ESSENTIAL FISH HABITAT ASSESSMENT FOR SUNRISE WIND OFFSHORE WIND PROJECT

FOR THE NATIONAL MARINE FISHERIES SERVICE

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

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Acronyms and Abbreviations

AC	alternating current
ACCOL	Anderson Cabot Center for Ocean Life
ADCPs	Acoustic Doppler Current Profilers
AELs	adult equivalent losses
AIF	average intake flow
AIS	automatic identification system
AMSL	above mean sea level
APM	Applicant Proposed Measures
BACI	Before-After-Control-Impact
BOEM	Bureau of Ocean Energy Management
CFE	controlled flow excavation
CFF	Coonamessett Farm Foundation
CFR	Code of Federal Regulations
CFRF	Commercial Fisheries Research Foundation
cm	centimeter
CMECS	Coastal and Marine Ecological Classification Standard
COP	Construction and Operations Plan
CORMIX	Cornell Mixing Zone Expert System
CPA	Connecticut Port Authority
CT	Connecticut
CTV	crew transfer vessel
CVs	coefficient of variations
CWIS	cooling water intake system
dB	decibels
DC	direct current
DEEP	Department of Energy and Environmental Protection
DIF	Design Intake Flow
EcoMon	Ecosystem Monitoring
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
EIS	Environmental Impact Statement
ELMR	Estuarine Living Marine Resources
EMF	electromagnetic field
EPA	Environmental Protection Agency

EPM	environmental protection measure
FMP	Fishery Management Plan
ft	foot or feet
ft/s	feet per second
g	grams
gal	gallons
HAPC	Habitat Areas of Particular Concern
HDD	horizontal directional drilling
HMS	highly migratory species
IAC	inter-array cable
ICW	Intercoastal waterway
in	inch
kg	kilograms
kHz	kilohertz
kJ	kilojoule
km	kilometer
kV	kilovolt
L	liters
LAT	lowest astronomical tide
L_E	sound exposure level
LIE	Long Island Expressway
LIPA	Long Island Power Authority
LMSL	local mean sea level
L_p	sound pressure level
Lpk	peak sound pressure level
m	meter
$m\ s^{-1}$	meter(s) per second
$m\ s^{-2}$	meter(s) per squared second
m/s	meters per second
MA	Massachusetts
MAFMC	Mid-Atlantic Fisheries Management Council
MARMAP	marine resource monitoring, assessment, and prediction
MBES	multibeam echo sounding
MCDA	multi-criteria decision algorithm
MD	Maryland
MEC	munition and explosives of concern

MGD	million gallons per day
MHHW	mean higher high water
MHWL	mean high water line
mi	mile
mm	millimeter
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NAS	Noise Attenuation Systems
NCCW	non-contact cooling water
NCEI	National Centers for Environmental Information
NEAMAP	Northeast Area Monitoring and Assessment Program
NEFMC	New England Fishery Management Council
NJ	New Jersey
nm	nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NY	New York
O&M	operations and maintenance
OCS	Outer Continental Shelf
OCS-DC	Offshore Converter Station
OECC	offshore export cable corridor
OnCS-DC	onshore converter station
OSS	offshore substation
PSO	protected species observer
PTS	permanent threshold shift
RARMS	risk assessment with risk mitigation strategy
RI	Rhode Island
RI-MA	Rhode Island-Massachusetts
ROV	remotely operated vehicle
RWF	Revolution Wind Farm
SAV	submerged aquatic vegetation
SCADA	supervisory control and data acquisition
SHPO	State Historic Preservation Office
SMAST	University of Massachusetts Dartmouth School for Marine Science and Technology
SOV	service operating vessel

SPI/PV	sediment profile and plan view imaging
SPL	sound pressure level
SPL_{peak}	peak sound pressure level
SPL_{RMS}	root-mean-square sound pressure level
SRWEC	Sunrise Wind Export Cable
SRWF	Sunrise Wind Farm
TJB	Transition Joint Bay
TOPSIS	Technique for Order Preference by Similarity of Ideal Solution
TP	transition piece
TTS	temporary threshold shift
U.S.	United States
USACE	United States Army Corp of Engineers
UXO	unexploded ordinances
VA	Virginia
VFD	variable frequency drive
WDA	wind development area
WEA	wind energy area
WTG	wind turbine generator
ΔT	temperature differential
μPa	microPascal
°C	degrees Celsius
°F	degrees Fahrenheit

1.0 Introduction

In the Magnuson-Stevens Fishery Conservation and Management Act (MSA), Congress recognized that one of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats. Congress also determined that habitat considerations should receive increased attention for the conservation and management of fishery resources in the United States. As a result, one of the purposes of the MSA is to promote the protection of Essential Fish Habitat (EFH) in the review of projects conducted under federal permits, licenses, or other authorities that affect, or have the potential to affect, such habitat.

The MSA requires federal agencies to consult with the Secretary of Commerce, through the National Marine Fisheries Service (NMFS), with respect to “any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this Act,” 16 U.S.C. § 1855(b)(2). This process is guided by the requirements of the EFH regulation at 50 CFR 600.905. In April 2009, the Department of Interior (DOI) announced the final regulations for the Outer Continental Shelf (OCS) Renewable Energy Program authorized under the Outer Continental Shelf Lands Act (OCSLA) as amended by the Energy Policy Act of 2005 (EPAct). OCSLA, as amended, mandates the Secretary of the Interior (Secretary), through the Bureau of Ocean Energy Management (BOEM), to manage the siting and development of OCS renewable energy facilities. Specifically, Section 8(p)(1)(C) of OCSLA grants the Secretary the authority to issue leases, easements, or rights-of-way for the purpose of renewable energy development (43 U.S.C. § 1337(p)(1)(C)). BOEM is delegated the responsibility for overseeing offshore renewable energy development in Federal waters (30 CFR 585) and has accepted designation as the lead Federal agency (50 C.F.R. 402.07) for the purposes of fulfilling interagency consultation under EFH provisions of the MSA. The Bureau of Safety and Environmental Enforcement, U.S. Army Corps of Engineers (USACE), and Environmental Protection Agency (EPA) are co-action agencies pursuant to their authorities. BOEM will respond to NMFS EFH conservation recommendations (CRs) under its authority pursuant to OCSLA, while USACE will respond to NMFS EFH CRs under its authorities pursuant to Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act.

Pursuant to the MSA, each Fishery Management Plan (FMP) must identify and describe EFH for the managed fishery, and the statute defines EFH as “those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity” 16 U.S.C. § 1853(a)(7) and § 1802(10). The National Oceanic and Atmospheric Administration’s (NOAA) regulations further define EFH, adding “waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species' full life cycle.

The EFH final rule published in the Federal Register on January 17, 2002, defines an adverse effect as: “any impact which reduces the quality and/or quantity of EFH.” The rule further states that:

An adverse effect may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat and other ecosystem components if such modifications reduce the quality and/or quantity of EFH. The EFH final rule also states that the loss of prey may have an adverse effect on EFH and managed species. As a result, actions that reduce the availability of prey species, either through direct harm or capture or through adverse impacts to the prey species' habitat, may also be considered adverse effects on EFH. Adverse effects to EFH may result from actions occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

Fish and Wildlife Coordination Act

The DOI has consistently determined that the Fish and Wildlife Coordination Act (FWCA) does not apply to OCS leases and permits[1]. Therefore, BOEM will not respond to NMFS FWCA recommendations for this Project.

1 Department of the Interior, 1982. Memorandum from Solicitor to the Director of the Bureau of Land Management, the U.S. Geological Survey, and the Acting Director of the Minerals Management Service, “The Fish and Wildlife Coordination Act Does Not Apply to OCS Leases and Permits Issued by the Secretary,” February 12, 1982.

2.0 EFH Proposed Action

BOEM is evaluating the potential environmental effects of approval of the Construction and Operations Plan (COP) for the Project by Sunrise Wind. The proposed Project would allow Sunrise Wind to construct, operate, maintain, and eventually decommission a wind energy facility with an operating capacity ranging between 880 megawatts (MW) and 1,034 MW in scale. The Project would be located offshore of Rhode Island and Massachusetts on the Outer Continental Shelf (OCS) with a cable landing on Long Island, New York, within the range of design parameters outlined in Section 1.2 of the COP (Sunrise Wind 2022b). The EFH Proposed Action (Proposed Action) analyzes up to 87 wind turbine generators (WTGs) in 87 potential positions for a total of up to 957 MW, one Offshore Converter Station (OCS-DC), offshore export cable routes, onshore cable landfall sites, onshore cable routes, and onshore substation locations.

The Proposed Action area would be located on the OCS in the designated BOEM Lease Area OCS-A 0487. The Project area comprises the Sunrise Wind Farm (SRWF); Sunrise Wind Export Cable (SRWEC), inclusive of offshore export cable (SRWEC-OCS) and export cable in New York State waters (SRWEC-NYS); and onshore transmission cable, onshore interconnection cable, and an onshore converter station (OnCS-DC) (Figure 2-1). The Lease Area contains portions of areas that were originally awarded through the BOEM competitive renewable energy lease auctions of the Wind Energy Area (WEA) off the shores of Rhode Island and Massachusetts. Other components of the Project would be located on the OCS, in state waters of New York, and onshore in the Town of Brookhaven, Long Island, New York (COP, Sunrise Wind 2022b). The SRWF would be constructed in ocean habitats in the Rhode Island and Massachusetts WEA on the Atlantic Ocean OCS, state waters of New York, and tidal wetlands and coastal inshore habitats of Long Island, New York. The proposed offshore Project elements would be located on the OCS, as defined in the Outer Continental Shelf Lands Act, with the exception of a portion of the export cable within state waters.

2.1 Project Area

2.2 Construction and Installation

The Proposed Action would result in the construction and installation of up to 87 WTGs within 87 positions and their monopile foundations; one OCS-DC and its piled jacket foundation; scour protection for WTG and OCS-DC foundations, and inter-array and export cables. Collectively, these elements comprise the offshore Project area. Onshore, power from the SRWF would be delivered to the grid via distinct project segments: the submarine segment of the export cable (SRWEC), which will be located in both federal and New York State (NYS) waters (the NYS portion of the cable referred to as the SRWEC–NYS); the terrestrial underground segment of the transmission cable (Onshore Transmission Cable); the new Onshore Converter Station (OnCS–DC); and the underground segment of the interconnection cable (Onshore Interconnection Cable) to the existing Holbrook Substation.

Construction and installation would include transportation and installation of foundations, installation of cable systems, installation of WTGs and installation of the OCS-DC. The Project would involve temporary construction laydown areas and ports utilized by construction vessels. The Project would use existing port facilities located in New York, Rhode Island, Connecticut, Massachusetts, Maryland, New Jersey, and/or Virginia for offshore construction, staging and fabrication, crew transfer, and logistics support. It is not anticipated that modifications of these ports would be needed. These ports would not be solely dedicated to the Project, and Project-specific construction is not anticipated at the port locations.

The Project’s export cables would include both offshore and onshore segments. The SRWEC would be located in federal (OCS) and New York State (NYS) waters and consist of one distinct cable bundle (comprised of two 320-kilovolt (kV) direct current (DC) conductors and one fiber optic cable). In NYS waters, the SRWEC-NYS would be buried to a target depth of 6 feet (ft) (2 meters [m]) where possible and in federal waters, the SRWEC-OCS would target a burial depth of 3 to 7 ft (1 to 2 m). The SRWEC-NYS would connect to the Onshore Transmission Cable within the Transition Joint Bay (TJB) and link boxes located at Smith Point County Park on Fire Island in the Town of Brookhaven, New York. The onshore portion of the SRWEC-NYS, up to 1,152 feet (351 m), would be buried underground. The Onshore Facilities have been largely located within existing developed areas, including parking lots and paved roadways. The Onshore Transmission Cable Intracoastal Waterway (ICW) horizontal directional drilling (HDD) path would cross under Great South Bay-East significant coastal fish and wildlife habitat (SCFWH) before reaching the ICW-HDD Work Area at Smith Point Marina. Potential land disturbance to coastal habitats and wetlands would be avoided by using HDD methods. To facilitate the transportation of heavy equipment and materials (i.e., loads greater than 15 tons) from Long Island to the construction site on Fire Island, a temporary pile-supported trestle (or landing structure) would be constructed on the inshore side of Fire Island. The temporary landing structure would extend approximately 242 feet (73.8 m) offshore and be approximately 16 feet (4.9 m) wide. The landing structure would be secured to the seabed by approximately 21 steel piles, each measuring 16 inches in diameter. It is anticipated that approximately 4.35 cubic yards (CY) of flowable concrete would be installed within the steel pipes below the plane of spring high water over an approximate 150 ft^2 area.

