofferdam installation, sheetpile installation, or removal of berthing piles, or for impact driving of goal post piles. Therefore, noise attenuation was not included in the analysis of these activities.

J.3. Methodology

J.3.1 Noise Propagation Modeling

J.3.1.1. Impact Pile Driving for Foundation Installation

To model the sound from impact pile driving, including WTG foundation monopiles, OSS jacket foundation pin piles, and goal post piles, the force of the pile-driving hammers was computed using the GRLWEAP 2010 wave equation model (Pile Dynamics 2010). The forcing functions from GRLWEAP were used as inputs to the Finite Difference model to compute the resulting pile vibrations. The sound radiating from the pile was simulated using a vertical array of discrete point sources. Their amplitudes and phases were derived using an inverse technique, such that their collective particle velocity, calculated using a near-field wave-number integration model, matched the particle velocity in the water at the pile wall. The sound field propagating away from the vertical array was calculated using the FWRAM, which utilizes an array starter method to accurately model sound propagation from a spatially distributed sound source (Empire 2023 citing MacGillivray and Chapman 2012).

FWRAM was used to model synthetic pressure waveforms over a 10- to 1,024-Hz frequency range. Pressure wave forms were computed as a function of range and depth using Fourier synthesis of transfer functions. The modeled pressure waveforms were post-processed to calculate SPL and SEL metrics moving away from the sound source, both vertically (i.e., with depth) and horizontally (i.e., over range). A 20-dB-per-decade decay rate was used to extend the sound field frequency range up to 65,000 Hz.

J.3.1.2. Impact Pile Driving for Goal Post Installation

Modeling of goal post installation utilized the optional User Spreadsheet Tool developed by NMFS, which generates estimated distances to cumulative and peak sound exposure thresholds based on user-provided sound source characteristics. Unlike foundation installation, which is a significantly more impactful offshore activity with complex propagation mechanics that benefit from the more robust modeling described in Section J.3.1.1, goal post installation is a standard, small-scale, coastal activity. These types of activities are typically evaluated with simpler propagation models, such as those used in the NMFS optional User Spreadsheet Tool, because evaluation of activities of this scale does not benefit from more complicated modeling. The use of the optional User Spreadsheet Tool to evaluate impact pile driving for goal post installation was discussed and agreed to by NMFS and BOEM acousticians.

J.3.1.3. Vibratory Pile Driving

Vibratory pile-driving activities include cofferdam installation, sheetpile installation for bulkhead repairs, and berthing pile removal. dBSea software was used to model vibratory pile-driving for cofferdam installation by calculating noise levels throughout the Project area in one-third octave bands. To analyze vibratory pile-driving noise, a split solver was used to cover frequencies from 12.5 to 20,000 Hz. dBSeaPE was used for frequencies from 12.5 to 800 Hz, and dBSeaRay was used for frequencies from 1,000 to 20,000 Hz. Modeling of sheetpile installation and berthing pile removal utilized the optional User Spreadsheet Tool developed by NMFS.

J.3.2 Ranges to Regulatory Thresholds

A maximum-over-depth approach was used to calculate distances to acoustic thresholds associated with injury and behavioral effects on marine animals (i.e., isopleths) (Section J.5). For this approach, the maximum received sound level that occurs within the water column at a given range was used as the sound level at that distance. The 95th percentile of all isopleth distances from the source ($R_{95\%}$) was used to represent the range to regulatory thresholds for the determination of ensonified areas (Figure J-1). As shown on Figure J-1, 95 percent of the area exceeding a specific acoustic threshold occurs within this range from the source.

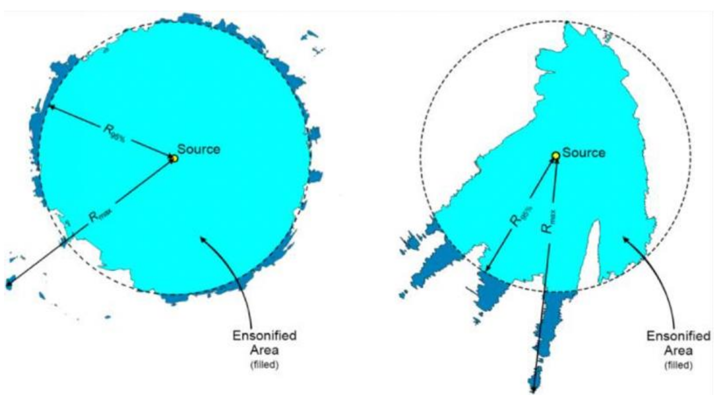


Figure J-1 Illustration of Ensonified Areas Based on $R_{95\%}$, which Was Calculated from Maximum Isopleth Ranges (R_{max})

J.3.3 Animal Movement Modeling

Predicted animal movements, in combination with predicted ensonified areas, are needed to estimate animal exposures to underwater noise during Project construction. Models using simulated animals, called “animats,” are generally used to predict animal movements (Dean 1998; Frankel et al. 2002). Such modeling is typically conducted for individual species but may be conducted for representative species groups if sufficient data are not available. Animat models require input data describing a variety of species-specific behavioral parameters, such as the range of swimming speeds, dive depths, and course changes. Animat models simulate four-dimensional movements of the animat across latitude, longitude, depth, and time.

The JASMINE animat modeling program was used to simulate animal movement through predicted ensonified areas modeled for the Projects to estimate the probability of exposure to sound levels exceeding regulatory thresholds (Section J.5). As the input parameters for the model are based on observations of swimming behavior collected over relatively short periods (i.e., hours to days) and do not include large-scale movements over relatively long periods (e.g., migration patterns), a simulation period of 7 days was selected for this modeling effort. The simulation area was limited to a maximum distance of 38 miles (70 kilometers) of the Lease Area. All simulations were seeded with an animat density of 0.5 animat per km^2 over the entire simulation area to generate statistically reliable probability density functions.

Within each simulation, the animat served as a sound receiver, sampling sound levels within the predicted ensonified area as the animat moved. For each simulation, JASMINE provided output quantifying the exposure history (i.e., received sound levels over the course of the simulation period) for each animat as it moved through the environment during noise-producing Project activities. Each animat's exposure history was used to identify maximum received SPLs, and exposure levels were summed over a 24-hour period to determine received SELs. These SPLs and SELs were then compared to regulatory thresholds.

To estimate the number of marine animals likely to be exposed to sound levels exceeding the regulatory thresholds over the duration of the Projects, four different construction schedules occurring over a 2-year period were modeled, with 96 monopiles and 24 pin piles being installed in Year 1 and 51 monopiles and no pin piles being installed in Year 2 (COP Volume 2, Appendix M-2, Section 1.2.2; Empire 2023). In construction schedule 1, one monopile and two pin piles are driven per day; in construction schedule 2, one monopile and three pin piles are driven per day; in construction schedule 3, two monopiles and 2 pin piles are driven per day; and in construction schedule 4, two monopiles and three pin piles are driven per day.

Behavioral aversion to sound sources was modeled for a subset of scenarios for comparison purposes only. Parameters determining aversion at specified sound levels were implemented for two species: NARW (*Eubalaena glacialis*) and harbor porpoise (*Phocoena phocoena*). NARW was selected due to its critically endangered status, and harbor porpoise was selected based on its documented strong aversive response to loud sounds. Aversion for these two marine mammal species was implemented by allowing the animats to change course away from the sound source, with heading changes determined by received sound levels. Aversion thresholds were based on the Wood et al. (2012) step function (COP Appendix M-2, Tables I-1 and I-2; Empire 2023). Animats remained in the aversive state for a specified amount of time based on received sound levels before returning to a normal state.

J.4. Marine Species Present in the Project Area

Thirty-nine marine mammal stocks (38 species) and four species of sea turtles potentially occur near the Project area. All four sea turtle species and six marine mammal species are listed under the ESA; all marine mammals are protected under the MMPA. Species with common or uncommon occurrence (Table J-2) were selected for quantitative movement modeling and exposure estimates. Rare species were not modeled because acoustic impacts on these species would approach zero due to their low densities.

Table J-2 Marine Mammal and Sea Turtle Species Quantitatively Analyzed

Species	Stock	Abundance
Mysticetes		
Fin whale *Balaenoptera physalus*	Western North Atlantic	6,802
Humpback whale *Megaptera novaeangliae*	Gulf of Maine	1,396

Species	Stock	Abundance
Minke whale *B. acutorostrata*	Canadian Eastern Coastal	21,968
NARW *E. glacialis*	Western	368
Sei whale *B. borealis*	Nova Scotia	6,292
Odontocetes		
Atlantic spotted dolphin *Stenella frontalis*	Western North Atlantic	39,921
Atlantic white-sided dolphin *Lagenorhynchus acutus*	Western North Atlantic	93,233
Bottlenose dolphin *Tursiops truncatus*	Western North Atlantic Offshore	62,851
	Western North Atlantic Northern Migratory Coastal	6,639
Harbor porpoise *P. phocoena*	Gulf of Maine/Bay of Fundy	95,543
Long-finned pilot whale *Globicephala melas*	Western North Atlantic	39,215
Risso's dolphin *Grampus griseus*	Western North Atlantic	35,493
Short-beaked common dolphin *Delphinus delphis*	Western North Atlantic	172,974
Short-finned pilot whale *G. macrorhynchus*	Western North Atlantic	28,924
Sperm whale *Physeter macrocephalus*	North Atlantic	4,349
Pinnipeds		
Gray seal *Halichoerus grypus*	Western North Atlantic	27,300
Harbor seal *Phoca vitulina*	Western North Atlantic	61,336
Harp seal *Pagophilus groenlandicus*	Western North Atlantic	Unknown
Sea Turtles		
Green sea turtle *Chelonia mydas*	--	--
Kemp's ridley sea turtle *Lepidochelys kempii*	--	--
Leatherback sea turtle *Dermochelys coriacea*	--	--
Loggerhead sea turtle *Caretta caretta*	--	--

Source: COP Volume 2, Section 3.15, and COP Appendix M-2; Empire 2023

J.4.1 Marine Mammal Densities

J.4.1.1. Lease Area

To estimate marine mammal exposures for impact pile driving for foundation installation, estimates of mean monthly density (animals per 100 km^2) for all common and uncommon marine mammal species occurring in the Project area (Table J-2) were obtained from the Duke University Marine Geospatial Ecology Laboratory (Roberts et al. 2016a, 2016b, 2017, 2018, 2021a, 2021b), including the recently updated model results for the NARW. These densities are provided in Table J-3. The updated model includes new NARW abundance estimates for Cape Cod Bay in December. The modeling used the most recent 2010 to 2018 density predictions for the NARW.

Densities were calculated for a 3.4-mile (5.5-kilometer) buffered polygon around the Lease Area perimeter. This buffer size was selected as the largest 10 dB-attenuated exposure range, rounded up to the nearest 0.5 kilometer. All species, scenarios, and threshold criteria were included in this calculation.

Mean density for each month was determined by calculating the unweighted mean density of all grid cells partially or fully within the buffered polygon. Grid cells were 6.2 by 6.2 miles (10 by 10 kilometers), except for NARW, which were 3.1 by 3.1 miles (5 by 5 kilometers). Densities were computed monthly, annually, and for the May through December period to coincide with proposed pile-driving activities for the Projects. In cases where monthly densities were unavailable, annual mean densities were used instead.

Although long-finned and short-finned pilot whales were modeled separately, only one density model was available for pilot whales that encompasses both pilot whale species (Roberts et al. 2016a, 2016b, 2017). Densities for each species were calculated by estimating the total pilot whale densities in the buffered polygon and then scaling by relative abundance of both species.

J.4.1.2. Cable Landfall Area

To estimate marine mammal exposures for vibratory pile driving for cofferdam installation, average seasonal densities in the cable landfall area were obtained from the Duke University Marine Geospatial Ecology Laboratory (Roberts et al. 2016b, 2017, 2018, 2020, 2021a). These densities are provided in Table J-4.

Table J-3 Mean Monthly Marine Mammal Density Estimates for Impact Pile Driving for Foundation Installation

Species	Monthly Densities (animals per 100 km^2)												Annual Mean Density
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Fin whale	0.099	0.095	0.115	0.189	0.236	0.258	0.232	0.172	0.163	0.189	0.105	0.084	0.161
Humpback whale	0.061	0.031	0.020	0.044	0.042	0.048	0.020	0.013	0.062	0.129	0.054	0.065	0.049
Minke whale	0.036	0.044	0.045	0.148	0.148	0.080	0.012	0.013	0.062	0.035	0.018	0.026	0.051
NARW	0.479	0.548	0.645	0.726	0.122	0.007	0.002	0.002	0.002	0.005	0.031	0.230	0.233
Sei whale	0.001	0.001	0.001	0.021	0.018	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.004
Atlantic spotted dolphin	0.005	0.002	0.003	0.011	0.027	0.114	0.283	0.148	0.263	0.146	0.145	0.015	0.097
Atlantic white sided dolphin	0.755	0.501	0.588	1.537	2.533	2.111	0.741	0.260	0.495	1.158	1.012	1.254	1.079
Bottlenose dolphin	0.629	0.045	0.018	0.305	0.705	2.442	2.679	2.941	2.240	1.318	1.284	0.651	1.271
Harbor porpoise	7.573	11.683	11.252	6.946	2.059	0.037	0.051	0.079	0.072	0.157	2.874	6.549	4.111
Long-finned pilot whale	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098
Risso's dolphin	0.006	0.003	0.001	0.001	0.003	0.003	0.014	0.030	0.012	0.003	0.006	0.014	0.008
Short-beaked common dolphin	7.494	1.434	0.573	0.947	1.038	0.930	0.863	2.235	3.413	5.013	4.336	11.713	3.332
Short-finned pilot whale	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072
Sperm whale	0.001	0.001	0.001	0.001	0.006	0.027	0.042	0.029	0.027	0.009	0.007	0.001	0.013
Seals	5.941	11.886	10.158	8.808	6.431	0.266	0.017	0.008	0.022	0.095	0.318	3.984	3.994

Sources: Roberts et al. 2016a, 2016b, 2017, 2018, 2021a, 2021b

Table J-4 Mean Seasonal Marine Mammal Density Estimates for Vibratory Pile Driving for Cofferdam Installation

Species	Seasonal Densities (animals per 100 km²)	
	EW 1 Cofferdams	EW 2 Cofferdams
NARW	0.29	0.029
Humpback whale	0.07	0.07
Fin whale	0.17	0.17
Sei whale	0.01	0.01
Sperm whale	0.02	0.02
Minke whale	0.08	0.08
Bottlenose dolphin (Western North Atlantic Northern Migratory Coastal Stock)	6.6	6.6
Atlantic spotted dolphin	0.14	0.14
Short-beaked common dolphin	4.94	4.94
Atlantic white-sided dolphin	1.02	1.02
Risso's dolphin	0.01	0.01
Pilot whale spp.	0.11	0.11
Harbor porpoise	9.07	9.07

Sources: Roberts et al. 2016b, 2017, 2018, 2020, 2021a

J.4.2 Sea Turtle Densities

Density estimates for sea turtles in the Project area are limited. Aerial survey data collected by the New York State Energy Research and Development Authority (Normandeau Associates and APEM 2018, 2019a, 2019b, 2019c, 2020) were used to develop seasonal density estimates for quantitative analysis of acoustic impacts on sea turtles. Maximum seasonal abundance for each species was extracted from the aerial survey data and corrected to represent the Project area. Corrected abundance was scaled by the Project area to obtain species density in units of animals per km^2 (Table J-5).

Table J-5 Mean Seasonal Sea Turtle Density Estimates for All Modeled Sea Turtle Species

Species	Seasonal Densities (animals per 100 km²)			
	Spring	Summer	Fall	Winter
Green sea turtle	0.000	0.000	0.000	0.000
Kemp's ridley sea turtle	0.001	0.010	0.002	0.000
Leatherback sea turtle	0.000	0.003	0.008	0.000
Loggerhead sea turtle	0.003	0.268	0.002	0.000

J.5. Acoustic Impact Criteria

J.5.1 Marine Mammals

Marine mammal acoustic criteria used for the modeling effort were derived from the current U.S. regulatory acoustic criteria. Peak SPLs (L_{pk}) and frequency-weighted accumulated SELs ($L_{E,\text{24h}}$) were taken from the NOAA Technical Guidance (NMFS 2018) for marine mammal injury thresholds (Table

J-6). SPL (L_p) for marine mammal behavioral thresholds were based on the unweighted NMFS (2005) (Table J-6) and the frequency-weighted Wood et al. (2012) criteria (Table J-7).

Table J-6 NMFS Regulatory Acoustic Criteria for Marine Mammals

Functional Hearing Group	Sound Source Type				
	Impulsive			Non-Impulsive	
	Level A $L_{E,\,24h}$[1]	Level A L_{pk}[2]	Level B L_p[2]	Level A $L_{E,\,24h}$[1]	Level B L_p[2]
LFC	183	219	160	199	120
MFC	185	230		198	
HFC	155	202		173	
Phocid pinnipeds in water	185	218		201	

Sources: NMFS 2005, 2018
[1] Measured in dB re 1 μPa^{2}s
[2] Measured in dB re 1 μPa

Table J-7 Frequency-Weighted Acoustic Criteria for Probabilistic Behavioral Response to Impulsive Noise Sources in Marine Mammals

Marine Mammal Group	Probabilistic Response			
	L_p[1] > 120	L_p[1] > 140	L_p[1] > 160	L_p[1] > 180
Beaked whales and harbor porpoises	50%	90%	--	--
Migrating mysticetes	10%	50%	90%	--
All other species	--	10%	50%	90%

[1] Measured in dB re 1 μPa

J.5.2 Sea Turtles

Peak SPLs and frequency-weighted accumulated SELs from Finneran et al. (2017) were used for the onset of PTS and TTS in sea turtles (Table J-8 and Table J-9). Behavioral response thresholds for sea turtles were obtained from McCauley et al. (2000).

J.5.3 Fish

Injury thresholds (L_{pk} and $L_{E,\,24hr}$) for different sized fish (i.e., less than 2 grams or 2 grams and larger) were based on the Fisheries Hydroacoustic Working Group (2008) and Stadler and Woodbury (2009). Injury thresholds (L_{pk} and $L_{E,\,24hr}$) for fish with different hearing capabilities (i.e., without swim bladder, with swim bladder not involved in hearing, and with swim bladder involved in hearing) were obtained from Popper et al. (2014). Behavioral thresholds for fish were developed by the NMFS Greater Atlantic Regional Fisheries Office (Andersson et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011; Wysocki et al. 2007) (Table J-8 and Table J-9).

Table J-8 Acoustic Metrics and Thresholds for Impulsive Noise Sources for Fish and Sea Turtles

Faunal Group	Injury		Impairment		Behavior
	L_{pk}[1]	$L_{E,\,24hr}$[2]	L_{pk}[1]	$L_{E,\,24hr}$[2]	L_p[1]
Fish equal to or greater than 2 grams	206	187	--	--	150
Fish less than 2 grams		183	--	--	

Faunal Group	Injury		Impairment		Behavior
	L_{pk}[1]	$L_{E,\ 24hr}$[2]	L_{pk}[1]	$L_{E,\ 24hr}$[2]	L_p[1]
Fish without swim bladder	213	216	--	--	--
Fish with swim bladder not involved in hearing	207	203	--	--	--
Fish with swim bladder involved in hearing	207	203	--	--	--
Sea turtles	232	204	226	189	175

Sources: Andersson et al. 2007; Finneran et al. 2017; Fisheries Hydroacoustic Working Group 2008; McCauley et al. 2000; Mueller-Blenkle et al. 2010; Popper et al. 2014; Purser and Radford 2011; Stadler and Woodbury 2009; Wysocki et al. 2007
[1] Measured in dB re 1 µPa
[2] Measured dB re 1 µPa^{2}s

Table J-9 Acoustic Metrics and Thresholds for Non-Impulsive Noise Sources for Fish and Sea Turtles

Faunal Group	Injury		Impairment		Behavior
	L_p[1]	$L_{E,\ 24hr}$[2]	L_p[1]	$L_{E,\ 24hr}$[2]	L_p[1]
Fish equal to or greater than 2 grams	--	--	--	--	150
Fish less than 2 grams	--	--	--	--	
Fish without swim bladder	--	--	--	--	--
Fish with swim bladder not involved in hearing	--	--	--	--	--
Fish with swim bladder involved in hearing	170	--	158	--	--
Sea turtles	--	220	--	200	175

Sources: Andersson et al. 2007; Finneran et al. 2017; Fisheries Hydroacoustic Working Group 2008; McCauley et al. 2000; Mueller-Blenkle et al. 2010; Popper et al. 2014; Purser and Radford 2011; Stadler and Woodbury 2009; Wysocki et al. 2007
[1] Measured in dB re 1 µPa
[2] Measured dB re 1 µPa^{2}s

J.6. Results

J.6.1 Ranges to Acoustic Regulatory Thresholds

J.6.1.1. Impact Pile Driving for Foundation Installation

The complete results of acoustic modeling for impact pile driving of monopiles and pin piles presented in Appendix M-2 (Empire 2023) for the multiple combinations of the two modeled seasons, four modeled locations (two locations for monopiles and two locations for pin piles), varying levels of attenuation, pile-driving scenarios (i.e., typical and difficult-to-drive), and driving schedules are too numerous to replicate here. Instead, summaries of exposure ranges ($ER_{95\%}$) for marine mammals and sea turtles are presented herein (Table J-10 through Table J-23). Additionally, summaries of ranges to acoustic thresholds for sea turtles and fish are presented herein and are based on the maximum acoustic range (R_{max}) among the modeled scenarios for sea turtles and fish (Table J-24 through Table J-30). Variation in ranges presented in the tables arises from a number of factors, including differences in model assumptions for different foundation types (e.g., maximum hammer energy, number of strikes), differences in sound speed profiles due to differences in water column properties between seasons, differences in modeled location and the associated differences in environmental inputs (e.g., depth, sediment properties), and differences in schedule assumptions[3] (i.e., number of piles driven per day). Model inputs such as hammer energy,

[3] Differences in schedule assumptions would only be expected to affect ranges to SEL ($L_{E,24h}$) thresholds.

number of strikes (i.e., driving duration) at each energy level, and embedment depth are more significant inputs to the acoustic model than foundation diameter. The amount of sound generated during pile driving varies with the number of required strikes, and the energy required to drive piles to a desired depth depends on the sediment resistance encountered. Sediment types with greater resistance require higher hammer energy or an increased number of strikes relative to installations in softer sediment. For example, the greater ranges to Level B thresholds for marine mammals associated with 9.6-meter monopiles compared to those associated with 11-meter monopiles result mainly from the generally higher hammer energy used for the smaller monopiles (see Table J-1) due to the firmer substrates in which the smaller monopiles would be installed.

Table J-10 Exposure Ranges ($ER_{95\%}$) to MMPA Level A (Injury) and Level B (Behavioral Disturbance) Thresholds for Marine Mammals Due to Sound from Impact Pile Driving of One 9.6-meter Monopile WTG Foundation per Day with 0 and 10 dB of Noise Attenuation

Functional Hearing Group	Range (kilometers)											
	Typical Scenario						Difficult-to-Drive Scenario					
	0 dB			10 dB			0 dB			10 dB		
	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p
LFC	0.00	3.07	7.35	0.01	0.88	3.40	0.05	4.28	8.97	<0.01	1.80	5.24
MFC	0.00	0.00	7.09	0.00	0.00	3.40	0.00	0.00	8.82	0.00	0.00	5.14
HFC	0.22	0.00	7.04	0.00	0.00	3.15	0.57	0.02	8.71	0.08	0.00	5.04
PW	<0.01	0.11	7.37	0.00	0.00	3.54	<0.01	0.54	9.09	0.00	0.00	5.35

Source: Summarized from Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
PW = phocid pinniped in water

Table J-11 Exposure Ranges ($ER_{95\%}$) to MMPA Level A (Injury) and Level B (Behavioral Disturbance) Thresholds for Marine Mammals Due to Sound from Impact Pile Driving of Two 9.6-meter Monopile WTG Foundations per Day with 0 and 10 dB of Noise Attenuation

Functional Hearing Group	Range (kilometers)											
	Typical Scenario						Difficult-to-Drive Scenario					
	0 dB			10 dB			0 dB			10 dB		
	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p
LFC	0.02	3.14	7.10	0.00	1.01	3.46	0.05	4.46	8.79	0.00	1.95	4.87
MFC	<0.01	0.00	6.86	0.00	0.00	3.32	<0.01	0.00	8.56	0.00	0.00	4.92
HFC	0.27	<0.01	6.80	<0.01	0.00	3.22	0.55	0.04	8.56	0.04	0.00	4.75
PW	0.03	0.13	7.22	0.00	0.00	3.50	0.07	0.52	8.96	0.00	<0.01	5.19

Source: Summarized from Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
PW = phocid pinniped in water

Table J-12 Exposure Ranges ($ER_{95\%}$) to MMPA Level A (Injury) and Level B (Behavioral Disturbance) Thresholds for Marine Mammals Due to Sound from Typical Impact Pile Driving of One and Two 11-meter U3 Monopile WTG Foundations per Day with 0 and 10 dB of Noise Attenuation

Functional Hearing Group	Range (kilometers)											
	1 Monopile per Day						2 Monopiles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p
LFC	<0.01	2.70	5.61	<0.01	0.90	2.71	0.02	2.30	5.55	0.00	0.82	2.59
MFC	0.00	0.00	5.55	0.00	0.00	2.63	0.00	0.00	5.40	0.00	0.00	2.53
HFC	0.20	0.00	5.39	0.00	0.00	2.53	0.24	0.00	5.32	<0.01	0.00	2.51
PW	0.00	0.08	5.79	0.00	0.00	2.70	<0.01	0.04	5.71	<0.01	<0.01	2,67

Source: Summarized from Appendix I, *Animal Movement and Exposure Modeling,* to COP Appendix M-2 (Empire 2023)
PW = phocid pinniped in water

Table J-13 Exposure Ranges ($ER_{95\%}$) to MMPA Level A (Injury) and Level B (Behavioral Disturbance) Thresholds for Marine Mammals Due to Sound from Typical Impact Pile Driving of One and Two 11-meter T1 Monopile WTG Foundations per Day with 0 and 10 dB of Noise Attenuation

Functional Hearing Group	Range (kilometers)											
	1 Monopile per Day						2 Monopiles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p
LFC	<0.01	2.87	7.20	0.00	0.87	3.56	0.01	2.66	6.99	0.00	0.83	3.53
MFC	0.00	0.00	6.87	0.00	0.00	3.48	<0.01	0.00	6.76	0.00	0.00	3.35
HFC	0.22	0.00	6.87	0.00	0.00	3.41	0.24	0.00	6.64	<0.01	0.00	3.35
PW	<0.01	0.12	7.30	0.00	0.00	4.98	<0.01	0.14	7.20	0.00	0.00	3.66

Source: Summarized from Appendix I, *Animal Movement and Exposure Modeling,* to COP Appendix M-2 (Empire 2023)
PW = phocid pinniped in water

Table J-14 Exposure Ranges ($ER_{95\%}$) to MMPA Level A (Injury) and Level B (Behavioral Disturbance) Thresholds for Marine Mammals Due to Sound from Typical Impact Pile Driving of One and Two 11-meter R3 Monopile WTG Foundations per Day with 0 and 10 dB of Noise Attenuation

Functional Hearing Group	Range (kilometers)											
	1 Monopile per Day						2 Monopiles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Level A L_{pk}	Level A $L_{E,24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E,24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E,24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E,24h}$	Level B L_p
LFC	<0.01	2.73	6.41	0.00	0.87	3.17	0.01	2.50	6.42	<0.01	0.48	3.14
MFC	<0.01	0.00	6.42	0.00	0.00	3.10	<0.01	0.00	6.25	0.00	0.00	4,21
HFC	0.23	0.00	6.27	0.00	0.00	3.07	0.26	0.00	6.23	<0.01	0.00	3.09
PW	<0.01	0.12	6.46	0.00	0.00	3.25	0.01	0.04	6.42	0.00	0.00	3.25

Source: Summarized from Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
PW = phocid pinniped in water

Table J-15 Exposure Ranges ($ER_{95\%}$) to MMPA Level A (Injury) and Level B (Behavioral Disturbance) Thresholds for Marine Mammals Due to Sound from Impact Pile Driving of OSS1 Jacket Foundations with 0 and 10 dB of Noise Attenuation

Functional Hearing Group	Range (kilometers)											
	Two Pin Piles per Day						Three Pin Piles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Level A L_{pk}	Level A $L_{E,24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E,24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E,24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E,24h}$	Level B L_p
LFC	0.00	0.46	2.49	0.00	0.00	0.90	0.00	0.55	2.45	0.00	0.00	0.85
MFC	0.00	0.00	2.56	0.00	0.00	0.88	0.00	0.00	2.41	0.00	0.00	0.87
HFC	0.00	0.00	2.50	0.00	0.00	0.86	0.00	0.00	2.47	0.00	0.00	0.79
PW	0.00	0.00	2.62	0.00	0.00	0.99	0.00	0.00	2.60	0.00	0.00	0.99

Source: Summarized from Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
PW = phocid pinniped in water

Table J-16 Exposure Ranges ($ER_{95\%}$) to MMPA Level A (Injury) and Level B (Behavioral Disturbance) Thresholds for Marine Mammals Due to Sound from Impact Pile Driving of OSS2 Jacket Foundations with 0 and 10 dB of Noise Attenuation

Functional Hearing Group	Range (kilometers)											
	Two Pin Piles per Day						Three Pin Piles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p	Level A L_{pk}	Level A $L_{E, 24h}$	Level B L_p
LFC	0.00	0.86	2.58	0.00	0.00	0.84	0.00	0.85	2.53	0.00	0.00	0.84
MFC	0.00	0.00	2.40	0.00	0.00	0.83	0.00	0.00	2.39	0.00	0.00	0.78
HFC	0.00	0.00	2.34	0.00	0.00	0.71	0.00	0.00	2.43	0.00	0.00	0.71
PW	0.00	0.00	2.68	0.00	0.00	0.79	0.00	0.00	2.67	0.00	0.00	0.78

Source: Summarized from Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
PW = phocid pinniped in water

Table J-17 Exposure Ranges ($ER_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Sea Turtles Due to Sound from Impact Pile Driving of One 9.6-meter Monopile WTG Foundation per Day with 0 and 10 dB of Noise Attenuation

Species	Range (kilometers)											
	Typical Scenario						Difficult-to-Drive Scenario					
	0 dB			10 dB			0 dB			10 dB		
	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p
Kemp's ridley turtle	0.00	0.41	1.96	0.00	0.00	0.51	0.00	0.97	3.37	0.00	0.10	1.29
Leatherback turtle	0.00	0.79	2.37	0.00	0.00	0.73	0.00	1.54	3.87	0.00	0.15	1.60
Loggerhead turtle	0.00	0.00	1.99	0.00	0.00	0.38	0.00	0.48	3.19	0.00	0.00	1.24
Green turtle	0.00	0.39	2.13	0.00	0.00	0.36	0.00	1.44	3.61	0.00	0.17	1.67

Source: Summarized from Appendix I, *Animal Movement and Exposure Modeling,* to COP Appendix M-2 (Empire 2023)
Beh. = behavior; Inj. = injury

Table J-18 Exposure Ranges ($ER_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Sea Turtles Due to Sound from Impact Pile Driving of Two 9.6-meter Monopile WTG Foundations per Day with 0 and 10 dB of Noise Attenuation

Species	Range (kilometers)											
	Typical Scenario						Difficult-to-Drive Scenario					
	0 dB			10 dB			0 dB			10 dB		
	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p
Kemp's ridley turtle	0.00	0.37	1.90	0.00	0.00	0.67	<0.01	0.96	3.36	0	0.12	0.67
Leatherback turtle	0.00	0.80	2.35	0.00	0.06	0.75	0	1.57	3.85	0	0.31	0.82
Loggerhead turtle	0.00	0.45	1.89	0.00	0.00	0.49	0	0.56	2.91	0	0.03	0.55
Green turtle	0.00	0.50	2.11	0.00	0.00	0.66	0	1.48	3.61	0	0.19	0.67

Source: Summarized from Tables I-47 through I-54, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
Beh. = behavior; Inj. = injury

Table J-19 Exposure Ranges ($ER_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Sea Turtles Due to Sound from Impact Pile Driving of One and Two 11-meter U3 Monopile WTG Foundations per Day with 0 and 10 dB of Noise Attenuation

Species	Range (kilometers)											
	One Monopile per Day						Two Monopiles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p
Kemp's ridley turtle	0	0.15	1.41	0	0	0.45	0	0.21	1.45	0	0	0.33
Leatherback turtle	0	0.68	1.65	0	0	0.15	0	0.70	1.76	0	0	0.58
Loggerhead turtle	0	0	1.37	0	0	0.44	0	0.03	1.38	0	0	0.21
Green turtle	0	0.17	1.75	0	0	0.35	0	0.36	1.60	0	0	0.38

Source: Summarized from Tables I-55 through I-58, Appendix I, *Animal Movement and Exposure Modeling* , to COP Appendix M-2 (Empire 2023)
Beh. = behavior; Inj. = injury

Table J-20 Exposure Ranges ($ER_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Sea Turtles Due to Sound from Impact Pile Driving of One and Two 11-meter T1 Monopile WTG Foundations per Day with 0 and 10 dB of Noise Attenuation

Species	Range (kilometers)											
	One Monopile per Day						Two Monopiles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p
Kemp's ridley turtle	0	0.34	2.21	0	0	0.44	0	0.38	1.99	0	0	0.59
Leatherback turtle	0	0.70	2.50	0	0	0.74	0	0.76	2.47	0	0	0.81
Loggerhead turtle	0	0	2.00	0	0	0.39	0	0.45	2.02	0	0	0.59
Green turtle	0	0.16	2.32	0	0	0.81	0	0.64	2.29	0	0	0.75

Source: Summarized from Tables I-59 through I-62, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
Beh. = behavior; Inj. = injury