From the landing (landfall) site, the Onshore Transmission Cable would carry the power from the TJB to the OnCS-DC. The Onshore Transmission Cable route has been sited within existing disturbed right-of-way (ROW) to the extent practicable, traveling from the eastern portion of Smith Point County Park, following the Long Island Expressway (LIE) Service Road Route to the OnCS-DC at the Union Avenue Site. The Onshore Transmission Cable would cross the Carmans River via HDD. The Onshore Interconnection

Cable would carry the power from the OnCS-DC to the existing grid at the Holbrook Substation, also located in the Town of Brookhaven, New York. The Onshore Transmission Cable route would intersect with tidal wetlands at a few limited points and runs parallel to or intersect with delineated tidal wetlands. The Onshore Transmission Cable route would be installed with trenchless construction methods to avoid wetlands.

A temporary offshore wave (measurement) buoy would be installed within the Lease Area proximate to the WTGs in the eastern region of the wind farm and would be sited to avoid complex habitat and marine archaeological resources. The offshore wave buoy would be installed at the beginning of offshore construction (tentatively planned for Q1 2024) and remain in place during the installation and potentially after wind farm commissioning, tentatively until Q1 2026 (personal communication, M. Evans, 2023b). The mooring configuration would be dependent on buoy type, water depth, and environmental considerations but generally would consist of an anchor weight (approximately 2,600 pounds [lbs]), single mooring line (taut Dyneema rope to minimize potential for anchor sweep), and navigational lighting.

A second wave (measurement) buoy would be installed nearshore within the project corridor identified as the vessel anchoring area within NYS waters (see Figure 2-6). The inshore wave buoy would be installed prior to cable installation and would remain in place for the duration of the cable installation process (i.e., approximately 7 months). The wave buoy mooring configuration would be dependent on buoy type, water depth, and environmental considerations, but generally would consist of an anchor weight (approximately 2,600 lbs) and a single mooring line (taut Dyneema rope to minimize potential for anchor sweep) and would be equipped with navigational lighting.

In addition, up to three Acoustic Doppler Current Profilers (ADCPs) would be deployed during construction of the nearshore area in the vicinity of the HDD exit pit (within the defined anchoring area; see Figure 2-6) and along the cable route to support installation activities. Recovery of the units would occur within a few months of completion of the cable installation. The upward-facing ADCPs (1-MHz frequency) would be deployed from a trawl-resistant bottom mount consisting of a 1-inch fiberglass grid with a footprint of 20.75 ft^2 (1.9 m^2) and would be equipped with an acoustic release recovery system (personal communication, M. Evans, 2023b). A downward-looking ADCP would be mounted on the lower part of the submerged hull of a standard wave buoy described above.

During buoy retrieval a work vessel would position itself on-site to detach the hull from the mooring chain and attach float markers to the loose ends of the mooring chain. The buoys would then either be recovered to deck or towed off-site. The clump weight would then be connected to the crane or A-frame of the work vessel and recovered to deck. The mooring chain would then be recovered to site. Buoy installation process would be similar to the retrieval process, but in reverse.

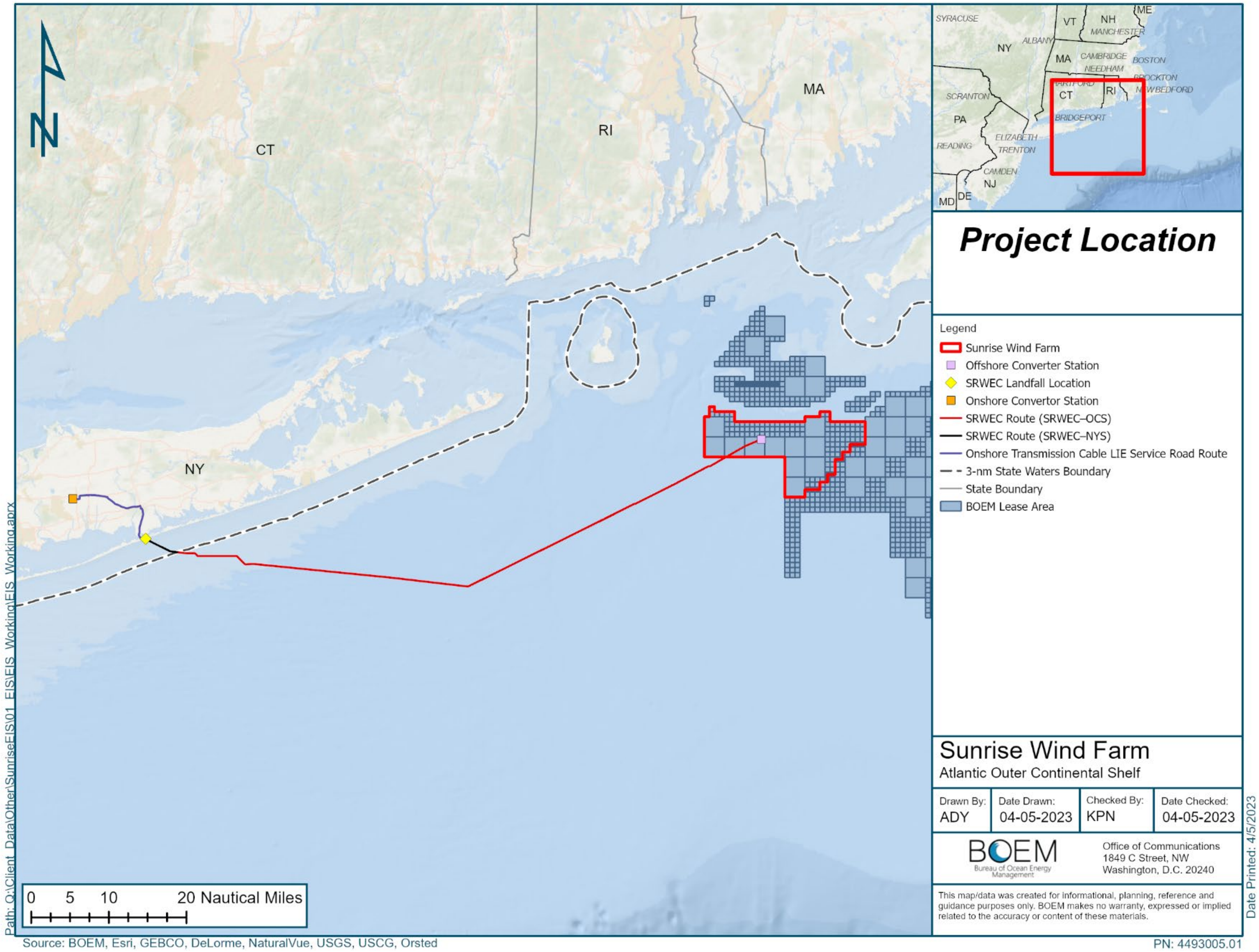

Figure 2-1. Sunrise Wind Farm and Export Cable Location

Table 2-1: Summary of SRWF and SRWEC Construction and O&M Effect Mechanisms by Project Stage and Location

Project Stage/Location	Design Element	Effect Mechanism	Measurement Parameter	Component	Effect Measurement	Options (if applicable)
SRWF Construction	Turbine selection/ spacing	Installation disturbance area	WTG size		39 ft (12 m)	-
			Number of turbines		up to 87 within 87 potential positions	-
			Rotor height above mean sea level		Upper blade tip height of 787 ft (240 m)	-
			Spacing		1.15 mi (1 nm, 1.8 km) spacing	-
	Foundation installation	Habitat alteration, physical disturbance	Number of piles	39-foot (12 m) WTG monopiles	Up to 87 (1 per WTG)	-
				OCS-DC	Up to 8	4 legs with up to 2 piles per leg
			Footprint area total (with scour protection)	39-foot (12 m) monopile foundation	1.06 acres (0.43 hectares) per monopile	
				OCS-DC (piled jacket, scour protection in entire OCS-DC footprint)	1.39 acres (0.56 hectares)	
				39-foot (12 m) monopile	Impact pile driving: 4,000 kJ hammer, 32 strikes/minute, 1-4 hours per foundation	Vibratory pile driving is possible. Drilling is not anticipated but is a contingency option. Drill spoil volume is unknown and noise from drilling would likely not exceed 107 dB re 1 $\mu Pa_{0\text{-}pk}$ at 24.6 ft (7.5 m).
			Duration	Piled jacket	Impact pile driving: 4,000 kJ hammer, 32 strikes/minute, with a pile penetration range of 90 m and up to 17088 strikes per pile, 8.9 hours per pile	Vibratory pile driving is possible.

Project Stage/Location	Design Element	Effect Mechanism	Measurement Parameter	Component	Effect Measurement	Options (if applicable)
	Inter-array cable	Physical disturbance, turbidity, entrainment	Total Length	All	Approximately 155 mi (249 km)	-
			Installation depth	All	Cable trenching/burial 3 to 7 ft (1 to 2 m) depth	
			Short-term disturbance	All	1,394.56 acres (564.36 hectares)	-
			Long-term habitat conversion (exposed cable protection)	All	652.24 acres (263.95 hectares)	-
			Installation Method	All	Jet Plow	Cable trenching/burial could also be utilized
			Max Distance to TSS Plume >50 mg/L Above Ambient	All	7,815 ft (2,382 m)	-
			Max Distance of Sediment Deposition	All	220 ft (67.1 m)	-
			Area of Sediment Deposition	All	7.4 acres (3.0 hectares)	-
	Construction vessels	Physical disturbance, noise	Number of vessels	All	13 simultaneous wind turbine vessels during foundation installation 6 simultaneous wind turbine vessels during structure installation 15 vessels for OCS-DC installation 33 simultaneous vessels during array cable installation	A helicopter may also be used to support construction activities.
			Number of Trips per Vessel Type	WTGs	4 trips for the scour protection vessel, 5 trips for the installation vessel, 15 trips for support vessels, 102 trips for transport/feeder vessels (including tugs)	-
			Number of Trips per Vessel Type	Structure Installation	26 trips for installation vessels, feeder/commissioning vessels: 28 trips for SOV, 392 trips for CTVs, 9 trips for other support vessels, and 24 trips for helicopters	-
			Number of Trips per Vessel Type	Array Cable Installation	3 trips for main laying vessels, 3 trips for main burial vessels, 5 trips for support vessels	-

Project Stage/Location	Design Element	Effect Mechanism	Measurement Parameter	Component	Effect Measurement	Options (if applicable)
			Anchoring distance	All	Vessels would not be anchored during these activities; dynamic positioning vessels would generally be used	Dynamic positioning vessels would be used to the extent practicable. If anchoring vessels are needed, anchor dimensions would be: 9 ft (2.7 m) x 9 ft (2.7 m) with 2 to 7 anchors per vessel
			Jack-Up Vessels	All	4-leg jack-up vessels: 1,850 sq ft (171.9 m^2) per spudcan; 6-leg jack-up vessels: 1,027 sq ft (95.4 m^2) per spudcan	
			Vessel noise	All	SPL 150 to 180 dB re 1 µPa for dynamically positioned vessels (BOEM 2014), SPL 177 to 180 dB re 1 µPa for large shipping vessels (McKenna et al. 2012) during construction	-
SRWF Operation		Operational electro-magnetic field (EMF) (IAC)	Transmission voltage		Typical voltage 66 kV, maximum voltage 161 kV	-
			Magnetic Field	All	At a height of 3.3 ft (1 m) over the cables at peak loading, alternating current (AC) magnetic induced electric field levels = 4.5 mG and <0.09 millivolts/ meter, decreasing to 1.1 mG and <0.1 mV/m or less at horizontal distance of 10 ft (3 m)	-
SRWEC	Export cable construction	Installation disturbance area	TL	SRWEC	104.6 mi (168.4 km)	
			Installation Method	SRWEC	Cable trenching/burial (3 to 7 ft [1 to 2 m]): short-term disturbance of 1,258 acres (509.5 hectares). Boulder clearance: short-term seabed disturbance = 81.5 acres (33 hectares) and long- term habitat alteration = 25.2 acres of (10.2 hectares)	-

Project Stage/Location	Design Element	Effect Mechanism	Measurement Parameter	Component	Effect Measurement	Options (if applicable)
			Full corridor with short-term seabed disturbance	SRWEC	1,171 acres (473.9 hectares)	-
			Number of Vessels	All	38 vessels during installation	
			Number of Trips per Vessel Type	SRWEC Installation	2 trips per main cable-laying vessels, 1 trip per main cable jointing vessel, 2 trips per main cable burial vessels, 5 trips for support vessels	-
Landfall Construction		Installation disturbance area	Area of Short-Term Disturbance	HDD Exit Pits	61.8 acres (25 hectares) of offshore seafloor	-
	HDD Casing Pipe and Goal Posts	Physical disturbance area	Area of Disturbance	Casing Pipes	Up to two 3.9-foot (1.2-meter) diameter, 450-foot (137.2-meter) length casing pipes	
		Noise	Duration	Casing Pipe Installation	Impact pile driving: 18 kJ hammer of up to 3 hours of hammering per day on each of days of installation per pipe. For two casing pipes, this would mean a total of 12 hours of hammering and a total of four days of installation.	
				Casing Pipe Removal	Up to 3 hours of pneumatic hammering on each of 2 days per pipe. For two casing pipes this would mean a total of 12 hours of hammering and a total of four days of removal.	
			Area of Disturbance	Sheet Pile Goal Posts	Up to six goal posts may be installed to support installation of the casing pipe. Each goal post would be composed of two vertical sheet piles and a horizontal cross beam. Sheet piles would be up to 100 feet (30 m) long, 2 feet (0.6 m) wide, and 1 inch thick.	
			Area of Disturbance	Sheet Pile Supports	In addition to the goal posts, up to 20 additional support sheet piles 100 feet (30 m) long, 2 feet (0.6 m) wide, and 1 inch thick may be installed to help anchor the barge and support construction activities.	
			Installation Method	Sheet Pile Goal Posts and Sheet Pile Supports	Up to two hours of vibratory piling per sheet. Up to 4 sheet piles may be installed per day, resulting in up to 12 total days of vibratory	

Project Stage/Location	Design Element	Effect Mechanism	Measurement Parameter	Component	Effect Measurement	Options (if applicable)
					piling for both the sheet pile goal posts and supports.	
	Temporary Pier	Installation disturbance area	Area of Disturbance	Production Piles	Up to 21 H-shaped production piles 35.6 x 35.6 cm (14 x 14 inch)	The production piles could also be 40.6 cm (16 inch) diameter round steel piles.
			Installation Method	Production Piles	The piles would first be driven using a vibratory hammer followed by an impact hammer.	
			Duration of Pile Driving	Production Piles	Installation would include up to 283.5 minutes (4 hours 43 minutes) of vibratory pile driving (21 x 13.5 minutes) and 31 minutes of impact pile driving (21 x 1.5 minutes). Removal of the production piles would use a vibratory hammer for a total duration of up to 315 minutes (5 hours, 15 minutes; 21 x 15 minutes).	
			Area of Disturbance	Temporary Piles	Up to 21 H-shaped temporary piles 35.6 x 35.6 cm (14 x 14 inch) may be installed, and in some cases removed, during construction	The temporary piles could also be 40.6 cm (16 inch) diameter round steel piles
			Duration of Pile Driving	Temporary Piles	Installation and removal may require up to 630 minutes (10.5 hours) of vibratory pile driving (2 x 21 x 15 minutes)	
	Onshore Construction Area		Length of Onshore Cable Route	Cable Route	17.5 miles	
	Onshore Transmission Cable and Onshore Interconnecti on Cable	HDD	Approximate Crossing Length	Tidal Wetlands Crossings	2,660 ft (811 m)	
			Area of Short-Term Disturbance	Tidal Wetlands Crossings	1.83 acre (0.74 hectare)	-

The Proposed Action would include the construction and installation of both onshore and offshore facilities. For the purposes of this EFH assessment, distinct areas of the Proposed Action include the SRWF, SRWEC-OCS and SRWEC-NYS. Components in these areas would be the WTGs (including foundations and scour protection), OCS-DC (including foundations and scour protection), inter-array cables (IAC) (including scour and protection), and offshore export cables in federal and state waters (including scour protection). Construction activities would tentatively begin in Q1 of 2024 and would be completed in Q4 of 2025, although the schedule is dependent on receipt of permit approvals and may change as project plans are refined. Sunrise Wind anticipates beginning land-based construction before the offshore components. An approximate schedule is shown in Table 2-2.

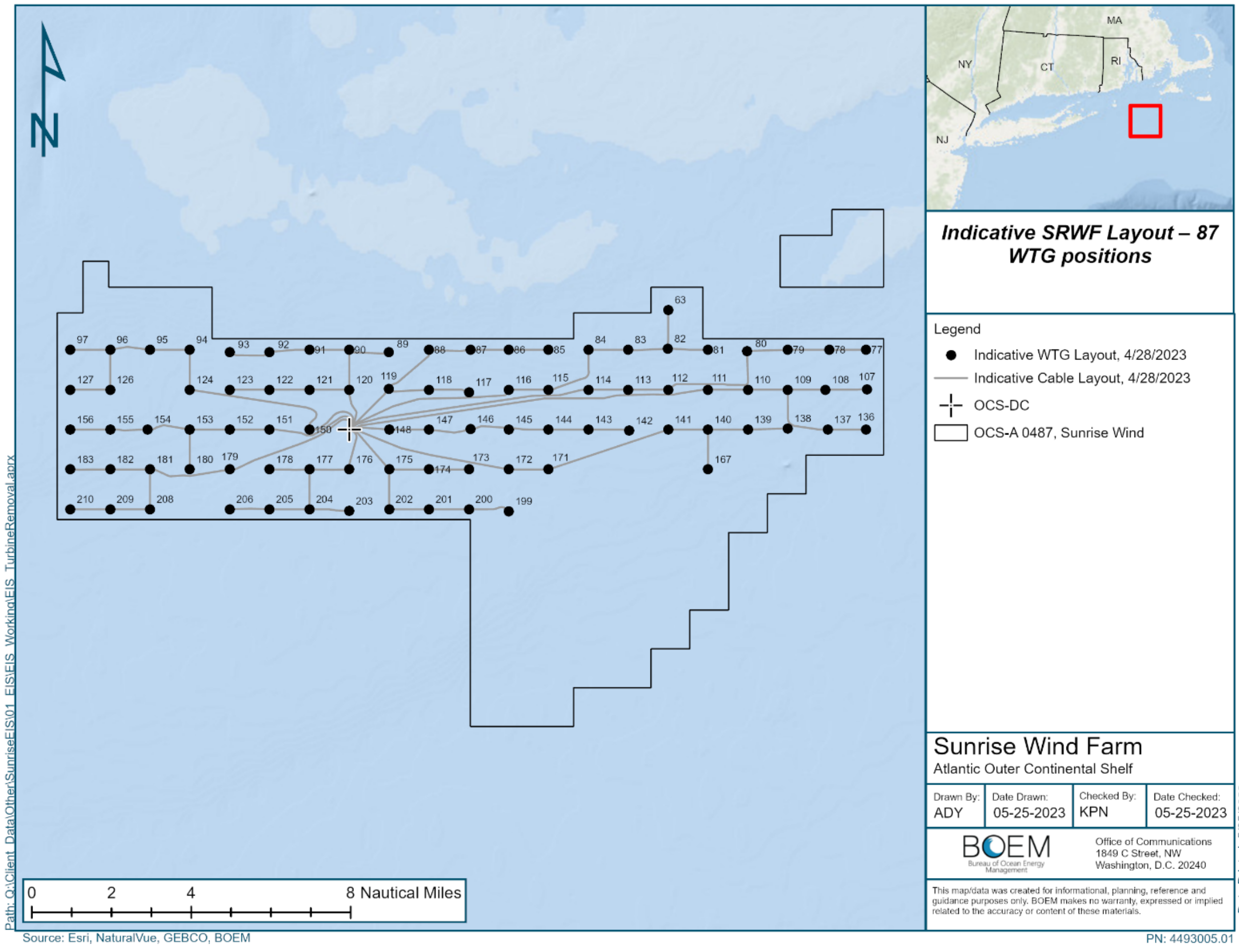

Figure 2-2. Sunrise Wind Proposed Action WTG and IAC Layout

Table 2-2: Tentative Project Schedule

Event	Schedule
Onshore Facilities (OnCS-DC and Onshore Transmission Cables)	Q1 of 2024 through Q2 of 2025
SRWEC	Q1 – Q2 of 2024; Q1 - Q3 of 2025
Offshore Foundations	Q1 – Q4 of 2024; Q2 – Q3 of 2025 (no pile driving January -April)
Inter-Array Cables	Q1 - Q2 of 2024; Q2 - Q4 of 2025
WTGs	Q2 - Q4 of 2025
OCS-DC	Q4 of 2024 through Q3 of 2025

2.2.1 Installation of WTG/OSS Structures and Foundations

Proposed offshore Project components include WTGs and their foundations, an OCS-DC and its foundation, scour protection for foundations, IAC, and offshore export cables (these elements collectively compose the offshore Project area). The proposed offshore Project elements would be on the OCS as defined in the Outer Continental Shelf Lands Act, with the exception of a portion of the export cables within state waters and state lands (SRWEC-NYS).

Sunrise Wind proposes the installation of up to 87 WTGs within 87 potential positions extending up to 787 ft (240 m) above mean sea level (AMSL). Turbines would be sited in a uniform east-west/north-south grid with 1.15 by 1.15-mile (mi) (1 by 1-nautical mile [nm]; 1.85 by 1.85 kilometer [km]) spacing. Sunrise Wind would maintain diagonal lanes between 0.7 and 0.9 mi (0.6 to 0.8 nm; 1.1 and 1.5 km) wide when micrositing foundations. Sunrise Wind would mount the WTGs on monopile foundations. The WTG foundations as proposed in the COP would be 39 ft (12 m) in diameter at the seabed and 23 ft (7 m) in diameter at the sea surface (Sunrise Wind 2022b). A monopile foundation typically consists of a single steel tubular section, with several sections of rolled steel plate welded together. For a WTG monopile foundation, a Transition Piece (TP) may be fitted over the top of the monopile and secured via a bolted connection. Secondary structures on each WTG monopile foundation would include a boat landing or alternative means of safe access, a crane, and other ancillary components.

The OCS-DC would be placed on an up to four-legged piled jacket foundation. A piled jacket foundation would be formed of a steel lattice construction (comprising tubular steel members and welded joints) secured to the seafloor by means of hollow steel pin piles attached to the jacket. Schematic drawings and renderings of the conceptual monopile foundation with secondary structure after installation and the piled jacket foundations are included in COP Section 3.3.5 (Sunrise Wind 2022b). When required, scour protection would be placed around foundations to stabilize the seabed near the foundations as well as the foundations themselves. The OCS-DC requires the withdrawal of raw seawater through a cooling water intake system (CWIS) to dissipate heat produced through the alternating current (AC) to DC conversion and then discharge this water as thermal effluent to the marine receiving waters. The DIF for the OCS-DC would be 8.1 MGD; however, the average intake flow (AIF) would generally range from 4.0 MGD to 5.3 MGD.

The OCS-DC is proposing to discharge non-contact cooling water and non-contact stormwater to the marine receiving water. The Dump Caisson consists of a single outlet vertical pipe oriented downward in the water column. The Dump Caisson would be the primary discharge point for the OCS-DC. Pollutants discharged at the Dump Caisson would include non-contact cooling water and residual chlorine.

Each WTG would contain approximately 1,850 gallons (gal) (7,000 liters [L]) of transformer oil, 159 gal (600 L) of hydraulic oil, and 79 gal (300 L) of gear oil. Use of other chemicals would include nitrogen (104 CY, 80 m^3), diesel fuel (793 gal, 3,000 L), and glycol/coolants (3,434 gal, 13,000 L). The OCS-DC would contain approximately 105,700 gal (400,000 L) of transformer oil and 700 gal (2,650 L) of general oil for hydraulics and lube oil. Use of other chemicals would include diesel fuel (24,304 gal, 92,000 L), SF6, grease (3,960 lbs, 1,796 kg), high pressure nitrogen (52,834 gal (200,000 L at 300 bar), inert gas (volume unknown currently), refrigerant (40 gal, 150 L), battery acid (volume unknown currently), and glycol/water mix (13,748 gal, 50,000 L).

2.2.1.1 Vessel Activity

The construction and installation phase of the Proposed Action would make use of both construction and support vessels to complete tasks in the SRWF. During installation of array and converter station interconnection cables, Sunrise Wind anticipates a maximum of 33 vessels operating during a typical workday in the SRWF. Many vessels would remain in the SRWF and along the export cable route for days or weeks at a time, potentially only making infrequent trips to port for bunkering or provisioning as needed.

Sunrise Wind would install foundations and WTGs using dynamic positioning heavy lift vessels or up to two jack-up vessels with up to four spudcans for foundation installation. Jack-up would occur within the Seafloor Preparation Area. Additionally, a scour protection vessel, and 4 transport/feeder vessels would be necessary to support the two installation vessels. Six support vessels, including 1 completion vessel, 1 noise mitigation vessel, and 4 protected species observe (PSO) vessels would be anticipated to be needed during installation and commissioning. The OCS-DC would be anticipated to have 1 primary installation vessel present with 5 support vessels, including 3 transport vessels and 2 planned support vessels (Sunrise Wind 2022b). Anchoring (other than jack-up vessels) would not be anticipated during construction or operations and maintenance (O&M). Jacking-up on the OCS would only be expected to occur during the WTG installation and certain WTG and OCS-DC non-routine O&M scopes of the Project, though anchoring of support vessels for contingency purposes could happen during the scopes for WTG, monopile and piled jacket foundation, OCS-DC topside, and/or cable installation/O&M. These emergency contingency situations could include mechanical issues with the vessel, loss of steering, or an onboard emergency. Even in contingency anchoring situations, anchoring within complex habitat and marine archaeological resources identified within SRWF and along the SRWEC-OCS would be avoided, unless anchoring in such areas would be necessary to avoid jeopardizing the safety of the vessel and crew. In addition to the vessels associated with the various construction scopes, placement of miscellaneous equipment on the OCS could include bubble curtains as well as buoys for the purposes of metocean data collection (wave or measurement buoys, ADCPs), passive acoustic monitoring (PAM) and sound field verification. The bubble curtains would be kept in place by a weighted surface apron. The buoys would be moored with a single line and surface clump weights. These buoys would avoid the marine archaeological resources identified within SRWF and they would be placed to avoid complex habitat where possible.