Table J-21 Exposure Ranges ($ER_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Sea Turtles Due to Sound from Impact Pile Driving of One and Two 11-meter R3 Monopile WTG Foundations per Day with 0 and 10 dB of Noise Attenuation

Species	Range (kilometers)											
	One Monopile per Day						Two Monopiles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p
Kemp's ridley turtle	0	0.37	1.79	0	<0.01	0.53	0	0.34	1.84	0	0	0.51
Leatherback turtle	0	0.57	2.20	0	0	0.71	0	0.51	2.15	0	0	0.75
Loggerhead turtle	0	0	1.66	0	0	0.39	0	0.14	1.81	0	0	0.45
Green turtle	0	0.16	2.05	0	0	0.61	0	0.47	1.99	0	0	0.58

Source: Summarized from Tables I-63 through I-66, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
Beh. = behavior; Inj. = injury

Table J-22 Exposure Ranges ($ER_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Sea Turtles Due to Sound from Impact Pile Driving of OSS1 Jacket Foundations per Day with 0 and 10 dB of Noise Attenuation

Species	Range (kilometers)											
	Two Pin Piles per Day						Three Pin Piles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p
Kemp's ridley turtle	0	0	0.35	0	0	0.11	0	0	0.35	0	0	0.10
Leatherback turtle	0	0	0.52	0	0	0	0	0	0.57	0	0	0
Loggerhead turtle	0	0	0.38	0	0	0	0	0	0.37	0	0	0
Green turtle	0	0	0.46	0	0	0	0	0	0.45	0	0	0

Source: Summarized from Tables I-67 through I-70, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
Beh. = behavior; Inj. = injury

Table J-23 Exposure Ranges ($ER_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Sea Turtles Due to Sound from Impact Pile Driving of OSS2 Jacket Foundations per Day with 0 and 10 dB of Noise Attenuation

Species	Range (kilometers)											
	Two Pin Piles per Day						Three Pin Piles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p
Kemp's ridley turtle	0	0	0.37	0	0	0.07	0	0	0.40	0	0	0.07
Leatherback turtle	0	0	0	0	0	0	0	0	0	0	0	0
Loggerhead turtle	0	0	0.20	0	0	0	0	0	0.19	0	0	0
Green turtle	0	0	0.27	0	0	0	0	0	0.30	0	0	0

Source: Summarized from Tables I-71 through I-74, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
Beh. = behavior; Inj. = injury

Table J-24 Acoustic Ranges (R_{max}) to Injury and Behavioral Disturbance Thresholds for Fish and Sea Turtles Due to Sound from Impact Pile Driving of Typical 9.6-meter Monopile WTG Foundations with 0 and 10 dB of Noise Attenuation

Faunal Group	Range (kilometers)					
	0 dB			10 dB		
	Injury L_{pk}	Injury $L_{E, 24h}$	Behavior L_p	Injury L_{pk}	Injury $L_{E, 24h}$	Behavior L_p
Fish greater than or equal to 2 grams	0.19	7.22	14.36	0.05	2.78	5.90
Fish less than 2 grams	0.19	9.24	14.36	0.05	3.87	5.90
Fish without swim bladder	0.09	0.37	--	--	0.07	--
Fish with swim bladder not involved in hearing	0.16	1.95	--	0.05	0.50	--
Fish with swim bladder involved in hearing	0.16	1.95	--	0.05	0.50	--
Sea turtles	--	1.78	2.42	--	0.44	0.72

Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire 2023)

Table J-25 Acoustic Ranges (R_{max}) to Injury and Behavioral Disturbance Thresholds for Fish and Sea Turtles Due to Sound from Impact Pile Driving-of-Difficult to Drive 9.6-meter Monopile WTG Foundations with 0 and 10 dB of Noise Attenuation

Faunal Group	Range (kilometers)					
	0 dB			10 dB		
	Injury L_{pk}	Injury $L_{E, 24h}$	Behavior L_p	Injury L_{pk}	Injury $L_{E, 24h}$	Behavior L_p
Fish greater than or equal to 2 grams	0.46	9.34	17.00	0.11	5.20	9.28
Fish less than 2 grams	0.46	12.03	17.00	0.11	6.64	9.28
Fish without swim bladder	0.15	0.85	--	0.02	0.16	--
Fish with swim bladder not involved in hearing	0.41	3.39	--	0.09	1.27	--
Fish with swim bladder involved in hearing	0.41	3.39	--	0.09	1.27	--
Sea turtles	--	3.06	4.01	--	1.08	1.67

Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire 2023)

Table J-26 Acoustic Ranges (R_{max}) to Injury and Behavioral Disturbance Thresholds for Fish and Sea Turtles Due to Sound from Impact Pile Driving of 11-meter (R3, T1, and U3) Monopile WTG Foundations with 0 and 10 dB of Noise Attenuation

Faunal Group	Range (kilometers)					
	0 dB			10 dB		
	Injury L_{pk}	Injury $L_{E, 24h}$	Behavior L_p	Injury L_{pk}	Injury $L_{E, 24h}$	Behavior L_p
Fish greater than or equal to 2 grams	0.30	6.53	12.24	0.07	3.18	7.51
Fish less than 2 grams	0.30	8.46	13.72	0.07	4.39	7.51
Fish without swim bladder	0.11	0.34	--	0.01	0.07	--
Fish with swim bladder not involved in hearing	0.19	1.83	--	0.06	0.52	--
Fish with swim bladder involved in hearing	0.19	1.83	--	0.06	0.52	--
Sea turtles	--	1.67	2.57	--	0.44	0.87

Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire 2023)

Table J-27 Acoustic Ranges (R_{max}) to Injury and Behavioral Disturbance Thresholds for Fish and Sea Turtles Due to Sound from Impact Pile Driving of OSS1 Jacket Foundations (One Pin Pile per Day) with 0 and 10 dB of Noise Attenuation

Faunal Group	Range (kilometers)					
	0 dB			10 dB		
	Injury L_{pk}	Injury $L_{E, 24h}$	Behavior L_p	Injury L_{pk}	Injury $L_{E, 24h}$	Behavior L_p
Fish greater than or equal to 2 grams	0.02	2.87	6.31	0.01	0.92	2.67
Fish less than 2 grams	0.02	4.24	6.31	0.01	1.57	2.67
Fish without swim bladder	0.01	0.05	--	--	--	--
Fish with swim bladder not involved in hearing	0.02	0.42	--	0.01	0.11	--
Fish with swim bladder involved in hearing	0.02	0.42	--	0.01	0.10	--
Sea turtles	--	0.34	0.44	--	0.10	0.12

Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire 2023)

Table J-28 Acoustic Ranges (R_{max}) to Injury and Behavioral Disturbance Thresholds for Fish and Sea Turtles Due to Sound from Impact Pile Driving of OSS1 Jacket Foundations (Two and Three Pin Piles per Day) with 0 and 10 dB of Noise Attenuation

Faunal Group	Range (kilometers)											
	2 Pin Piles per Day						3 Pin Piles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E, 24h}$	Beh. L_p
Fish ≥ 2 grams	0.02	3.91	6.31	0.01	1.41	2.66	0.02	4.51	6.31	0.01	1.72	2.66
Fish < 2 grams	0.02	5.35	6.31	0.01	2.19	2.66	0.02	6.08	6.31	0.01	2.59	2.66
Fish without swim bladder	0.01	0.11	--	--	0.01--		0.01	0.13	--	--	0.02	--
Fish with swim bladder not involved in hearing	0.02	0.64	--	0.01	0.16		0.02	0.82	--	0.01	0.20	--
Fish with swim bladder involved in hearing	0.02	0.64	--	0.01	0.16		0.02	0.82	--	0.01	0.20	--
Sea turtles	--	0.54	0.44	--	0.13	0.12	--	0.70	0.44	--	0.18	0.12

Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire 2023)
≥ = greater than or equal to; < = less than; Beh. = behavior; Inj. = injury

Table J-29 Acoustic Ranges (R_{max}) to Injury and Behavioral Disturbance Thresholds for Fish and Sea Turtles Due to Sound from Impact Pile Driving of OSS2 Jacket Foundations (One Pin Pile per Day) with 0 and 10 dB of Noise Attenuation

Faunal Group	Range (kilometers)					
	0 dB			10 dB		
	Injury L_{pk}	Injury $L_{E, 24h}$	Behavior L_p	Injury L_{pk}	Injury $L_{E, 24h}$	Behavior L_p
Fish greater than or equal to 2 grams	0.02	3.01	6.78	--	0.93	2.60
Fish less than 2 grams	0.02	4.64	6.78	--	1.60	2.66
Fish without swim bladder	--	0.05	--	--	--	--
Fish with swim bladder not involved in hearing	--	0.39	--	--	0.06	--
Fish with swim bladder involved in hearing	--	0.39	--	--	0.06	--

Faunal Group	Range (kilometers)					
	0 dB			10 dB		
	Injury L_{pk}	Injury $L_{E,\ 24h}$	Behavior L_p	Injury L_{pk}	Injury $L_{E,\ 24h}$	Behavior L_p
Sea turtles	--	0.35	0.42	--	0.06	0.10

Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire 2023)

Table J-30 Acoustic Ranges (R_{max}) to Injury and Behavioral Disturbance Thresholds for Fish and Sea Turtles Due to Sound from Impact Pile Driving of OSS2 Jacket Foundations with 0 and 10 dB of Noise Attenuation

Faunal Group	Range (kilometers)											
	2 Pin Piles per Day						3 Pin Piles per Day					
	0 dB			10 dB			0 dB			10 dB		
	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p	Inj. L_{pk}	Inj. $L_{E,\ 24h}$	Beh. L_p
Fish ≥ 2 grams	0.02	4.25	6.78	--	1.41	2.60	0.02	4.97	6.78	--	1.74	2.66
Fish < 2 grams	0.02	6.01	6.78	--	2.28	2.66	0.02	6.95	6.78	--	2.73	2.66
Fish without swim bladder	--	0.09	--	--	--	--	--	0.11	--	--	0.02	--
Fish with swim bladder not involved in hearing	0.02	0.61	--	--	0.13	--	0.02	0.79	--	--	0.18	--
Fish with swim bladder involved in hearing	0.02	0.61	--	--	0.13	--	0.02	0.79	--	--	0.18	--
Sea turtles	--	0.50	0.42	--	0.11	0.10	--	0.66	0.42	--	0.15	0.10

Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire 2023)
≥ = greater than or equal to; < = less than; Beh. = behavior; Inj. = injury

J.6.1.2. Vibratory Pile Driving for Cofferdam Installation

The results of acoustic modeling for vibratory pile driving are presented in Appendix M-1 of the COP (Empire 2023) for the multiple modeled locations. Summaries of ranges to acoustic thresholds for marine mammals, sea turtles, and fish are presented herein and are based on the maximum acoustic range to the 95th maximum percentile ($R_{95\%}$) among the modeled scenarios (Table J-31 and Table J-32).

Table J-31 Maximum Acoustic Ranges ($R_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Marine Mammals Due to Sound from Vibratory Pile Driving without Noise Attenuation

Functional Hearing Group	Range (meters)	
	Level A $L_{E, 24h}$	Level B L_p
LFC	122	2,191
MFC	0	
HFC	52	
PW	62	

Source: Summarized from Tables M-1-8 and M-1-11 in COP Appendix M-1 (Empire 2023).
PW = phocid pinniped in water

Table J-32 Acoustic Ranges (R_{95}%) to Injury and Behavioral Disturbance Thresholds for Fish and Sea Turtles Due to Sound from Vibratory Pile Driving without Noise Attenuation

Faunal Group	Range (meters)	
	Injury $L_{E, 24h}$	Behavior L_p
Fish greater than or equal to 2 grams	260	268
Fish less than 2 grams	304	
Sea turtles	0	53

Source: Summarized from Tables M-1-9 through M-1-11 in COP Appendix M-1 (Empire 2023).

J.6.1.3. Impact Pile Driving for Goal Post Installation

The results of acoustic modeling for goal post pile driving are presented in Appendix M-1 of the COP (Empire 2023) for the multiple modeled locations. Summaries of ranges to acoustic thresholds for marine mammals, sea turtles, and fish are presented herein and are based on the maximum acoustic range to the 95th maximum percentile ($R_{95\%}$) among the modeled scenarios (Table J-33 and Table J-34).

Table J-33 Acoustic Ranges ($R_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Marine Mammals Due to Sound from Goal Post Pile Driving without Noise Attenuation

Functional Hearing Group	Range (meters)	
	Level A $L_{E, 24h}$	Level B 160 L_p
LFC	632.1	398.1
MFC	22.5	
HFC	752.9	
PW	338.3	

Source: Summarized from Tables M-1-13 and M-1-16 in COP Appendix M-1 (Empire 2023)
PW = phocid pinniped in water

Table J-34 Acoustic Ranges ($R_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Fish and Sea Turtles Due to Sound from Goal Post Pile Driving without Noise Attenuation

Faunal Group	Range (meters)	
	Injury $L_{E,\ 24h}$	Behavior L_p
Fish greater than or equal to 2 grams	342	1,847.8
Fish less than 2 grams	631	
Sea turtles	18.3	39.8

Source: Summarized from Tables M-1-14 and M-1-15 in COP Appendix M-1 (Empire 2023)

J.6.1.4. Vibratory Pile Driving for Sheetpile Installation and Berthing Pile Removal

The results of acoustic modeling for vibratory pile driving associated with marina bulkhead repairs and berthing pile removal are presented in Appendix M-1 of the COP (Empire 2023). Summaries of ranges to acoustic thresholds for marine mammals, sea turtles, and fish are presented herein and are based on the maximum acoustic range to the 95th maximum percentile ($R_{95\%}$) among the modeled scenarios (Table J-35 through Table J-38).

Table J-35 Acoustic Ranges ($R_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Marine Mammals Due to Sound from Vibratory Pile Driving for Marina Bulkhead Repairs without Noise Attenuation

Functional Hearing Group	Range (meters)	
	Level A $L_{E,\ 24h}$	Level B 120 L_p
LFC	43.2	1,000
MFC	3.8	
HFC	63.8	
PW	26.2	

Source: Summarized from Tables M-1-17 and M-1-20 in COP Appendix M-1 (Empire 2023)
PW = phocid pinniped in water

Table J-36 Acoustic Ranges ($R_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Fish and Sea Turtles Due to Sound from Vibratory Pile Driving for Marina Bulkhead Repairs without Noise Attenuation

Faunal Group	Range (meters)	
	Injury $L_{E,\ 24h}$	Behavior L_p
Fish greater than or equal to 2 grams	68.8	46.4
Fish less than 2 grams	37.2	
Sea turtles	2.0	1.0

Source: Summarized from Tables M-1-18 through M-1-19 in COP Appendix M-1 (Empire 2023)

Table J-37 Acoustic Ranges ($R_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Marine Mammals Due to Sound from Vibratory Pile Driving for Marina Berthing Pile Removal without Noise Attenuation

Functional Hearing Group	Range (meters)	
	Level A $L_{E,\ 24h}$	Level B 120 L_p
LFC	43.5	1,600
MFC	3.9	
HFC	64.3	
PW	26.5	

Source: Summarized from Tables M-1-21 and M-1-24 in COP Appendix M-1 (Empire 2023)
PW = phocid pinniped in water

Table J-38 Acoustic Ranges ($R_{95\%}$) to Injury and Behavioral Disturbance Thresholds for Fish and Sea Turtles Due to Sound from Vibratory Pile Driving for Marina Berthing Pile Removal without Noise Attenuation

Faunal Group	Range (meters)	
	Injury $L_{E,\ 24h}$	Behavior L_p
Fish greater than or equal to 2 grams	45.5	90.0
Fish less than 2 grams	84.0	
Sea turtles	2.4	1.9

Source: Summarized from Tables M-1-22 and M-1-23 in COP Appendix M-1 (Empire 2023)

J.6.2 Animal Exposure Estimates

J.6.2.1. Marine Mammals

The numbers of individual marine mammals predicted to receive sound levels above threshold criteria during impact pile driving for foundation installation were determined using animal movement modeling, as described in Section J.3.3. The modeled results for impact pile driving, with 0 and 10 dB of noise attenuation, for four 2-year construction schedules are presented in Table J-39 through Table J-42.

Table J-39 Number of Marine Mammals Predicted to Receive Sound Levels Above Regulatory Criteria for Impact Pile Driving Construction Schedule 1 (one monopile per day/two pin piles per day)

Marine Mammal Species	Year 1								Year 2							
	0 dB				10 dB				0 dB				10 dB			
	Level A		Level B		Level A		Level B		Level A		Level B		Level A		Level B	
	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]
LFC																
Fin whale	0.0	7.66	36.81	34.87	0	1.63	12.19	14.09	0	3.62	18.53	17.55	0	0.74	5.75	6.95
Minke whale	0.02	2.91	16.74	59.19	0	0.42	7.10	30.57	0.01	1.94	11.09	35.72	0	022	4.79	19.25
Humpback whale[3]	<0.01	1.81	13.60	59.12	<0.01	0.23	5.10	28.15	0	0.99	7.69	35.84	0	0.10	2.86	16.60
NARW	0.00	3.28	24.04	123.85	0	0.38	9.27	52.54	0	2.40	18.91	89.03	0	0.24	7.23	39.55
Sei whale	<0.01	0.19	1.06	4.20	<0.01	0.04	0.41	2.14	<0.01	0.14	0.82	3.12	0	0.03	0.30	1.60
MFC																
Atlantic white sided dolphin	0.00	0.00	453.10	159.80	0	0	179.81	61.88	0	0	261.87	86.48	0	0	103.87	35.11
Atlantic spotted dolphin	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-beaked common dolphin	0.00	0.00	2202.9	839.14	0	0	937.74	305.77	0	0	1392.62	520.43	0	0	581.15	184.17
Bottlenose dolphin	0.00	0.00	430.90	166.36	0	0	182.59	60.82	0	0	216.30	81.55	0	0	91.59	29.67
Risso’s dolphin	0.00	0.00	3.73	1.39	0	0	1.30	0.51	0	0	2.18	0.80	0	0	0.71	0.29
Long-finned pilot whale	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-finned pilot whale	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperm whale	0.00	0.00	4.42	1.61	0	0	1.55	0.53	0	0	2.3	0.81	0	0	0.78	0.26
HFC																
Harbor porpoise	9.63	0.15	656.15	7850.26	0.15	0	220.61	2318.93	5.80	0	484.13	5524.89	0	0	153.84	1667.90
PW																
Gray seal	0.23	0.55	129.97	95.97	0	0.04	42.26	32.26	0.22	0.44	107.04	77.37	0	0	33.92	26.16
Harbor seal	0.52	1.12	313.14	216.93	0	0	92.53	74.04	0.50	0.50	254.28	170.71	0	0	69.71	58.27

Source: Summarized from Table I-3 and Table I-4, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
[1] Unweighted criterion from NMFS 2005
[2] Frequency-weighted criteria from Wood et al. 2012.
[3] Given protected species observer sightings in the Project area from 2018 to 2021, behavioral exposure estimates for this species are likely underestimates. Therefore, this value was adjusted based on protected species observer data, and Empire requested take of 86 humpback whales by Level B harassment in its Letter of Authorization application.
PW = phocid pinniped in water

Table J-40 Number of Marine Mammals Predicted to Receive Sound Levels Above Regulatory Criteria for Impact Pile Driving Construction Schedule 2 (one monopile per day/three pin piles per day)

Marine Mammal Species	Year 1								Year 2							
	0 dB				10 dB				0 dB				10 dB			
	Level A		Level B		Level A		Level B		Level A		Level B		Level A		Level B	
	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]
LFC																
Fin whale	0	7.69	36.57	34.43	0	1.63	12.18	13.97	0	3.62	18.53	17.55	0	0.74	5.75	6.95
Minke whale	0.02	2.92	16.95	58.74	0	0.42	7.17	30.47	0.01	1.94	11.09	35.72	0	0.22	4.79	19.25
Humpback whale	<0.01	1.81	13.73	57.91	<0.01	0.23	5.15	28.05	0	0.99	7.69	35.84	0	0.10	2.86	16.60
NARW	0	3.28	24.27	123.07	0	0.38	9.32	52.69	0	2.40	18.91	89.03	0	0.24	7.23	39.55
Sei whale	<0.01	0.20	1.07	4.16	<0.01	0.04	0.41	2.13	<0.01	0.14	0.82	3.12	0	0.03	0.30	1.60

Marine Mammal Species	Year 1								Year 2							
	0 dB				10 dB				0 dB				10 dB			
	Level A		Level B		Level A		Level B		Level A		Level B		Level A		Level B	
	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]
MFC																
Atlantic white sided dolphin	0	0	452.5	159.05	0	0	179.82	61.85	0	0	261.87	86.48	0	0	103.87	35.11
Atlantic spotted dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-beaked common dolphin	0	0	2227.21	849.12	0	0	945.64	308.78	0	0	1392.62	520.43	0	0	581.15	184.17
Bottlenose dolphin	0	0	429.53	165.33	0	0	182.91	60.64	0	0	216.30	81.55	0	0	91.59	29.67
Risso’s dolphin	0	0	3.74	1.38	0	0	1.31	0.51	0	0	2.18	0.80	0	0	0.71	0.29
Long-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperm whale	0	0	4.42	1.60	0	0	1.56	0.53	0	0	2.30	0.81	0	0	0.78	0.26
HFC																
Harbor porpoise	9.63	0.15	661.97	7712.44	0.15	0	222.30	2294.06	5.80	0	484.13	5524.89	0	0	153.84	1667.90
PW																
Gray seal	0.23	0.55	129.30	93.71	0	0.04	42.23	31.86	0.22	0.44	107.04	77.37	0	0	33.92	26.16
Harbor seal	0.52	1.12	312.29	212.97	0	0	92.62	73.46	0.50	0.50	254.28	170.71	0	0	69.71	58.27

Source: Summarized from Table I-5 and Table I-6, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
[1] Unweighted criterion from NMFS 2005
[2] Frequency-weighted criteria from Wood et al. 2012
PW = phocid pinniped in water

Table J-41 Number of Marine Mammals Predicted to Receive Sound Levels Above Regulatory Criteria for Impact Pile Driving Construction Schedule 3 (two monopiles per day/two pin piles per day)

Marine Mammal Species	Year 1								Year 2							
	0 dB				10 dB				0 dB				10 dB			
	Level A		Level B		Level A		Level B		Level A		Level B		Level A		Level B	
	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]
LFC																
Fin whale	0.03	7.59	28.72	24.98	0	1.58	11.17	10.92	0.02	3.65	14.52	12.30	0	0.68	5.45	5.33
Minke whale	0.02	2.97	16.2	47.58	0	0.35	6.84	26.13	<0.01	1.97	10.45	27.14	0	0.16	4.51	15.72
Humpback whale	<0.01	1.95	14.23	51.38	<0.01	0.18	5.36	26.60	0	1.09	7.95	30.45	0	0.07	2.93	15.26
NARW	0	3.34	23.66	114.79	0	0.37	9.28	49.32	0	2.49	17.96	71.46	0	0.20	7.12	34.19
Sei whale	<0.01	0.19	0.89	3.20	<0.01	0.03	0.37	1.67	<0.01	0.14	0.64	1.93	0	0.02	0.27	1.06
MFC																
Atlantic white sided dolphin	0	0	397.32	147.02	0	0	171.14	55.69	0	0	224.05	9.68	0	0	98.24	30.79
Atlantic spotted dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-beaked common dolphin	0.73	0	2037.33	784.12	0	0	866.31	299.54	0.53	0	1228.35	456.45	0	0	522.05	175.52
Bottlenose dolphin	0	0	385.79	144.60	0	0	159.12	57.47	0	0	192.88	69.86	0	0	78.97	27.68
Risso’s dolphin	<0.01	0	3.13	1.18	0	0	1.27	0.45	<0.01	0	1.77	0.65	0	0	0.70	0.24
Long-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperm whale	0	0	3.86	1.37	0	0	1.46	0.49	0	0	2.00	0.67	0	0	0.74	0.24

Marine Mammal Species	Year 1								Year 2							
	0 dB				10 dB				0 dB				10 dB			
	Level A		Level B		Level A		Level B		Level A		Level B		Level A		Level B	
	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]
HFC																
Harbor porpoise	13.22	0.69	559.88	6319.98	0.89	0	203.99	1868.04	9.02	0.54	396.87	3476.65	0.64	0	141.46	1100.75
PW																
Gray seal	0.12	0.28	105.61	69.68	0	0.12	36.46	24.31	0.11	0.22	85.34	53.09	0	0.11	28.49	18.61
Harbor seal	036	1.48	261	171.76	0	0	97.72	65.06	0.25	0.74	204.39	129.78	0	0	76.19	49.65

Source: Summarized from Table I-7 and Table I-8, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
[1] Unweighted criterion from NMFS 2005
[2] Frequency-weighted criteria from Wood et al. 2012
PW = phocid pinniped in water

Table J-42 Number of Marine Mammals Predicted to Receive Sound Levels Above Regulatory Criteria for Impact Pile Driving Construction Schedule 4 (two monopiles per day/three pin piles per day)

Marine Mammal Species	Year 1								Year 2							
	0 dB				10 dB				0 dB				10 dB			
	Level A		Level B		Level A		Level B		Level A		Level B		Level A		Level B	
	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]	L_{pk}	$L_{E, 24h}$	L_p[1]	L_p[2]
LFC																
Fin whale	0.03	7.62	28.45	24.50	0	1.58	11.15	10.78	0.02	3.65	14.52	12.30	0	0.68	5.45	5.33
Minke whale	0.02	2.98	16.17	46.16	0	0.35	6.84	25.53	<0.01	1.97	10.45	27.14	0	0.16	4.51	15.72
Humpback whale	<0.01	1.95	14.21	50.69	<0.01	0.18	5.37	26.40	0	1.09	7.95	30.45	0	0.07	2.993	15.26
NARW	0	3.34	23.60	108.26	0	0.37	9.27	48.01	0	2.49	17.96	71.46	0	0.20	7.12	34.19
Sei whale	<0.01	0.20	0.88	2.97	<0.01	0.03	0.37	1.58	<0.01	0.14	0.64	1.93	0	0.02	0.27	1.06
MFC																
Atlantic white sided dolphin	0	0	395.42	145.67	0	0	170.84	55.49	0	0	224.05	79.68	0	0	98.24	30.79
Atlantic spotted dolphin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-beaked common dolphin	0.73	0	2031.30	775.97	0	0	866.80	298.06	0.53	0	1228.35	456.45	0	0	522.05	175.52
Bottlenose dolphin	0	0	383.89	143.29	0	0	159.35	57.21	0	0	192.88	69.86	0	0	78.97	27.68
Risso's dolphin	<0.01	0	3.11	1.16	0	0	1.26	0.44	<0.01	0	1.77	0.65	0	0	0.70	0.24
Long-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-finned pilot whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperm whale	0	0	3.84	1.36	0	0	1.46	0.49	0	0	2.00	0.67	0	0	0.74	0.24
HFC																
Harbor porpoise	13.22	0.69	558.14	5706.38	0.89	0	204.03	1738.98	9.02	0.54	396.87	3476.65	0.64	0.11	141.46	1100.75
PW																
Gray seal	0.12	0.28	103.91	67.37	0	0.12	36.30	23.77	0.11	0.22	85.34	53.09	0	0	28.49	18.61
Harbor seal	0.36	1.48	257.19	167.54	0	0	97.18	63.82	0.25	0.74	204.39	129.78	0	0	76.19	49.65

Source: Summarized from Table I-9 and Table I-10, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)
[1] Unweighted criterion from NMFS 2005
[2] Frequency-weighted criteria from Wood et al. 2012
PW = phocid pinniped in water

This page intentionally left blank.

J.6.2.2. Sea Turtles

The numbers of individual sea turtles predicted to receive sound levels above threshold criteria were also determined using animal movement modeling. The model results for impact pile driving, with 0 and 10 dB of noise attenuation are presented in Table J-43 through Table J-46.

Table J-43 Number of Sea Turtles Predicted to Receive Sound Levels Above Regulatory Criteria for Impact Pile Driving Construction Schedule 1 (one monopile per day/two pin piles per day)

Sea Turtle Species	Year 1						Year 2					
	0 dB			10 dB			0 dB			10 dB		
	Injury		Behavior	Injury		Behavior	Injury		Behavior	Injury		Behavior
	$L_{E,24h}$	L_{pk}	L_p	$L_{E,24h}$	L_{pk}	L_p	$L_{E,24h}$	L_{pk}	L_p	$L_{E,24h}$	L_{pk}	L_p
Kemp's ridley sea turtle	2.69	0	21.81	0.33	0	5.48	1.01	0	11.84	0.14	0	2.74
Leatherback sea turtle	1.70	0	14.61	0.03	0	1.65	0.53	0	7.49	0	0	0.42
Loggerhead sea turtle	4.99	0	292.48	0	0	29.57	0	0	160.11	0	0	11.72
Green sea turtle	0.08	0	0.67	<0.01	0	0.10	0.03	0	0.36	0	0	0.04

Source: Summarized from Table I-11 and Table I-12, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)

Table J-44 Number of Sea Turtles Predicted to Receive Sound Levels Above Regulatory Criteria for Impact Pile Driving Construction Schedule 2 (one monopile per day/three pin piles per day)

Sea Turtle Species	Year 1						Year 2					
	0 dB			10 dB			0 dB			10 dB		
	Injury		Behavior	Injury		Behavior	Injury		Behavior	Injury		Behavior
	$L_{E,24h}$	L_{pk}	L_p	$L_{E,24h}$	L_{pk}	L_p	$L_{E,24h}$	L_{pk}	L_p	$L_{E,24h}$	L_{pk}	L_p
Kemp's ridley sea turtle	2.69	0	21.81	0.33	0	5.48	1.01	0	11.84	0.14	0	2.74
Leatherback sea turtle	1.70	0	14.62	0.03	0	1.65	0.53	0	7.49	0	0	0.42
Loggerhead sea turtle	4.99	0	293.70	0	0	29.57	0	0	160.11	0	0	11.72
Green sea turtle	0.08	0	0.67	<0.01	0	0.10	0.03	0	0.36	0	0	0.04

Source: Summarized from Table I-13 and Table I-14, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)

Table J-45 Number of Sea Turtles Predicted to Receive Sound Levels Above Regulatory Criteria for Impact Pile Driving Construction Schedule 3 (two monopiles per day/two pin piles per day)

Sea Turtle Species	Year 1						Year 2					
	0 dB			10 dB			0 dB			10 dB		
	Injury		Behavior	Injury		Behavior	Injury		Behavior	Injury		Behavior
	$L_{E,24h}$	L_{pk}	L_p	$L_{E,24h}$	L_{pk}	L_p	$L_{E,24h}$	L_{pk}	L_p	$L_{E,24h}$	L_{pk}	L_p
Kemp's ridley sea turtle	3.35	0.02	21.15	0.05	0	5.14	1.65	<0.01	11.91	<0.01	0	2.67

Sea Turtle Species	Year 1						Year 2					
	0 dB			10 dB			0 dB			10 dB		
	Injury		Behavior	Injury		Behavior	Injury		Behavior	Injury		Behavior
	$L_{E, 24h}$	L_{pk}	L_p	$L_{E, 24h}$	L_{pk}	L_p	$L_{E, 24h}$	L_{pk}	L_p	$L_{E, 24h}$	L_{pk}	L_p
Leatherback sea turtle	1.70	0	12.42	0.04	0	1.26	0.63	0	6.15	0	0	0.32
Loggerhead sea turtle	9.52	0	334.58	0.46	0	62.83	7.91	0	202.22	0	0	32.77
Green sea turtle	0.14	0	0.74	<0.01	0	0.16	0.08	0	0.43	0	0	0.09

Source: Summarized from Table I-15 and Table I-16, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)

Table J-46 Number of Sea Turtles Predicted to Receive Sound Levels Above Regulatory Criteria for Impact Pile Driving Construction Schedule 4 (two monopiles per day/three pin piles per day)

Sea Turtle Species	Year 1						Year 2					
	0 dB			10 dB			0 dB			10 dB		
	Injury		Behavior	Injury		Behavior	Injury		Behavior	Injury		Behavior
	$L_{E, 24h}$	L_{pk}	L_p	$L_{E, 24h}$	L_{pk}	L_p	$L_{E, 24h}$	L_{pk}	L_p	$L_{E, 24h}$	L_{pk}	L_p
Kemp's ridley sea turtle	3.35	0.02	21.16	0.05	0	5.14	1.65	0	11.91	<0.01	0	2.67
Leatherback sea turtle	1.70	0	12.42	0.04	0	1.26	0.63	0	6.15	0	0	0.32
Loggerhead sea turtle	9.52	0	335.80	0.46	0	62.83	1.91	0	202.22	0	0	32.77
Green sea turtle	0.14	0	0.74	<0.01	0	0.16	0.08	0	0.43	0	0	

Source: Summarized from Table I-17 and Table I-18, Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire 2023)

J.7. References Cited

Andersson, M. H., E. Dock-Åkerman, R. Ubral-Hedenberg, M.C. Öhman, and P. Sigray. 2007. Swimming behavior of roach (*Rutilus rutilus*) and three-spined stickleback (*Gasterosteus aculeatus*) in response to wind power noise and single-tone frequencies. *AMBIO* 36:636–638.

Becker, J. J., D. T. Sandwell, W. H. F. Smith, J. Braud, B. Binder, J. Depner, D. Fabre, J. Factor, S. Ingalls, S. H. Kim, R. Ladner, K. Marks, S. Nelson, A. Pharaoh, R. Trimmer, J. Von Rosenberg, G. Wallace, and P. Weatherall. 2009. Global bathymetry and elevation data at 30 arc second resolution: SRTM30_PLUS. *Marine Geodesy* 32:355–371.

Dean, J. 1998. Animats and what they can tell us. *Trends in Cognitive Sciences* 2:60–67.