2.2.1.2 Pile Driving

Each WTG would require one monopile foundation. Installation of piles would be anticipated to normally require 1 to 4 hours (6 to 12 hours maximum) of pile driving. Installation of a single monopile at a minimum would include a 1-hour pre-clearance period, 4 hours of piling, and 4 hours to move to the next piling location where the process would begin again. This results in an estimated 9 hours of installation time per pile, or 783 total hours for 87 WTG monopile foundations under ideal conditions for all installations. Up to three monopile foundations would be installed in a 24-hour period, using one installation vessel. It would be possible that two separate vessels may work simultaneously to install up to four total monopiles per day (assuming two monopiles per day, per vessel), assuming 24-hour pile driving operations (COP Section 3.3.5.2; Sunrise Wind 2022b). Should nighttime pile driving occur, the best currently available technology would be used to mitigate adverse effects. If pile driving were only allowed from sunrise to sunset, and no pile driving was conducted from January 1 to April 30, then approximately 2,940 hours would initially be available for pile driving (this assumes an average of 12 hours of daylight per day for 245 days). Based on prior experience, it is reasonable to assume that approximately 30 percent of the time would be unavailable due to weather conditions, bringing the available time down to 2,058 hours and leaving a buffer of approximately 1,275 hours between the minimum time required to install the foundations and the time available.

After the seabed has been prepared for foundations, including boulder clearance and removal of any obstructions within the Seafloor Preparation Area at each foundation location, monopiles would be driven until the target embedment depth is met. The maximum embedment depth for WTG monopile foundations would be up to 164 ft (50 m). Then, the pile hammer would be removed and the monopile released from the pile gripper. Once the monopile is installed to the target depth, the TP or separate secondary structures would be lifted over the pile by the installation vessel. If used, the TP would be bolted to the monopile.

The OCS-DC would have a four-legged piled jacket foundation. Installation of a single piled jacket foundation for the OSC-DC is estimated to require approximately 48 hours maximum of pile driving, with actual impact pile driving likely to occur within a 3-day period (72 hours). If one monopile vessel and one piled jacket vessel are working simultaneously, up to six piles may be installed (two monopiles and four pin piles). At a maximum, the Project expects up to two vessels working simultaneously (i.e., two monopile vessels or one monopile foundation vessel and one piled jacket foundation vessel). This approach assumes 24/7 piling in addition to simultaneous piling operations among the up to two pile installation vessels (COP Section 3.3.5.2; Sunrise Wind 2022b). The typical sequence of piled jacket foundation installation includes pre-installation surveys, seafloor preparation, scour protection, foundation setup and piled jacket installation, pin pile driving, drilling (optional), grouting, and completion.

The OCS-DC would consist of a topside structure with one or more decks on a piled jacket foundation. An up to four-legged piled jacket foundation would be used for the proposed OCS-DC. A piled jacket foundation would be formed of a steel lattice construction secured to the seafloor by means of hollow steel pin piles attached to the jacket. Monopile foundations or pin piles for the piled jacket foundation would be driven to target embedment depths using impact pile driving and/or vibratory filing driving. The installation of a single piled jacket foundation for the OCS-DC is estimated to require approximately 48 hours maximum of pile driving, A single monopile foundation is estimated to normally require 1 to 4 hours (6 to 12 hours maximum) of pile driving (COP Section 3.3.5; Sunrise Wind 2022b). Array cables would transfer electrical energy generated by the WTGs to the OCS-DC. The OCS-DC would include stepup transformers and other electrical equipment needed to connect the 66-kV IAC to the ±320-kV DC voltage per circuit offshore export cable.

2.2.1.3 Seabed Preparation/Boulder Relocation/Dredging

Prior to foundation installation, a number of operations would be completed. Geophysical surveys would be conducted to identify seafloor debris; geotechnical surveys would be conducted to identify the geological, archaeological, and cultural resource conditions; Munition and Explosives of Concern (MEC)/ Unexploded Ordinances (UXO) Clearance surveys would be conducted to identify and confirm MEC/UXO targets for removal/disposal; and seafloor debris clearance would occur. Seafloor debris clearance would consist of removing seafloor debris and boulders where necessary to ensure the seafloor is suitable for safe foundation installation. Boulder clearance via a boulder grab would occur within a 722-ft (220-m) radius centered on the foundations (COP Section 3.3.5; Sunrise Wind 2022b). Prior to seafloor clearing activities, Sunrise Wind has indicated that boulder clearance trials using a boulder grab may occur in the norther/northwestern portion of the Lease Area, although the exact location may depend on the wider construction schedule, including the sequence of foundation installation and thus the sequence of boulder clearance. The exact timeframe for the clearance trials would also depend on the construction schedule and receipt of permits. Assuming COP approval in March 2024, wide-scale boulder clearance in the Lease Area, including boulder trials, is anticipated to begin in June 2024.

Seafloor preparation, including boulder relocation and sand wave leveling would result in temporary sediment suspension and deposition within the SRWF. Seafloor Preparation Area would occur within a 722 ft (220 m) radius centered on the foundations to ensure safe foundation installation as well as safe vessel jack-up. For each WTG foundation, a seafloor preparation area per foundation of 37.6 acres (152,053 m^3) would be anticipated. For each foundation, a seafloor footprint area of 1.06 acres (4,290 m^3) would be anticipated with 1.03 acres (4,168 m^3) of scour protection and cable protection system stabilization per foundation (COP Section 3.3.5; Sunrise Wind 2022b). For WTG installation, the total area of seafloor disturbance would be 3,271 acres (1,324 hectares [ha]) (personal communication, M. Evans, 2023b).

Extensive geophysical surveys through the Project area have identified individual boulders (stones of 0.5 m diameter or greater) scattered throughout the SRWF area (see Figure 3-5), with boulder fields (20 boulders or more within 100 m by 100 m area) predominantly in the northern extent of the site. The highest concentration of boulder fields occurs in the northwest portion of the SRWF. Smaller areas of boulder fields are further to the southeast. The higher density areas of boulders identified in the north and northwest of the SRWF generally conform with areas of glacial drift deposits. Large boulders are present in these areas, with heights in excess of 4 m (13 ft). According to the Boulder Relocation Plan prepared by Sunrise Wind (2023a), boulders ranging from 0.5 m (1.6 ft) to 2.4 m (7.9 ft) in diameter would be relocated via boulder grab (method described further in Section 2.2.2.2) for WTG and OCS-DC foundation installation. Boulders encountered within the foundation seabed preparation area would be moved to the edge of the 220 m (772 ft) disturbance area of WTG foundation installation and away from sensitive benthic habitat. Sunrise Wind has estimated that 70 of the 87 WTG positions may require boulder relocation, although additional boulders may be identified during construction that could also require relocation (personal communication, M. Evans, 2023b).

Additional information on seabed preparation and boulder relocation activities are discussed below in Section 2.2.2.2.

2.2.1.4 Installation of Scour Protection

Scour protection would be used to protect the offshore foundations from erosion of the seabed. Where required, scour protection would be placed around foundations to stabilize the seabed near the foundations, as well as the foundations themselves. The scour protection of monopiles would be a maximum of 13.1 ft (4 m) in height (inclusive of scour and rock protection), would extend radially from the foundation as far as five times the monopile radius, and would cover an area of 1.03 acres (0.41 ha) per monopile. The scour protection of the piled jacket foundation would extend up to 66 ft (20 m) beyond the base of the foundation, for total a covered area of 1.06 acres (0.43 ha) per piled jacket. This would include stabilizing the cable protection system where cables are pulled into the foundation. Additional secondary protection over the IAC and SRWEC would extend 16 ft (5 m) and would be approximately 39 ft (12 m) wide per cable. Several types of scour protection for monopiles and piled jackets are being considered. These include rock protection, rock bags or concrete mattresses. Scour protection may be placed pre- and/or post-installation of the foundations. Cable protection system rock cover would serve as scour protection over the IAC and SRWEC. Rock placement scour protection may comprise a rock armor layer resting on a filter layer. The filter layer could either be installed before the foundation is installed (pre-installed) or afterwards (post-installed). Alternatively, by using heavier rock material with a wider gradation, it is possible to avoid using a filter layer and pre- or post-install a single layer of scour protection. Scour protection installation is planned to be performed using a dynamically positioned fall pipe installation vessel. After foundation installation and cable pulling, further rock materials would be installed as part of the cable protection system using an inclined fall pipe installation method.

The SRWEC and IAC would also require protection where they cross existing cables. Rock berm or concrete mattress separation layers would be installed over the previously installed cable prior to installing a crossing cable, while the rock berm or concrete mattress cover layers would be installed after cable installation. The location of the IAC and associated cable protection would be provided to NOAA's Office of Coast Survey after installation so that they may be marked on nautical charts.

2.2.1.5 Offshore Converter Station – DC (OCS-DC)

The OCS-DC would be centrally located within the Lease Area and house the AC and DC equipment rated up to ±320 kV. The main equipment for the OCS-DC to convert the high voltage alternating current (HVAC) generated by WTGs prior to onshore transmission includes medium voltage AC (66 kV) gas-insulated switchgear, one or more converter transformers, converter reactors, and supervisory control and data acquisition (SCADA) and protection systems. The approximate dimensions of the main OCS-DC topside platform would be 253 ft (77 m) long, 171 ft (52 m) wide, and 197 ft (60 m) tall. The topside platform would be located approximately 78 ft (23.8 m) above the mean higher high water elevation. The total height of the OCS-DC platform and equipment, including lightning protection and ancillary structures, would extend approximately 295 ft (90 m) from the lowest astronomical tide. The OCS-DC platform would be founded on a steel jacket pile structure. The placement of gravel material would be required to the level the seafloor (pre-installation seafloor grade) where the jacket pile structure would be installed.

Raw seawater for the OCS-DC would be withdrawn through three individual vertical pipes in a single parallel cluster attached to the steel foundation jacket. The openings of each of the three intake pipes would be located approximately 30 ft (10 m) above the seafloor. The water depth of the intake pipe openings was selected to minimize the potential for biofouling and entrainment of ichthyoplankton (discussed in Section 5.1) and to take advantage of the cooler water temperatures found at depth to maximize cooling potential of the water withdrawn (i.e., minimize water withdrawal volumes). One dedicated sea water lift pump (SWLP) per intake pipe, equipped with a variable frequency drive (VFD), would withdraw water through each of the three vertical intake pipes. The VFD technology would allow the cooling water intake of the OCS-DC to be optimized as it relates to minimizing water withdrawals as power output and source water temperature varies temporally. This would be continuously managed remotely through the OCS-DC SCADA system. Each intake pipe would be separate, with no cross-over connections between intake pipes. The SWLPs would be located within the vertical intake pipe, approximately 39 ft (12 m) below the ocean surface. The terminus of each intake pipe would be 30 ft (10 m) above the pre-installation seafloor grade, have a total intake surface area of approximately 27 ft^2 (2.54 m^2), and would be oriented downward. Three steel crash bars of 2.4 x 0.8 in (60 x 20 mm) oriented with the narrow aspect facing the current would be fixed across the opening to exclude large solids. Cooling water withdrawn by the SWLPs would be directed to the Coarse Filters, after which a small portion (approximately 1 percent) would be diverted to the Electrochlorination System, and the remainder (approximately 99 percent) directed to the Heat Exchange System and then discharged through the Dump Caisson.

The single manifold from the three SWLPs would lead to the two Coarse Filters, which typically would operate in parallel. Each of the two Coarse Filters would consist of a Super Duplex Stainless Steel vertical housing that encases a series of three banks of wedge wire filter tubes designed to filter suspended solids and organisms larger than 500 microns. Cooling water would exit the Coarse Filters and travel to the Heat Exchange System, with a small portion traveling to the Electrochlorination System.

The Coarse Filters would be equipped with a backwash system to periodically remove buildup of filtered solids and organisms. The backwash would be initiated at least once a day or more frequently when an increased pressure differential is detected across the filter. The backwash system would operate in one filter at a time and use 2 to 5 percent of the system flowrate. Within the filter, the backwash would operate at the system normal operating pressure of 71 to 83 pounds per square inch gauge (psig). Backwashed water from the Coarse Filters would be directed to the Dump Caisson and bypass the Heat Exchange System.

A small portion of the water passing through the Coarse Filters would travel through seawater booster pumps through a continuous, closed-loop system containing the Electrochlorination System. The Electrochlorination System contains two trains of electrochlorination cells that would use electrolysis of seawater to produce sodium hypochlorite. The chlorinated seawater would be directed to the intake pipes, upstream of the SWLPs, to be taken up with raw seawater and proceed through the cooling water system through the Heat Exchange System and to the Dump Caisson. The Electrochlorination System is designed to limit biofouling. Chlorine dosage would be automatically adjusted so that chlorine is completely consumed within the system and chlorine concentration would be near zero as the water enters the Dump Caisson. The majority of the water withdrawn by the SWLPs and passing through the Coarse Filters would travel to the Heat Exchange System. This non-contact cooling water, once-through, Heat Exchange System comprises three parallel plate-and-frame heat exchangers to facilitate the non-contact exchange of heat from the closed-circuit, cooling medium coolant loop to the raw seawater. This system would dissipate heat produced by the OCS-DC to satisfy cooling requirements. After passing through the Heat Exchange System, the cooling water would be discharged into the Dump Caisson.

The Dump Caisson would consist of a single outlet vertical pipe oriented downward in the water column. The heated effluent from the Heat Exchange System would be directed to the Dump Caisson, as would the backwash water from the Coarse Filters. To reduce backpressure on pumps during startup of the SWLPs, water would bypass the Coarse Filters and Heat Exchange System to discharge directly into the

Dump Caisson. Water would discharge through the Dump Caisson opening (at the bottom of the Dump Caisson), which would be located approximately 40 ft (12 m) below local mean sea level.

Each SWLP would have a design capacity of 4,245 gallons per minute (gpm) (964 m^3/h), or 6.1 million gallons per day (MGD). Depending on cooling water volume requirements, typical operation of the SWLPs would require either one or two SWLPs on duty with the other SWLP(s) on standby. The specific SWLPs placed on duty or on standby would be cycled on a weekly basis to prolong pump lifespan. The two duty SWLPs would have a combined maximum design intake flow (DIF) of 8.1 MGD through the intake openings. In this scenario, seawater would flow into the SWLPs at a maximum through-screen velocity (TSV) of 0.43 foot per second (ft/s [0.13 m/s]) under DIF conditions and a corresponding lower TSV under typical conditions, as discussed below. The cooling water volume requirements would vary according to ambient water temperature, wind farm power production, and other factors. There would be no scenario where all three pumps would be operating simultaneously. The DIF of 8.1 MGD for the OCS-DC involves the simultaneous operation of two SWLPs operating at 66-percent capacity (4.1 MGD each) and represents the maximum daily flow that could occur. The standard operating procedure for the SWLPs indicates a daily AIF ranging from 4.0 MGD to 5.3 MGD. This AIF range is based on seasonal changes in water temperatures and electrical demand during startup of the SWLPs, during which water would bypass the Coarse Filters and Heat Exchange System to discharge directly into the Dump Caisson to reduce backpressure on pumps. This process would continue as the pumps ramp up to intake the minimum amount of water required for operation. The SWLPs would receive seal fluid to maintain the pump seals from a header tank located on top of the SWLP caisson. The seal fluid would be a mixture of 65 percent water and 35 percent glycol and administered continuously when the SWLP would be in operation. A maximum leakage of up to 3 liters would be anticipated during the initial commissioning startup of each SWLP and most of this would be pulled into the intake water and released in the Dump Caisson. This release would be expected to be a one-time event unless a pump needs to be taken out of service for maintenance and recommissioned. However, in all subsequent operating scenarios, including pump changeover, leakage would be not anticipated. Standard operation of the SWLP would involve pump changeover and ramp up/ramp down procedures with respect to seasonality in order to accommodate for cooling requirements and reduce operational wear. Pump changeover would involve bringing the standby pump online by opening its corresponding valves and turning on the unit while simultaneously turning off and closing the valves of the duty pump such that the flow remains continuous and at least one unit would be operating at all times. Scheduled shutdowns for maintenance of the SWLPs would occur every second year for 3-5 days.

The OCS-DC would be placed on an up to four-legged piled jacket foundation. A piled jacket foundation is formed of a steel lattice construction (comprising tubular steel members and welded joints) secured to the seafloor by means of hollow steel pin piles attached to the jacket. Schematic drawings and renderings of the conceptual monopile foundation with secondary structure after installation and the piled jacket foundations are included in COP Section 3.3.5 (Sunrise Wind 2022b). When required, scour protection would be placed around foundations to stabilize the seabed near the foundations as well as the foundations themselves. The OCS-DC requires the withdrawal of raw seawater through a CWIS to dissipate heat produced through the AC to DC conversion and then discharge this water as thermal effluent to the marine receiving waters. The DIF for the OCS-DC would be 8.1 MGD; however, the AIF would generally range from 4.0 MGD to 5.3 MGD.

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2.2.2 Inter-Array and Offshore/Onshore Cable Installation

The SRWEC would occur in both federal (SRWEC-OCS) and NYS (SRWEC-NYS) waters and have an onshore segment, up to 1,152 ft (351 m), located underground. The onshore transmission cable would convey energy from the SRWF to the OnCS-DC. The onshore transmission cable would connect to the SRWEC-NYS at the landfall site within TJB and link boxes. Installation of the onshore transmission cable would result in the crossing of two waterways, which would require additional temporary disturbance areas. In these crossings, the installation would involve using HDD methodologies. The first crossing at the ICW (ICW HDD) would involve an approximate crossing length of 2,660 ft (811 m) and have a temporary disturbance area of approximately 80,000 ft^2 (7,432 m^2). The second waterway crossing at Carmans River (Carmans River HDD) would have an approximate crossing length of 1,990 ft (607 m) and result in an area of temporary disturbance of approximately 75,000 ft^2 (6,968 m^2).

The SRWEC-NYS would be spliced together with the onshore transmission cable at the TJB and link boxes located at the landfall site at Smith Point County Park in the Town of Brookhaven, New York. A transit barge would be deployed during construction activities in Smith Point County Park. Temporary equipment during construction activities would include a temporary pile-supported trestle (or temporary landing structure) located within the Project corridor (Figure 2-3). The temporary landing structure would be installed within the Narrow Bay/Long Island ICW to support the transport of heavy construction materials to the ocean-side export cable landing site at Smith Point County Park. The landing structure would be approximately 16-ft wide by 242-ft long and secured to the seabed by approximately 21 steel piles each measuring 16 inches in diameter (Figure 2-4). It is anticipated that approximately 4.35 cy of flowable concrete would be installed within the steel pipes below the plane of spring high water over an approximate 150 ft^2 area. The piles would be placed using a crane barge with four spuds each with a diameter of 30 inches. The barge used for installation of the piles and trestle would require two to four temporary spuds to hold its station during installation. The spuds associated with the installation barge would have a diameter of approximately 30 inches. Once the temporary pile-supported trestle is installed, a transit barge would require up to four spuds to hold its station during equipment transfer to shore. For HDD activities, the contractor would primarily utilize vessels that do not require the use of anchors to maintain position (e.g., dynamic positioning vessels). Two of the vessels supporting HDD activities would need to touch down at several locations within the work area, meaning that the pads would contact the seafloor in these locations. The touch down locations for the pads would depend on the task being performed.

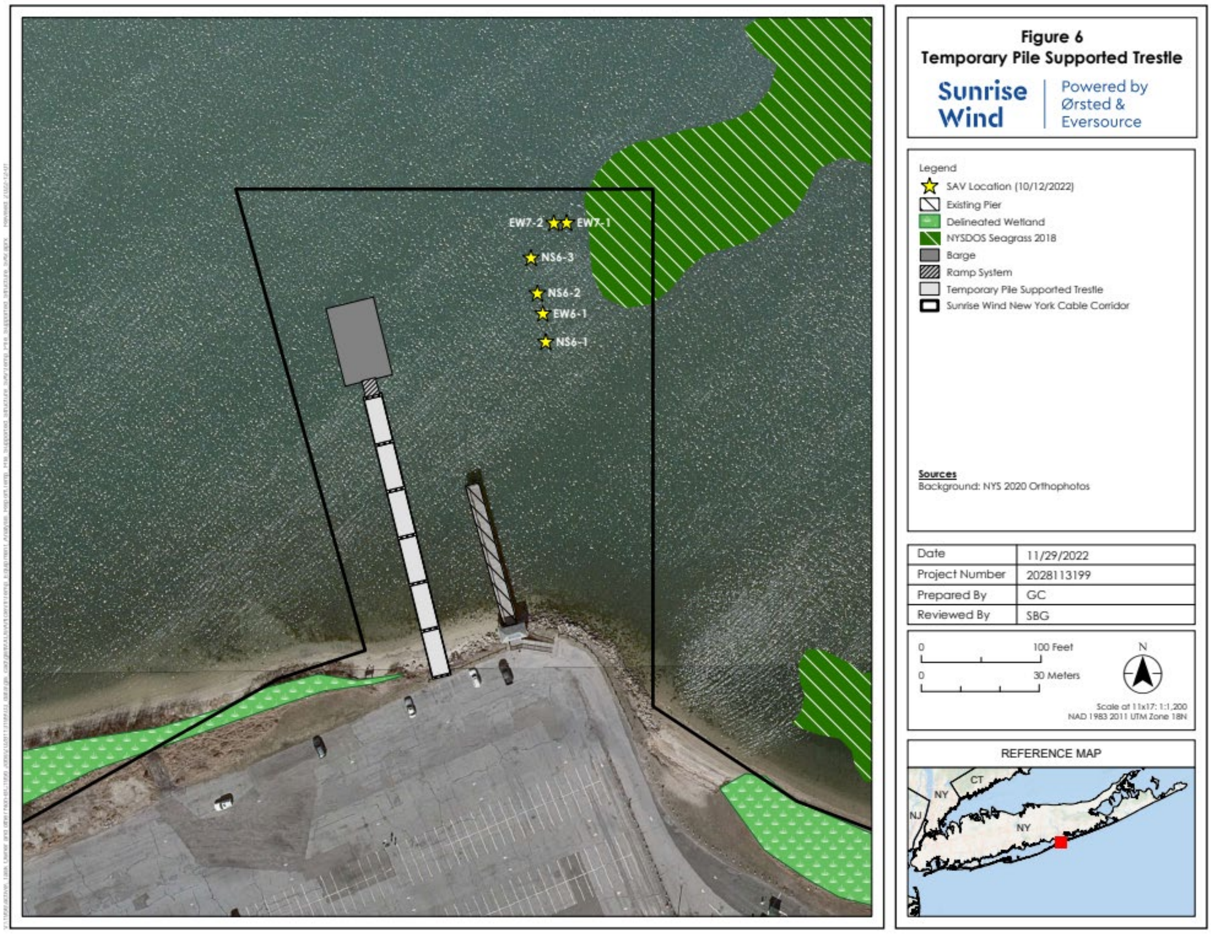


Figure 2-3. Temporary Pile-Supported Trestle and SAV Locations at Smith Point Landing Area

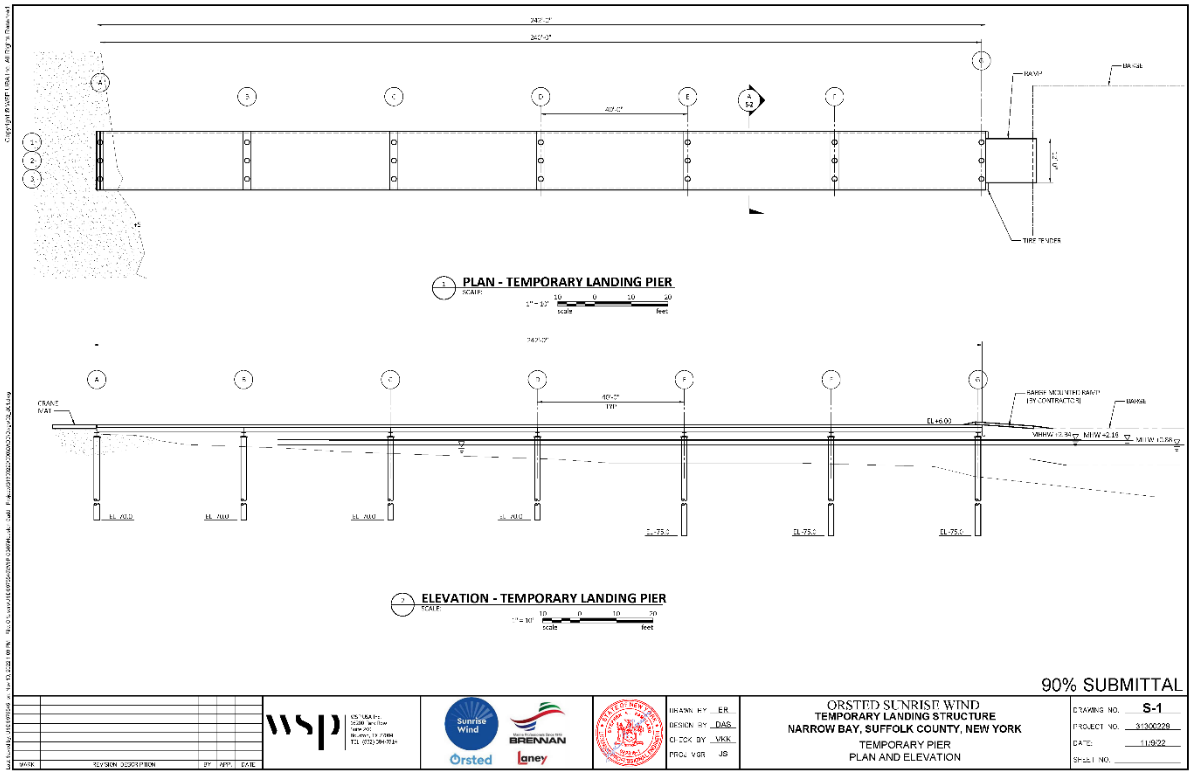


Figure 2-4 Preliminary Plan and Elevation Details for the Temporary Landing Structure