Empire Offshore Wind, LLC (Empire). 2023. *Empire Offshore Wind: Empire Wind Project (EW1 and EW2), Construction and Operations Plan*. July. Available: https://www.boem.gov/renewable-energy/empire-wind-construction-and-operations-plan.

Empire Offshore Wind, LLC (Empire). 2023. Citing Austin, M. E., and Z. Li. 2016. *Marine mammal monitoring and mitigation during exploratory drilling by Shell in the Alaskan Chukchi Sea, July-October 2015*: Draft 90-day Report. In D. S. Ireland and L. N. Bisson, eds. LGL Rep. P1363D. 188 pp. + appendices.

Empire Offshore Wind, LLC (Empire). 2023. Citing Bellman, M. A. 2014. Overview of existing noise mitigation systems for reducing pile driving noise. *Inter-noise* 2014. Melbourne, Australia. Available: https://www.acoustics.asn.au/conference_proceedings/INTERNOISE2014/papers/p358.pdf.

Empire Offshore Wind, LLC (Empire). 2023. Citing Buehler, D., R. Oestman, J. A. Reyff, K. Pommerenck, and B. Mitchell. 2015. *Technical guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish.* Report CTHWANP-RT-15-306.01.01. Report by California Department of Transportation (Caltrans), Division of Environmental Analysis. 532 pp. Available: https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/bio-tech-guidance-hydroacoustic-effects-110215-a11y.pdf.

Empire Offshore Wind, LLC (Empire). 2023. Citing Dunlop, R. A., M. J. Noad, R. D. McCauley, L. Scott-Hayward, E. Kniest, R. Slade, D. Paton, and D. H. Cato. 2017. Determining the behavioural dose–response relationship of marine mammals to air gun noise and source proximity. *Journal of Experimental Biology* 220:2878–2886.

Empire Offshore Wind, LLC (Empire). 2023. Citing Koschinski, S., and K. Lüdemann. 2013. *Development of Noise Mitigation Measures in Offshore Wind Farm Construction.* Available: https://www.bfn.de/fileadmin/MDB/documents/themen/meeresundkuestenschutz/downloads/Berichte-und-Positionspapiere/Mitigation-Measures-Underwater-Noise_2013-08-27_final.pdf.

Empire Offshore Wind, LLC (Empire). 2023. Citing MacGillivray, A. O., and N. R. Chapman. 2012. Modeling underwater sound propagation from an airgun array using the parabolic equation method. *Canadian Acoustics* 40:19–25.

Finneran, J. J, E. E. Henderson, D. S. Houser, K. Jenkins, S. Kotecki, and J. Muslow. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*. Technical report by Space and Naval Warfare Systems Center Pacific. 183 pp.

Fisheries Hydroacoustic Working Group. 2008. Agreement in principle for interim criteria for injury to fish from pile driving activities. Technical/Policy Meeting June 11, 2008, Vancouver, Washington.

Frankel, A. S., W. T. Ellison, and J. Buchanan, J. 2002. Application of the Acoustic Integration Model (AIM) to predict and minimize environmental impacts. *IEEE Oceans* 2002:1438–1443.

McCauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M. N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdoch, and K. A. McCabe. 2000. *Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid*. Prepared for Australian Petroleum Production Exploration Association by Centre for Maine Science and Technology, Western Australia. 198 pp.

Mueller-Blenkle, C., P. K. McGregor, A. B. Gill, M. H. Andersson, J. Metcalfe, V. Bendall, P. Sigray, D. T. Wood, and F. Thomsen. 2010. Effects of pile-driving noise on the behaviour of marine fish. COWRIE Ref: Fish 06-08; Cefas Ref: C3371. 62 pp.

National Marine Fisheries Service (NMFS). 2005. Endangered fish and wildlife: Notice of intent to prepare an environmental impact statement. 70 *Federal Register* 1871.

National Marine Fisheries Service (NMFS). 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0) Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. Silver Spring, MD. 178 pp.

Naval Oceanographic Office. 2003. Database description for the generalized digital environmental model (GDEMV) (U), Version 3.0. Oceanographic Data Bases Division, Stennis Space Center, MS 39522-5003.

Normandeau Associates, Inc. and APEM Inc. 2018. *Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Spring 2018 Taxonomic Analysis Summary Report*. Report for New York State Energy Research and Development Authority.

Normandeau Associates, Inc. and APEM Inc. 2019a. *Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Fall 2018 Taxonomic Analysis Summary Report*. Report for New York State Energy Research and Development Authority.

Normandeau Associates, Inc. and APEM Inc. 2019b. *Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Spring 2019 Taxonomic Analysis Summary Report*. Report for New York State Energy Research and Development Authority.

Normandeau Associates, Inc. and APEM Inc. 2019c. *Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Summer 2016–Spring 2018 Fourth Interim Report*. Second Annual Report for New York State Energy Research and Development Authority.

Normandeau Associates, Inc. and APEM Inc. 2020. *Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Winter 2018–2019 Taxonomic Analysis Summary Report*. Report for New York State Energy Research and Development Authority.

Pile Dynamics, Inc. 2010. GRLWEAP: Wave equation analysis software.

Popper, A. N., A. D. Hawkins, R. R. Fay, D. A. Mann, S. Bartol, T. J. Carlson, S. Coombs, W. T. Ellison, R. L. Gentry, M. B. Halvorsen, S. Løkkeborg, P. H. Rogers, B. L. Southall, D. G. Zeddies, and W. N. Tavolga. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report Prepared by ANSI-Accredited Standards Committee S3/SC1 and Registered with ANSI.* ASA Press and Springer.

Purser, J., and A. N. Radford. 2011. Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (*Gasterosteus aculeatus*). *PLOS ONE* 6:e17478.

Roberts, J. J., B. D. Best, L. Mannocci, E. Fujioka, P. N. Halpin, D. L. Palka, L. P. Garrison, K. D. Mullin, T. V. N. Cole, C. B. Khan, W. A. McLellan, D. A. Pabst, and G. G. Lockhart. 2016a. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. *Scientific Reports* 6:22615.

Roberts, J. J., L. Mannocci, and P. N. Halpin. 2016b. *Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2015-2016 (Base Year)*. Document Version 1.0. Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC, USA.

Roberts, J. J., L. Mannocci, and P. N. Halpin. 2017. *Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2016-2017 (Opt. Year 1)*. Version 1.4. Report by Duke University Marine Geospatial Ecology Lab for Naval Facilities Engineering Command, Atlantic, Durham, NC, USA.

Roberts, J. J., L. Mannocci, R. S. Schick, and P. N. Halpin. 2018. *Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2017-2018 (Opt. Year 2)*. Version 1.2. Report by the Duke University Marine Geospatial Ecology Lab for Naval Facilities Engineering Command, Atlantic Durham, NC, USA.

Roberts J. J., R. S. Schick, and P. N. Halpin. 2020. *Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2018-2020 (Opt. Year 3)*. Version 1.4. Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts, J. J., R. S. Schick, and P. N. Halpin. 2021a. *Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2020 (Opt. Year 4)*. Version 1.0. Report by the Duke University Marine Geospatial Ecology Lab for Naval Facilities Engineering Command, Atlantic Durham, NC, USA.

Roberts, J. J., R. S. Schick, and P. N. Halpin. 2021b. *Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2020 (Option Year 4)*. Document version 1.0 (DRAFT). Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC, USA.

Stadler, J. H., and D. P. Woodbury. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. *Inter-Noise 2009: Innovations in Practical Noise Control*, Ottawa, Canada.

Wood, J. D., B. L. Southall, and D. J. Tollit. 2012. *PG&E Offshore 3-D Seismic Survey Project Environmental Impact Report–Marine Mammal Technical Draft Report*. Report by SMRU Ltd. 121 pp.

Wysocki, L. E., S. Amoser, and F. Ladich. 2007. Diversity in ambient noise in European freshwater habitats: Noise levels, spectral profiles, and impact on fishes. *The Journal of the Acoustical Society of America* 121:2559–2566.

This page intentionally left blank.

Appendix K. List of Agencies, Organizations, and Persons to Whom Copies of the Statement Are Sent

This EIS is available in electronic form for public viewing at https://www.boem.gov/renewable-energy/state-activities/empire-wind. Hard copies and digital copies of the EIS can be requested by contacting the Program Manager, Office of Renewable Energy in Sterling, Virginia. Publication of the Draft EIS initiated a 60-day comment period where government agencies, members of the public, and interested stakeholders provided comments and input. BOEM accepted comments in any of the following ways:

- In hard copy form, delivered by hand or by mail, enclosed in an envelope labeled "Empire Wind COP Draft EIS" and addressed to Program Manager, Office of Renewable Energy, Bureau of Ocean Energy Management, 45600 Woodland Road, Sterling, Virginia 20166.
- Through the regulations.gov web portal by navigating to http://www.regulations.gov and searching for docket number "BOEM-2022-0053."
- By attending one of the EIS public hearings listed in the notice of availability and providing written or verbal comments.

BOEM used comments received during the public comment period to inform its preparation of the Final EIS, as appropriate. EIS notification lists for the Project are provided in Table K-1 through Table K-4.

K.1. Notification List

Table K-1 Federal Agencies

Agency	Contact
ACHP	Christopher Daniel, Program Analyst Blythe Semmer, Assistant Director for Special Initiatives Christopher Koeppel, Assistant Director Jamie Lee Marks, Senior Program Analyst, Office of Native American Affairs
BSEE	Cheri Hunter, Renewable Energy Program Coordinator Ramona Sanders, FAST-41 Coordinator Juliette Giordano, Environmental Compliance Program TJ Broussard, Office of Environmental Compliance Andrea Heckman, Office of Environmental Compliance, NEPA Coordinator Graham Tuttle, Marine Protected Species Program National Lead Shawn Arnold, Historic Preservation Program National Lead
DOD	Steven Sample, Executive Director, DOD Siting Clearinghouse Scott Kiernan, Deputy Director, Military Aviation and Installation Assurance Siting Clearinghouse Mike Lignowski, Analyst, DOD Siting Clearinghouse
DON	Matthew Senska, Director, Marine Resources and At-Sea Policy
MARAD	Kris Gilson, Director, Office of Environmental Compliance Kelly O'Reilly, Environmental Protection Specialist

Agency	Contact
NMFS	Sue Tuxbury, Fishery Biologist/Wind Coordinator, GARFO HESD Keith Hanson, Marine Habitat Resource Specialist, GARFO HESD Julie Crocker, Chief, ESA Fish, Energy, and Ecosystems Branch, GARFO Protected Resources Division Jaclyn Daly, Fishery Biologist, Office of Protected Resources Dale Youngkin, FAST-41
NPS	Mary Krueger, Energy Specialist Kathy Schlegel, Historic Landscape Architect Lindsay Gillham, FAST-41
U.S. Naval History and Heritage Command	Dr. Alexis Catsambis, Underwater Archaeology Branch Brad Krueger, Archaeologist
USACE	Chris Minck, New York District, Regulatory, Project Manager Robert Vietri, New York District, Regulatory, Project Manager Stephan Ryba, New York District, Regulatory, Branch Chief Naomi Handell, North Atlantic Division, Regulatory Program Manager Ann Marie Dilorenzo, North Atlantic Division, Section 408 Coordinator
USCG	George Detweiler, Headquarters John Stone, Headquarters, Navigation Standards Division Maureen Kallgren, Marine Transportation Specialist Michele Desautels, District 1 Chris Sparkman, District 1, Marine Information Specialist Commander John Singletary, Chief, Waterways Management Division, Sector New York Lieutenant Natasha Hope, Waterways Management Division, Sector Long Island Sound Allen M. Garneau, Bridge Program Matthew Robertson, FAST-41 Coordinator
USEPA	Mark Austin, NEPA Program Coordinator, Region 2 Anne Rosenblatt, Region 2 Viorica Petriman, Environmental Engineer, Air and Radiation Division, Region 2 Neha Sareen, Air and Radiation Division, Region 2 Scott Bowles, FAST-41 Coordinator Prasad Chumble, FAST-41
USFWS	David Stilwell, Field Supervisor Steve Papa, Fish and Wildlife Biologist Jane Ledwin, Infrastructure Streamlining Coordinator Frankie Green, FAST-41 Coordinator

DON = Department of the Navy; FAST-41 = Title 41 of Fixing America's Surface Transportation Act; GARFO = Greater Atlantic Regional Fisheries Office; HESD = Habitat and Ecosystems Services Division; MARAD = U.S. Maritime Administration; NPS = National Park Service

Table K-2 State and Local Agencies

Agency	Contact
NYSERDA	Tom King, Senior Counsel Sherryl Huber, Project Manager for Offshore Wind
NYSDEC	Lisa Covert, Climate Change Section Chief, Bureau of Climate, Air & Energy Karen Gaidasz, Offshore Wind Section Chief, Division of Environmental Permits Tyler Hepner, Senior Attorney, Bureau of Climate, Air & Energy
NYSDOS	Laura McLean, Coastal Energy Review Specialist Matthew Maraglio, Coastal Resources Specialist Michael Snyder, Program Manager Kari Gathen, Counsel's Office Terra Haight
City of New York	Max Taffet, Vice President, Transportation, PortNYC Planning Hilary Semel, Director and General Counsel, Mayor's Office of Environmental Coordination

NYSDOS = New York State Department of State

Table K-3 Tribal Nations

Tribal Nation	Contact
Delaware Tribe of Indians	Susan Bachor, Archaeologist, Deputy Tribal Historic Preservation Officer Brad KillsCrow, Chief
The Delaware Nation	Deborah Dotson, President of Executive Committee Carissa Speck, Tribal Historic Preservation Director Katelyn Lucas, Tribal Historic Preservation Officer
Mashantucket Pequot Tribal Nation	Michael Kickingbear Johnson, Acting Tribal Historic Preservation Officer Stormy Hay, Tribal Historic Preservation Office Coordinator
Stockbridge-Munsee Community, Wisconsin/Band of Mohican Indians	Jeff Bendremer, PhD., Tribal Historic Preservation Officer
The Shinnecock Indian Nation	Bryan Polite, Chairman Shavonne Smith, Director, Shinnecock Environmental Department Lance Gumbs, Councilman
Wampanoag Tribe of Gay Head (Aquinnah)	Cheryl Andrews-Maltais, Chairwoman Bettina Washington, Tribal Historic Preservation Officer Lael Eco-Hawk, General Council Al Clark, Vice-Chair Kevin Devine, Councilman

Table K-4 Section 106 Consulting Parties

Government or Organization	Participating Consulting Parties	Contact
SHPOs and State Agencies	NJDEP, Historic Preservation Office	Katherine Marcopul, Administrator and Deputy Historic Preservation Officer Jesse West-Rosenthal, Historic Preservation Specialist 2 Robin Madden Mark Texel Maggie Mitchell-Strehl Nicholas Wood
	New Jersey Office of Planning Advocacy	Lisa Avichal, Area Planner Donna Rendeiro, Executive Director
	New York SHPO	R. Daniel Mackay, Deputy Commissioner for Historic Preservation Tim Lloyd, Archaeologist Weston Davey, Historic Site Restoration Coordinator
	New York State Parks, Recreation and Historic Preservation	Erik Kullesaid, Commissioner, SHPO
	New York State Parks, Recreation and Historic Preservation, Long Island State Parks Region 9	George Gorman, Jr., Regional Director (Primary) Kevin Connelly, Assistant Region Director (Alternate)
	New York State Parks, Recreation and Historic Preservation, Region 9, Gilgo State Park	Kevin Boone, Park Director
	New York State Parks, Recreation and Historic Preservation, Region 9, Jones Beach State Park	Jeffery Mason, Park Director
	New York State Parks, Recreation and Historic Preservation, Region 9, Robert Moses State Park	Kevin Boone, Park Director
Federal Agencies	ACHP	Christopher Koeppel, Federal Property Management Section, Assistant Director Christopher Daniel, Federal Property Management Section, Program Analyst Jamie Lee Marks, Senior Program Analyst, Office of Native American Affairs
	BSEE	Shawn Arnold, Historic Preservation Program National Lead

Government or Organization	Participating Consulting Parties	Contact
	U.S. Maritime Administration	Kris Gilson, Director, Office of Environmental Compliance
	National Park Service	Mary Krueger, Energy Specialist for the Northeast Region
	U.S. Naval History and Heritage Command	Dr. Alexis Catsambis, Underwater Archaeology Branch
	USACE	Chris Minck, New York District, Regulatory, Project Manager
	USEPA	Viorica Petriman, Environmental Engineer, Air and Radiation Division, Region 2
Federally Recognized Tribes	The Delaware Nation	Deborah Dotson, President of Executive Committee Carissa Speck, Tribal Historic Preservation Director Katelyn Lucas, Tribal Historic Preservation Officer
	Delaware Tribe of Indians	Susan Bachor, Archaeologist, Deputy Tribal Historic Preservation Officer Brad KillsCrow, Chief
	The Shinnecock Indian Nation	Bryan Polite, Chairman Shavonne Smith, Director, Shinnecock Environmental Department Lance Gumbs, Councilman
	Mashantucket Pequot Tribal Nation	Michael Kickingbear Johnson, Acting Tribal Historic Preservation Officer (Primary) Stormy Hay, Tribal Historic Preservation Office Coordinator
	Stockbridge-Munsee Community, Wisconsin/Band of Mohican Indians	Jeff Bendremer, PhD., Tribal Historic Preservation Officer (Primary)
	Wampanoag Tribe of Gay Head (Aquinnah)	Cheryl Andrews-Maltais, Chairwoman Bettina Washington, Tribal Historic Preservation Officer Lael Eco-Hawk, General Council Al Clark, Vice-Chair Kevin Devine, Councilman
Local Government	Atlantic Highlands Borough	Blake Deakin, Chairman Environmental Commission Adam Hubeny, Administrator
	City of Long Beach	Scott Kemins, Building Commissioner Joe Febrizio, Commissioner of Public Works
	Highlands Borough	Michael F. Muscillo, Borough Administrator
	Lake Como Borough	Kevin Higgins, Mayor Christopher D'Antuono, Councilman
	Long Branch	Nicholas Graviano, PP, AICP, JD, Planning Director George Jackson, Business Administrator

Government or Organization	Participating Consulting Parties	Contact
	Middletown Township	Donna Claussen, Middletown Township Landmarks Commission Anthony P. Mercantante, P.P. AICP, Township Adminstrator
	Nassau County	Bruce Blakeman, County Executive Kendra Armstead, Special Assistant for Economic Development, Office of the Nassau County Executive David Viana, Planner II, Nassau County Department of Public Works - Planning Division
	New York City Landmarks Commission	Gina Santucci, Director of Environmental Review Timothy Frye, Director of Special Projects and Strategic Planning
	Ocean County	Nicole Leaf, Environmental Specialist I Anthony Agliata, Department of Planning, Director
	Sea Girt Borough	Robert Walker, Planning Board Representative Karen Brisben, Planning Board Secretary
	Suffolk County	Dorian Dale, Director of Sustainability Sarah Lansdale, Director of Planning
	Town of Babylon	Marwa Fawaz, Comprehensive Planning and Downtown Revitalization Rachel Scelfo, Office of Planning and Development
	Town of Hempstead	Christine Grillo Douglas Tuman, Commissioner
	Town of Islip	George Munkenbeck, Town Historian
	Village of Amityville	Dennis M. Siry, Mayor Kevin Smith, Deputy Mayor
	Village of Bellport	Stephen Musolino, Planning Board Chair
Nongovernmental Organizations or Groups	Bay Shore Historical Society	Barry R. Dlouhy, President
	Equinor Wind US LLC	Laura Morales, Head of Permitting - New York
	Historical Society of Highlands	Shelia Weinstock, President
	Ocean Grove Camp Meeting Association	Michael Badger, President Steven Colombo, Director of Operations
	Point O'Woods Association	William J. Cook, Special Counsel Jessica Krauss, Special Counsel
	The League of Historical Societies of New Jersey	Tim Hart, President

Appendix L. Other Impacts

L.1. Unavoidable Adverse Impacts of the Proposed Action

CEQ's NEPA-implementing regulations (40 CFR 1502.16(a)(2)) require that an EIS evaluate the potential unavoidable adverse impacts associated with a Proposed Action. Adverse impacts that can be reduced by mitigation measures but not eliminated are considered unavoidable. Table L-1 provides a listing of such impacts. Most potential unavoidable adverse impacts associated with the Proposed Action would occur during the construction phase and would be temporary. Chapter 3 provides additional information on the potential impacts listed below.

All impacts from planned activities are still expected to occur as described in the No Action Alternative analysis in this EIS, regardless of whether the Proposed Action is approved.

Table L-1 Potential Unavoidable Adverse Impacts of the Proposed Action

Resource Area	Potential Unavoidable Adverse Impact of the Proposed Action
Air Quality	• Air quality impacts from emissions from engines associated with vessel traffic, vehicle traffic, construction activities, and equipment operation
Bats	• Displacement and avoidance behavior due to habitat loss/alteration, equipment noise, and vessel traffic
Benthic Resources	• Suspension and re-settling of sediments due to seafloor disturbance • Conversion of soft-bottom habitat to new hard-bottom habitat • Habitat quality impacts, including reduction in certain habitat types as a result of seafloor alterations • Disturbance, displacement, and avoidance behavior due to habitat loss/ alteration, equipment activity and noise, and vessel traffic • Individual mortality due to construction activities
Birds	• Displacement and avoidance behavior due to habitat loss/alteration, equipment noise, and vessel traffic
Coastal Habitat and Fauna	• Habitat alteration and removal of vegetation, including trees • Temporary avoidance behavior by fauna during construction activity and noise-producing activities • Individual fauna mortality due to collision with vehicles or equipment during clearing and grading activities, particularly species with limited mobility
Commercial Fisheries and For-Hire Recreational Fishing	• Disruption of access or temporary restriction in harvesting activities due to construction of offshore Project elements • Disruption of harvesting activities during operations of offshore wind facility • Changes in vessel transit and fishing operation patterns • Changes in risk of gear entanglement or availability of target species
Cultural Resources	• Visual impacts on viewsheds of historic properties • Physical impacts on known submerged archaeological resources • Physical impacts on known ancient submerged landforms with archaeological or TCP potential

Resource Area	Potential Unavoidable Adverse Impact of the Proposed Action
Demographics, Employment, and Economics	• Disruption of commercial fishing, for-hire recreational fishing, and marine recreational businesses during offshore construction and cable installation • Hindrances to ocean economy sectors due to the presence of the offshore wind facility, including commercial fishing, recreational fishing, sailing, sightseeing, and supporting businesses
Environmental Justice	• Compounded health issues of local environmental justice communities near ports resulting from increased air emissions and noise associated with vessel traffic, construction activities, and equipment operation • Loss of employment or income due to disruption to commercial fishing, for-hire recreational fishing, or marine recreation businesses • Hindrances to coastal visibility and subsistence fishing due to offshore construction and operation of the offshore wind facility
Finfish, Invertebrates, and Essential Fish Habitat	• Suspension and re-settling of sediments due to seafloor disturbance • Displacement, disturbance, and avoidance behavior due to construction-related impacts, including noise, vessel traffic, increased turbidity, sediment deposition, and EMF • Individual mortality due to construction activities • Habitat quality impacts, including reduction in certain habitat types as a result of seafloor surface alterations • Conversion of soft-bottom habitat to new hard-bottom habitat
Land Use and Coastal Infrastructure	• Conversion from existing use to utility right-of-way or easement • Land use disturbance due to construction as well as effects due to noise, vibration, and travel delays • Potential for accidental releases during construction
Marine Mammals	• Increased risk of injury (TTS or PTS) to individuals due to underwater noise from pile-driving activities during construction • Disturbance (behavioral effects) and acoustic masking due to underwater noise from pile driving, shipping and other vessel traffic, aircraft, geophysical surveys (HRG surveys), WTG operation, cable laying, and drilling during construction and operations • Increased risk of individual injury and mortality due to vessel strikes • Increased risk of individual injury and mortality associated with fisheries gear
Navigation and Vessel Traffic	• Congestion in port channels • Increased navigational complexity, vessel congestion, and allision risk within the offshore Wind Farm Development Area • Potential for disruption to marine radar on vessels operating within or near the Projects, increasing navigational complexity • Hindrances to SAR missions within the offshore Wind Farm Development Area • Submerged export cable risk to vessel anchors
Other Uses	• Disruption to offshore scientific research and surveys and species monitoring and assessment • Increased navigational complexity for military or national security vessels operating within the Wind Farm Development Area • Changes to aviation and air traffic navigational patterns

Resource Area	Potential Unavoidable Adverse Impact of the Proposed Action
Recreation and Tourism	• Disruption of coastal recreation activities during onshore construction, such as beach access • Viewshed effects from the WTGs altering enjoyment of marine and coastal recreation and tourism activities • Disruption to access or temporary restriction of in-water recreational activities from construction of offshore Project elements • Temporary disruption to the marine environment and marine species important to fishing and sightseeing due to turbidity and noise • Hindrances to some types of recreational fishing, sailing, and boating within the area occupied by WTGs during operation
Sea Turtles	• Increased risk of for individual injury and mortality due to vessel strikes during construction, O&M, and decommissioning • Increased risk for individual injury and mortality associated with fisheries gear • Disturbance, displacement, and avoidance behavior due to habitat disturbance and underwater noise during construction • Migratory impacts on navigation associated with EMF from transmission cables
Scenic and Visual Resources	• Alterations to the seascape, open ocean, and landscape character units' character and effects on viewer experience due to construction, O&M, and decommissioning of the wind farm, onshore landing sites, onshore export cable routes, onshore substations, and electrical connections with the power grid
Water Quality	• Increase in suspended sediments due to seafloor disturbance during construction, O&M, and decommissioning
Wetlands	• Temporary wetland alterations, including increased sedimentation deposition and removal of vegetation

L.2. Irreversible and Irretrievable Commitment of Resources

CEQ's NEPA-implementing regulations (40 CFR 1502.16(a)(4)) require that an EIS review the potential impacts on irreversible or irretrievable commitments of resources resulting from implementation of a Proposed Action. CEQ considers a commitment of a resource irreversible when the primary or secondary impacts from its use limit the future options for its use. Irreversible commitment of resources typically applies to impacts on nonrenewable resources such as marine minerals or cultural resources. The irreversible commitment of resources occurs due to the use or destruction of a specific resource. An irretrievable commitment refers to the use, loss, or consumption of a resource, particularly a renewable resource, for a period of time.

Table L-2 provides a listing of potential irreversible and irretrievable impacts by resource area. EIS Chapter 3 provides additional information on the impacts summarized below.

Table L-2 Irreversible and Irretrievable Commitment of Resources by Resource Area for the Proposed Action

Resource Area	Irreversible Impacts	Irretrievable Impacts	Explanation
Air Quality	No	No	BOEM expects air pollutant emissions to comply with permits regulating compliance with air quality standards. Emissions would be temporary during construction activities and would be limited to the Project lifetime for O&M activities. To the extent that the Proposed Action displaces fossil-fuel energy generation, overall regional improvement of air quality would be expected.
Bats	No	No	Injury or mortality of individual bats could occur during Project construction, O&M, and decommissioning. Implementation of mitigation measures developed in consultation with USFWS would reduce or eliminate the potential for such impacts and BOEM does not anticipate population-level impacts on bats. Decommissioning of the Projects would reverse the impacts of bat displacement from foraging habitat.
Benthic Resources	No	No	Although local mortality of benthic fauna and habitat alteration is likely to occur, BOEM does not anticipate population-level impacts on benthic organisms; habitat could recover after decommissioning activities.
Birds	No	No	Injury or mortality of individual birds could occur during Project construction, O&M, and decommissioning. Implementation of mitigation measures developed in consultation with USFWS would reduce or eliminate the potential for such impacts and BOEM does not anticipate population-level impacts on birds. Decommissioning of the Projects would reverse the impacts of bird displacement from foraging habitat.
Coastal Habitat and Fauna	No	No	Although limited removal of natural habitat associated with clearing and grading for construction of the onshore export cable and substation are likely to occur, BOEM does not anticipate population-level impacts on flora or fauna; coastal habitat could recover after construction in some areas, and after decommissioning activities in other areas.
Commercial Fisheries and For-Hire Recreational Fishing	No	Yes	Based on the anticipated duration of construction and O&M activities, BOEM does not anticipate irreversible impacts on commercial fisheries. The Projects could alter habitat during construction and operations, limit access to fishing areas during construction, or reduce vessel maneuverability during operations. However, the conceptual decommissioning of the Projects would reverse those impacts. Irretrievable impacts (lost revenue) could occur due to the loss of use of fishing areas at an individual level.

Resource Area	Irreversible Impacts	Irretrievable Impacts	Explanation
Cultural Resources	Yes	Yes	Although unlikely, unanticipated removal or disturbance of previously unidentified cultural resources onshore and offshore could result in irreversible and irretrievable impacts. Physical impacts on cultural resources that would be irreversible include impacts caused by activities that result in ground disturbance, which has the potential to disturb or destroy terrestrial archaeological resources; seafloor disturbance, which has the potential to damage or destroy marine archaeological resources or ancient submerged landforms; and construction activities that could damage, destroy, or diminish the integrity of buildings, structures, objects, and historic districts onshore.
Demographics, Employment, and Economics	No	Yes	Construction activities could temporarily increase contractor needs, housing needs, supply requirements, and demand for local businesses, leading to an irretrievable loss of workers for other projects. However, given the size of the workforce relative to the size of the population of the New York City area and the size of the Projects compared to the number of other construction activities in the area, and considering that construction activities are temporary, the Projects are not expected to result in a shortage of housing or workers for other projects.
Environmental Justice	No	Yes	Impacts on environmental justice communities could occur due to loss of income or employment for low-income workers in marine industries; this could be reversed by Project decommissioning or by other employment, but income lost during Project operations would be irretrievable.
Finfish, Invertebrates, and Essential Fish Habitat	No	No	Although local mortality of finfish and invertebrates and habitat alteration and loss of SAV habitat could occur, BOEM does not anticipate population-level impacts on finfish, invertebrates, and essential fish habitat. It is expected that the aquatic habitat for finfish and invertebrates would recover following decommissioning activities.
Land Use and Coastal Infrastructure	No	Yes	Land use for construction and operation of the Projects could result in a minor irreversible impact due to the temporary or long-term loss of use of the land for otherwise typical activities. Other land uses could be restored upon Project decommissioning.

Resource Area	Irreversible Impacts	Irretrievable Impacts	Explanation
Marine Mammals	No	Yes	Irreversible impacts on marine mammal populations could occur if one or more individuals of an ESA-listed species were injured or killed or if those populations experienced behavioral effects of high severity. With implementation of mitigation measures, developed in consultation with NMFS (e.g., timing windows, vessel speed restrictions, safety zones), the potential for an ESA-listed species to experience high-severity behavioral effects or be injured or killed would be reduced or eliminated. No irreversible high-severity behavioral effects from Project activities are anticipated, as described in Section 3.15; however, due to the uncertainties from lack of information that are outlined in Appendix D, these effects are still possible. Irretrievable impacts could occur if individuals or populations grow more slowly as a result of injury or mortality due to vessel strikes or entanglement with fisheries gear, or due to displacement from the Project area.
Navigation and Vessel Traffic	No	No	Based on the anticipated duration of construction and operations, BOEM does not anticipate impacts on vessel traffic to result in irreversible or irretrievable impacts.
Other Uses	No	Yes	Disruption of offshore scientific research and surveys would occur during proposed Project construction, operations, and decommissioning activities.
Recreation and Tourism	No	No	Construction activities near the shore could result in a minor, temporary loss of use of the land for recreation and tourism purposes.
Sea Turtles	No	Yes	Irreversible impacts on sea turtles could occur if one or more individuals of species listed under the ESA were injured or killed; however, the implementation of mitigation measures, developed in consultation with NMFS, would reduce or eliminate the potential for impacts on listed species. Irreversible impacts could occur if individuals or populations grow more slowly as a result of injury or mortality due to vessel strikes or entanglement with fisheries gear caught on the structures, or due to displacement from the Project area.
Scenic and Visual Resources	No	Yes	Long-term (until post-decommissioning) alterations to the seascape, open ocean, and landscape character units’ character and effects on viewer experience due to construction, O&M, and decommissioning of the wind farm, onshore landing sites, onshore export cable routes, onshore substations, and electrical connections with the power grid.
Water Quality	No	No	BOEM does not expect activities to cause loss of, or major impacts on, existing inland waterbodies or wetlands. Turbidity impacts in marine and coastal environments would be temporary.

Resource Area	Irreversible Impacts	Irretrievable Impacts	Explanation
Wetlands	No	No	BOEM does not expect activities to cause loss of, or major impacts on, existing inland wetlands.

L.3. Relationship Between the Short-Term Use of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

CEQ's NEPA-implementing regulations (40 CFR 502.16(a)(3)) require that an EIS address the relationship between short-term use of the environment and the potential impacts of such use on the maintenance and enhancement of long-term productivity. Such impacts could occur as a result of a reduction in the flexibility to pursue other options in the future, or assignment of a specific area (land or marine) or resource to a certain use that would not allow other uses, particularly beneficial uses, to occur at a later date. An important consideration when analyzing such effects is whether the short-term environmental effects of the action will result in detrimental effects on long-term productivity of the affected areas or resources.

As assessed in EIS Chapter 3, BOEM anticipates that the majority of the potential adverse effects associated with the Proposed Action would occur during construction activities and would be short term in nature and minor to moderate in severity/intensity. These effects would cease after decommissioning activities. In assessing the relationships between short-term use of the environment and the maintenance and enhancement of long-term productivity, it is important to consider the long-term benefits of the Proposed Action, which include:

- Promotion of clean and safe development of domestic energy sources and clean energy job creation;
- Promotion of renewable energy to help ensure geopolitical security, combat climate change, and provide electricity that is affordable, reliable, safe, secure, and clean;
- Delivery of power to the electric grid to contribute to New York State's renewable energy goals; and
- Increased habitat for certain fish species.