Landfall construction would occur via HDD methodology. The Landfall HDD work area would be situated onshore within the eastern side of the Smith Point County Parking Lot located north of Fire Island Beach Road at Smith Point, Long Island, New York and would occupy approximately 6.5 acres. The borehole would be approximately 44 inches in diameter and consist of three high density polyethylene (HDPE) conduits measuring approximately 3,290 ft in length (0.6 mi.). The exit pit would be located at the offshore terminal end of the HDD drill path and would be utilized during construction as an access point to the HDD borehole. The HDD exit pit would be located approximately 2,200 ft (650 m) seaward of mean high water line in soft bottom habitats of the Atlantic Ocean and approximately 3,280 ft (1,000 m) southeast of the entry pit (Figure 2-6).

At the offshore HDD exit pit, Sunrise Wind anticipated that approximately 4,900 cy (3,750 m^3) of material would be excavated from within an approximate 164-ft x 49-ft x 16-ft (50 m x 15 m x 5 m) area, as reported in the Sediment Transport Modelling Report (COP Appendix H), noting the actual volume would be less due to angled side slopes (not vertical sides). More recently, in the Environmental Monitoring and Construction Plan 2 (EM&CP 2) submitted to NYS Department of Public Service in March 2023, the HDD exit pit dimensions and methods have been refined. Appendix QQ of the EM&CP 2 indicates the HDD exit pit would be approximately 20-ft by 50-ft by 10-ft deep with 3:1 side slope and a total volume of 731 CY (559 m^3).

The full HDD drill and dredging plans are detailed in Appendix NN and Appendix QQ of the EM&CP 2 submitted to NYS Department of Public Service in March 2023. Excavation of the HDD exit pit would occur via divers using diver jetting (e.g., high lift portable venturi dredge system) and airlift tools (e.g., high lift gold dredge) to accommodate drilling activities and the HDD pipe string pull-in work. The discharged end would be placed approximately 10 to 20 feet (3 to 6 meters) away from the excavation, and materials from the pit would be selectively relocated away from the pit. As the material is placed on the sea floor, the divers would move the discharge end to minimize build-up in one location. The divers would be deployed and recovered to the lift boat deck by a launch and recovery system (LARS). To ensure the excavated pit does not naturally backfill before drilling is completed, a trench box, approximately 20-ft by 50-ft in size (1,000 ft^2) would be placed within the excavated area. Once the drilling has been completed, the trench box would be removed and the exit pit would be naturally backfilled.

Consistent with Certificate of Environmental Compatibility and Public Need (Certificate) Conditions, Sunrise Wind would minimize the sediment removed from the offshore HDD exit to the maximum extent practicable. Excavated material would be expected to naturally backfill the exit area excavation to pre-existing elevations after completion of drilling, alleviating the need to dispose of dredged material at an offsite facility. Temporary placement of excavated HDD exit pit sediment on the seabed for a 45-day period may occur. Model simulations show this placed sediment would be subject to mobilization and resettlement during storm events (multi-day events with average winds in excess of 20 mph and gusts exceeding 35 mph). After a 45-day model simulation which included two mobilization events associated with storm activity, 89 percent of the excavated sediment would be within 38 m (125 ft) of the initial placement. All impacts from the HDD exit pit and anchoring support area would be temporary and occur entirely in soft bottom habitats (Table 4-1, Appendix M3 Benthic Habitat Mapping to Support EFH Consultation). All areas where vessel pads contact the seafloor would be within the designated anchoring area (see Figure 2-6) and outside areas identified as sensitive benthic habitat and Significant Coastal Fish and Wildlife Habitats.

In addition, results of geotechnical and chemical analysis of sediment cores from the HDD exit pit area indicated dredged sediments would be expected to be suitable for disturbance and natural backfill in the proposed excavation area. Therefore, offsite disposal of dredged sediments from HDD activities would not be necessary. Consistent with the Certificate, backfill would be evaluated for presence/absence of a discernable depression no later than three months following dredge completion, exclusive of the construction windows described in the Certificate Conditions. If a discernable depression was to be discovered, the depression would be backfilled in a timely manner unless, in consultation with agencies, it is determined backfill is not necessary. In addition, the Sediment Transport Modelling Report (COP Appendix H) also includes a model scenario (Scenario 3) that was developed to assess the potential mobilization and resettlement of the temporary sediment mound following excavation of the HDD exit pit. At the end of 45 days, 89 percent of the material would remain within 38 m (125 ft), 92 percent would remain within 76 m (250 ft), and 95 percent of the material would remain within 152 m (500 ft). As noted above, the volumes utilized in the Sediment Transport Modelling Report of the COP are greater than current plans for excavation quantities.

In-water seabed disturbing work (including dredging) is planned to occur beginning December 1 and ending on, but inclusive of, April 30 of the succeeding year (e.g., will not occur between May 1 to June 30 or September 1 to November 30). If backfill of the HDD exit or remedial burial/secondary cable protection installation and defect remedy would need to occur during the restricted window (May 1 to June 30 or September 1 to November 30), Sunrise Wind has developed an Atlantic Sturgeon Monitoring and Impact Minimization Plan (Appendix TT in EM&CP 2). Within four months of completion of activities, results of water quality monitoring with respect to model prediction would be reported, per the Suspended Sediment and Water Quality Monitoring Plan (Appendix SS in EM&CP 2).

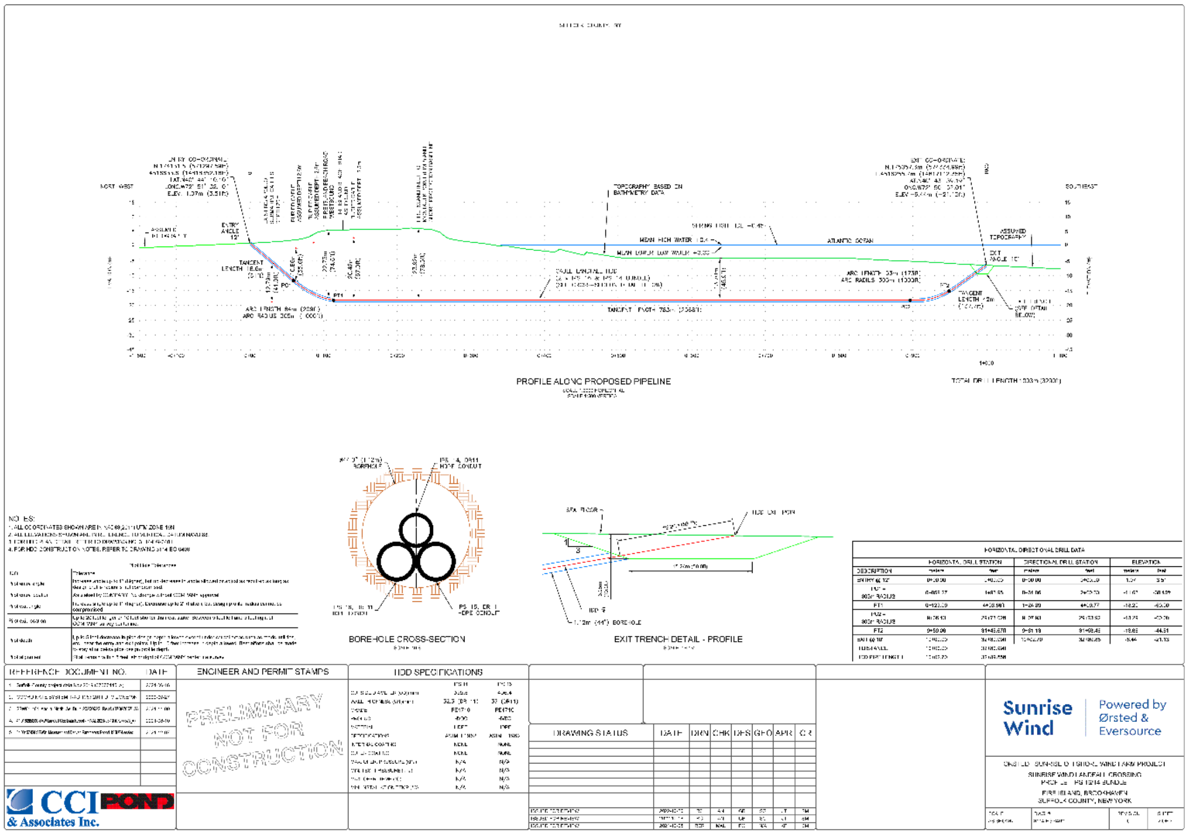


Figure 2-5 Preliminary Plans for Landfall HDD Exit Pit

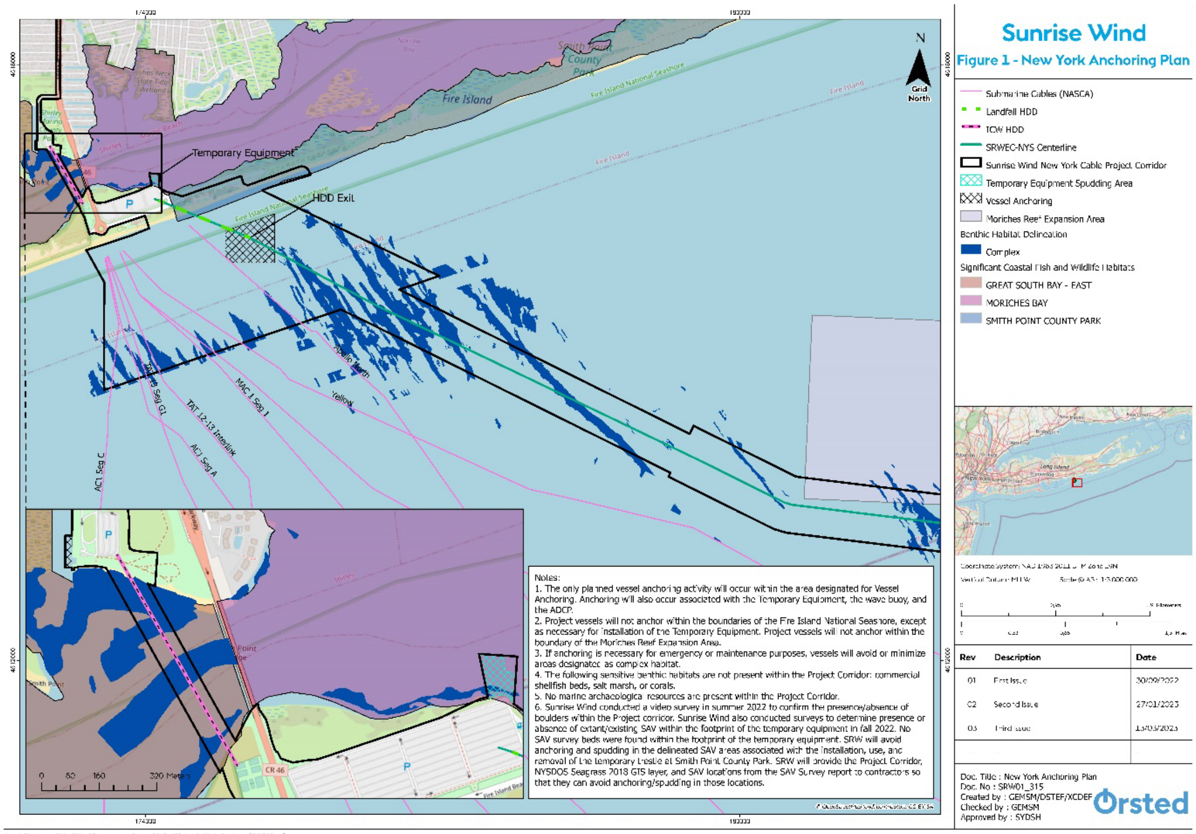


Figure 2-6 HDD Exit Pit and Vessel Anchoring Area Locations

Up to three ducts will be installed in the drilled hole, two for the transmission cables (i.e., conductors) and one for the fiber optic cable, pending engineering design. The offshore duct end would be installed with a welded flange or awaiting the subsequent installation of the export cable. When the export cable installation begins, a pull winch attached to either a piled anchor or a gravity anchor (e.g., a large bulldozer) would then be used to pull the cable through the conduit. Material needed for cover of the landfall HDD conduit end would be placed adjacent to the landfall HDD conduit location for later use as cover material.