Based on the anticipated potential impacts evaluated in this document and the Final EIS that could occur during Proposed Action construction, O&M, and decommissioning, and with the exception of some potential impacts associated with onshore components, BOEM anticipates that the Proposed Action would not result in impacts that would significantly narrow the range of future uses of the environment. For purposes of this analysis, BOEM assumes that the irreversible impacts presented in Table L-2 would be long term. After completion of the Proposed Action's operations and decommissioning phases, however, BOEM expects the majority of marine and onshore environments to return to normal long-term productivity levels.

This page intentionally left blank.

Appendix M. Seascape, Landscape, and Visual Impact Assessment

M.1. Introduction

This appendix describes the SLVIA methodology and key findings that BOEM used to identify the potential impacts of offshore wind structures (WTGs and OSS) on scenic and visual resources within the geographic analysis area. This SLVIA methodology applies to any offshore wind energy development proposed for the OCS and incorporates by reference the detailed description of the methodology described in the *Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States* (BOEM 2021). Section M.2, *Method of Analysis*, describes the specific methodology used to apply the SLVIA methodology to the COP and Section M.3, *Results,* summarizes the wind farm distances, FOVs, noticeable elements, visual contrasts, scale of change, and prominence that contributed to the determination of impact levels for each KOP under the Proposed Action and each of the action alternatives that include modifications to WTG array layouts (Alternatives B, E, and F). Visual simulations of the Proposed Action alone, other planned offshore wind projects without the Proposed Action, and other offshore wind projects in combination with the Proposed Action are included in Attachment M-1, *Cumulative Visual Simulations*. A nighttime simulation of the Proposed Action is included as Attachment M-2, *Nighttime Visual Simulation.*

The demarcation line between seascape and open ocean is the U.S. states jurisdictional boundary, 3 nm (3.45 statute miles) (5.5 kilometers) seaward from the coastline (US Congress Submerged Lands Act, 1953). This line coincides with shoreline visibility toward the ocean surface. The line defining the separation of seascape and landscape is based on the juxtaposition of seacoast and landward landscape elements, including topography, water (bays and estuaries), vegetation, and structures.

M.2. Method of Analysis

The SLVIA has two separate but linked parts: seascape, open ocean, and landscape impact assessment (SLIA) and VIA. SLIA analyzes and evaluates resource sensitivity, susceptibility, and magnitude of change in the consideration of impacts on both the physical elements and features that make up a landscape, seascape, or open ocean; and the aesthetic, perceptual, and experiential aspects of the landscape, seascape, or open ocean that make it distinctive. These impacts affect the “feel,” “character,” or “sense of place” of an area of landscape, seascape, or open ocean, rather than the composition of a view from a particular place. In SLIA, the impact receptors (the entities that are potentially affected by the proposed Projects) are the seascape/open ocean/landscape itself and its components, both its physical features and its distinctive character. VIA analyzes and evaluates the impacts on people of adding the proposed development to views from selected viewpoints. VIA evaluates the change to the composition of the view itself and assesses how the people who are likely to be at that viewpoint may be affected by the change to the view. Enjoyment of a particular view is dependent on the viewer and, in VIA, the impact receptors are people. The inclusion of both SLIA and VIA in the BOEM SLVIA methodology is consistent with NEPA’s objective of providing Americans with aesthetically and culturally pleasing surroundings and its requirement to consider all potentially significant impacts of development.

The magnitude of effect (change) in a seascape, open ocean, landscape, or view depends on the nature, scale, prominence, and visual contrast of the change and its experiential duration. The SLVIA offshore geographic analysis area consists of the extent of the zone of theoretical visibility and zones of visual influence (COP Volume 3, Appendix AA; Empire 2023), as follows:

- Offshore turbine array area where the WTGs and OSS would be located plus a 40-mile (64.4-kilometer) radius area. This distance is the maximum extent within which a seascape, landscape, or visual effect could occur, given visibility of the maximum height of the WTG rotor (951 feet [276.1 meters]) and OSS (200 feet [61 meters]).

WTG visibility would be variable through the day depending on many factors. View angle, sun angle, and atmospheric conditions would affect the WTG visibility. Visual contrast of WTGs would vary throughout the day depending on the visual character of the horizon's backdrop and whether the WTGs are backlit, side-lit, or front-lit. If less visual contrast is apparent in the morning hours, then it is likely that the visual contrast may be more pronounced in the afternoon. The inverse is possible, as well. These effects are also influenced by varying atmospheric conditions, direction of view, distance between the viewer and the WTGs, and elevation of the viewer.

At closer distances, approximately 12 miles or closer, the form of the WTG may be the dominant visual element creating the visual contrast regardless of color. At greater distances, color may become the dominant visual element creating visual contrast under certain visual conditions that gives visual definition to the WTG's form and line.

Mathematical calculation of EC over the ocean's surface defines the physical structure height(s) at which the Projects' WTGs and OSS are visible from offshore and onshore view receptors. Consideration of the height(s) of receptor(s) eye level(s) above the topography or ocean surface results in precise definition of WTG and OSS visibility. As the elevation of the viewer increases, the visible extent of individual WTGs and OSS increases.

The geographic analysis area shorelines have prevailing eastward and southward viewing directions. All cardinal directions are conceivable when viewing from a water vessel while at sea. When viewing from onshore and scanning across the ocean's horizon, the color of the horizon backdrop will often vary, including as the sun arcs across the sky from sunrise to sunset. Depending on sun angle, the backdrop sky color may have various intensities of white to gray and sky blue to pale blue to dark blue-gray. Blue sky, partly cloudy, overcast, fog, and haze conditions will influence the color make-up of the horizon's backdrop. The sunrise and sunset have varying degrees of light blue to dark blue, light and dark purples intermixed with oranges, yellows, and reds. Partly cloudy skies may increase the remarkable color effects during the sunset and sunrise periods of the day.

When placing WTGs offshore, the visual interplay and contrasting elements in form, line, color, and texture may vary with the ever-changing character of the backdrop. Front-lit WTGs may have strong color contrast against a darker gray sky, giving definition to the WTG vertical form and line contrast to the ocean's horizontal character and the line where the sea meets sky, or visually dissipate against a whiter backdrop created by high levels of evaporative atmospheric moisture during clear sunny days. Partly cloudy skies may create varying degrees of sunlight reflecting off the white color wind turbines, placing some WTGs in the shadow and making them appear darker gray and less conspicuous while highlighting others with a bright white color contrast. The level of noticeability would be directly proportional to the scale of change and prominence in the view and the degree of visual contrast between the WTGs, OSS, and the corresponding backdrop.

These variations through the course of the day may result in periods of moderate to major visual effect while at other times of day would have minor or negligible effect.

The SLVIA methodology and parameters assessed consider local stakeholders' identity, culture, values, and issues and the understanding of baseline maritime conditions. Project activities for all stages of the Project life cycle (construction and installation, O&M, and decommissioning) are assessed against the environmental baseline to identify the potential interactions between the Projects and the seascape, landscape, and viewers. The onshore geographic analysis area includes landfalls, buried onshore export cables, onshore substations, and transmission connections to the electric grid. The visual impacts of onshore components are discussed and summarized in Section 3.20, *Scenic and Visual Resources*.

Potential impacts are assessed to determine an impact level consistent with the definitions in Table M-1.

Table M-1 Definitions of Potential Adverse Impact Levels

Impact Level	Historic Properties under Section 106 of the NHPA	Visual Resources
Negligible	No historic properties affected, as defined at 36 CFR 800.4(d)(1).	SLIA: Very little or no effect on seascape/landscape unit character, features, elements, or key qualities either because unit lacks distinctive character, features, elements, or key qualities; values for these are low; or Project visibility would be minimal. VIA: Very little or no effect on viewers' visual experience because view value is low, viewers are relatively insensitive to view changes, or Project visibility would be minimal.
Minor	No adverse effects on historic properties could occur, as defined at 36 CFR 800.5(b).	SLIA: The Projects would introduce features that may have low to medium levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The Project features may introduce a visual character that is slightly inconsistent with the character of the unit, which may have minor to medium negative effects on the unit's features, elements, or key qualities, but the unit's features, elements, or key qualities have low susceptibility or value. VIA: The visibility of the Projects would introduce a small but noticeable to medium level of change to the view's character, have a low to medium level of visual prominence that attracts but may or may not hold the viewer's attention, and have a small to medium effect on the viewer's experience. The viewer receptor sensitivity/ susceptibility/value is low. If the value, susceptibility, and viewer concern for change are medium or high, the nature of the sensitivity is evaluated to determine if elevating the impact to the next level is justified. For instance, a KOP with a low magnitude of change but a high level of viewer concern (combination of susceptibility/value) may justify adjusting to a moderate level of impact.

Impact Level	Historic Properties under Section 106 of the NHPA	Visual Resources
Moderate	Adverse effects on historic properties as defined at 36 CFR 800.5(a)(1) could occur but would be avoided or minimized using a less-impactful scenario contemplated under the PDE.	SLIA: The Projects would introduce features that would have medium to large levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The Projects would introduce a visual character that is inconsistent with the character of the unit, which may have a moderate negative effect on the unit's features, elements, or key qualities. In areas affected by large magnitudes of change, the unit's features, elements, or key qualities have low susceptibility or value. VIA: The visibility of the Projects would introduce a moderate to large level of change to the view's character, may have moderate to large levels of visual prominence that attracts and holds but may or may not dominate the viewer's attention, and has a moderate effect on the viewer's visual experience. The viewer receptor sensitivity/susceptibility/value is medium to low. Moderate impacts are typically associated with medium viewer receptor sensitivity (combination of susceptibility/ value) in areas where the view's character has medium levels of change, or low viewer receptor sensitivity (combination of susceptibility/value) in areas where the view's character has large changes to the character. If the value, susceptibility, and viewer concern for change are high, the nature of the sensitivity is evaluated to determine if elevating the impact to the next level is justified.
Major	Adverse effects on historic properties as defined at 36 CFR 800.5(a)(1) could occur; at least some would require mitigation to resolve.	SLIA: The Projects would introduce features that would have dominant levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The Projects would introduce a visual character that is inconsistent with the character of the unit, which may have a major negative effect on the unit's features, elements, or key qualities. The concern for change (combination of susceptibility/value) to the character unit is high. VIA: The visibility of the Projects would introduce a major level of character change to the view; attract, hold, and dominate the viewer's attention; and have a moderate to major effect on the viewer's visual experience. The viewer receptor sensitivity/ susceptibility/value is medium to high. If the magnitude of change to the view's character is medium but the susceptibility or value at the KOP is high, the nature of the sensitivity is evaluated to determine if elevating the impact to major is justified. If the sensitivity (combination of susceptibility/value) at the KOP is low in an area where the magnitude of change is large, the nature of the sensitivity is evaluated to determine if lowering the impact to moderate is justified.

M.3. Results

M.3.1 Impacts of Proposed Action on Scenic and Visual Resources

Atmospheric conditions offshore and near the shoreline limit views more than the typically drier-air conditions in inland areas. Visual simulations from representative viewpoints included as Appendix D to the *Empire Wind Visual Impact Assessment Report* (COP Volume 3, Appendix AA; Empire 2023) indicate that daytime and nighttime visibility of WTGs and OSS would be noticeable to the casual observer from beach and landward viewpoints. Distances to the Proposed Action WTG and OSS array from designated KOPs would range from:

- 32.3 miles (52 kilometers) from KOP-9 (Otis Park Fire Island High Dune Wilderness) on the northeastern extent of the geographic analysis area;
- 14.1 miles (22.7 kilometers) from KOP-7 (Jones Beach State Park), the closest KOP to the WTG array; and
- 32 miles (51.5 kilometers) from KOP-13 (Point Pleasant Beach) on the southern beach of the geographic analysis area.

The noticeable daytime and nighttime elements of the Projects' WTGs and substations and their viewshed distances are listed in Table M-2. Each WTG would have two L-864 flashing red obstruction lights on the top of the nacelle, one of which is required to be lit (BOEM 2021). WTGs would have additional intermediate lighting on the tower utilizing low-intensity red flashing (L-810) obstruction lighting (see Section 2.1.1.2, *Offshore Activities and Facilities*). Line-of-sight calculations for onshore viewers (5-foot [1.5-meter] eye level) are based on intervening EC screening (7.98 inches [20.3 centimeters] height per mile). Heights of WTG and substation components are stated relative to MLLW and highest astronomical tide.

Table M-3 and Table M-4 indicate the Proposed Action's effects based on horizontal FOV and vertical FOV, respectively, defined as the extent of the observable landscape seen at any given moment, usually measured in degrees (BOEM 2021). The horizontal FOV for each KOP is listed in Appendix D to COP Volume 3, Appendix AA (Empire 2023). FOVs are valid and reliable indicators of the magnitude of view occupation by Proposed Action facilities. Typical human perception extends to 124° in the horizontal axis and 55° in the vertical axis. The nearest shoreline viewers would be 14.1 miles (25.9 kilometers) from the Wind Farm Development Area. EC, at this distance, reduces the observable height above the horizon of the nearest WTG by 86.1 feet (26.2 kilometers), from 951 feet (289.9 meters) MLLW to 864.9 feet (263.6 meters), resulting in occupation of 0.7°, 1.3 percent of the vertical view. Remaining WTGs would further diminish in perceived size with distance and EC.

Table M-2 Heights of Noticeable[1] WTG Elements and Substations and Visible Distances[2]

Noticeable Element	Height in Feet (meters)	Visible Distance[2] in Miles (kilometers)
Rotor Blade Tip	951 (290) MLLW	0–40.5 (65.2)
Navigation Light	544 (165.8) MLLW	0–31.3 (50.4)
Nacelle	534 (162.8) MLLW	0–31.1 (50.1)
Hub	525 (160) MLLW	0–30.8 (49.6)
Mid-tower Light	263 (78) MLLW[1]	0–22.6 (36.4)

[1] Empire indicated in its response to a request for information that the mid-tower lights would be located approximately halfway from the highest nacelle point and lowest astronomical tide above sea level.

Noticeable Element	Height in Feet (meters)	Visible Distance[2] in Miles (kilometers)
OSS	200 (61) HAT	0–20.1 (32.3)
Yellow Tower Base Color	68.9 (21) HAT	0–11.4 (18.3)

[1] Perception of Project elements, from 5 feet (1.5 meters) human eye-level while standing at mean sea level, involves static distance-related sizes, forms, lines, colors, and textures; variable daytime lighting conditions; variable nighttime light conditions; and variable meteorological conditions.
[2] Based on intervening EC and clear-day conditions.
HAT = highest astronomical tide

Table M-3 Horizontal FOV Occupied by the Proposed Action

Noticeable Element	Width[1] miles (kilometers)	Distance[2] miles (kilometers)	Horizontal FOV	Human FOV	Percent of FOV
Wind Farm	25.6 (41.2)	14.1 (22.7)	61.1°	124°	49%

[1] Maximum extent of the wind farm array.
[2] Nearest onshore distance to the wind farm array.

Table M-4 Vertical FOV Occupied by the Proposed Action

Noticeable Element	Height feet (miles)	Distance miles (kilometers)	Height Above Horizon[1] feet (meters)	Vertical FOV	Human FOV	Percent of FOV
Rotor Blade Tip	951 (276.1) MLLW	14.1 (22.7)	864 (263.3)	0.7°	55°	1.3%

[1] Based on intervening EC, clear-day, and clear-night conditions.

Table M-5 lists the wind farm's distances, horizontal FOVs, noticeable features based on their heights and EC, and visual contrasts. The analysis considers the introduction of WTGs and OSS to an open ocean baseline. The scale, size, contrast, and prominence of change focuses on the:

- Arrangement of WTGs and OSS in the view;
- Horizontal FOV and vertical FOV scale of the wind farm array, based on WTG and OSS size and number;
- Position of the array in the open ocean;
- Position of the array in the view; and
- Array's distance from the viewer.

Visibility, character-changing effects, scale, prominence, and visual contrasts reduce steadily with distance from the observation point. Visibility, character-changing effects, scale, prominence, and visual contrasts increase with elevated observer positions in comparison with the wind farm. Distance and observer elevation considerations are informed by the COP VIA simulations (COP Volume 3, Appendix D to Appendix AA; Empire 2023), EC calculations, horizontal FOV, and vertical FOV in undeveloped open ocean. The wind farm's nearest WTGs and OSS would be:

- Unavoidably dominant features (WTG yellow tower base and above) in the view between 0 and 12 miles (0 and 19.3 kilometers) distance;
- Strongly pervasive features (OSS, WTG mid-tower, mid-tower light, and above) between 12 and 20 miles (19.3 and 32.2 kilometers) distance;

- Clearly visible features (OSS lights, WTG tower, and above) between 20 and 28 miles (32.2 and 45.1 kilometers) distance;
- Low on the horizon, but persistent features (WTG hub, nacelle, navigation light, and rotor) in the view between 28 and 31 miles (45.1 and 49.9 kilometers) distance;
- Intermittently noticed features (WTG rotor) between 31 and 39.6 miles (49.9 and 63.7 kilometers) distance; and
- Below the horizon beyond 39.6 miles (63.7 kilometers) distance.

The prominence of offshore turbines is rated on a scale of 1 to 6, based on typical viewers' acuity (NAEP 2012).

- Visibility Level 1: Visible only after extended, close viewing; otherwise not visible.
- Visibility Level 2: Visible when scanning in general direction of study subject; otherwise likely to be missed by casual observer.
- Visibility Level 3: Visible after brief glance in general direction of study subject and unlikely to be missed by casual observer.
- Visibility Level 4: Plainly visible, could not be missed by casual observer, but does not strongly attract visual attention, or dominate view because of apparent size, for views in general direction of study subject.
- Visibility Level 5: Strongly attracts visual attention of views in general direction of study subject. Attention may be drawn by strong contrast in form, line, color, texture, luminance, or motion.
- Visibility Level 6: Dominates view because study subject fills most of visual field for views in its general direction. Strong contrasts in form, line, color, texture, luminance, or motion may contribute to view dominance.

Visual contrast determinations involve comparisons of characteristics of the seascape, open ocean, and landscape before and after Project implementation. The range of potential contrasts includes strong, moderate, weak, and none (BOEM 2021). The strongest daytime contrasts would result from tranquil and flat seas combined with sunlit WTG towers, nacelles, rotating rotors, flickering rotors, and a yellow tower base color against a dark background sky and an undifferentiated foreground. There would be daily variation in WTG color contrast as sun angles change from backlit to front-lit (sunrise to sunset) and the backdrop would vary under different lighting and atmospheric conditions. The weakest daytime contrasts would result from turbulent seas combined with overcast daylight conditions on WTG towers, nacelles, and rotors against an overcast background sky and a foreground modulated by varied landscape elements. The strongest nighttime contrasts would result from dark skies (absent moonlight) combined with navigation lights, activated lighting on the OSS, mid-tower lights, and Project lighting reflections on low clouds and active (non-reflective) surf, and the dark-sky light dome. The weakest nighttime contrasts would result from moonlit, cloudless skies; tranquil (reflective) seas; ADLS activation; and only mid-tower lights.

This page intentionally left blank.

Table M-5 Wind Farm Distances, FOVs, Noticeable Elements, Visual Contrasts, Scale of Change, and Prominence

KOP[1]	Distance in miles (kilometers)					Proposed Action FOV Degrees (% of 124°)	Noticeable Elements[2] & Impact Level	Contrast, Scale of Change, and Prominence							
	Proposed Action	Alternative B	Alternative E	Alternative F	Alternatives C, D, G, & H			Proposed Action Form	Proposed Action Line	Proposed Action Color	Proposed Action Texture	Proposed Action Scale	Proposed Action Prominence[3]	Alternatives B, E, and F	Alternatives C, D, G, & H
KOP-1[4]	33.9 (54.6)	35.9 (57.8)	33.9 (54.6)	35.2 (56.6)	33.9 (54.6)	17° (14%)	R, NL, N, H, M, O, Y **Moderate**	Moderate	Weak	Moderate	Weak	Medium	4	Same as Proposed Action	Same as Proposed Action
KOP-2	22.6 (36.4)	24.6 (39.6)	22.6 (36.4)	23.9 (38.5)	22.6 (36.4)	16° (13%)	R, NL, N, H, M **Moderate**	Moderate	Weak	Moderate	Weak	Medium	4	Same as Proposed Action	Same as Proposed Action
KOP-3[4]	21.8 (35.1)	21.8 (35.1)	21.8 (35.1)	21.8 (35.1)	21.8 (35.1)	49° (40%)	R, NL, N, H, M, O **Major**	Strong	Moderate	Strong	Moderate	Large	6	Same as Proposed Action	Same as Proposed Action
KOP-4	32.1 (51.7)	34.4 (55.4)	32.1 (51.7)	33.2 (53.4)	32.1 (51.7)	10° (8%)	R, NL **Minor**	Weak	Weak	Weak	Weak	Small	1	Same as Proposed Action	Same as Proposed Action
KOP-5	27.0 (43.5)	27.0 (43.5)	27.0 (43.5)	27.0 (43.5)	27.0 (43.5)	43° (35%)	R, NL, N, H **Moderate**	Moderate	Weak	Moderate	Weak	Medium	3	Same as Proposed Action	Same as Proposed Action
KOP-6	21.0 (33.8)	23.2 (37.3)	21.0 (33.8)	22.5 (36.2)	21.0 (33.8)	17° (14%)	R, NL, N, H, M **Moderate**	Moderate	Weak	Moderate	Weak	Medium	4	Same as Proposed Action	Same as Proposed Action
KOP-7	14.1 (22.7)	14.7 (23.7)	14.1 (22.7)	14.4 (23.2)	14.1 (22.7)	42° (34%)	R, NL, N, H, M, O **Major**	Strong	Moderate	Strong	Moderate	Medium	6	Same as Proposed Action	Same as Proposed Action
KOP-8	18.1 (29.1)	19.0 (30.6)	18.1 (29.1)	18.7 (30.1)	18.1 (29.1)	41° (33%)	R, NL, N, H, M **Moderate**	Moderate	Moderate	Moderate	Weak	Medium	4	Same as Proposed Action	Same as Proposed Action
KOP-9	32.1 (51.7)	32.1 (51.7)	32.1 (51.7)	32.1 (51.7)	32.1 (51.7)	57° (46%)	R, NL **Minor**	Weak	Weak	Weak	Weak	Small	2	Same as Proposed Action	Same as Proposed Action
KOP-10	24.3 (39.1)	24.3 (39.1)	24.3 (39.1)	24.3 (39.1)	24.3 (39.1)	50° (40%)	R, NL, N, H **Moderate**	Moderate	Weak	Moderate	Weak	Medium	4	Same as Proposed Action	Same as Proposed Action
KOP-11	21.7 (34.9)	24.0 (38.6)	21.7 (34.9)	22.5 (36.2)	21.7 (34.9)	15° (12%)	R, NL, N, H, M **Moderate**	Moderate	Weak	Moderate	Weak	Medium	4	Same as Proposed Action	Same as Proposed Action
KOP-12	25.4 (40.9)	26.9 (43.3)	25.4 (40.9)	25.8 (41.5)	25.4 (40.9)	25° (20%)	R, NL, N, H **Moderate**	Moderate	Weak	Moderate	Weak	Medium	3	Same as Proposed Action	Same as Proposed Action
KOP-13	30.7 (49.4)	31.7 (51.0)	30.7 (49.4)	30.9 (49.7)	30.7 (49.4)	26° (21%)	R, NL, N, H **Moderate**	Moderate	Weak	Moderate	Weak	Medium	3	Same as Proposed Action	Same as Proposed Action
KOP-14	24.2 (25.6)	26.4 (42.5)	24.2 (25.6)	25.2 (40.6)	24.2 (25.6)	10° (8%)	R, NL, N, H **Moderate**	Moderate	Weak	Moderate	Weak	Medium	3	Same as Proposed Action	Same as Proposed Action
KOP-15[4]	24.5 (38.9)	26.8 (43.1)	24.5 (38.9)	25.5 (41.0)	24.5 (38.9)	10° (8%)	R, NL, N, H, M **Major**	Strong	Moderate	Strong	Moderate	Large	6	Same as Proposed Action	Same as Proposed Action
KOP-16	0–40 (0–64)	0–40 (0–64)	0–40 (0–64)	0–40 (0–64)	0–40 (0–64)	124° (100%) to 13° (10%)	R, NL, N, H, M, O, Y **Major**	Strong	Strong	Strong	Strong	Large	6	Same as Proposed Action	Same as Proposed Action
KOP-17	0–40 (0–64)	0–40 (0–64)	0–40 (0–64)	0–40 (0–64)	0–40 (0–64)	58° (47%) to 28° (22%)	R, NL, N, H, O, M, Y **Major**	Strong	Strong	Strong	Strong	Large	6	Same as Proposed Action	Same as Proposed Action
EW1 KOP-1	0.02 (0.03)	NA	NA	NA	0.02 (0.03)	NA	NA	Weak	Weak	Weak	Weak	Small	1	Same as Proposed Action	Same as Proposed Action
EW1 KOP-2	0.4 (0.6)	NA	NA	NA	0.4 (0.6)	NA	NA	Weak	Weak	Weak	Weak	Small	1	Same as Proposed Action	Same as Proposed Action
EW1 KOP-3	3.7 (6.0)	NA	NA	NA	3.7 (6.0)	NA	NA	Weak	Weak	Weak	Weak	Small	2	Same as Proposed Action	Same as Proposed Action

KOP[1]	Distance in miles (kilometers)					Proposed Action FOV Degrees (% of 124°)	Noticeable Elements[2] & Impact Level	Contrast, Scale of Change, and Prominence							
	Proposed Action	Alternative B	Alternative E	Alternative F	Alternatives C, D, G, & H			Proposed Action Form	Proposed Action Line	Proposed Action Color	Proposed Action Texture	Proposed Action Scale	Proposed Action Prominence[3]	Alternatives B, E, and F	Alternatives C, D, G, & H
EW1 KOP-4[4]	2.8 (4.5)	NA	NA	NA	2.8 (4.5)	NA	NA	Weak	Weak	Weak	Weak	Small	1	Same as Proposed Action	Same as Proposed Action
EW2A KOP-1	0.2 (0.3)	NA	NA	NA	0.2 (0.3)	NA	NA	Weak	Weak	Weak	Weak	Small	1	Same as Proposed Action	Same as Proposed Action
EW2A KOP-2	2.5 (3.6)	NA	NA	NA	2.5 (3.6)	NA	NA	Weak	Weak	Weak	Weak	Small	2	Same as Proposed Action	Same as Proposed Action
EW2A KOP-3	1.0 (1.6)	NA	NA	NA	1.0 (1.6)	NA	NA	Weak	Weak	Weak	Weak	Small	2	Same as Proposed Action	Same as Proposed Action
EW2C KOP-1	0.07 (0.11)	NA	NA	NA	0.07 (0.11)	NA	NA	Weak	Weak	Weak	Weak	Small	2	Same as Proposed Action	Same as Proposed Action
EW2C KOP-2	0.09 (0.15)	NA	NA	NA	0.09 (0.15)	NA	NA	Strong	Moderate	Strong	Weak	Large	6	Same as Proposed Action	Same as Proposed Action
EW2C KOP-3	0.43 (0.69)	NA	NA	NA	0.43 (0.69)	NA	NA	Strong	Moderate	Strong	Weak	Large	6	Same as Proposed Action	Same as Proposed Action
EW2C KOP-4	0.19 (0.31)	NA	NA	NA	0.19 (0.31)	NA	NA	Weak	Weak	Weak	Weak	Small	3	Same as Proposed Action	Same as Proposed Action
SBMT KOP-1	0.2 (0.3)	NA	NA	NA	0.02 (0.03)	NA	NA	Strong	Moderate	Strong	Weak	Large	6	Same as Proposed Action	Same as Proposed Action
SBMT KOP-2	0.2 (0.3)	NA	NA	NA	0.04 (0.06)	NA	NA	Strong	Moderate	Strong	Weak	Large	6	Same as Proposed Action	Same as Proposed Action
SBMT KOP-3	3.7 (6.0)	NA	NA	NA	3.7 (6.0)	NA	NA	Moderate	Moderate	Moderate	Weak	Medium	4	Same as Proposed Action	Same as Proposed Action
SBMT KOP 4[4]	2.8 (4.5)	NA	NA	NA	0.8 (4.5)	NA	NA	Moderate	Moderate	Moderate	Weak	Medium	4	Same as Proposed Action	Same as Proposed Action

[1] KOP-1 Empire State Building (elevated view); KOP-2 Floyd Bennet Field-Gateway National Recreation Area; KOP-3 Fire Island Lighthouse (elevated view); KOP-4 Great Kills Park-Gateway National Recreation Area; KOP-5 Heckscher State Park; KOP-6 Jacob Riis Park-Gateway National Recreation Area; KOP-7 Jones Beach State Park; KOP-8 Norman J Levy Park and Preserve; KOP-9 Otis Pike Fire Island High Dune Wilderness; KOP-10 Sunken Forest; KOP-11 Hartshorne Wood Park; KOP-12 Ocean Grove Beach; KOP-13 Point Pleasant Beach; KOP-14 North Beach-Gateway National Recreation Area; KOP-15 Sandy Hook Light-Gateway National Recreation Area (elevated view); KOP-16 Recreational Fishing, Pleasure, and Tour Boat Area; KOP-17 Commercial and Cruise Ship Shipping Lanes; EW1 KOP-1 2nd Avenue, Brooklyn; EW1 KOP-2 Columbia Street Esplanade, Brooklyn; EW1 KOP-3 Hudson River Waterfront Parkway; EW1 KOP-4 Statue of Liberty; EW2A KOP-1 Oceanlea Drive/Residential Neighborhood; EW2A KOP-2 Woodmere Dock Residential Neighborhood; EW2A KOP-3 Masone Point Beach/Residential Neighborhood; EW2C KOP-1 Quebec Road/Residential Neighborhood; EW2C KOP-2 Long Beach Bridge; EW2C KOP-3 Long Beach Skate Park; EW2C KOP-4 Island Park Station; SBMT Staging Facility KOP-1 2nd Avenue, Brooklyn; SBMT Staging Facility KOP-2 Columbia Street Esplanade, Brooklyn; SBMT Staging Facility KOP-3 Hudson River Waterfront Parkway; SBMT Staging Facility KOP-4 Statue of Liberty
[2] Noticeable elements: R = rotor, NL = navigation light, N = nacelle, H = hub, M = mid-tower light, O = OSS, and Y = yellow tower base color
[3] WTGs and offshore or onshore substation visibility: 0-Not visible. 1-Visible only after extended study; otherwise not visible. 2-Visible when viewing in general direction of the wind farm; otherwise likely to be missed by casual observer. 3-Visible after brief glance in general direction of the wind farm; unlikely to be missed by casual observer. 4-Plainly visible; could not be missed by casual observer but does not strongly attract visual attention or dominate view. 5-Strongly attracts viewers' attention to the wind farm; moderate to strong contrasts in form, line, color, or texture, luminance, or motion. 6-Dominates view; strong contrasts in form, line, color, texture, luminance, or motion fill most of the horizontal FOV or vertical FOV (NAEP 2012).
[4] Elevated observation deck or lighthouse.
NA = not applicable

The seascape character units, landscape character units, and viewer experiences would be affected by the Proposed Action's noticeable features, applicable distances and FOV extents, open views versus view framing and intervening foregrounds, and form, line, color, and texture contrasts, scale of change, and prominence in the characteristic seascape and landscape. Higher impact levels would stem from unique, extensive, and long-term appearance of strongly contrasting, large, and prominent vertical structures in the otherwise horizontal seascape environment; where structures are an unexpected element and viewer experience is of formerly open views of high-sensitivity seascape and landscape; and from high sensitivity view receptors.

Construction involving moving and stationary visual feature contrasts to forms, lines, colors, and textures, scale, and prominence in formerly open seascape may have more effect on viewers than operational and decommissioning impacts, where the viewing context is existing WTGs and substations. Construction impacts would be temporary and include:

- Daytime and nighttime movement of installation vessels, cranes, and other equipment visible in the seascape in and around the Lease Area;
- Dawn, dusk, and nighttime construction lighting on WTGs and OSS;
- Beach, other sensitive land-based, and boat and cruise ship views of WTGs and OSS under construction;
- Laying of the offshore and onshore buried export cables and the connections between offshore and onshore export cables at beach landing sites; and
- Activities along the onshore landfalls, export cable routes, and onshore substations.

Operational effects would be similar to those of end-stage construction and would be long term and fully reversible.

Proposed Action impacts on high-sensitivity seascape character would be **major**. The daytime and nighttime (lighting) presence of the WTGs, OSS, and construction and O&M vessel traffic would change perception of this area from natural, undeveloped seascape to a developed wind energy environment characterized by visually dominant WTGs and OSS.

Maintenance activities would cause **minor** effects on seascape character by increased O&M vessel traffic to and from the Wind Farm Development Area. Increases in these vessel movements would be noticeable to offshore viewers but are unlikely to have a significant effect.

Decommissioning would involve the removal of all offshore structures and is expected to follow the reverse of the construction activity. Decommissioning activities would cause effects similar to those of construction activities.

Viewshed analyses (COP Volume 3, Appendix AA; Empire 2023) determined that clear-weather visibility of the WTGs and OSS would occur from 12.5 percent of the land area within the Proposed Action's zone of visual influence. The Proposed Action would be visible along the barrier islands' southern beaches. The majority of landward visibility (155 square miles) would occur within 14.2–28 miles of the Proposed Action over inland bays. Visibility would diminish between 28 and 40 miles, contributing 44 square miles to the zone of visual influence. Elevated viewing conditions, such as would occur at the Fire Island Lighthouse (160 feet [48.5 meters]), Sandy Hook Lighthouse (108 feet [32.9 meters]), and Empire State Building (1,304 feet [397.5 meters]), would increase WTG visibility distances to as much as 42 miles (67.6 kilometers). Due to coastal meteorological conditions, Proposed Action visibility in these areas would be noticeably reduced on approximately 3 days out of 4 to 5 days.

Daytime lighting of WTGs is not required. ADLS would reduce nighttime impact levels from **major** to **moderate** or **moderate** to **minor**, due to substantially limited hours of lighting. Residual impacts would result from the presence of continuously flashing lights, sky light dome, and reflections on clouds during those limited hours. Lights of the two OSS, as required by the Occupational Safety and Health Administration for the safety of O&M personnel, potentially would be visible from beaches and adjoining land and built environment during hours of darkness. The nighttime sky light dome and cloud lighting caused by reflections from the water surface may be seen from distances beyond the 40-mile (64.4-kilometer) geographic analysis area, depending on variable ocean surface and meteorological reflectivity. Onshore substations' nighttime lighting would be visible in their immediate neighborhoods during hours of darkness and similar in magnitude and extent to existing conditions.

Table M-6 lists the Proposed Action's noticeable features based on their heights, distances, and EC.

Table M-6 Noticeable Elements and Impacts by Seascape Character Unit, Open Ocean Character Unit, Landscape Character Unit, and KOP for the Proposed Action

Noticeable Elements[1] Impacts	Seascape Units, Open Ocean Unit, Landscape Units, and Offshore and Onshore Key Observation Points
R, NL, N, H, M, O, Y **Major**	Open Ocean Character Unit: KOP-16 Recreational Fishing, Pleasure, and Tour Boat Area KOP-17 Commercial and Cruise Ship Shipping Lanes
R, NL, N, H, M, O, Y **Moderate**	KOP-1 Empire State Building[2] (elevated view)
R, NL, N, H, M, O **Major**	Seascape Character Units: Beach and Islands KOP-3 Fire Island Lighthouse[2] (elevated view)
R, NL, N, H, M **Major**	KOP-7 Jones Beach State Park KOP-15 Sandy Hook Light-Gateway National Recreation Area[2] (elevated view)
R, NL, N, H, M **Moderate**	Landscape Character Units: Marshland, and Bay/Shoreline KOP-2 Floyd Bennett Field-Gateway National Recreation Area KOP-6 Jacob Riis Park-Gateway National Recreation Area KOP-8 Norman J Levy Park and Preserve KOP-11 Hartshorne Woods Park
R, NL, N, H **Moderate**	Landscape Character Units: Marshland, and Bay/Shoreline KOP-5 Heckscher State Park, New York KOP-10 Sunken Forest, New York KOP-12 Ocean Grove Beach KOP-13 Point Pleasant Beach KOP-14 North Beach-Gateway National Recreation Area
R, NL **Minor**	Landscape Character Units: Mainland and Ridges KOP-4 Great Kills Park-Gateway National Recreation Area KOP-9 Otis Pike Fire Island High Dune Wilderness

[1] R = rotor, NL = navigation light, N = nacelle, H = hub, M = mid-tower light, O = OSS, Y = yellow tower base color
[2] Elevated observation deck or lighthouse.

Table M-7 summarizes the Proposed Action's wind farm distance, percent of FOV occupied by the wind farm, and effects on the seascape units, open ocean unit, landscape units, and KOPs.

Table M-7 Wind Farm Distance Effects by Seascape Character Unit, Open Ocean Character Unit, Landscape Character Unit, and KOP for the Proposed Action

Distance miles (km) Noticeability Effects	Seascape Units, Open Ocean Unit, Landscape Units, and Offshore and Onshore Key Observation Points
0–40.0 (0–64.4) **Dominant/Major to Minor Noticeability**	Open Ocean Character Unit KOP-16 Recreational Fishing, Pleasure, and Tour Boat Area KOP-17 Commercial and Cruise Ship Shipping Lanes
21.8 (35.1) (Elevated Observer) **Dominant/Major Noticeability**	KOP-3 Fire Island Lighthouse (eye level: 160 feet [48.8 meters] HAT)
24.5 (38.9) (Elevated Observer) **Dominant/Major Noticeability**	KOP-15 Sandy Hook Light-Gateway National Recreation Area (eye level: 108 feet [32.9 meters] HAT)
33.9 (54.6) (Elevated Observer)[1] **Moderate Noticeability**	KOP-1 Empire State Building (eye level: 1,304 feet [397.5 meters] HAT)[1]
14.1–30.7 (49.4–51.7) **Moderate Noticeability**	Seascape Character Units: Beachfront and Jetty/Seawall, Boardwalk, Coastal Dune, Island Community, Marshland, and Bay/Shoreline KOP-2 Floyd Bennett Field-Gateway National Recreation Area KOP-5 Heckscher State Park KOP-6 Jacob Riis Park-Gateway National Recreation Area KOP-7 Jones Beach State Park KOP-8 Norman J Levy Park and Preserve KOP-10 Sunken Forest KOP-11 Hartshorne Woods Park KOP-12 Ocean Grove Beach KOP-13 Point Pleasant Beach KOP-14 Sandy Hook–North Beach
32.1–40.0 (51.7–64.4) **Minor to Negligible Noticeability**	Landscape Character Units: Mainland and Ridges KOP-4 Great Kills Park-Gateway National Recreation Area KOP-9 Otis Pike Fire Island High Dune Wilderness

[1] The Empire State Building's upper observation view height includes 49 feet (14.9 meters) HAT, 1,250 feet (381 meters) floor elevation, and 5 feet (1.5 meters) human eye level.
HAT = highest astronomical tide

Table M-8 summarizes the Proposed Action's wind farm distance, percent of FOV occupied by the wind farm, and effects on the seascape units, landscape units, and KOPs.

Table M-8 Wind Farm Percent of FOV by Seascape Character Unit, Open Ocean Character Unit, Landscape Character Unit, and KOP for the Proposed Action

Percent (°) of 124° FOV POV[1]	Seascape Units, Open Ocean Unit, Landscape Units, and Offshore and Onshore Key Observation Points
100% (124°) to 16% (20°)	Open Ocean Character Unit KOP-16 Recreational Fishing, Pleasure, and Tour Boat Area KOP-17 Commercial and Cruise Ship Shipping Lanes

Percent (°) of 124° FOV POV[1]	Seascape Units, Open Ocean Unit, Landscape Units, and Offshore and Onshore Key Observation Points
57° (46%) to 10° (8%)	Seascape Character Units: Beachfront and Jetty/Seawall, Boardwalk, Coastal Dune, Island Community Landscape Character Units[3]: Marshland, Bay/Shoreline, Mainland and Ridges KOP-1 Empire State Building (elevated view) KOP-2 Floyd Bennett Field-Gateway National Recreation Area KOP-3 Fire Island Lighthouse (elevated view) KOP-4 Great Kills Park-Gateway National Recreation Area KOP-5 Heckscher State Park KOP-6 Jacob Riis Park-Gateway National Recreation Area KOP-7 Jones Beach State Park KOP-8 Norman J Levy Park and Preserve KOP-9 Otis Pike Fire Island High Dune Wilderness KOP-10 Sunken Forest KOP-11 Hartshorne Woods Park KOP-12 Ocean Grove Beach KOP-13 Point Pleasant Beach KOP-14 North Beach-Gateway National Recreation Area KOP-15 Sandy Hook Light-Gateway National Recreation Area (elevated view)
Unseen[2]	Landscape Character Units[3]: Marshland, Bay/Shoreline, Mainland and Ridges

[1] Percent of view
[2] Seen, based on ArcGIS viewshed analyses.
[3] Unseen, based on ArcGIS viewshed analyses

Foreground influence assessments, involving the presence of intervening or framing elements and their influence on effects of Project characteristics, are based on each KOP's locale photography and visual simulations (COP Volume 3, Appendix AA; Empire 2023) and summarized in Table M-9.

Table M-9 Foreground View Framing and Intervening Elements for the Proposed Action Wind Farm

Foreground Element(s) Influence[1]	Seascape Units, Open Ocean Unit, Landscape Units, and Offshore and Onshore Key Observation Points
Open Ocean **Negligible Influence**	Open Ocean Character Unit: KOP-16 Recreational Fishing, Pleasure, and Tour Boat Area KOP-17 Commercial and Cruise Ship Shipping Lanes

Foreground Element(s) Influence[1]	Seascape Units, Open Ocean Unit, Landscape Units, and Offshore and Onshore Key Observation Points
Beach, Dunes, and Ocean **Minor Influence**	Seascape Character Units: Beachfront and Jetty/Seawall, Boardwalk, and Coastal Dune KOP-4 Great Kills Park-Gateway National Recreation Area KOP-5 Heckscher State Park, New York KOP-7 Jones Beach State Park KOP-9 Otis Pike Fire Island High Dune Wilderness KOP-10 Sunken Forest, New York KOP-12 Ocean Grove Beach KOP-13 Point Pleasant Beach KOP-14 North Beach-Gateway National Recreation Area
Buildings, Landscape Structures, Vegetation, and Topography **Dominant/Major Influence**	KOP-2 Floyd Bennett Field-Gateway National Recreation Area
Buildings, Landscape Structures, Vegetation, and Topography **Minor to Moderate Influence**	Landscape Character Units: Island Community, Marshland, Bay/Shoreline, Mainland, and Ridges KOP-1 Empire State Building (elevated view) KOP-3 Fire Island Lighthouse (elevated view) KOP-6 Jacob Riis Park-Gateway National Recreation Area KOP-8 Norman J Levy Park and Preserve KOP-11 Hartshorne Woods Park KOP-15 Sandy Hook Lighthouse (elevated view)
Buildings, Landscape Structures, Vegetation, and Topography Screening **Unseen**[2]	Landscape Character Units: Island Community, Marshland, Bay/Shoreline, Mainland, and Ridges

[1] Based on conditions portrayed by representative photography contained in COP Volume 3, Appendix AA (Empire 2023). Nearby view receptor locations may vary from screened to open views of the wind farm.
[2] Based on ArcGIS viewshed analysis.

Proposed Action contrasts in the characteristic seascape and landscape, as perceived in views from each KOP, are based on visual simulations for eight representative KOPs (Appendix D to COP Volume 3, Appendix AA; Empire 2023). Open ocean unit view contrasts are estimated based on similar open view conditions in ocean environments. Landscape and seascape compatibility and photography conditions for each viewpoint are presented in COP Volume 3, Appendix AA, Table 9.1 (Empire 2023). The landscape and seascape evaluation scale ranges from faint, apparent, conspicuous, and prominent to dominant. No onshore substation viewpoints other than EW 2 Substation C viewpoints would result in either prominent or dominant conditions. Offshore potential viewpoints' evaluations range from faint to dominant. Visual contrast determinations involve comparisons of characteristics of the seascape and landscape before and after Proposed Action implementation. The range of potential contrasts includes strong, moderate, weak, and none. The strongest daytime contrasts would result from tranquil and flat seas combined with sunlit WTG towers, nacelles, rotating and flickering rotors, rotor shadow flicker, and the yellow tower 68.9-foot (21-meter) base color against a dark background sky and an undifferentiated foreground. The weakest daytime contrasts would result from turbulent seas combined with overcast daylight conditions on WTG towers, nacelles, and rotors again an overcast background sky and a foreground modulated by varied landscape elements. The strongest nighttime contrasts would result from dark skies (absent moonlight) combined with navigation lights, activated lighting on the OSS, mid-tower lights, and Project lighting reflections on low clouds and active (non-reflective) surf, and the dark-sky light dome. The weakest nighttime contrasts would result from moonlit, cloudless skies, tranquil (reflective) seas, ADLS activation, and only mid-tower lights.

Photographic comparisons of characteristics of the seascape's and landscape's existing conditions and Proposed Action implementation are included in COP Volume 3, Appendix AA (Empire 2023) for eight of the 17 KOPs in the following summary tables. Visual contrast determinations are listed in Table M-10.

Table M-10 Visual Contrasts to Seascape, Open Ocean, Landscape, and KOPs for the Proposed Action

Contrast Rating Effects	Seascape, Open Ocean, Landscape, and Offshore and Onshore Key Observation Points
Strong Contrasts **Major**	Open Ocean Character Unit Seascape Character Units Landscape Character Units KOP-3 Fire Island Lighthouse (elevated view) KOP-7 Jones Beach State Park KOP-15 Sandy Hook Lighthouse (elevated view) KOP-16 Recreational Fishing, Pleasure, and Tour Boat Area KOP-17 Commercial and Cruise Ship Shipping Lanes EW 2 Substation C: KOP-2 Long Beach Bridge KOP-3 Long Beach Skate Park **SBMT Staging Facility:** KOP-1 2nd Avenue, Brooklyn KOP-2 Columbia Street Esplanade, Brooklyn
Moderate Contrasts **Moderate**	Seascape Character Units: Beachfront and Jetty/Seawall, Boardwalk, and Coastal Dune Landscape Character Units: Island Community, Marshland, Bay/Shoreline, Mainland, and Ridges KOP-2 Floyd Bennett Field-Gateway National Recreation Area KOP-5 Heckscher State Park KOP-6 Jacob Riis Park-Gateway National Recreation Area KOP-8 Norman J Levy Park and Preserve KOP-10 Sunken Forest KOP-11 Hartshorne Woods Park KOP-12 Ocean Grove Beach KOP-13 Point Pleasant Beach KOP-14 North Beach-Gateway National Recreation Area **SBMT Staging Facility:** KOP-3 Hudson River Waterfront Walkway KOP-4 Statue of Liberty

Contrast Rating Effects	Seascape, Open Ocean, Landscape, and Offshore and Onshore Key Observation Points
Weak Contrasts **Minor**	**Landscape Character Units:** Island Community, Marshland, Bay/Shoreline, Mainland, and Ridges KOP-1 Empire State Building (elevated view) KOP-4 Great Kills Park-Gateway National Recreation Area KOP-9 Otis Pike Fire Island High Dune Wilderness **EW 1 Onshore Substation:** KOP-1 2nd Avenue, Brooklyn KOP-2 Columbia Street Esplanade, Brooklyn KOP-3 Hudson River Waterfront Walkway KOP-4 Statue of Liberty **EW 2 Onshore Substation A:** KOP-1 Residential Neighborhood/Oceanlea Drive KOP-2 Woodmere Dock/Residential Neighborhood KOP-3 Masone Point Beach/Residential Neighborhood **EW 2 Onshore Substation C:** KOP-1 Quebec Road/Residential Neighborhood KOP-4 Island Park Station/Residential Neighborhood
None (Unseen) **Negligible**	Unseen areas of Landscape Character Units

Table M-11 summarizes resource sensitivity, susceptibility, and magnitude of change in Proposed Action impacts on the seascape character units, open ocean character unit, and landscape character units throughout the geographic analysis area. The seascape, open ocean, and landscape criteria listed in Table M-1 and consideration of the preceding assessments would result in impact levels for character units as shown in Table M-11.

Table M-11 Proposed Action Impact on Seascape Character, Open Ocean Character, and Landscape Character

Level of Impact	Seascape Character Units, Open Ocean Character Unit, and Landscape Character Units
Major	SLIA: Open Ocean Character Unit
Moderate	SLIA: Seascape Character Units and Landscape Character Units: Beachfront and Jetty/Seawall, Boardwalk, Coastal Dune, and Island Community
Minor	SLIA: Landscape Character Units: Bay/Shoreline, Island, Mainland, Marshland, and Ridges
Negligible	SLIA: Landscape Character Units: Island, Mainland, and Ridges

Table M-12 summarizes Proposed Action impacts on viewer experience (KOP locations) throughout the geographic analysis area. The viewer experience criteria listed in Table M-1 and consideration of the preceding assessments would result in impact levels for KOPs as shown in Table M-12.

Table M-12 Proposed Action Impact on Viewer Experience

Impact Level	Offshore and Onshore Key Observation Points
Major	VIA: KOP-3 Fire Island Lighthouse, New York (elevated view) KOP-7 Jones Beach State Park, New York—Nighttime and Daytime KOP-15 Sandy Hook Light-Gateway National Recreation Area, New Jersey (elevated view) KOP-16 Recreational Fishing, Pleasure, and Tour Boat Area KOP-17 Commercial and Cruise Ship Shipping Lanes **EW 2 Substation C:** KOP-2 Long Beach Bridge KOP-3 Long Beach Skate Park **SBMT Staging Facility:** KOP-1 2nd Avenue, Brooklyn KOP-2 Columbia Street Esplanade, Brooklyn
Moderate	**VIA:** KOP-1 Empire State Building (elevated view) KOP-2 Floyd Bennett Field-Gateway National Recreation Area KOP-5 Heckscher State Park KOP-6 Jacob Riis Park-Gateway National Recreation Area KOP-8 Norman J Levy Park and Preserve KOP-10 Sunken Forest KOP-11 Hartshorne Woods Park KOP-12 Ocean Grove Beach KOP-13 Point Pleasant Beach KOP-14 North Beach-Gateway National Recreation Area **SBMT Staging Facility:** KOP-3 Hudson River Waterfront Walkway KOP-4 Statue of Liberty
Minor	**VIA:** KOP-4 Great Kills Park-Gateway National Recreation Area KOP-9 Otis Pike Fire Island High Dune Wilderness **EW 1 Onshore Substation:** KOP-1 2nd Avenue, Brooklyn KOP-2 Columbia Street Esplanade, Brooklyn KOP-3 Hudson River Waterfront Walkway KOP-4 Statue of Liberty **EW 2 Onshore Substation A:** KOP-1 Residential Neighborhood/Oceanlea Drive KOP-2 Woodmere Dock/Residential Neighborhood KOP-3 Masone Point Beach/Residential Neighborhood **EW 2 Onshore Substation C:** KOP-4 Island Park Station/Residential Neighborhood

Impact Level	Offshore and Onshore Key Observation Points
Negligible	VIA: KOP-12 Ocean Grove Beach—Nighttime

Attachment M-1 portrays simulations of the incremental effects of the Projects in the context of other planned wind farms.

Consideration of effects of other planned wind farms on seascape character, open ocean character, and landscape character is listed in Table M-13.

Consideration of effects on viewer experience of other planned wind farms is listed in Table M-14.

Consideration of effects on seascape character, open ocean character, and landscape character of other planned wind farms in combination with the Proposed Action is listed in Table M-15.

Consideration of effects on viewer experience of other planned wind farms in combination with the Proposed Action is listed in Table M-16.

This page intentionally left blank.

Table M-13 Other Planned Wind Farms' Seascape, Open Ocean, and Landscape Units Cumulative Wind Farm Distances, FOVs, Noticeable Elements, Visual Contrasts, Scale of Change, and Prominence

Character Unit	Distance in miles (kilometers)[2,3]					FOV Degrees (% of 124°)	Noticeable Elements[4] & Impact Level	Visual Contrast, Scale of Change, and Prominence					
	ASN	OWE	VMA	AE	BWH			Form	Line	Color	Texture	Scale	Prominence[5]
New Jersey's Seascape (Beaches)[1]	47.6 (76.6)	63.6 (102.4)	41.9 (67.4)	53.7 (86.4)	60.5 (97.4)	None	None **Negligible**	None	None	None	None	1	0
Open Ocean	0.0 to 40.5 (0.0 to 65.2)	0.0 to 40.5 (0.0 to 65.2)	0.0 to 40.5 (0.0 to 65.2)	0.0 to 40.5 (0.0 to 65.2)	0.0 to 40.5 (0.0 to 65.2)	109° to 360° (88 to 290%)	R, NL, N, H, O, M, and Y to R **Major**	Strong	Strong	Strong	Strong	Large	6
New Jersey's Landscape[6]	47.8 (76.9)	63.8 (102.7)	42.1 (67.7)	53.9 (86.7)	60.7 (97.7)	None	None **Negligible**	None	None	None	None	Large	0
New York's Seascape (Beaches)[1]	65.3 (105.1)	54.9 (88.4)	32.3 (52.0)	54.7 (88.0)	64.9 (104.4)	33° (27%)	R **Minor**	Weak	Weak	Weak	Weak	Small	2
New York's Landscape[6]	65.5 (105.4)	55.1 (88.7)	32.5 (52.3)	54.9 (88.3)	65.1 (104.7)	33° (27%)	R **Minor**	Weak	Weak	Weak	Weak	Small	2

[1] The most conservative onshore case involves the seaward edge of the beach nearest the projects. The seascape unit edge is 3.45 miles (5.55 kilometers) offshore (New Jersey and New York jurisdictional boundaries). New Jersey's nearest beach (Sea Bright Beach) is 25.1 miles (40.1 kilometers) distant and New York's nearest beach (Jones Beach) is 14.1 miles (22.7 kilometers) distant from the Projects.
[2] AE = Attentive Energy LLC; ASN = Atlantic Shores North; BWH = Bight Wind Holdings; OWE = OW Ocean Winds East LLC; VMA = Vineyard Mid-Atlantic LLC
[3] Due to EC and known WTG heights, those WTGs beyond 40.5 miles (65.2 kilometers) would not be visible from ground level plus 5.5 feet (1.7 meters).
[4] Noticeable elements: R = rotor, NL = navigation light, N = nacelle, H = hub, O = OSS, M = mid-tower light, Y = yellow tower base color
[5] WTGs and OSS Prominence (visibility): 0 = Not visible. 1 = Visible only after extended study; otherwise not visible. 2 = Visible when viewing in general direction of the wind farm; otherwise likely to be missed by casual observer. 3 = Visible after brief glance in general direction of the wind farm; unlikely to be missed by casual observer. 4 = Plainly visible; could not be missed by casual observer, but does not strongly attract visual attention or dominate view. 5 = Strongly attracts viewers' attention to the wind farm; moderate to strong contrasts in form, line, color, or texture, luminance, or motion. 6 = Dominates view; strong contrasts in form, line, color, texture, luminance, or motion fill most of the horizontal FOV or vertical FOV (NAEP 2012).
[6] The seaward edge between landscape and seascape varies. The most conservative case is 0.2-mile (0.3-kilometer) distance from seaward beach edge.

Table M-14 Other Planned Wind Farms' Cumulative Viewer Experience Wind Farm Distances, FOVs, Noticeable Elements, Visual Contrasts, Scale of Change, and Prominence

Viewer[1]	Distance in miles (kilometers)[2,3]					FOV Degrees (% of 124°)	Noticeable Elements[4] & Impact Level	Visual Contrast, Scale of Change, and Prominence					
	ASN	OWE	VMA	AE	BWH			Form	Line	Color	Texture	Scale	Prominence[5]
KOP-3	76.5 (123.1)	45.7 (73.5)	24.0 (38.6)	55.7 (89.6)	67.1 (108.0)	33° (27%)	R, NL, N, H, O, and M[1] **Major**	Strong	Moderate	Strong	Moderate	Large	6
KOP-7	65.3 (105.1)	54.9 (88.4)	32.3 (52.0)	54.7 (88.0)	64.9 (104.4)	29° (23%)	R, NL, N, H, O, and M **Moderate**	Moderate	Weak	Moderate	Weak	Medium	6
KOP-12	37.7 (60.7)	61.5 (99.0)	41.9 (67.4)	48.2 (77.6)	54.1 (87.1)	11° (8%)	R, NL, N, and H **Negligible**	Weak	Weak	Weak	Weak	Small	2
KOP-13	30.1 (48.4)	61.4 (98.8)	44.1 (71.0)	45.7 (73.5)	50.1 (80.6)	13° (10%)	R and NL **Minor**	Weak	Weak	Weak	Weak	Small	3

[1] KOP-3 Fire Island Lighthouse (elevated view), KOP-7 Jones Beach State Park, KOP-12 Ocean Grove Beach, and KOP-13 Point Pleasant Beach
[2] AE = Attentive Energy LLC; ASN = Atlantic Shores North; BWH = Bight Wind Holdings; OWE = OW Ocean Winds East LLC; VMA = Vineyard Mid-Atlantic LLC
[3] Due to EC and known WTG heights, those WTGs beyond 40.5 miles (65.2 kilometers) would not be visible from ground level plus 5.5 feet (1.7 meters).
[4] Noticeable elements: R = rotor, NL = navigation light, N = nacelle, H = hub, O = OSS, M = mid-tower light, Y = yellow tower base color
[5] WTGs and OSS (onshore) visibility: 0 = Not visible. 1 = Visible only after extended study; otherwise not visible. 2 = Visible when viewing in general direction of the wind farm; otherwise likely to be missed by casual observer. 3 = Visible after brief glance in general direction of the wind farm; unlikely to be missed by casual observer. 4 = Plainly visible; could not be missed by casual observer, but does not strongly attract visual attention or dominate view. 5 = Strongly attracts viewers' attention to the wind farm; moderate to strong contrasts in form, line, color, or texture, luminance, or motion. 6 = Dominates view; strong contrasts in form, line, color, texture, luminance, or motion fill most of the horizontal FOV or vertical FOV (NAEP 2012)

Table M-15 Empire Wind and Other Planned Wind Farms' Seascape, Open Ocean, and Landscape Units Cumulative Wind Farm Distances, FOVs, Noticeable Elements, Visual Contrasts, Scale of Change, and Prominence

Character Unit	Distance in miles (kilometers)[2,3]						FOV Degrees (% of 124°)	Noticeable Elements[4] & Impact Level	Contrast, Scale of Change, and Prominence							
	EW	ASN	OWE	VMA	AE	BWH			Form	Line	Color	Texture	Scale	Prominence[5]	EW B, E, F	EW C, D, G, H
New Jersey's Seascape (Beaches) [1]	21.5 (34.3)	47.6 (76.6)	63.6 (102.4)	41.9 (67.4)	53.7 (86.4)	60.5 (97.4)	129° (104%)	R, NL, N, H **Moderate**	Moderate	Weak	Moderate	Weak	Medium	3	Same as Proposed Action	Same as Proposed Action
Open Ocean	0.0 to 40.5 (0.0 to 65.2)	0.0 to 40.5 (0 to 65.2)	0.0 to 40.5 (0 to 65.2)	0.0 to 40.5 (0 to 65.2)	0.0 to 40.5 (0 to 65.2)	0.0 to 40.5 (0 to 65.2)	109° to 360° (88 to 290%)	R, NL, N, H, O, M, Y to R **Major to Minor**	Strong to Weak	Strong to Weak	Strong to Weak	Strong to Weak	Large to Small	6 to 2	Same as Proposed Action	Same as Proposed Action
New Jersey's Landscape[6]	21.7 (34.6)	47.8 (76.9)	63.8 (102.7)	42.1 (67.7)	53.9 (86.7)	60.7 (97.7)	129° (104%)	R, NL, N, H **Moderate**	Moderate	Weak	Moderate	Weak	Medium	3	Same as Proposed Action	Same as Proposed Action
New York's Seascape (Beaches)[1]	14.1 (22.7)	65.3 (105.1)	54.9 (88.4)	32.3 (52.0)	54.7 (88.0)	64.9 (104.4)	49° (39%)	R, NL, N, H, M, O **Major**	Strong	Moderate	Strong	Moderate	Medium	6	Same as Proposed Action	Same as Proposed Action
New York's Landscape[6]	14.3 (23.0)	65.5 (105.4)	55.1 (88.7)	32.5 (52.3)	54.9 (88.3)	65.1 (104.7)	49° (39%)	R, NL, N, H, M, O **Major**	Strong	Moderate	Strong	Moderate	Medium	6	Same as Proposed Action	Same as Proposed Action

[1] The most conservative onshore case involves the seaward edge of the beach nearest the projects. The seascape unit edge is 3.45 miles (5.55 kilometers) offshore (New Jersey and New York jurisdictional boundaries). New Jersey's nearest beach (Sea Bright Beach) is 25.1 miles (40.1 kilometers) distant and New York's nearest beach (Jones Beach) is 14.1 miles (22.7 kilometers) distant from the Projects.
[2] AE = Attentive Energy LLC; ASN = Atlantic Shores North; BWH = Bight Wind Holdings; EW = Empire Wind; OWE = OW Ocean Winds East LLC; VMA = Vineyard Mid-Atlantic LLC
[3] Due to EC and known WTG heights, those WTGs beyond 40.5 miles (65.2 kilometers) would not be visible from ground level plus 5.5 feet (1.7 meters).
[4] Noticeable elements: R = rotor, NL = navigation light, N = nacelle, H = hub, O = OSS, M = mid-tower light, Y = yellow tower base color
[5] WTGs and OSS (onshore) visibility: 0 = Not visible. 1 = Visible only after extended study; otherwise not visible. 2 = Visible when viewing in general direction of the wind farm; otherwise likely to be missed by casual observer. 3 = Visible after brief glance in general direction of the wind farm; unlikely to be missed by casual observer. 4 = Plainly visible; could not be missed by casual observer, but does not strongly attract visual attention or dominate view. 5 = Strongly attracts viewers' attention to the wind farm; moderate to strong contrasts in form, line, color, or texture, luminance, or motion. 6 = Dominates view; strong contrasts in form, line, color, texture, luminance, or motion fill most of the horizontal FOV or vertical FOV (NAEP 2012).
[6] The seaward edge between landscape and seascape varies. The most conservative case is 0.2-mile (0.3-kilometer) distance from seaward beach edge.

Table M-16 Empire Wind and Other Planned Wind Farms' Cumulative Viewer Experience Wind Farm Distances, FOVs, Noticeable Elements, Visual Contrasts, Scale of Change, and Prominence

Viewer[1]	Distance in miles (kilometers)[2,3]						FOV Degrees (% of 124°)	Noticeable Elements[4] & Impact Level	Contrast, Scale of Change, and Prominence							
	EW	ASN	OWE	VMA	AE	BWH			Form	Line	Color	Texture	Scale	Prominence[5]	EW B, E, F	EW C, D, G, H
KOP-3	21.8 (35.1)	76.5 (123.1)	45.7 (73.5)	24.0 (38.6)	55.7 (89.6)	67.1 (108.0)	61° (49%)	R, NL, N, H, O, and M **Major**	Strong	Moderate	Strong	Moderate	Large	6	Same as Proposed Action	Same as Proposed Action
KOP-7	14.1 (22.7)	65.3 (105.1)	54.9 (88.4)	32.3 (52.0)	54.7 (88.0)	64.9 (104.4)	49° (39%)	R, NL, N, H, M, O **Major**	Strong	Moderate	Strong	Moderate	Medium	6	Same as Proposed Action	Same as Proposed Action
KOP-12	25.4 (40.9)	37.7 (60.7)	61.5 (99.0)	41.9 (67.4)	48.2 (77.6)	54.1 (87.1)	129° (104%)	R, NL, N, H **Moderate**	Moderate	Weak	Moderate	Weak	Medium	3	Same as Proposed Action	Same as Proposed Action
KOP-13	30.7 (49.4)	30.1 (48.4)	61.4 (98.8)	44.1 (71.0)	45.7 (73.5)	50.1 (80.6)	138° (112%)	R, NL, N, H **Moderate**	Moderate	Weak	Moderate	Weak	Medium	3	Same as Proposed Action	Same as Proposed Action

[1] KOP-3 Fire Island Lighthouse (elevated view), KOP-7 Jones Beach State Park, KOP-12 Ocean Grove Beach, and KOP-13 Point Pleasant Beach
[2] AE = Attentive Energy LLC; ASN = Atlantic Shores North; BWH = Bight Wind Holdings; EW = Empire Wind; OWE = OW Ocean Winds East LLC; VMA = Vineyard Mid-Atlantic LLC
[3] Due to EC and known WTG heights, those WTGs beyond 40.5 miles (65.2 kilometers) would not be visible from ground level plus 5.5 feet (1.7 meters).
[4] Noticeable elements: R = rotor, NL = navigation light, N = nacelle, H = hub, O = OSS, M = mid-tower light, Y = yellow tower base color
[5] WTGs and OSS (onshore) visibility: 0 = Not visible. 1 = Visible only after extended study; otherwise not visible. 2 = Visible when viewing in general direction of the wind farm; otherwise likely to be missed by casual observer. 3 = Visible after brief glance in general direction of the wind farm; unlikely to be missed by casual observer. 4 = Plainly visible; could not be missed by casual observer, but does not strongly attract visual attention or dominate view. 5 = Strongly attracts viewers' attention to the wind farm; moderate to strong contrasts in form, line, color, or texture, luminance, or motion. 6 = Dominates view; strong contrasts in form, line, color, texture, luminance, or motion fill most of the horizontal FOV or vertical FOV (NAEP 2012).

This page intentionally left blank.

M.3.2 Impacts of Alternative B on Scenic and Visual Resources

Visual contrast assessments and form, line, color, and texture comparisons of characteristics of the seascape, open ocean, and landscape before and after implementation of Alternative B are indicated in Table M-5. There would be a slight difference in contrasts between Alternative B and the Proposed Action due to alteration of the turbine array layout. Table M-17 and Table M-18 list Alternative B wind farm width-, height-, and distance-related occupation of views from the nearest shoreline area. Distance and FOV comparisons with the Proposed Action indicate similar effects, varying by 3.1 miles (5 kilometers) and the horizontal FOVs would vary by 3°. The vertical FOVs would vary by less than 1° (0.1° variation) of the viewer FOV. These results indicate slight changes to the FOV results compared to the Proposed Action (Table M-3 and Table M-4).

Table M-17 Horizontal FOV Occupied by Alternative B

Noticeable Element	Width[1] miles (km)	Distance[2] miles (km)	Horizontal FOV	Human FOV	Percent of FOV
WTGs	22.5 (36.2)	14.1 (22.7)	57.9°	124°	47%

[1] Maximum extent of the wind farm array.
[2] Nearest onshore distance to the wind farm array.
km = kilometers

Table M-18 Vertical FOV Occupied by Alternative B

Noticeable Element	Height feet (m) MLLW	Distance miles (km)	Visible Height[1] feet (m)	Vertical FOV	Human FOV	Percent of FOV
Rotor Blade Tip	951 (289.9)	14.1 (22.7)	865 (264)	0.6°	55°	1%

[1] Based on intervening EC, clear-day, and clear-night conditions.
km = kilometers; m = meters

M.3.2.1. Conclusion

The effects of Alternative B on seascape character, open ocean character, landscape character, and viewer experience would be similar to the effects of the Proposed Action. Due to distance, extensive FOVs, high view prominence, strong contrasts, and heretofore undeveloped ocean views, Alternative B would have **major** effects on the open ocean unit character and viewer boating and cruise ship experiences. Due to view distances, moderate FOVs, moderate and weak visual contrasts, clear-day conditions, and nighttime ADLS activation, effects of Alternative B on high- and moderate-sensitivity landscape character units would be **moderate** to **major**. The daytime presence of offshore WTGs and OSS, as well as their nighttime lighting, would change perception of ocean scenes from natural and undeveloped to a developed wind energy environment characterized by WTGs and OSS. In clear weather, the WTGs and OSS would be an unavoidable presence in views from the coastline, with **moderate** to **major** effects on landscape character.