The HDD Landfall installation method involves drilling a horizontal bore underneath the seafloor surface and the intertidal area using a drilling rig located onshore. A passage would be created using drilling heads and reaming tools that would be wide enough to accommodate the cable duct. Drilling fluid, comprised of bentonite, drilling additives, and water would be used to stabilize the hole preventing collapse.

Approximately 2,640 ft (0.4 mi.) of the onshore transmission cable would be installed via HDD under the Long Island Intracoastal Waterway (i.e., Narrow Bay). Two trenchless work sites would be located on both sides of the HDD and utilized for the duration of the Intracoastal Waterway (ICW) HDD work. The drill entry site would be located in the southeast corner of the Smith Point Marina parking lot. The exit site will be located on the northern side of Smith Point County Park just west of the Smith Point Bridge and William Floyd Parkway. The borehole would be approximately 36 inches in diameter and consist of six (6) HDPE conduits. The cables would be installed approximately 42 ft below the existing seabed of the waterway.

The second waterway crossing at Carmans River would consist of installing approximately 36 ft of the onshore transmission cable via HDD. Two trenchless work sites (entry and exit) would be located on each side of the HDD and utilized for the duration of the Carmans River HDD work. The drill entry site would be located approximately 1,100 ft east of the Carmans River culvert on Victory Ave.\Horseblock Rd. The exit site will be located approximately 1,100 feet west of the Carmans River culvert on Victory Ave.\Horseblock Rd. The cable would be installed a minimum of 40 ft below an existing culvert located within the waterway.

In order to minimize the potential risks associated with an inadvertent drilling fluid return/release, the Inadvertent Return Monitoring Plan would be followed. Visual monitoring would be conducted along the HDD alignment path. The monitoring frequency would vary seasonally (between September 15 and December 15 at the ICW HDD and between March 1 and May 31 at the Carmans River HDD). Monitoring conditions would include; full drilling fluid circulation, partial loss of drilling fluid circulation, or inadvertent return of drilling fluid (Sunrise Wind 2023).

Additionally, the Inadvertent Return Response Plan would be executed in the event of an inadvertent return. If the inadvertent return event is identified within the marine environment or Carmans River, the contractor would notify Sunrise Wind of the event. The release would be monitored for impact and a marine spill response contractor would deploy turbidity curtains for fluid containment. The response would vary depending upon the volume of drill fluids lost. If the inadvertent return event is identified within the onshore portion of the HDD alignment, Sunrise Wind would be notified of the event. The contractor would contain and clean-up as necessary. Following either an onshore or marine inadvertent return event, there would be a response close out procedure. Fluids would be transported to an appropriate disposal facility with oversight by the HDD and Environmental Monitors (Sunrise Wind 2023).

Approximately 99.4 mi (160 km) of the SRWEC would occur in federal waters at a maximum water depth of 223 ft (68 m) and approximately 5.2 mi (8.4 km) would occur in NYS waters at a maximum water depth of 95 ft (29 m). The approximately 104.6 mi (168.4 km) SRWEC would occur within a surveyed corridor ranging in width from 1,312 to 2,625 ft (400 to 800 m), depending on water depth. The total width of the disturbance corridor would be up to 98 ft (30 m), inclusive of any required sand wave leveling[2] and boulder clearance. Sunrise Wind anticipates that boulders ranging from 0.3 m (1 ft) to 2.4 m (7.9 ft) in diameter would be removed via boulder grab and relocated to just outside the SRWEC cable corridor. Boulders may be relocated longer distances where technically necessary; however, exact locations where this could be warranted have not yet been identified.

The SRWEC would consist of one cable bundle comprised of two individual conductors and a fiber optic cable. The SRWEC-OCS would have a target burial depth of 3 to 7 ft (1 to 2 m) in federal waters and the SRWEC-NYS would be buried to a target depth of 6 feet (ft) (2 meters [m]) where possible. Burial would be dependent upon an assessment of seabed conditions, seabed mobility, the risk of interaction with external hazards, and a site-specific cable burial risk assessment. Installation of the SRWEC consists of a sequence of events; including pre-lay down cable surveys, seafloor preparation, offshore cable

[2] Sand wave leveling is not required along the portion of the export cable within New York State waters (SRWEC-NYS).

installation, cable pull into the landfall, joint construction, cable installation surveys, cable protection, and connection to the OCS-DC (COP Section 3.3.3.4; Sunrise Wind 2022b).

The IAC would carry the electrical current produced by the WTGs to the OCS-DC. The cables would be installed within a 98-ft (30-m)-wide corridor, have a total maximum length of approximately 155 mi (249 km), and would have a typical target depth of 3 to 7 ft (1 to 2 m). Target burial depth of the IAC would be dependent upon the assessment of seafloor conditions, seafloor mobility, the risk of interaction with external hazards, and a site-specific cable burial risk assessment. Installation of the IAC would be anticipated to follow a similar sequence to the SRWEC, with two exceptions. After pre-lay cable surveys and seafloor preparation activities are completed, a cable-laying vessel would be pre-loaded with the IAC. The cable would either be laid on the seafloor and then trenched post-lay, or cable laying and burial would occur simultaneously using a lay and bury tool. Alternatively, a trench may be pre-cut prior to cable installation. The pull and lay operation would then be repeated for the remaining IAC lengths connecting the WTGs and OCS-DC together. The IAC would not require in-field joints. Installation of the IAC would involve seafloor preparation. Sunrise Wind assumes that up to 10 percent of the total IAC network would require boulder clearance (up to 185 acres [74.787 ha]) and up to 5 percent of the total IAC network would require sand wave leveling prior to the installation of the cables (92 acres [37.3 ha]) (Personal communication, M. Evans, 2023b). Sunrise Wind anticipates that boulders ranging from 0.3 m (1 ft) to 2.4 m (7.9 ft) in diameter would be removed via boulder grab and relocated to just outside the IAC corridor. Boulders may be relocated longer distances where technically necessary; however, exact locations where this could be warranted have not yet been identified. Cable protection would be necessary for the IAC, and Sunrise Wind assumes that up to 15 percent of the entire cable network may require secondary cable protection (Personal communication, M. Evans, 2023b). The maximum general disturbance area corridor would be 1,620.9 acres (655.9 ha).

2.2.2.1 Vessel Activity

For offshore cable installation, Sunrise Wind anticipates a maximum of 32 vessels required for IAC installation and 38 vessels for the installation of the SRWEC. During construction, installation vessels for array and SRWEC cable installation include main cable-laying vessels, main cable jointing vessels, main cable burial vessels, and support vessels. To the extent feasible, dynamic positioning vessels would be used for cable installation. If anchoring, or a pull ahead anchor, is required during cable installation, it would occur within a corridor centered on the cable. Anchors associated with cable-laying vessels would have a maximum penetration depth of 15 ft (4.6 m). Vessels would have up to seven anchors with anchor dimensions of 9 ft by 9 ft (2.74 m by 2.74 m). Support vessels would also be required (COP Section 4.2.1; Sunrise Wind 2022b).

Anchoring of vessels within NYS waters would only occur during the scope of work associated with the following activities: 1) installation and use of temporary equipment to receive the transit barge during construction activities in Smith Point County Park; 2) HDD and cable pull-in for the landfall HDD; and 3) installation of temporary wave or measurement buoys and ADCP units. Anchoring is not planned for 1) installation of the ICW HDD; 2) installation of the SRWEC-NYS; or 3) trials of installation equipment. Any anchoring or contact with the seafloor, is planned to occur within the areas designated within the Sunrise Wind New York Cable Project corridor. A figure and/or shape files would be provided to contractors, so that they can position to avoid anchoring or contacting the seafloor within the Fire Island National Seashore boundary or within the Moriches Reef Expansion, to avoid existing buried assets, and avoid sensitive benthic habitats.

2.2.2.2 Seabed Preparation

Boulder Relocation

There is a potential to encounter boulders during the proposed construction and installation of the offshore infrastructure. During construction activities, the presence of boulders can impact exposed or shallow buried cables that may require post-lay cable protection, can obstruct cable installation equipment that could result in failure to reach target cable burial depth, equipment damage, and/or delayed cable installation, and risk of damage to cable assets. Along the SRWEC, boulder fields were only identified in the nearshore area of the SRWEC-NYS, predominately consisting of smaller cobble-sized boulders (see Figure 3-6). Boulder fields were not encountered anywhere else along the SRWEC, although individual boulders were identified in some locations and would be relocated. Prior to installation, geophysical surveys would be performed to determine where boulders occur and to inform micrositing decisions. Boulder clearance trials may be performed nearshore with the boulder grab prior to wide-scale seafloor preparation activities to evaluate efficacy of boulder clearing techniques. The timing of the boulder clearance trials would depend on receipt of permits and approvals. Assuming COP approval in March 2024, boulder trails along the SRWEC, if needed, would occur in early 2025. Boulder removal would occur prior to construction to clear the cable corridor in preparation for cable trenching and burial. Boulder removal can be conducted using a combination of methods to optimize clearance of boulder debris of varying size and frequency. The choice of these activities would be dependent on the location, size, and density of the boulders. For cable installation to occur, Sunrise Wind anticipates that a route up to 98 ft (30 m) would need to be cleared of boulders. Boulder removal would be completed by a support vessel based on pre-construction surveys.

Boulder removal would be completed by deploying a boulder grab from a dynamic positioning support vessel. Removal would be based on pre-construction surveys to identify both the location and size of the boulders. This method would generally be used to remove large boulders and is most suited in areas of boulders with low density. The typical boulder grab methodology would include the following steps:

1. A grab is lowered to the seafloor over the target boulder.
2. Once grabbed, the boulder is either relocated away from the lay corridor or recovered to deck (COP Section 3.3.3; Sunrise Wind 2022b).
3. When using a boulder grab, the maximum distance a boulder would be moved is approximately 15 m (49 ft) from its original location if the boulder is located on the centerline of the SRWEC or IAC (i.e., it would be moved perpendicular to the edge of the 30 m [98 ft] wide installation corridor). The maximum distance for a boulder to be moved at a foundation location is approximately 220 m (722 ft) from its original location if it is in the center of the planned foundation location (i.e., it would be moved to the edge of the 220 m [722 ft] wide seabed preparation area). The boulders would be removed by boulder grab utilizing a remotely operated grab tool. The grab is deployed from the system's self-contained Launch and Recovery System, an A-frame, or a crane and guided by a video link from a remotely operated vehicle. The grab is lowered to the seabed over the targeted boulder, "grabbed", and relocated away from the designated location.
4. The location for boulders that are relocated utilizing a boulder grab would adhere to the following protocols: a) be as close to the original location, within the Area of Potential Effect corridor, but outside of the corridor for cable installation equipment; b) not be within an

Archaeological Exclusion Zone; c) not be within the exclusion zone of a potential MEC or archaeological contact; and, d) not be within any other exclusion or protected zone including, but not limited to, sensitive benthic habitat and shipwrecks.

On completion of the operation, a post clearance survey would be conducted, using either multibeam echo sounding (MBES) or a side-scan sonar (SSS) to confirm that boulder removal has been achieved (Section 3.3.3; Sunrise Wind 2022b).

Sand Wave Leveling

Sand waves are sediment features on the seabed that resemble sand dunes. Cables must be buried beneath the stable seafloor elevation to avoid cable exposure during the lifetime of the Project. Additionally, many of the cable installation tools proposed for cable installation require a relatively flat seafloor surface so that the operational criteria (pitch and roll) of the tools is not exceeded. The seafloor slope angles may be leveled to ensure burial tool maneuverability. The maximum acceptable slope angle is dependent upon the burial tool selected. Sand wave leveling may be required during seafloor preparation activities prior to cable installation.