Considering all the IPFs together, BOEM anticipates that the contribution of Alternative B to the impacts associated with ongoing and planned activities in combination with other future offshore wind development would be **major**. The main drivers for this impact rating are the major visual impacts associated with the presence of offshore structures, lighting, and vessel traffic.

M.3.3 Impacts of Alternative E on Scenic and Visual Resources

The effects of Alternative E on seascape character, open ocean character, landscape character, and viewer experience would be similar to the effects of the Proposed Action. Alternative E would alter the turbine array layout compared to the Proposed Action; however, Alternative E would allow for installation of up to 147 WTGs as defined in Empire's PDE. Table M-19 and Table M-20 list Alternative E wind farm width-, height-, and distance-related occupation of views from the nearest shoreline area. Distance and FOV comparisons would be the same as those of the Proposed Action. The vertical FOVs would be the same as for the Proposed Action.

Impacts of Alternative E related to the primary IPFs (presence of structures, lighting, vessel traffic, land disturbance, and accidental releases) would be similar to the impacts described for the Proposed Action. The seascape character units, open ocean character unit, landscape character units, and viewer experience would be affected by construction, O&M, and decommissioning of Alternative E due to the noticeable elements, distance effects, FOV extents, view framing and intervening foregrounds, prominence, and contrast rating.

Horizontal and vertical FOV extents (Table M-19 and Table M-20) of the Alternative E wind farm would be the same as for the Proposed Action (Table M-3 and Table M-4).

Table M-19 Horizontal FOV Occupied by Alternative E

Noticeable Element	Width[1] miles (km)	Distance[2] miles (km)	Horizontal FOV	Human FOV	Percent of FOV
WTGs	25.6 (41.2)	14.1 (22.7)	61.1°	124°	49%

[1] Maximum extent of the wind farm array.
[2] Nearest onshore distance to the wind farm array.
km = kilometers

Table M-20 Vertical FOV Occupied by Alternative E

Noticeable Element	Height feet (m) MLLW	Distance miles (km)	Visible Height[1] feet (m)	Vertical FOV	Human FOV	Percent of FOV
Rotor Blade Tip	951 (289.9)	14.1 (22.7)	865 (264)	0.6°	55°	1%

[1] Based on intervening EC, clear-day, and clear-night conditions.
km = kilometers; m = meters

M.3.3.1. Conclusions

The effects of Alternative E on seascape character, open ocean character, landscape character, and viewer experience would be similar to the effects of the Proposed Action. Due to distance, extensive FOVs, high view prominence, strong contrasts, and heretofore undeveloped ocean views, Alternative E would have **major** effects on the open ocean unit character and viewer boating and cruise ship experiences. Due to view distances, moderate FOVs, moderate and weak visual contrasts, clear-day conditions, and nighttime ADLS activation, effects of Alternative E on high- and moderate-sensitivity landscape character units would be **moderate** to **major**. The daytime presence of offshore WTGs and OSS, as well as their nighttime lighting, would change perception of ocean scenes from natural and undeveloped to a developed wind energy environment characterized by WTGs and OSS. In clear weather, the WTGs and OSS would be an unavoidable presence in views from the coastline, with **moderate** to **major** effects on seascape and landward landscape character.

Considering all the IPFs together, BOEM anticipates that the contribution of Alternative E to the impacts associated with ongoing and planned activities in combination with other future offshore wind development would be **major**. The main drivers for this impact rating are the major visual impacts associated with the presence of offshore structures, lighting, and vessel traffic.

M.3.4 Impacts of Alternative F on Scenic and Visual Resources

Table M-21 and Table M-22 list Alternative F wind farm width-, height-, and distance-related occupation of views from the nearest shoreline area. Distance and FOV comparisons with the Proposed Action indicate similar effects, varying by 3.1 miles (5 kilometers) and the horizontal FOVs would vary by 3°. The vertical FOVs would vary by less than 1° of the viewer FOV. These results indicate slight changes to the FOV results compared to the Proposed Action (Table M-3 and Table M-4).

Impacts of Alternative F related to the primary IPFs (presence of structures, lighting, vessel traffic, land disturbance, and accidental releases) would be similar to the impacts described for the Proposed Action. The seascape character units, open ocean character unit, landscape character units, and viewer experience would be affected by construction, O&M, and decommissioning of Alternative F due to the noticeable elements, distance effects, FOV extents, view framing and intervening foregrounds, prominence, and contrast rating effects.

The effects of Alternative F on seascape character, open ocean character, landscape character, and viewer experience would be similar to the effects of the Proposed Action. Alternative F would alter the turbine array layout compared to the Proposed Action; however, Alternative F would allow for installation of up to 147 WTGs as defined in Empire's PDE. Horizontal and vertical FOV extent (Table M-21 and Table M-22) differences between Alternative F and the Proposed Action (Table M-3 and Table M-4) would not be noticeable to the casual viewer at applicable seascape receptor distances to the WTG array.

Table M-21 Horizontal FOV Occupied by Alternative F

Noticeable Element	Width[1] miles (km)	Distance[2] miles (km)	Horizontal FOV	Human FOV	Percent of FOV
WTGs	24 (38.6)	14.1 (22.7)	59.6°	124°	48%

[1] Maximum extent of the wind farm array.
[2] Nearest onshore distance to the wind farm array.
km = kilometers

Table M-22 Vertical FOV Occupied by Alternative F

Noticeable Element	Height feet (m) MLLW	Distance miles (km)	Visible Height[1] feet (m)	Vertical FOV	Human FOV	Percent of FOV
Rotor Blade Tip	951 (289.9)	14.1 (22.7)	865 (264)	0.6°	55°	1%

[1] Based on intervening EC, clear-day, and clear-night conditions.
km = kilometers; m = meters

M.3.4.1. Conclusions

The effects of Alternative F on seascape character, open ocean character, landscape character, and viewer experience would be similar to the effects of the Proposed Action. Due to distance, extensive FOVs, high view prominence, strong contrasts, and heretofore undeveloped ocean views, Alternative F would have **major** effects on the open ocean unit character and viewer boating and cruise ship experiences. Due to view distances, moderate FOVs, moderate and weak visual contrasts, clear-day conditions, and nighttime

ADLS activation, effects of Alternative F on high- and moderate-sensitivity landscape character units would be **moderate** to **major**. The daytime presence of offshore WTGs and OSS, as well as their nighttime lighting, would change perception of ocean scenes from natural and undeveloped to a developed wind energy environment characterized by WTGs and OSS. In clear weather, the WTGs and OSS would be an unavoidable presence in views from the coastline, with **moderate** to **major** effects on seascape and landward landscape character.

Considering all the IPFs together, BOEM anticipates that the contribution of Alternative F to the impacts associated with ongoing and planned activities in combination with other future offshore wind development would be **major**. The main drivers for this impact rating are the major visual impacts associated with the presence of offshore structures, lighting, and vessel traffic.

M.3.5 Impacts of Alternatives C, D, G, and H on Scenic and Visual Resources

Alternatives C, D, and G involve selection of specific submarine export cable or onshore export cable routes to avoid impacts on federally maintained anchorage area (Alternative C-1), navigation channel (Alternative C-2), or sand borrow areas (Alternative D), or use a cable bridge to cross Barnums Channel (Alternative G). Alternative H would use a method of dredge or fill activities (clamshell dredging with environmental bucket) that would reduce the discharge of dredged material compared to other dredging options considered in the Empire Wind PDE (i.e., open cut trenching/jetting, suction hopper dredging, hydraulic dredging). None of these alternatives would add or modify above-water or aboveground infrastructure included in the PDE for the Proposed Action and impacts of Alternatives C, D, G, or H on scenic and visual resources would be the same as described for the Proposed Action. Impacts of Alternatives C, D, G, or H related to the primary IPFs (presence of structures, lighting, vessel traffic, and accidental releases) would also be similar to the impacts described for the Proposed Action.

M.3.5.1. Conclusions

The effects of Alternatives C, D, G, or H on seascape character, open ocean character, landscape character, and viewer experience would be similar to the effects of the Proposed Action. Due to distance, extensive FOVs, high view prominence, strong contrasts, and heretofore undeveloped ocean views, Alternatives C, D, G, or H would have **major** effects on the open ocean unit character and viewer boating and cruise ship experiences. Due to view distances, moderate FOVs, moderate and weak visual contrasts, clear-day conditions, and nighttime ADLS activation, effects of Alternatives C, D, G, or H on high- and moderate-sensitivity seascape character units would be **moderate** to **major**. The daytime presence of offshore WTGs and OSS, as well as their nighttime lighting, would change perception of ocean scenes from natural and undeveloped to a developed wind energy environment characterized by WTGs and OSS. In clear weather, the WTGs and OSS would be an unavoidable presence in views from the coastline, with **moderate** to **major** effects on seascape character.

Considering all the IPFs together, BOEM anticipates that the contribution of Alternative C, D, G, or H to the impacts associated with ongoing and planned activities in combination with other future offshore wind development would be **major**. The main drivers for this impact rating are the major visual impacts associated with the presence of offshore structures, lighting, and vessel traffic.

M.3.6 Impacts of the Connected Action on Scenic and Visual Resources

View distances, facility scale, view prominence, and visual contrasts (form, line, color, and texture comparisons) of characteristics of the seascape and landscape before and after implementation of the SBMT staging facility are indicated in Table M-5. Table M-10 lists visual contrasts as would be experienced from four representative KOPs: SBMT Staging Facility KOP-1 2nd Avenue, Brooklyn; SBMT Staging Facility KOP-2 Columbia Street Esplanade, Brooklyn; SBMT Staging Facility KOP-3

Hudson River Waterfront Parkway; and SBMT Staging Facility KOP-4 Statue of Liberty. Table M-12 lists impacts on viewer experience at each of these KOPs.

M.3.6.1. Conclusions

Due to nearness of view distances, large scale, high view prominence, and moderate to strong contrasts, the SBMT staging facility would have **moderate** to **major** effects on the seascape unit character, **minor** effects on the landscape character unit, and **moderate** to **major** effects on viewer experience. The daytime presence of moving and stationary cranes, storage and transfer of WTG components, moving and stationary barges and ships, and associated nighttime lighting would be moderately to strongly contrasting with the seascape. In clear weather, the SBMT staging facility would be an unavoidable presence in views from the water and from onshore sea level and elevated viewing locations, with **moderate** to **major** effects on seascape character.

Considering all the IPFs together, BOEM anticipates that the contribution of the SBMT staging facility activities to the impacts associated with ongoing and planned activities in combination with other future offshore wind development would be **major**. The main drivers for this impact rating are the major visual impacts associated with the presence of onshore equipment and WTGs, lighting, and offshore vessel traffic.

M.4. SLIA Summary

SLIA considers resource sensitivity, susceptibility, and magnitude of change in the impacts on the physical elements and features that make up a seascape, open ocean, or landscape and the aesthetic, perceptual, and experiential aspects of the seascape, open ocean, or landscape that contribute to its distinctive character. These impacts affect the “feel,” “character,” or “sense of place” of an area of seascape, open ocean, or landscape. Table M-23 summarizes the effects of the character of the offshore and onshore components of the Projects with the aspects that contribute to the distinctive character of the seascape, open ocean, and landscape areas from which the Projects would be visible (BOEM 2021).

Table M-23 Seascape Character, Open Ocean Character, Landscape Character and Impact Levels

Character Unit	Affected Environment						Proposed Action													Impact Levels				
	Unit Susceptibility			Unit Value			Project Visibility				Character Key Feature Change			Character Key Element Change			Character Key Quality Change			Proposed Action				Alternatives B, C, D, E, F, and G
	High	Medium	Low	High	Medium	Low	Dominant	Substantial	Low	Unseen	High	Medium	Low	High	Medium	Low	High	Medium	Low	Major	Moderate	Minor	Negligible	Impact Level
Open Ocean	X			X			X				X			X			X			X				Same as Proposed Action
Seascape Ocean	X			X			X				X			X			X			X				Same as Proposed Action
Seascape Beachfront	X			X			X				X			X			X			X				Same as Proposed Action
Seascape Boardwalks/Jetties/ Seawalls	X			X			X				X			X			X			X				Same as Proposed Action
Seascape Dunes	X			X			X				X			X			X			X				Same as Proposed Action
Seascape Commerce	X				X		X				X			X			X			X				Same as Proposed Action
Seascape Institutional	X			X			X				X			X			X			X				Same as Proposed Action
Seascape Municipal	X			X			X				X			X			X			X				Same as Proposed Action
Seascape Parks	X			X			X				X			X			X			X				Same as Proposed Action
Seascape Preserves	X			X			X				X			X			X			X				Same as Proposed Action
Seascape Residential	X			X			X				X			X			X			X				Same as Proposed Action

Character Unit	Affected Environment						Proposed Action													Impact Levels				
	Unit Susceptibility			Unit Value			Project Visibility				Character Key Feature Change			Character Key Element Change			Character Key Quality Change			Proposed Action				Alternatives B, C, D, E, F, and G
	High	Medium	Low	High	Medium	Low	Dominant	Substantial	Low	Unseen	High	Medium	Low	High	Medium	Low	High	Medium	Low	Major	Moderate	Minor	Negligible	Impact Level
Landscape Bay/ Estuary/Marsh	X			X				X				X			X			X			X			Same as Proposed Action
Landscape River	X			X				X				X			X			X			X			Same as Proposed Action
Landscape Agriculture			X			X		X				X			X			X			X			Same as Proposed Action
Landscape Commerce			X			X		X				X			X			X			X			Same as Proposed Action
Landscape Forest		X		X					X				X			X			X					Same as Proposed Action
Landscape Institutional	X			X				X				X			X			X			X			Same as Proposed Action
Landscape Park	X			X				X				X			X			X			X			Same as Proposed Action
Landscape Preserve	X			X				X				X			X			X			X			Same as Proposed Action
Landscape Recreation		X			X			X				X			X			X			X			Same as Proposed Action
Landscape Residential	X			X				X				X			X			X			X			Same as Proposed Action

M.5. VIA Summary

The VIA considers the characteristics of the view receptor, characteristics of the view toward the Project facilities, and the experiential impacts of the Projects. Table M-24 summarizes the viewer sensitivity, view receptor susceptibility, view value, and summary of the measures of effects from the visible character and magnitude of the offshore and onshore components of the Projects (BOEM 2021).

Table M-24 Viewer Sensitivity, Receptor Susceptibility, View Value, Viewer Experience, and Impact Levels

KOP[1]	Affected Environment									Viewer Experience				Impact Levels				
	Viewer Sensitivity			Receptor Susceptibility			View Value			Distance-Noticeable Elements-HFOV-VFOV-Contrast-Scale-Prominence Effects				Proposed Action				Alternatives B, C, D, E, F, and G
	High	Medium	Low	High	Medium	Low	High	Medium	Low	Dominant	Substantial	Low	Unseen	Major	Moderate	Minor	Negligible	Impact Levels
KOP-1[2]	X			X			X				X				X			Same as Proposed Action
KOP-2	X				X		X				X				X			Same as Proposed Action
KOP-3[2]	X			X			X				X			X				Same as Proposed Action
KOP-4	X					X	X					X				X		Same as Proposed Action
KOP-5	X				X		X				X				X			Same as Proposed Action
KOP-6	X				X		X				X				X			Same as Proposed Action
KOP-7	X			X			X			X				X				Same as Proposed Action
KOP-8	X			X			X			X					X			Same as Proposed Action
KOP-9	X					X	X				X					X		Same as Proposed Action
KOP-10	X				X		X				X				X			Same as Proposed Action
KOP-11	X				X		X				X				X			Same as Proposed Action
KOP-12	X				X		X				X				X			Same as Proposed Action
KOP-13	X				X		X				X				X			Same as Proposed Action
KOP-14	X				X		X				X				X			Same as Proposed Action
KOP-15[2]	X			X			X			X				X				Same as Proposed Action
KOP-16	X			X			X			X				X				Same as Proposed Action
KOP-17	X			X			X			X				X				Same as Proposed Action
EW1 KOP-1			X		X			X			X					X		Same as Proposed Action
EW1 KOP-2			X		X			X			X					X		Same as Proposed Action
EW1 KOP-3	X				X			X			X					X		Same as Proposed Action
EW1 KOP-4[2]	X				X		X					X				X		Same as Proposed Action

KOP[1]	Affected Environment									Viewer Experience				Impact Levels				
	Viewer Sensitivity			Receptor Susceptibility			View Value			Distance-Noticeable Elements-HFOV-VFOV-Contrast-Scale-Prominence Effects				Proposed Action				Alternatives B, C, D, E, F, and G
	High	Medium	Low	High	Medium	Low	High	Medium	Low	Dominant	Substantial	Low	Unseen	Major	Moderate	Minor	Negligible	Impact Levels
EW2A KOP-1			X		X			X			X					X		Same as Proposed Action
EW2A KOP-2		X			X		X				X					X		Same as Proposed Action
EW2A KOP-3		X			X			X			X					X		Same as Proposed Action
EW2C KOP-1			X		X			X			X				X			Same as Proposed Action
EW2C KOP-2		X			X			X		X				X				Same as Proposed Action
EW2C KOP-3		X			X		X			X				X				Same as Proposed Action
EW2C KOP-4		X			X			X			X				X			Same as Proposed Action
SBMT KOP-1			X	X				X		X				X				NA
SBMT KOP-2			X	X					X	X				X				NA
SBMT KOP3	X			X			X				X				X			NA
SBMT KOP-4	X			X			X				X				X			NA

[1] KOP-1 Empire State Building; KOP-2 Floyd Bennet Field-Gateway National Recreation Area; KOP-3 Fire Island Lighthouse; KOP-4 Great Kills Park-Gateway National Recreation Area; KOP-5 Heckscher State Park; KOP-6 Jacob Riis Park-Gateway National Recreation Area; KOP-7 Jones Beach State Park; KOP-8 Norman J Levy Park and Preserve; KOP-9 Otis Pike Fire Island High Dune Wilderness; KOP-10 Sunken Forest; KOP-11 Hartshorne Wood Park; KOP-12 Ocean Grove Beach; KOP-13 Point Pleasant Beach; KOP-14 North Beach-Gateway National Recreation Area; KOP-15 Sandy Hook Light-Gateway National Recreation Area; KOP-16 Recreational Fishing, Pleasure, and Tour Boat Area; KOP-17 Commercial and Cruise Ship Shipping Lanes; EW1 KOP-1 2nd Avenue, Brooklyn; EW1 KOP-2 Columbia Street Esplanade, Brooklyn; EW1 KOP-3 Hudson River Waterfront Parkway; EW1 KOP-4 Statue of Liberty; EW2A KOP-1 Oceanlea Drive/Residential Neighborhood; EW2A KOP-2 Woodmere Dock Residential Neighborhood; EW2A KOP-3 Masone Point Beach/Residential Neighborhood; EW2C KOP-1 Quebec Road/Residential Neighborhood; EW2C KOP-2 Long Beach Bridge; EW2C KOP-3 Long Beach Skate Park; EW2C KOP-4 Island Park Station; SBMT Staging Facility KOP-1 2nd Avenue, Brooklyn; SBMT Staging Facility KOP-2 Columbia Street Esplanade, Brooklyn; SBMT Staging Facility KOP-3 Hudson River Waterfront Parkway; SBMT Staging Facility KOP-4 Statue of Liberty
[2] Elevated observation deck or lighthouse.
HFOV = horizontal field of view; NA = not applicable; VFOV = vertical field of view

M.6. References

Bureau of Ocean Energy Management (BOEM). 2021. *Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States*. OCS Study BOEM 2021-032. April.

Empire Offshore Wind, LLC (Empire). 2023. *Empire Offshore Wind: Empire Wind Project (EW1 and EW2), Construction and Operations Plan*. Available: https://www.boem.gov/renewable-energy/empire-wind-construction-and-operations-plan.

National Association of Environmental Professionals. (NAEP). 2012. *Offshore Wind Turbine Visibility and Visual Impact Thresholds*. Available: https://blmwyomingvisual.anl.gov/docs/EnvPractice_Offshore%20Wind%20Turbine%20Visibility%20and%20Visual%20Impact%20Threshold%20Distances.pdf.

This page intentionally left blank.

ATTACHMENT M-1
CUMULATIVE VISUAL SIMULATIONS

This page intentionally left blank.

EMPIRE OFFSHORE WIND

CUMULATIVE EFFECTS SIMULATION

March 2022

EMPIRE OFFSHORE WIND
CUMULATIVE EFFECTS

TABLE OF CONTENTS

EXISTING CONDITION

KOP 1

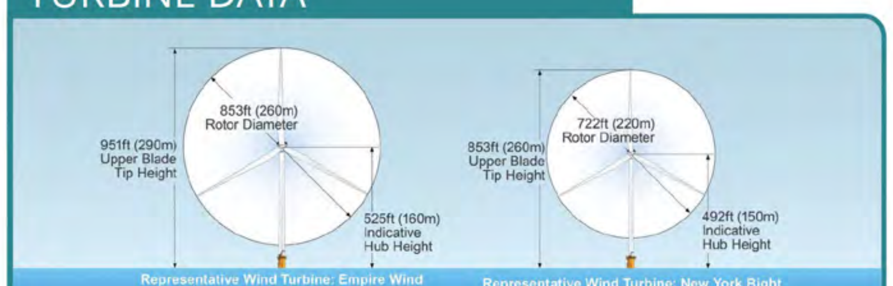
View of the existing condition at Fire Island Lighthouse

LOCATOR MAP

Legend

Visible	Not Visible	WTG Location
●	●	Empire Wind
●	●	NY Bight: Hudson South A
●	●	NY Bight: Hudson South B
●	●	NY Bight: Hudson South C
●	●	NY Bight: Hudson South D
●	●	NY Bight: Hudson South E
●	●	NY Bight: Hudson South F
●	●	NY Bight: Hudson North
●	●	NY Bight: Hudson Central
●	●	Atlantic Shores: North
●	●	Atlantic Shores: South
□		OSS Location
●		Photo Point

TURBINE DATA



	Distance to the closest WTG (mi)	Distance to the farthest WTG (mi)
Empire Offshore Wind	21.7	29.6
New York Bight - Hudson North	24.3	32.1
New York Bight - Hudson Central	45.9	60.5

PHOTOGRAPH INFORMATION

Viewpoint Location:	Fire Island Lighthouse
Date of Photograph:	February 10, 2022
Time of Photograph:	9:20 AM
Weather Condition:	Partly Cloudy
Temperature	35° F
Humidity	96%
Latitude:	40.632216° N
Longitude:	-73.218455° W

	Type	Brand	Model
Camera	Mirrorless	Nikon	Z6
Lens	NIKKOR Z 50mm f/1.8		
Focal Length	50 mm		
Viewing Direction:	South		
Ground Elevation + Tripod Height:	160 feet		

*The image on this page approximates the full horizontal and vertical field-of-view of typical human eyesight (124° horizontal by 55° vertical)

SIMULATION 1A.1: EMPIRE WIND

Simulation illustrating Empire Wind without other foreseeable future changes

COMPLETE PANORAMIC VIEW

SIMULATION 1A.2: EMPIRE WIND + NY BIGHT

Simulation illustrating full lease buildout showing foreseeable projects located in leased areas with Empire Wind

COMPLETE PANORAMIC VIEW

SIMULATION 1A.2: EMPIRE WIND + NY BIGHT *(Annotated)*

Simulation illustrating full lease buildout showing foreseeable projects located in leased areas with Empire Wind. NY Bight Hudson Central is not present in this view.

COMPLETE PANORAMIC VIEW

SIMULATION 1A.3: NY BIGHT

Simulation illustrating full lease buildout not including Empire Wind

COMPLETE PANORAMIC VIEW

SIMULATION 1A.3: NY BIGHT *(Annotated)*

Simulation illustrating full lease buildout not including Empire Wind. NY Bight Hudson Central is not present in this view.

COMPLETE PANORAMIC VIEW

SIMULATION 1B.1: EMPIRE WIND

Simulation illustrating Empire Wind without other foreseeable future changes

COMPLETE PANORAMIC VIEW

KOP 1 B

SIMULATION 1B.2: EMPIRE WIND + NY BIGHT

Simulation illustrating full lease buildout showing foreseeable projects located in leased areas with Empire Wind

COMPLETE PANORAMIC VIEW

SIMULATION 1B.2: EMPIRE WIND + NY BIGHT *(Annotated)*

Simulation illustrating full lease buildout showing foreseeable projects located in leased areas with Empire Wind

COMPLETE PANORAMIC VIEW

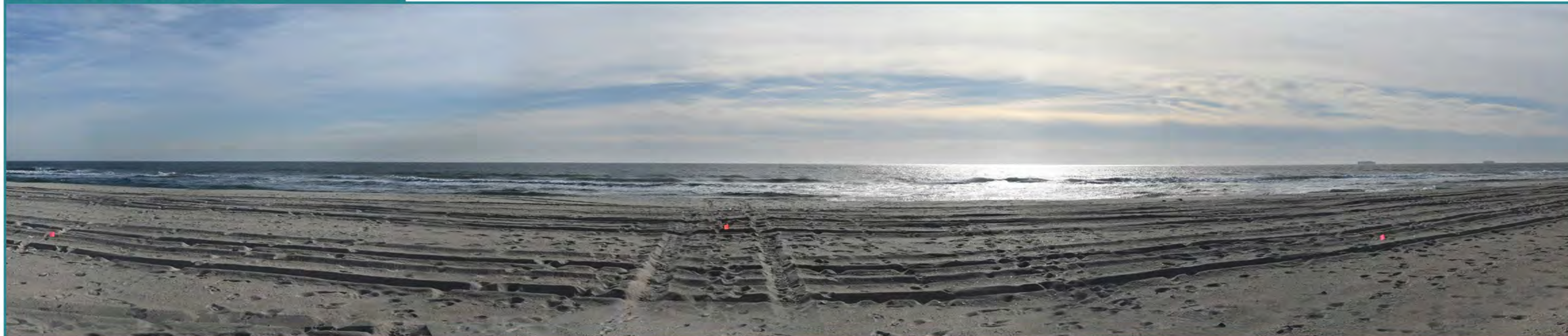
SIMULATION 1B.3: NY BIGHT

Simulation illustrating full lease buildout not including Empire Wind

COMPLETE PANORAMIC VIEW

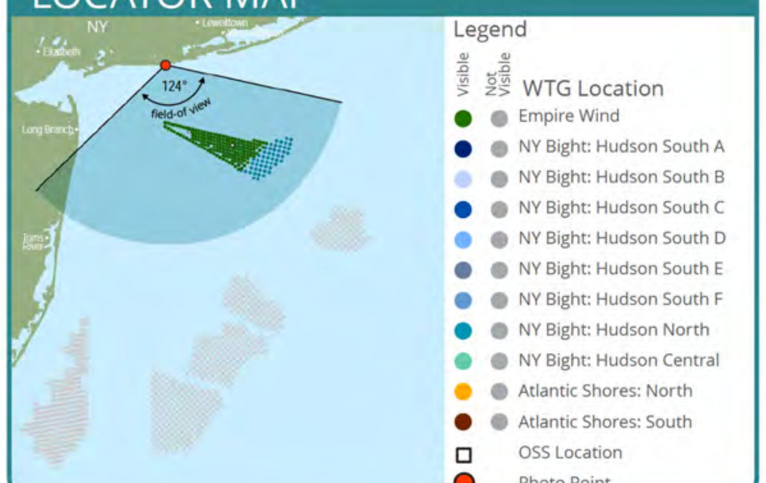
KOP 2

EXISTING CONDITION

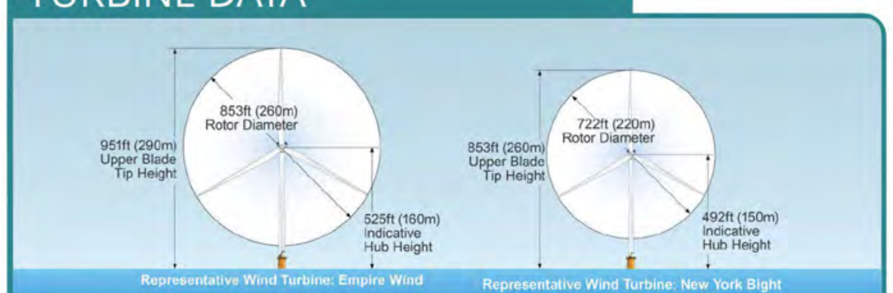


View of the existing condition at Jones Beach State Park

LOCATOR MAP



TURBINE DATA



	Distance to the closest WTG (mi)	Distance to the farthest WTG (mi)
Empire Offshore Wind	14.25	31.8
New York Bight - Hudson North	31.9	37.1

PHOTOGRAPH INFORMATION

Viewpoint Location:	Jones Beach State Park
Date of Photograph:	December 17, 2021
Time of Photograph:	11:12AM
Weather Condition:	Partly Cloudy
Temperature	58° F
Humidity	17%
Latitude:	40.580436° N
Longitude:	-73.55644° W

	Type	Brand	Model
Camera	Mirrorless	Nikon	Z6

Lens	NIKKOR Z 50mm f/1.8
Focal Length	50 mm
Viewing Direction:	South
Ground Elevation + Tripod Height:	16.5 feet

*The image on this page approximates the full horizontal field-of-view of typical human eyesight (124° horizontal)

SIMULATION 2A.1: EMPIRE WIND

Simulation illustrating Empire Wind without other foreseeable future changes

*The simulation image includes approximately 62° horizontal field of view.

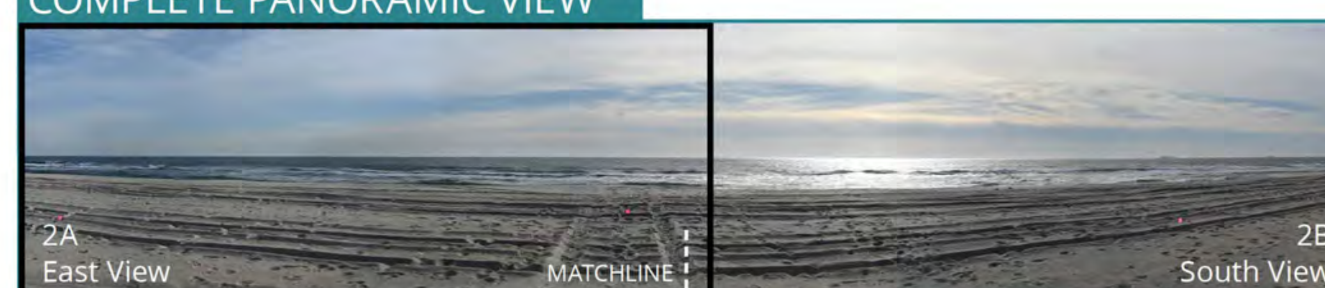
COMPLETE PANORAMIC VIEW

SIMULATION 2A.2: EMPIRE WIND + NY BIGHT

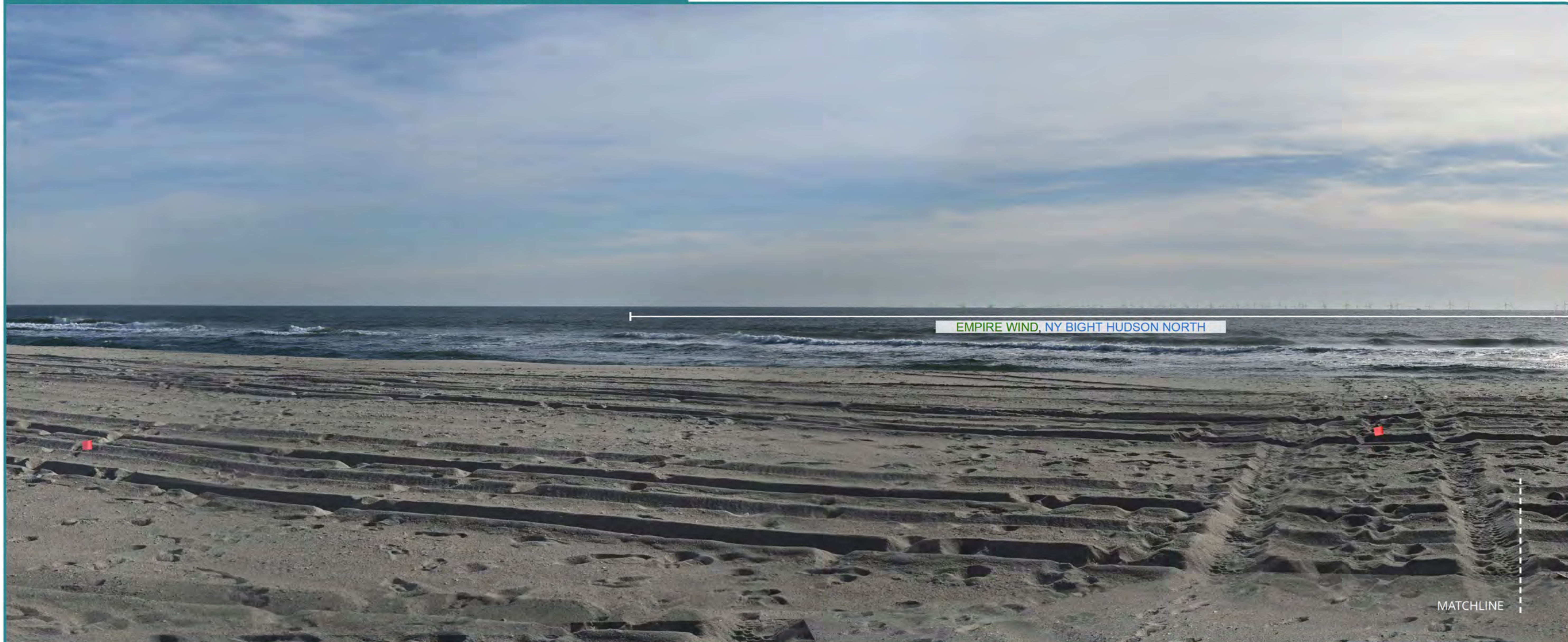
Simulation illustrating full lease buildout showing foreseeable projects located in leased areas with Empire Wind

*The simulation image includes approximately 62° horizontal field of view.

COMPLETE PANORAMIC VIEW



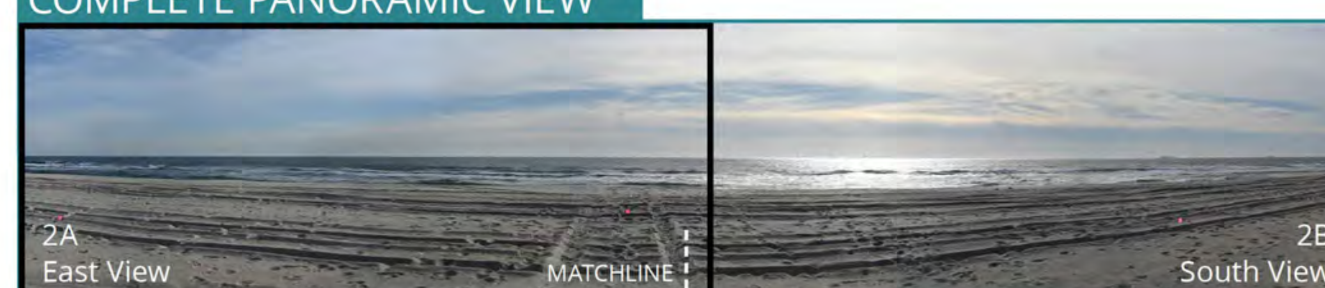
SIMULATION 2A.2: EMPIRE WIND + NY BIGHT *(Annotated)*



Simulation illustrating full lease buildout showing foreseeable projects located in leased areas with Empire Wind

*The simulation image includes approximately 62° horizontal field of view.

COMPLETE PANORAMIC VIEW



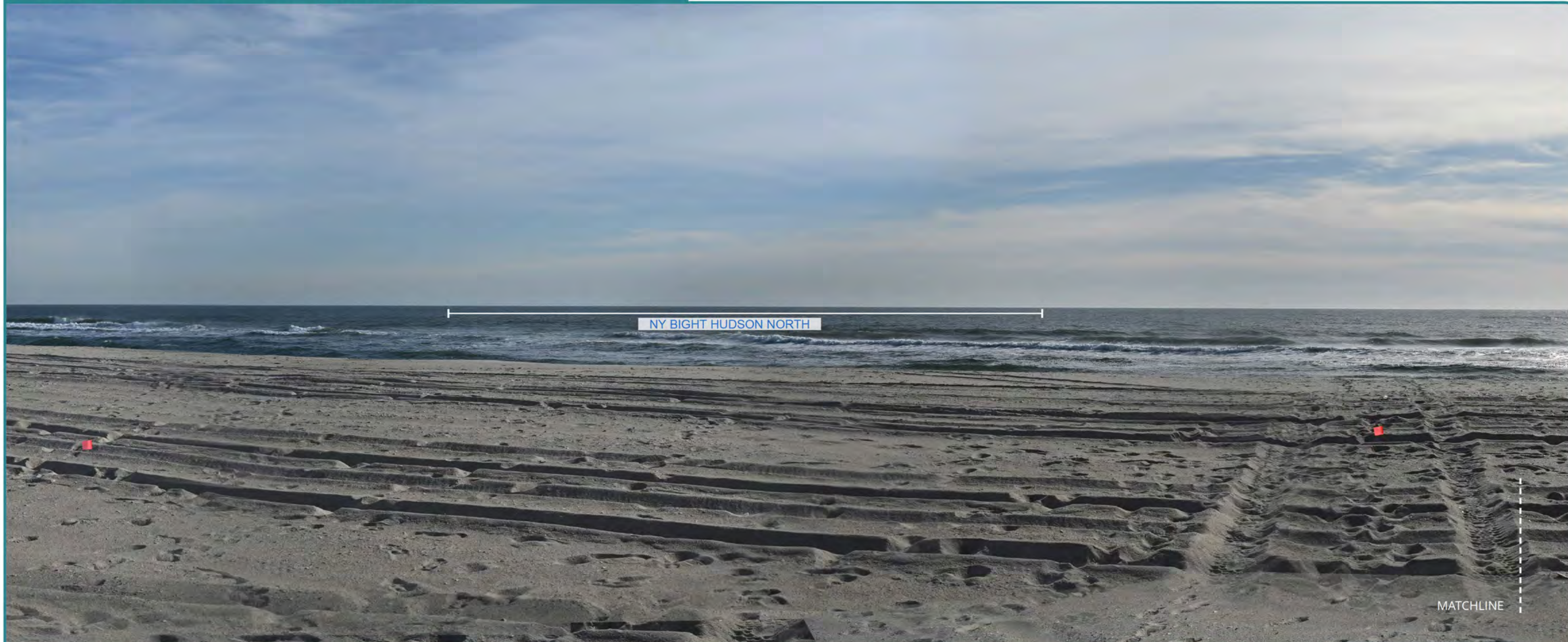
SIMULATION 2A.3: NY BIGHT

Simulation illustrating full lease buildout not including Empire Wind

*The simulation image includes approximately 62° horizontal field of view.

COMPLETE PANORAMIC VIEW

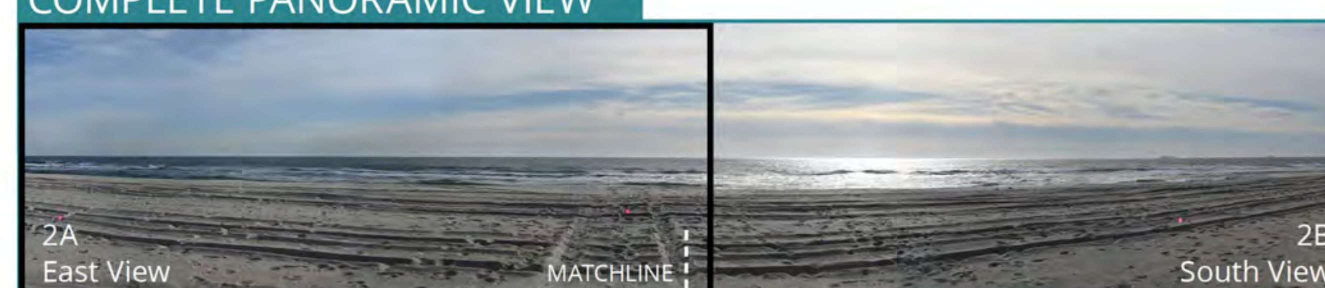
SIMULATION 2A.3: NY BIGHT *(Annotated)*



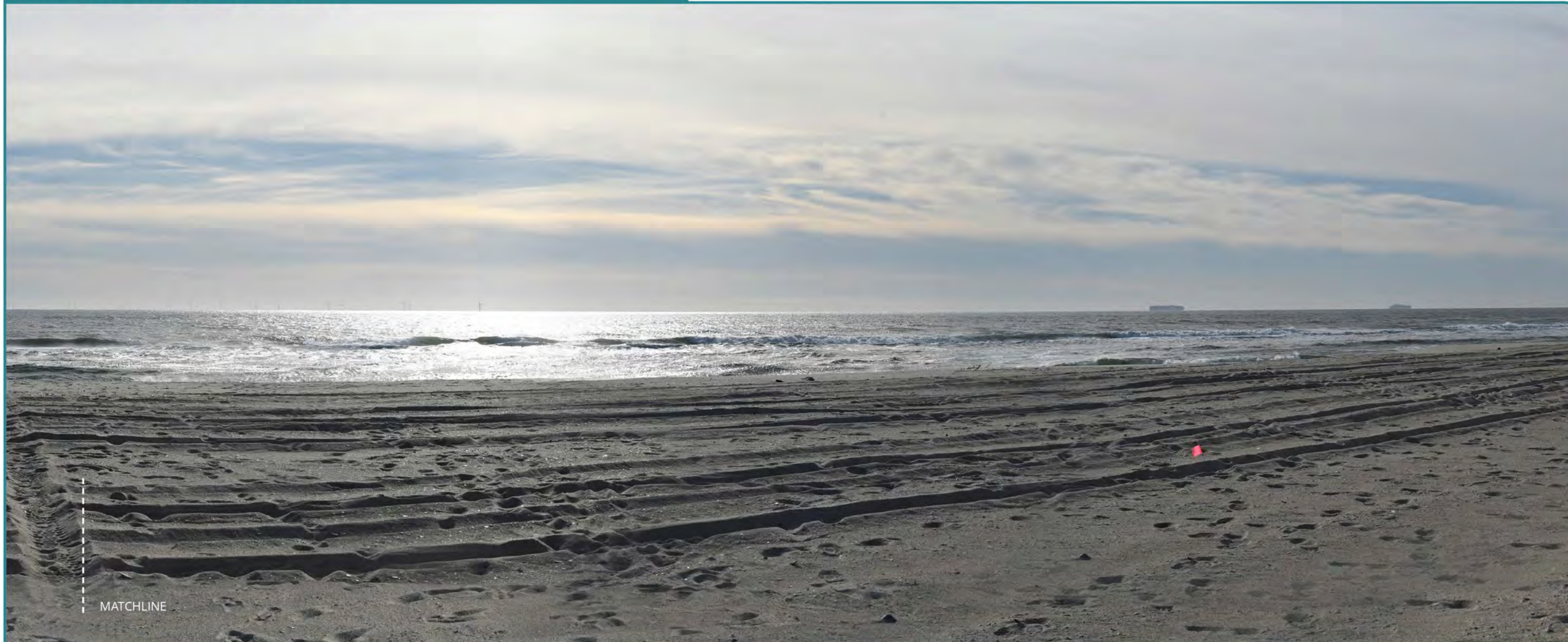
Simulation illustrating full lease buildout not including Empire Wind

*The simulation image includes approximately 62° horizontal field of view.

COMPLETE PANORAMIC VIEW



SIMULATION 2B.1: EMPIRE WIND

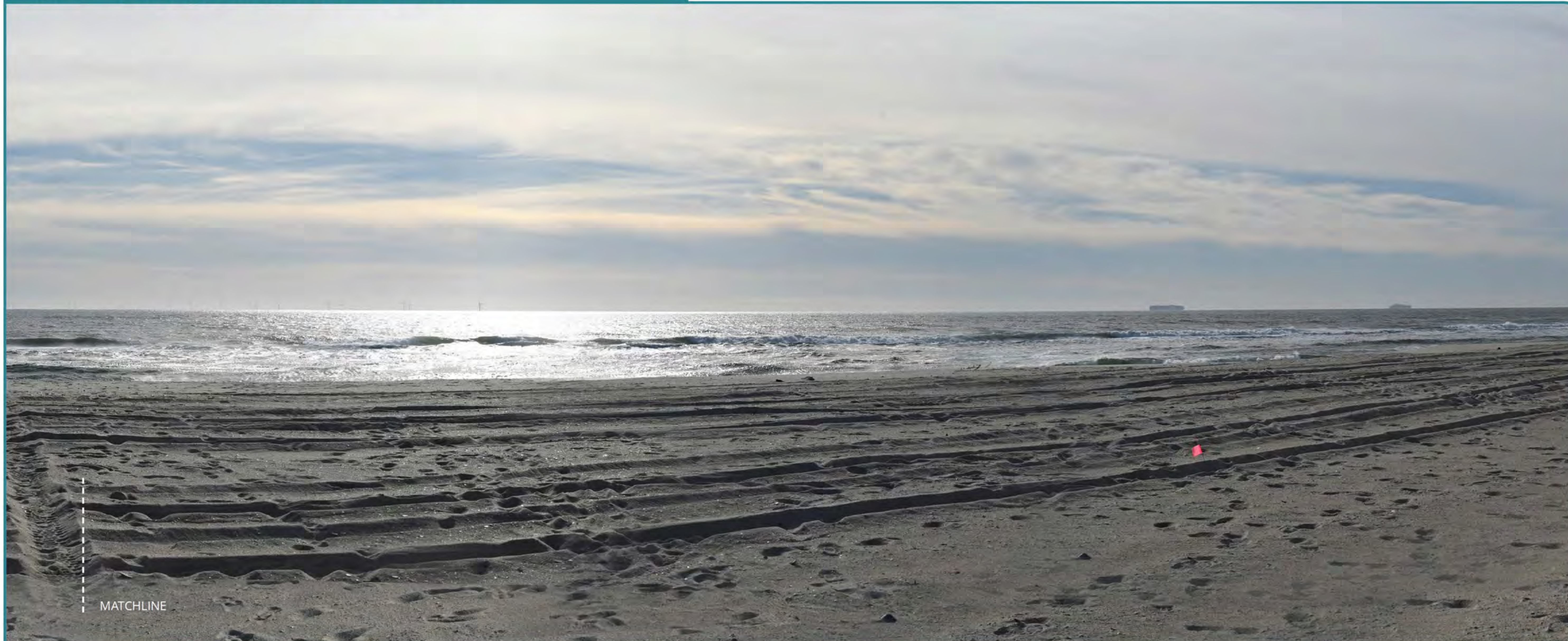


Simulation illustrating Empire Wind without other foreseeable future changes

*The simulation image includes approximately 62° horizontal field of view.

COMPLETE PANORAMIC VIEW

SIMULATION 2B.2: EMPIRE WIND + NY BIGHT

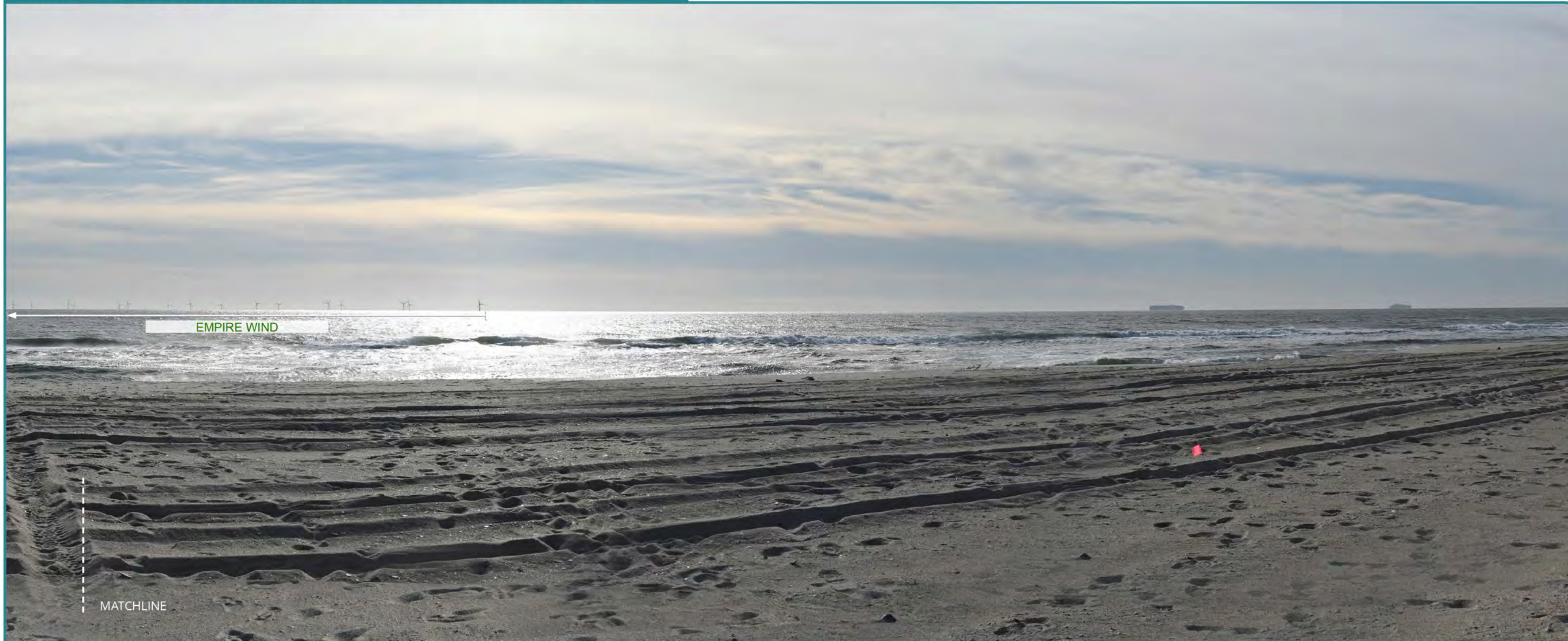


Simulation illustrating full lease buildout showing foreseeable projects located in leased areas with Empire Wind

*The simulation image includes approximately 62° horizontal field of view.

COMPLETE PANORAMIC VIEW

SIMULATION 2B.2: EMPIRE WIND + NY BIGHT *(Annotated)*

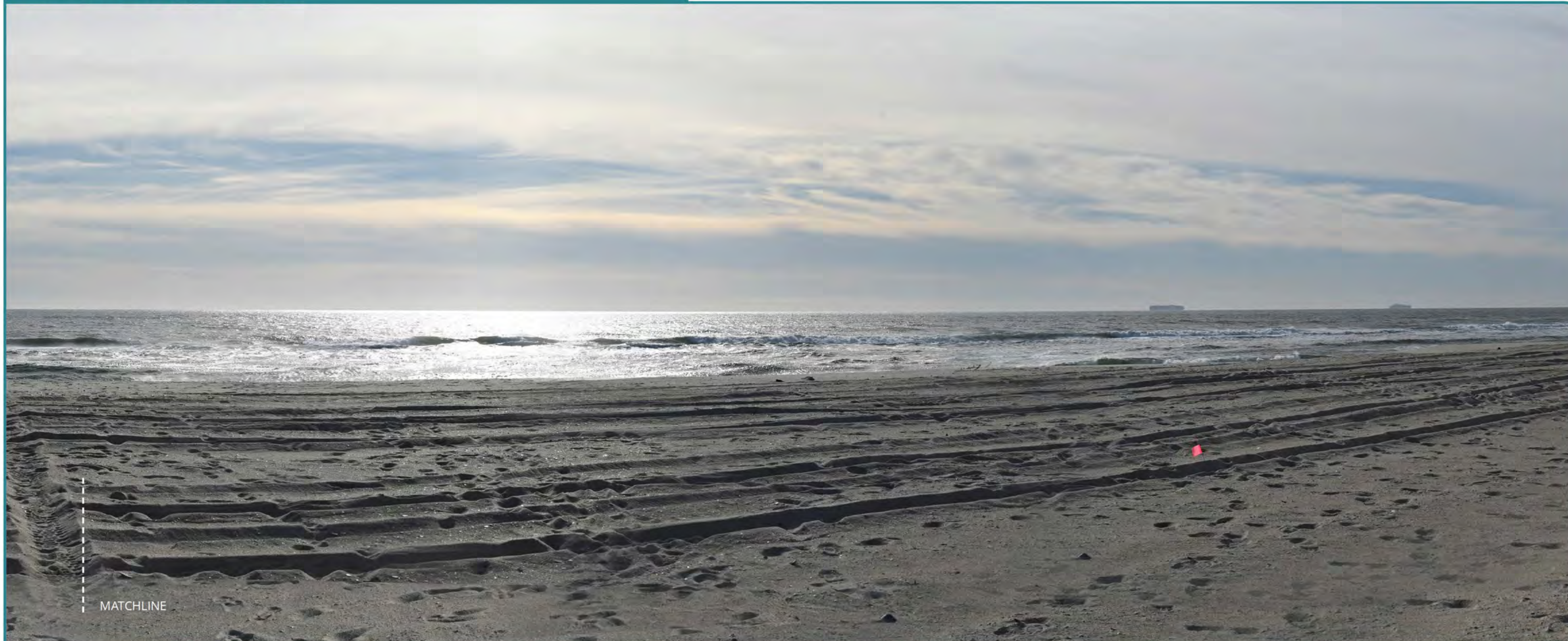


Simulation illustrating full lease buildout showing foreseeable projects located in leased areas with Empire Wind

*The simulation image includes approximately 62° horizontal field of view.

COMPLETE PANORAMIC VIEW

SIMULATION 2B.3: NY BIGHT

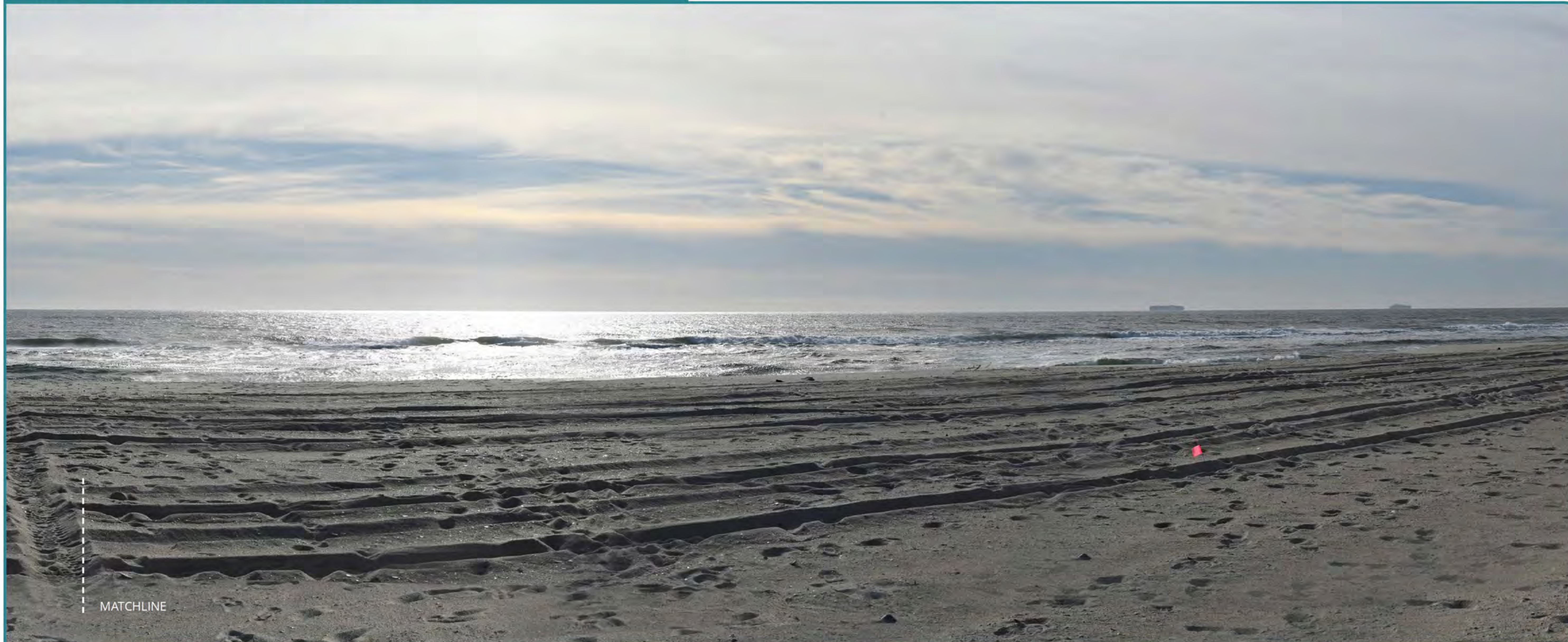


Simulation illustrating full lease buildout not including Empire Wind

*The simulation image includes approximately 62° horizontal field of view.

COMPLETE PANORAMIC VIEW

SIMULATION 2B.3: NY BIGHT *(Annotated)*



Simulation illustrating full lease buildout not including Empire Wind

*The simulation image includes approximately 62° horizontal field of view.

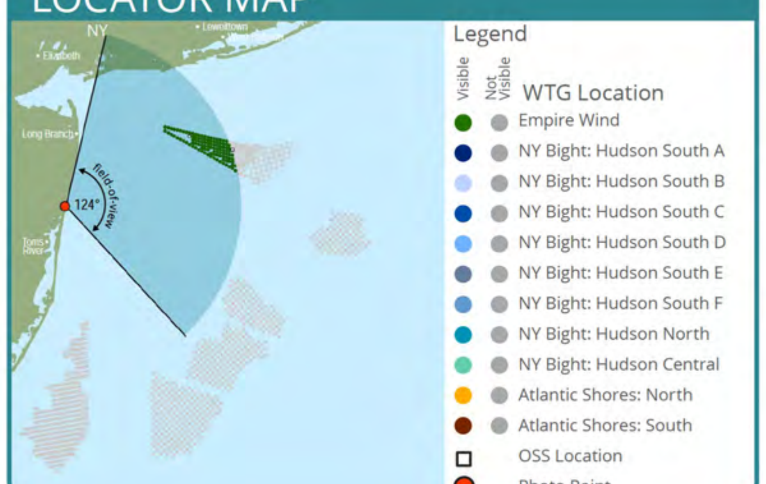
COMPLETE PANORAMIC VIEW

EXISTING CONDITION: NORTHEAST VIEW

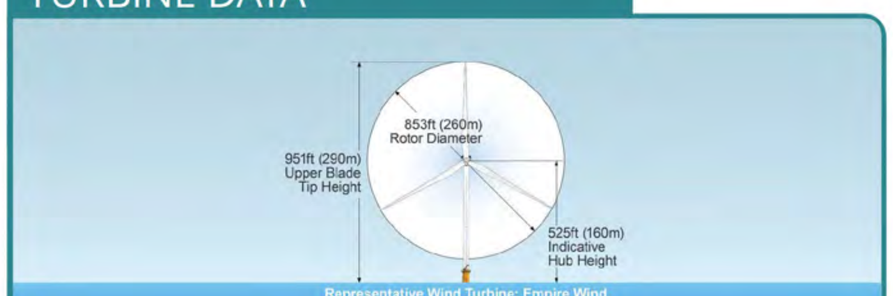
KOP 3

View of the existing condition at Point Pleasant Beach

LOCATOR MAP



TURBINE DATA



	Distance to the closest WTG (mi)	Distance to the farthest WTG (mi)
Empire Offshore Wind	31	51.88

PHOTOGRAPH INFORMATION

Viewpoint Location:	Point Pleasant Beach
Date of Photograph:	November 19, 2021
Time of Photograph:	1:00 PM
Weather Condition:	Partly Cloudy
Temperature	48° F
Humidity	37%
Latitude:	40.093589° N
Longitude:	-74.035308° W

	Type	Brand	Model
Camera	Mirrorless	Nikon	Z6
Lens	NIKKOR Z 50mm f/1.8		
Focal Length	50 mm		
Viewing Direction:	East/Northeast		
Ground Elevation + Tripod Height:	15 feet		

*The image on this page approximates the full horizontal and vertical field-of-view of typical human eyesight (124° horizontal by 55° vertical)

SIMULATION 3A.1: EMPIRE WIND

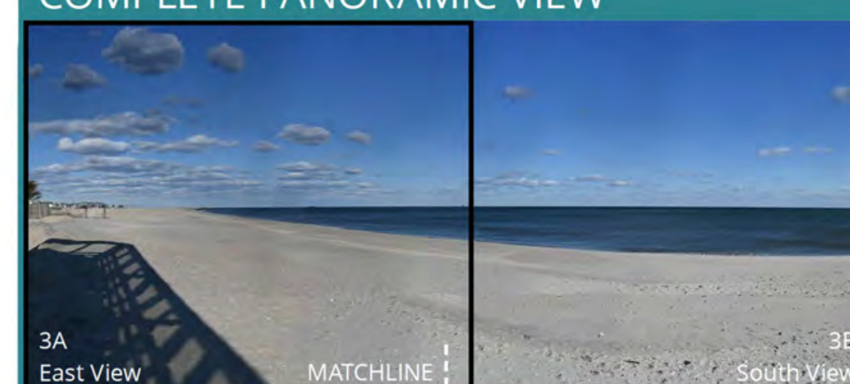
Simulation illustrating Empire Wind without other foreseeable future changes

COMPLETE PANORAMIC VIEW

SIMULATION 3A.1: EMPIRE WIND *(Annotated)*

Simulation illustrating Empire Wind without other foreseeable future changes

COMPLETE PANORAMIC VIEW



SIMULATION 3B.1: EMPIRE WIND

Simulation illustrating Empire Wind without other foreseeable future changes

COMPLETE PANORAMIC VIEW

SIMULATION 3B.1: EMPIRE WIND *(Annotated)*

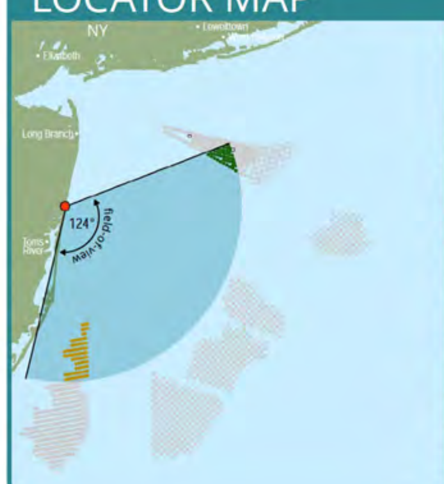
Simulation illustrating Empire Wind without other foreseeable future changes

COMPLETE PANORAMIC VIEW

EXISTING CONDITION: SOUTHEAST VIEW

View of the existing condition at Point Pleasant Beach

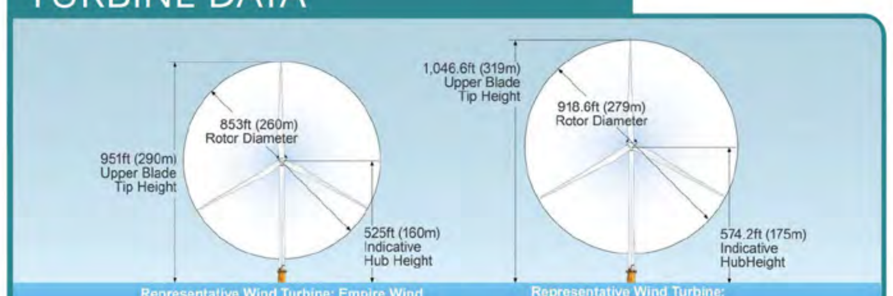
LOCATOR MAP



Legend

Visible	Not Visible	WTG Location
●	●	Empire Wind
●	●	NY Bight: Hudson South A
●	●	NY Bight: Hudson South B
●	●	NY Bight: Hudson South C
●	●	NY Bight: Hudson South D
●	●	NY Bight: Hudson South E
●	●	NY Bight: Hudson South F
●	●	NY Bight: Hudson North
●	●	NY Bight: Hudson Central
●	●	Atlantic Shores: North
●	●	Atlantic Shores: South
□		OSS Location
●		Photo Point

TURBINE DATA



	Distance to the closest WTG (mi)	Distance to the farthest WTG (mi)
Empire Offshore Wind	31	51.88
Atlantic Shores North	29.6	53

PHOTOGRAPH INFORMATION

Viewpoint Location:	Point Pleasant Beach
Date of Photograph:	November 19, 2021
Time of Photograph:	1:00 PM
Weather Condition:	Partly Cloudy
Temperature	48° F
Humidity	37%
Latitude:	40.093589° N
Longitude:	-74.035308° W

	Type	Brand	Model
Camera	Mirrorless	Nikon	Z6
Lens			NIKKOR Z 50mm f/1.8
Focal Length			50 mm
Viewing Direction:			Southeast
Ground Elevation + Tripod Height:			15 feet

*The image on this page approximates the full horizontal and vertical field-of-view of typical human eyesight (124° horizontal by 55° vertical)

SIMULATION 3C.1: EMPIRE WIND

Simulation illustrating Empire Wind without other foreseeable future changes. Empire Wind is not present in this view.

COMPLETE PANORAMIC VIEW

SIMULATION 3C.2: EMPIRE WIND + ATLANTIC SHORES

Simulation illustrating full lease buildout showing foreseeable projects with Empire Wind. Empire Wind and Atlantic Shores are not present in this view.

COMPLETE PANORAMIC VIEW

SIMULATION 3C.3: ATLANTIC SHORES

Simulation illustrating full lease buildout not including Empire Wind. Atlantic Shores is not present in this view.

COMPLETE PANORAMIC VIEW

SIMULATION 3D.1: EMPIRE WIND

Simulation illustrating Empire Wind without other foreseeable future changes. Empire Wind is not present in this view.

COMPLETE PANORAMIC VIEW

SIMULATION 3D.2: EMPIRE WIND + ATLANTIC SHORES

Simulation illustrating full lease buildout showing foreseeable projects located in Atlantic Shores with Empire Wind

COMPLETE PANORAMIC VIEW

SIMULATION 3D.2: EMPIRE WIND + ATLANTIC SHORES *(Annotated)*

Simulation illustrating full lease buildout showing foreseeable projects located in Atlantic Shores with Empire Wind

COMPLETE PANORAMIC VIEW

SIMULATION 3D.3: ATLANTIC SHORES

Simulation illustrating full lease buildout not including Empire Wind

COMPLETE PANORAMIC VIEW

SIMULATION 3D.3: ATLANTIC SHORES *(Annotated)*

Simulation illustrating full lease buildout not including Empire Wind

COMPLETE PANORAMIC VIEW

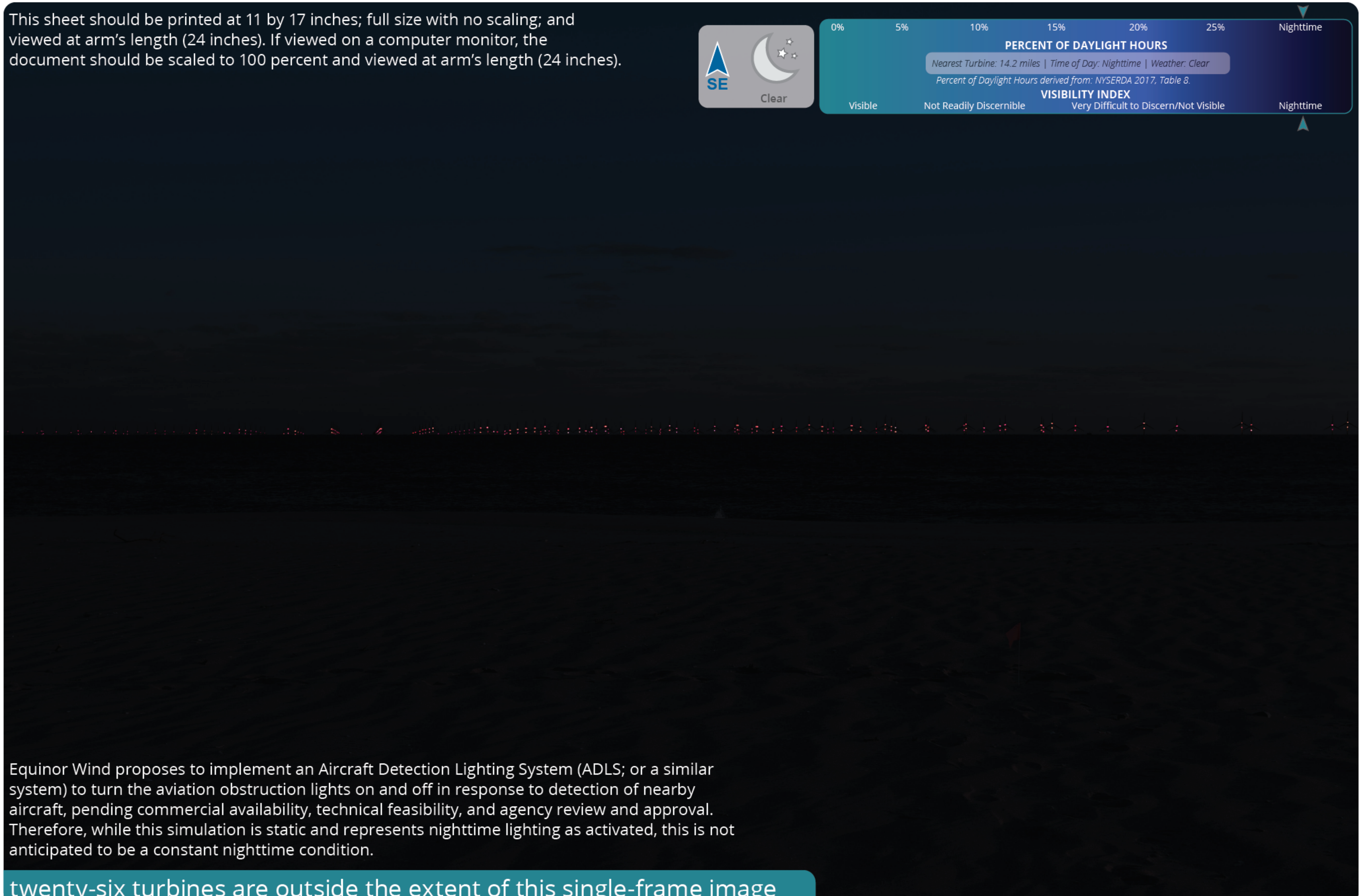
ATTACHMENT M-2
NIGHTTIME VISUAL SIMULATION

This page intentionally left blank.

Empire Offshore Wind: Empire Wind Project (EW 1 and EW 2)

Short Beach at Jones Beach State Park

This sheet should be printed at 11 by 17 inches; full size with no scaling; and viewed at arm's length (24 inches). If viewed on a computer monitor, the document should be scaled to 100 percent and viewed at arm's length (24 inches).

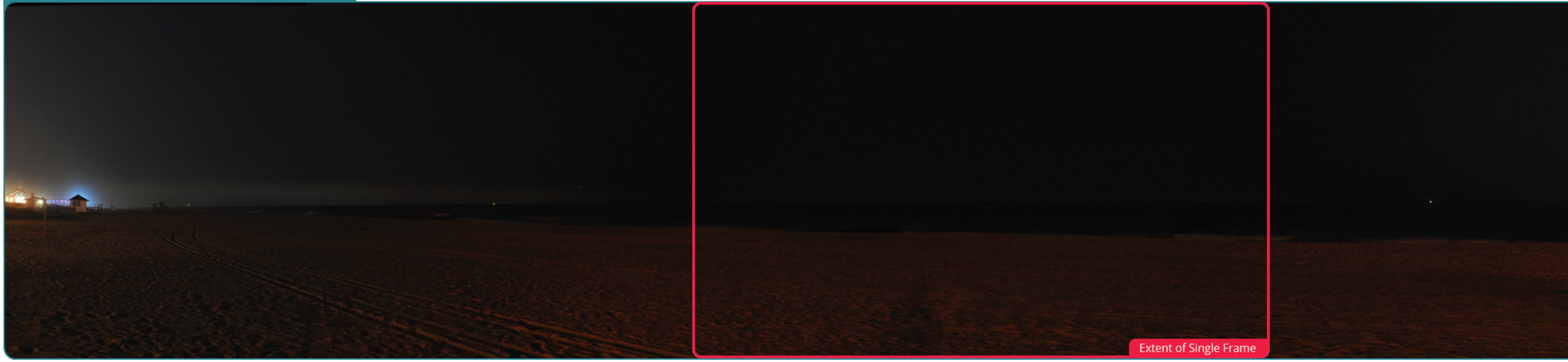


Equinor Wind proposes to implement an Aircraft Detection Lighting System (ADLS; or a similar system) to turn the aviation obstruction lights on and off in response to detection of nearby aircraft, pending commercial availability, technical feasibility, and agency review and approval. Therefore, while this simulation is static and represents nighttime lighting as activated, this is not anticipated to be a constant nighttime condition.

twenty-six turbines are outside the extent of this single-frame image

equinor

Panoramic Photograph

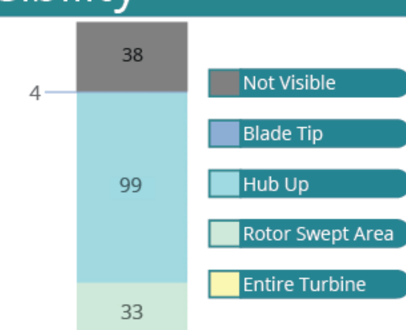


Vicinity Map

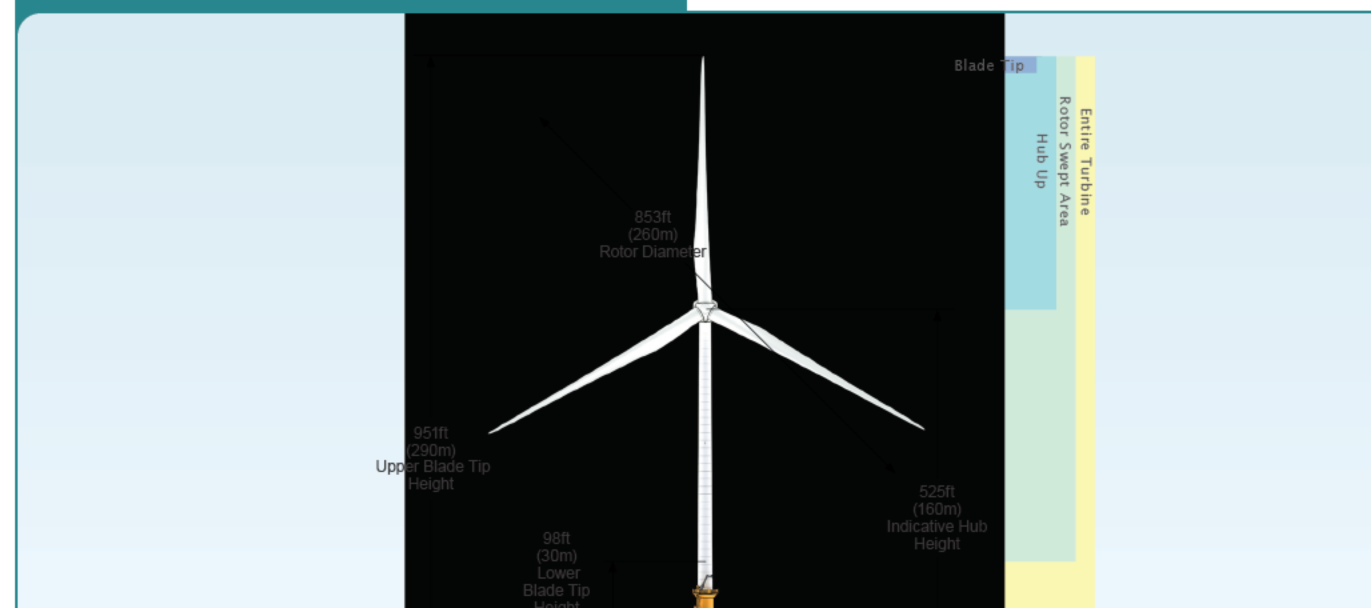
Photograph Information

Viewpoint Location:	Ocean Grove Beach
Date of Photograph:	September 10, 2019
Time of Photograph:	9:40 PM (EDT)
Weather Condition:	Clear
Latitude:	40.211768° N
Longitude:	-74.002643° W
Viewing Direction:	Northeast
Ground Elevation + Tripod Height:	15 feet

Turbine Visibility



Turbine Data



Representative Wind Turbine

Viewpoint Visibility	
Closest Visible Turbine	25.4 miles
Farthest Visible Turbine	48.5 miles
Structures Potentially Visible	136 of 174 total

*Fewer turbines may be visible in the simulation due to screening from topography or vegetation

equinor

This sheet should be printed at 11 by 17 inches; full size with no scaling; and viewed at arm's length (24 inches). If viewed on a computer monitor, the document should be scaled to 100 percent and viewed at arm's length (24 inches).

Equinor Wind proposes to implement an Aircraft Detection Lighting System (ADLS; or a similar system) to turn the aviation obstruction lights on and off in response to detection of nearby aircraft, pending commercial availability, technical feasibility, and agency review and approval. Therefore, while this simulation is static and represents nighttime lighting as activated, this is not anticipated to be a constant nighttime condition.

zero turbines are outside the extent of this single-frame image

Empire Offshore Wind: Empire Wind Project (EW 1 and EW 2)

Ocean Grove Beach

equinor

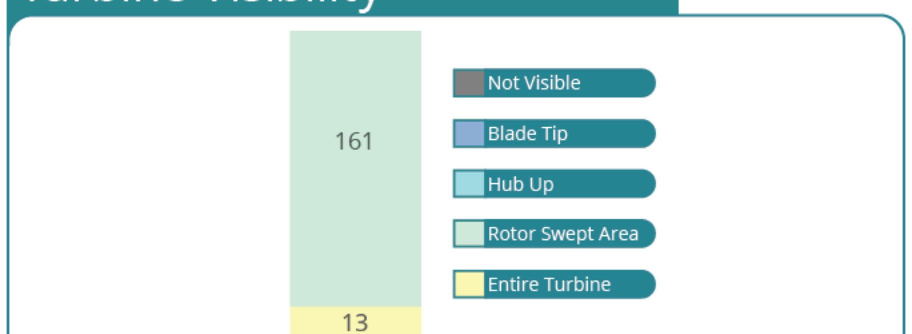
Panoramic Photograph

Vicinity Map

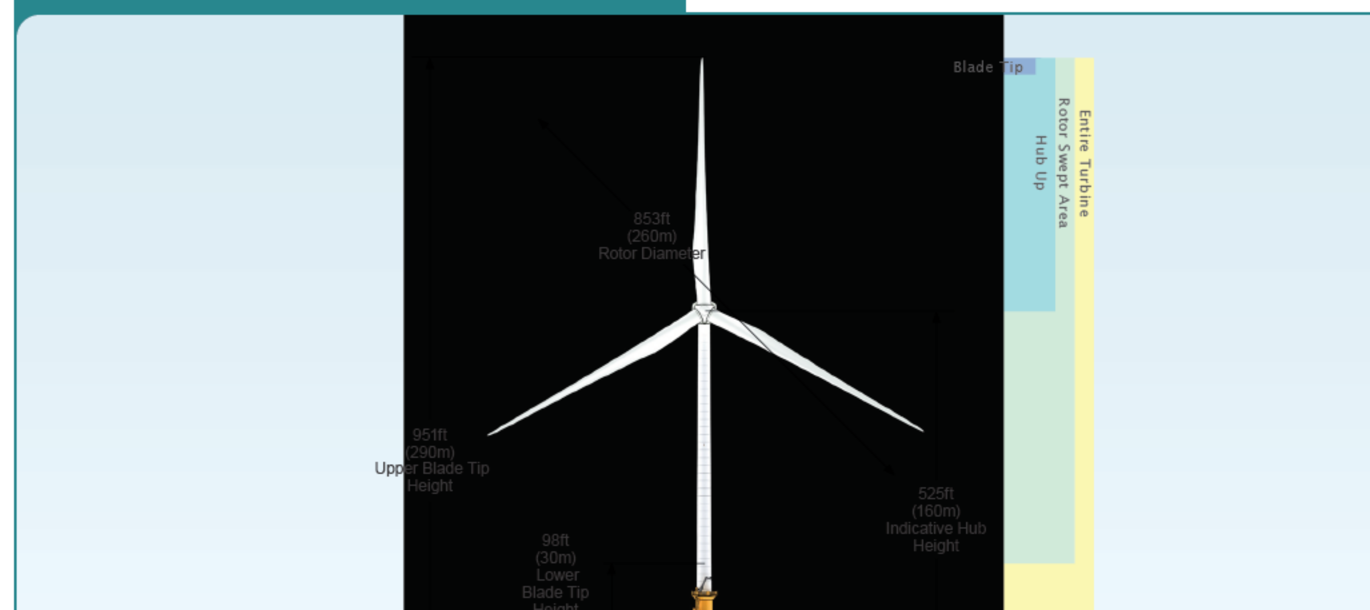
Photograph Information

Viewpoint Location:	Short Beach
Date of Photograph:	December 7, 2018
Time of Photograph:	3:30 PM (EDT)
Weather Condition:	Clear
Latitude:	40.580436° N
Longitude:	-73.55644° W
Viewing Direction:	Southeast
Ground Elevation + Tripod Height:	16 feet

Turbine Visibility



Turbine Data



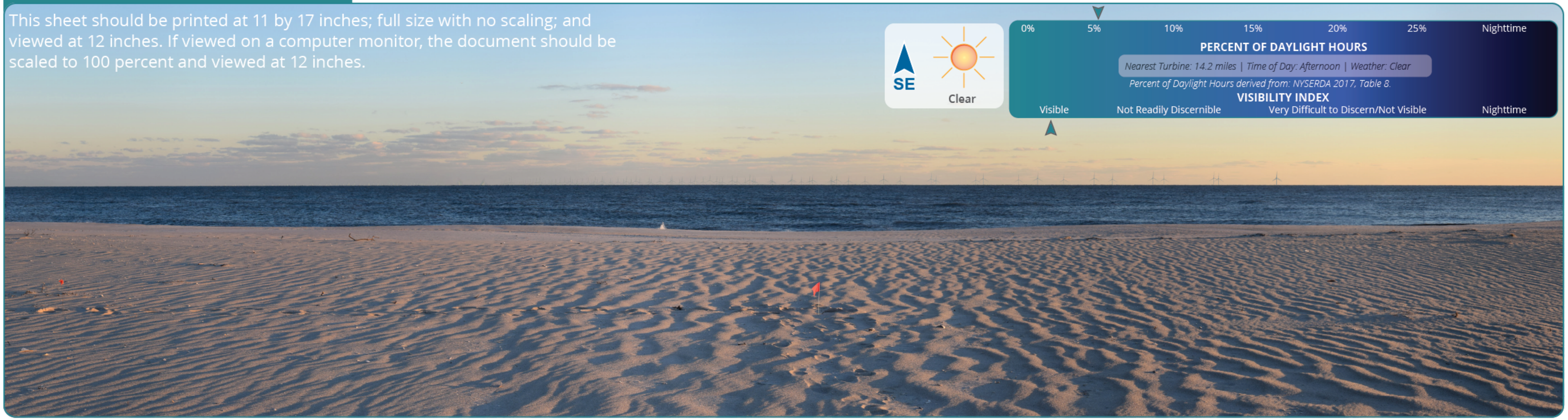
Representative Wind Turbine

Viewpoint Visibility	
Closest Visible Turbine	14.2 miles
Farthest Visible Turbine	31.8 miles
Structures Potentially Visible	174 of 174 total

*Fewer turbines may be visible in the simulation due to screening from topography or vegetation

Panoramic Simulation

This sheet should be printed at 11 by 17 inches; full size with no scaling; and viewed at 12 inches. If viewed on a computer monitor, the document should be scaled to 100 percent and viewed at 12 inches.



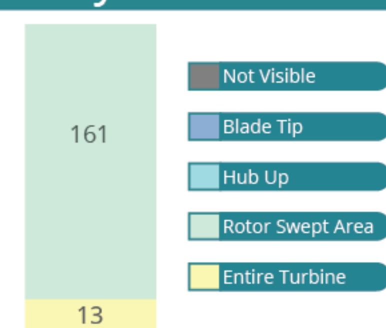
Panoramic Photograph

Vicinity Map

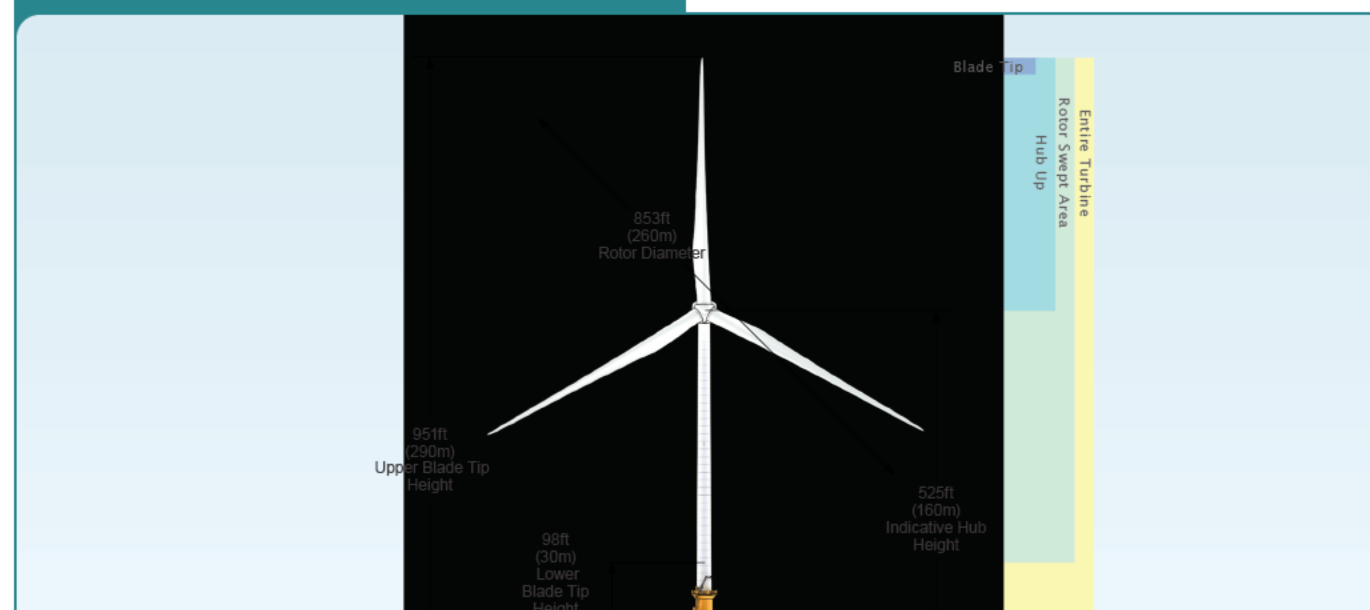
Photograph Information

Viewpoint Location:	Short Beach
Date of Photograph:	December 7, 2018
Time of Photograph:	Night (simulated)
Weather Condition:	Clear
Latitude:	40.580436° N
Longitude:	-73.55644° W
Viewing Direction:	Southeast
Ground Elevation + Tripod Height:	16 feet

Turbine Visibility



Turbine Data



Representative Wind Turbine

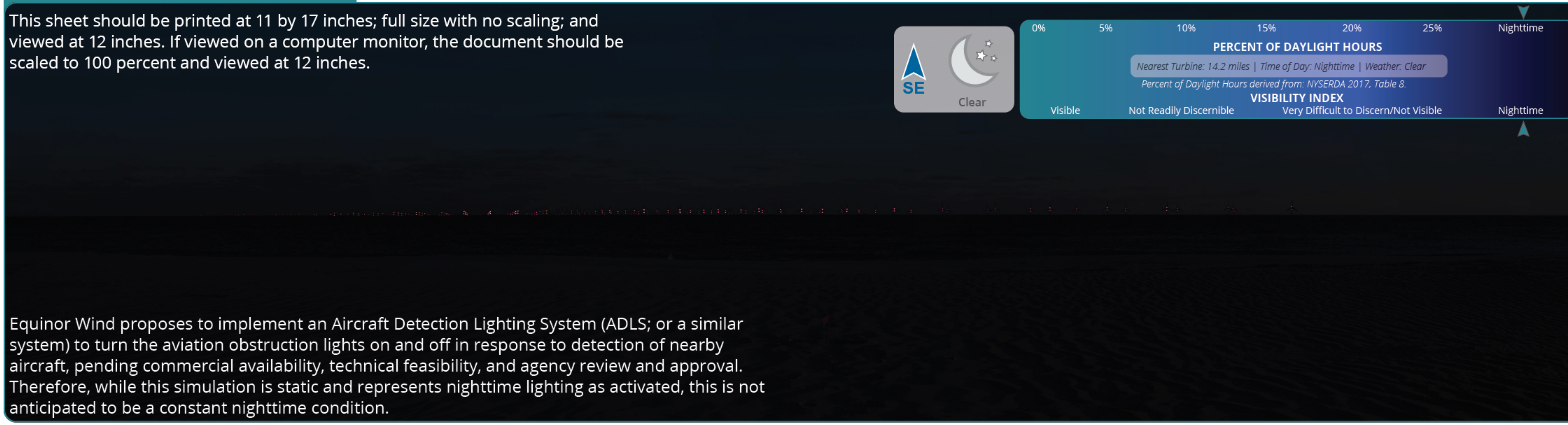
Viewpoint Visibility	
Closest Visible Turbine	14.2 miles
Farthest Visible Turbine	31.8 miles
Structures Potentially Visible	174 of 174 total

*Fewer turbines may be visible in the simulation due to screening from topography or vegetation

equinor

Panoramic Simulation

This sheet should be printed at 11 by 17 inches; full size with no scaling; and viewed at 12 inches. If viewed on a computer monitor, the document should be scaled to 100 percent and viewed at 12 inches.



Equinor Wind proposes to implement an Aircraft Detection Lighting System (ADLS; or a similar system) to turn the aviation obstruction lights on and off in response to detection of nearby aircraft, pending commercial availability, technical feasibility, and agency review and approval. Therefore, while this simulation is static and represents nighttime lighting as activated, this is not anticipated to be a constant nighttime condition.

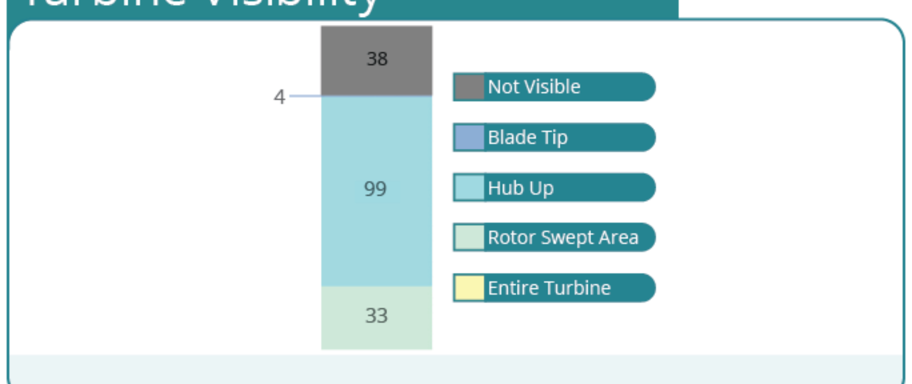
Panoramic Photograph

Vicinity Map

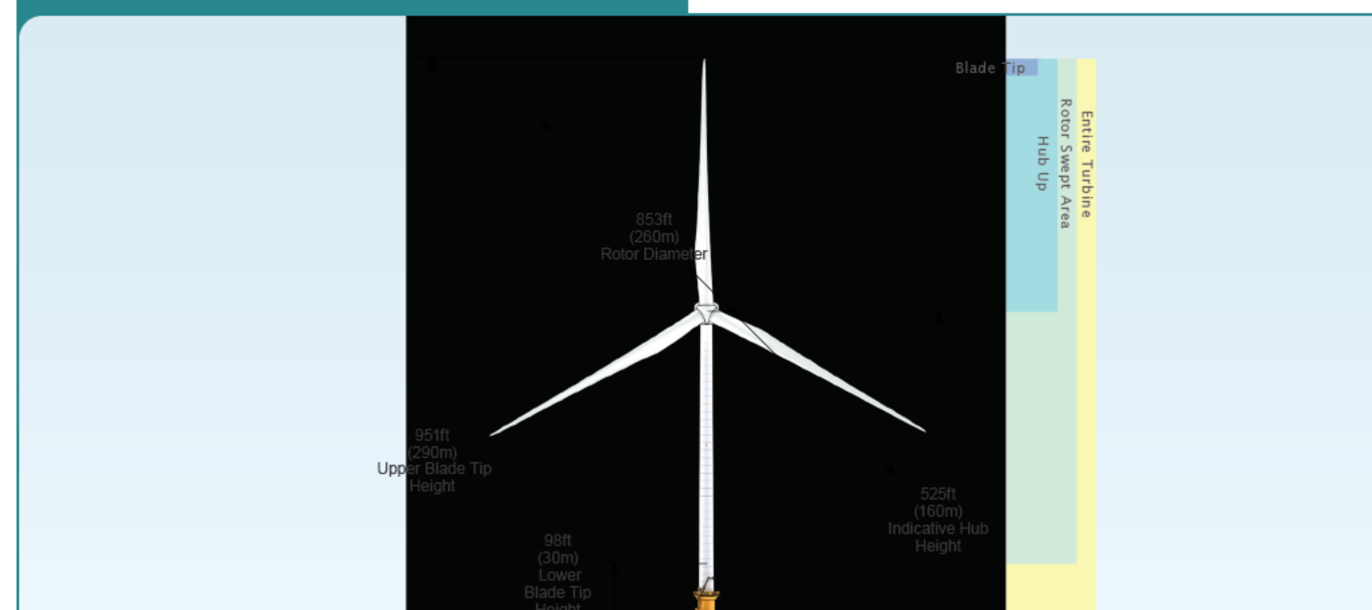
Photograph Information

Viewpoint Location:	Ocean Grove Beach
Date of Photograph:	November 11, 2018
Time of Photograph:	2:35 PM (EDT)
Weather Condition:	Clear
Latitude:	40.211317° N
Longitude:	-74.002595° W
Viewing Direction:	Northeast
Ground Elevation + Tripod Height:	15 feet

Turbine Visibility



Turbine Data



Representative Wind Turbine

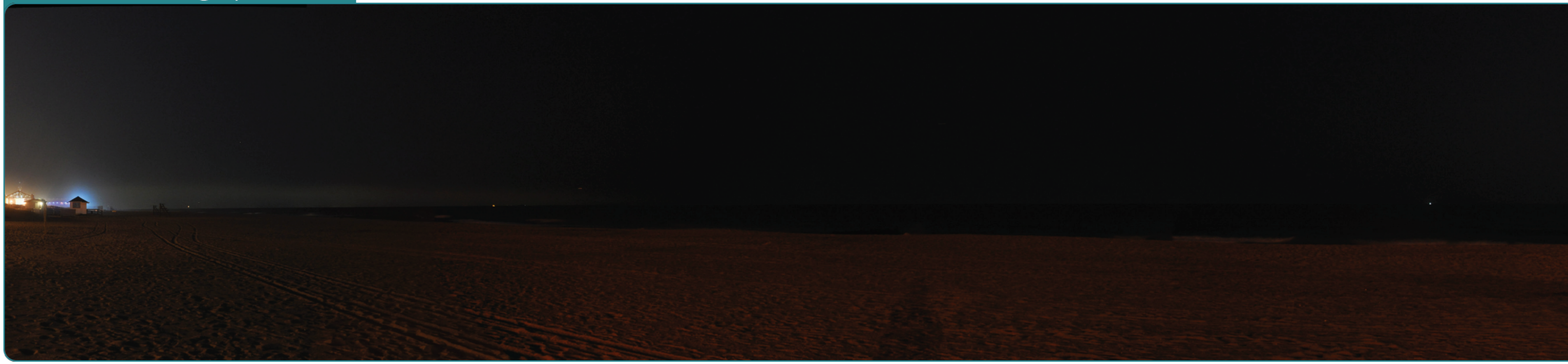
Viewpoint Visibility	
Closest Visible Turbine	25.4 miles
Farthest Visible Turbine	48.5 miles
Structures Potentially Visible	136 of 174 total

*Fewer turbines may be visible in the simulation due to screening from topography or vegetation

Panoramic Simulation

This sheet should be printed at 11 by 17 inches; full size with no scaling; and viewed at 12 inches. If viewed on a computer monitor, the document should be scaled to 100 percent and viewed at 12 inches.

Panoramic Photograph

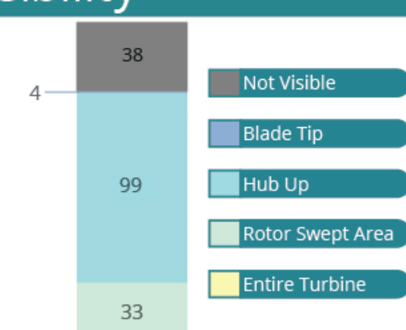


Vicinity Map

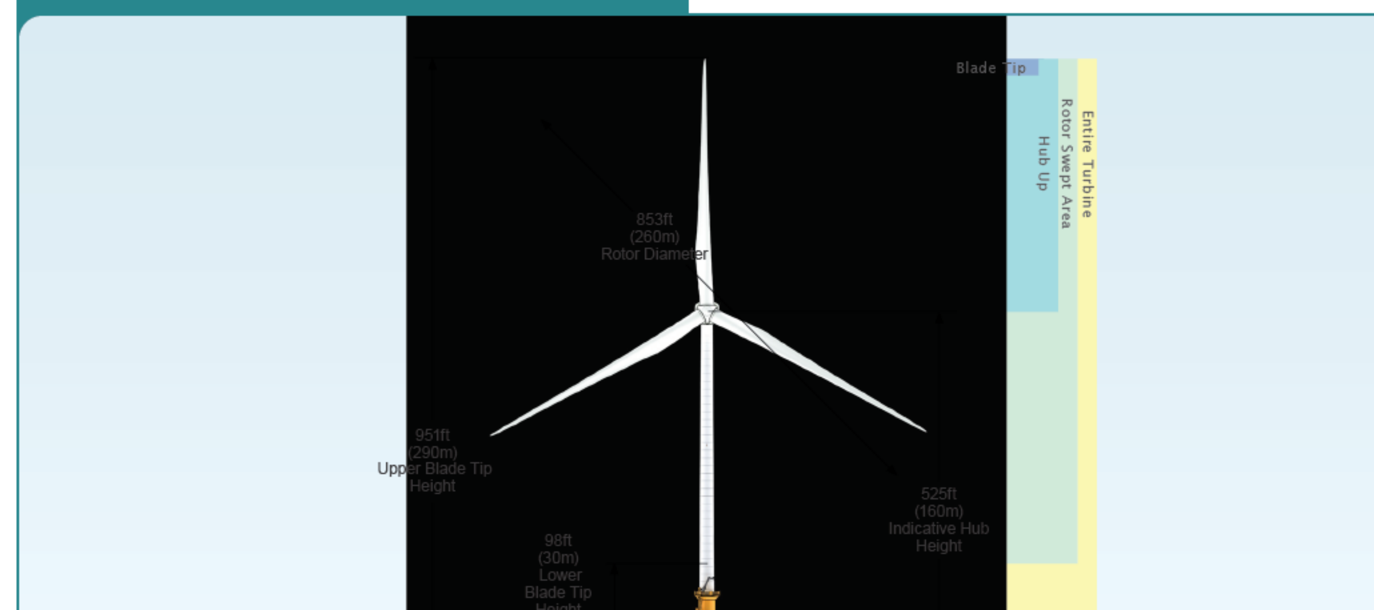
Photograph Information

Viewpoint Location:	Ocean Grove Beach
Date of Photograph:	September 10, 2019
Time of Photograph:	9:40 PM (EDT)
Weather Condition:	Clear
Latitude:	40.211768° N
Longitude:	-74.002643° W
Viewing Direction:	Northeast
Ground Elevation + Tripod Height:	15 feet

Turbine Visibility



Turbine Data



Representative Wind Turbine

Viewpoint Visibility	
Closest Visible Turbine	25.4 miles
Farthest Visible Turbine	48.5 miles
Structures Potentially Visible	136 of 174 total

*Fewer turbines may be visible in the simulation due to screening from topography or vegetation

equinor

Panoramic Simulation

This sheet should be printed at 11 by 17 inches; full size with no scaling; and viewed at 12 inches. If viewed on a computer monitor, the document should be scaled to 100 percent and viewed at 12 inches.

Equinor Wind proposes to implement an Aircraft Detection Lighting System (ADLS; or a similar system) to turn the aviation obstruction lights on and off in response to detection of nearby aircraft, pending commercial availability, technical feasibility, and agency review and approval. Therefore, while this simulation is static and represents nighttime lighting as activated, this is not anticipated to be a constant nighttime condition.