Methodologies for sand wave leveling proposed by Sunrise Wind include dredging and controlled flow excavation (CFE), which may be used as stand alone or in combination. The CFE is a non-contact dredging tool which utilizes thrust to direct waterflow into sediment, creating liquefaction and subsequent dispersal. The CFE tool draws in seawater from the sides and then jets this water out from a vertical down pipe at a specified pressure and volume. For dredging, a trailing suction hopper dredge (TSHD) is proposed and involves the use of a drag arm which is pulled along the seafloor from the dredge and hopper vessel at the surface. The drag arm fluidizes sediment at the seafloor which is then hydraulically pumped to the hopper portion of the vessel where the sediment is able to settle out of suspension. During this operation, there is often a continuous overflow of water and any sediments remaining in suspension from the hopper at the water surface. Once the hopper is filled with sediment, disposal is made either hydraulically at the surface or the vessel transports to a designated disposal site and the sediment is released from the bottom of the hopper through a hatch in the vessel’s hull, or more carefully position material subsea via means of a downpipe. If needed, TSHD disposal would likely occur via downpipe disposal in the adjacent sand wave field, within the survey corridor. The survey corridor width varies between 400 m and 800 m wide, depending on water depth, so disposal would occur approximately 150 m to 350 m from the corridor centerline.

Up to 10 percent of the SRWEC-OCS and up to 5 percent of the IAC may require sand wave leveling. Sand wave leveling is not required along the SRWEC-NYS. Where required, Sunrise Wind has assumed the 98-ft (30-m) construction corridor would be cleared of sand waves. Table 3.3.3-5 of the COP indicates that up to 118.5 ac (48 ha) of sand wave leveling may occur along the SRWEC-OCS (160 km x 0.1 x 30 m). Sand wave leveling is no longer anticipated along the IAC. However, using the conservative maximum IAC length of 155 mi (249 km), the up to 5-percent assumption, and the 30-m wide corridor, up to 92 ac (37.3 ha) of sand wave leveling may occur along the IAC (249 km x 0.05 x 30 m) (personal communication, M. Evans, 2023b). Based on a review of the geophysical and geotechnical data, potential cable installation tools, and cable burial requirements, Sunrise Wind has preliminarily identified four distinct segments of the SRWEC-OCS (KP8.8 to KP19.8, KP33.3 to KP36.5, KP48.4 to KP49.9, and KP66.6 to KP70.7) that total a length of 19.8 km where sand wave leveling may be required (see Section 10.3). The sand wave clearance areas identified in the figures in Section 10.3 total approximately 28.8 ac (11.7 ha) (2.4 percent of the SRWEC-OCS disturbance area). The locations where sand wave leveling would occur are primarily located in areas identified as Sand and Muddy Sand (i.e., soft bottom, non-complex habitat). COP Appendix H (*Sediment Transport Modeling Report*) modelled the more conservative bulk disposal release of material through the vessel's hull and the hydraulic disposal of material at surface of the water column. For a scenario modeling the release of 9,075 m3 of sediment at a depth of 5 m below the surface, and assuming 5 disposals would occur intermittently over the areas of sand wave leveling activity, results indicated that the maximum suspended sediment concentrations in excess of 100 mg/L would occur with 5,052 ft (1,540 m) of the cable centerline and TSS concentrations would return to ambient levels with 0.42 hours following completion of the clearance. The maximum predicted deposition thickness was estimated to be 20 ft (6.1 m) within a small area at the point of disposal. The total area of deposition greater than 3.3 ft (1 m) was estimated to be 0.3 ac (0.14 ha). Sedimentation at or above 10 mm (0.4 in) extends a maximum of 72 m (236 ft) from the point of disposal and covers an area of 3.2 ac (1.3 ha) of the seafloor in Federal waters. The use of a downpipe to more carefully dispose of material would result in smaller areas of sediment plume and sediment deposition.

UXO/MEC Risk Mitigation

During Project construction, the likelihood of UXO/MEC encounter is low. Prior to seafloor preparation, cable route, and micrositing of all assets, the Project implemented a UXO/MEC Risk Assessment with Risk Mitigation Strategy (RARMS), designed to evaluate and reduce risk in accordance with As Low As Reasonably Practicable (ALARP) risk mitigation principle. The RARMS consisted of a phased process, beginning with a Desktop Study and Risk Assessment that identified potential sources of UXO/MEC hazard based on charted UXO/MEC locations and historical activities, assessed the baseline risk that UXO/MEC pose to the Project, and recommended a strategy to mitigate that risk. The preferential method for UXO/MEC mitigation is avoidance, but it is anticipated that there is the potential for some instances where avoidance would not be possible. In these situations, confirmed UXO/MEC may be removed through in-situ disposal or physical relocation. Selection of removal method would be made in consultation with an UXO/MEC specialist and in coordination with the proper agencies. In-situ disposal would be done with low noise methods, such as deflagration of the UXO/MEC or cutting the UXO/MEC up to extract the explosive components. Deflagration is a relatively slow process that occurs at less than the speed of sound, compared to detonation, which happens at supersonic speeds. The overpressure of deflagration is much less than that of detonation, and the spatial extent of the shock front and energy released is much less than in a detonation. While non-explosive methods may be employed to lift and move these objects, as discussed above, some may need to be removed by explosive detonation. Underwater explosions of this type generate high pressure levels that could kill, injure, or disturb fish. The UXO/MEC could also be relocated through a "Lift and Shift" operation, where the UXO/MEC would be moved to another suitable location on the seabed. For all UXO/MEC clearance methods, safety measures such as the use of guard vessels, enforcement of safety zones, and others would be identified in consultation with an UXO/MEC specialist and the appropriate agencies and implemented as appropriate (COP Section 3.3.3; Sunrise Wind 2022b).

The RARMS process is conducted in a series of stages prior to construction of the Project. Sunrise Wind submitted to BOEM the Phase 4 (Survey Data Assessment) and Phase 5 (Target Discrimination) report (Sunrise Wind 2022c) which identified seafloor contacts and magnetic contacts in the Project area through a desktop study of all Project survey materials. These contacts are considered potential MEC/UXO (pUXO/pMEC).

Sunrise Wind is currently preparing the Phase 6/7 report, which is the next stage in the RARMS process. Phase 6 is the “Mitigative Actions for pMEC” stage and Phase 7 is the “MEC ALARP Sign-Off” stage, where Sunrise Wind would obtain the sign-off certification for the ALARP. The Phase 6/7 report is anticipated to show that there was one identified pUXO/pMEC in the Lease Area (at WTG 179), but Sunrise Wind has determined that the pUXO/pMEC can be avoided with micrositing. Additionally, any identified pUXO/pMECs along the export cable corridor would be avoided by micrositing the cable route. However, Sunrise Wind is retaining up to three detonations within the COP PDE to account for emergent finds (personal communication, M. Evans, 2023a).

2.2.2.3 Trenching/Cable Installation

Cable installation methodologies of offshore cables is dependent upon sediment conditions. As sediment conditions vary along the SRWEC and within the SRWF, several different cable installation methodologies may be required during installation. Geophysical surveys have been completed upon the proposed route of the SRWEC to inform preliminary routing and the most appropriate tools to reach target burial depths. The installation of the SRWEC would be completed by either having the cable bundle laid on the seafloor and then trenched post-lay or a trench may be pre-cut prior to cable installation. The SRWEC would typically be buried below the seabed. Site preparation activities would take place prior to the placement and burial of the cable. Sunrise Wind is currently considering mechanical plowing, jet plowing, mechanical cutting, CFE, pre-cut mechanical plowing, and pre-cut dredging, although jet trenching is the preferrable installation method. COP Appendix G4 (*Cable Burial Feasibility Assessment*) identifies areas where cable burial challenges could be encountered, such as where boulder fields are present. Although a jet trencher is planned to be used along of the SRWEC and IAC, other methods may be used in areas where potential challenges occur. For instance, CFE may be used to aid in reaching the target burial depth in the “potentially unfavorable” area identified in the nearshore portion of the SRWEC-NYS (see Figure 4 of COP Appendix G4), and mechanical cutting may be used in harder, more cohesive soils, such as those identified along the eastern half of the SRWEC-OCS and throughout the SRWF. The other tools listed above may be used in instances where the water depth and distance from the support vessel are too deep and far for the jet trencher to travel without increased risk of damage to the cable.

Jet trencher trials would be conducted prior to cable burial activities along the SRWEC-NYS and expected to occur over one week. The trials are anticipated to occur within an area between KP 1.88 and KP 3.5, subject to confirmation of suitability based on the pre-construction survey (e.g., free from obstacles). This location was selected to represent the most challenging soil conditions anticipated for the trenching tool based on the Cable Burial Assessment Study. The burial tool from the jet trencher trials would be deployed from either the cable lay vessel or a separate trenching support vessel. As described in Appendix SS of the EM&CP 2 (*Suspended Sediment and Water Quality Monitoring Plan*) pre-monitoring water quality calibration would be conducted prior to the jet trencher trials to enable real-time estimation of TSS concentrations during the trials. In addition, a combination of acoustic (“ADCP”) and calibrated optical backscatter (“OBS”) measurements would be used to estimate TSS concentrations on selected transects. TSS and OBS turbidity water samples would be 1,500 feet up-current (for baseline) and 1,500 feet down-current of the jet plow, at three-interval depths (near surface, mid-depth, and near bottom) and analyzed by a NYSDOH Environmental Laboratory Approval Program certified laboratory.

The offshore cable route would be 104.6 miles (168.4 km)-long and have a cable seabed disturbance width of 98 ft (29.9 m). There would be two cables bundled together with a fiber optic cable along the route. Up to four cable joints may be necessary per cable. Cable installation would include pulling operations. The cable would be pulled through the duct bank conduits and cut leaving a sufficient amount of cable to perform jointing operations. Once pulling has been completed, and appropriate testing of the cable performed to ensure no damage has occurred during installation. The cables would then be sealed to prevent moisture until jointing operations can be occurred (COP Section 3.3.3; Sunrise Wind 2022b).

Prior to trenching and cable installation pre-lay grapnel runs (PLGR) would be undertaken to remove any seafloor debris along the SRWEC and IAC routes. A specialized vessel would tow a grapnel reign along the centerline of each cable to recover any debris such as wires, ropes, fishing nets, and out of service cabling to the deck for appropriate licensed disposal onshore. Along the SRWEC, three parallel grapnel runs would be conducted. Along the IAC, one grapnel run would be conducted. Additional runs may be necessary in areas with a high density of debris. Once deployed on the seafloor, the PLGR equipment is towed along the planned submarine cable route within an accuracy of +/- 10 m (32 ft). The PLGR anchor system creates a disturbance corridor in the seabed approximately 1-m (3.3-ft) wide and has a penetration depth of up to 0.5 m (1.6 ft; subject to soil conditions). These impacts would occur completely within and would be entirely overlapped by seabed disturbance from subsequent boulder relocation and cable installation. Therefore, PLGR impacts are not quantified independently from these other activities. Best practice recommends performing PLGR(s) no more than two weeks prior to the start of the submarine cable installation. PLGR is anticipated to occur along the SRWEC in Q1 2025, and along the IAC in Q2 2025.

The maximum total installed array cable length would be approximately 155 mi (249 km). Installation of IAC would typically occur in a similar sequence to installation of the SRWEC with two exceptions. After pre-lay cable surveys and seafloor preparation activities are completed, a cable-laying vessel would be pre-loaded with the IAC. Prior to the first end-pull, the cable would be fitted with a cable protection system and the cable would be pulled into the WTG or OCS-DC. The vessel would then move towards the second WTG or the OCS-DC. Cable may be laid on the seafloor and then trenched post-lay, or alternatively, cable laying and burial may occur simultaneously using a lay and bury tool. Alternatively, a trench may be pre-cut prior to cable installation. The pull and lay operation, inclusive of fitting the cable with a cable protection system, is then repeated for the remaining inter-array cable lengths, connecting the WTGs and the OCS-DC together. Additionally, the IAC would not require in-field joints, so joint construction would not be necessary (COP Section 3.3.7; Sunrise Wind 2022b).

2.2.2.4 Cable Protection

In the event that cables cannot achieve proper burial depths or to avoid risk of interaction with external hazards, Sunrise Wind propose the following protection methods: (1) rock placement, (2) mattressing, (3) rock filter bags, or (4) grout bags. When the cable has been installed, post-lay cable surveys and depth-of-burial surveys would be conducted to determine if the cable has reached the desired depth. To the extent feasible, cable protection solutions implemented would be the of the type that minimizes potential for gear snags, as feasible (COP Section 3.3.3; Sunrise Wind 2022b).

Approximately 5 percent of the IAC and 5 percent of the SRWEC-OSC may require cable protection (Sunrise Wind 2022b). The SRWEC and IAC would also require protection where they cross existing cables (Figure 2-7). Rock berm or concrete mattress separation layers would be installed over the previously installed cable prior to installing a crossing cable, while the rock berm or concrete mattress cover layers would be installed after cable installation. The location of the IAC and associated cable protection would be provided to NOAA's Office of Coast Survey after installation is completed so that they may be marked on nautical charts.

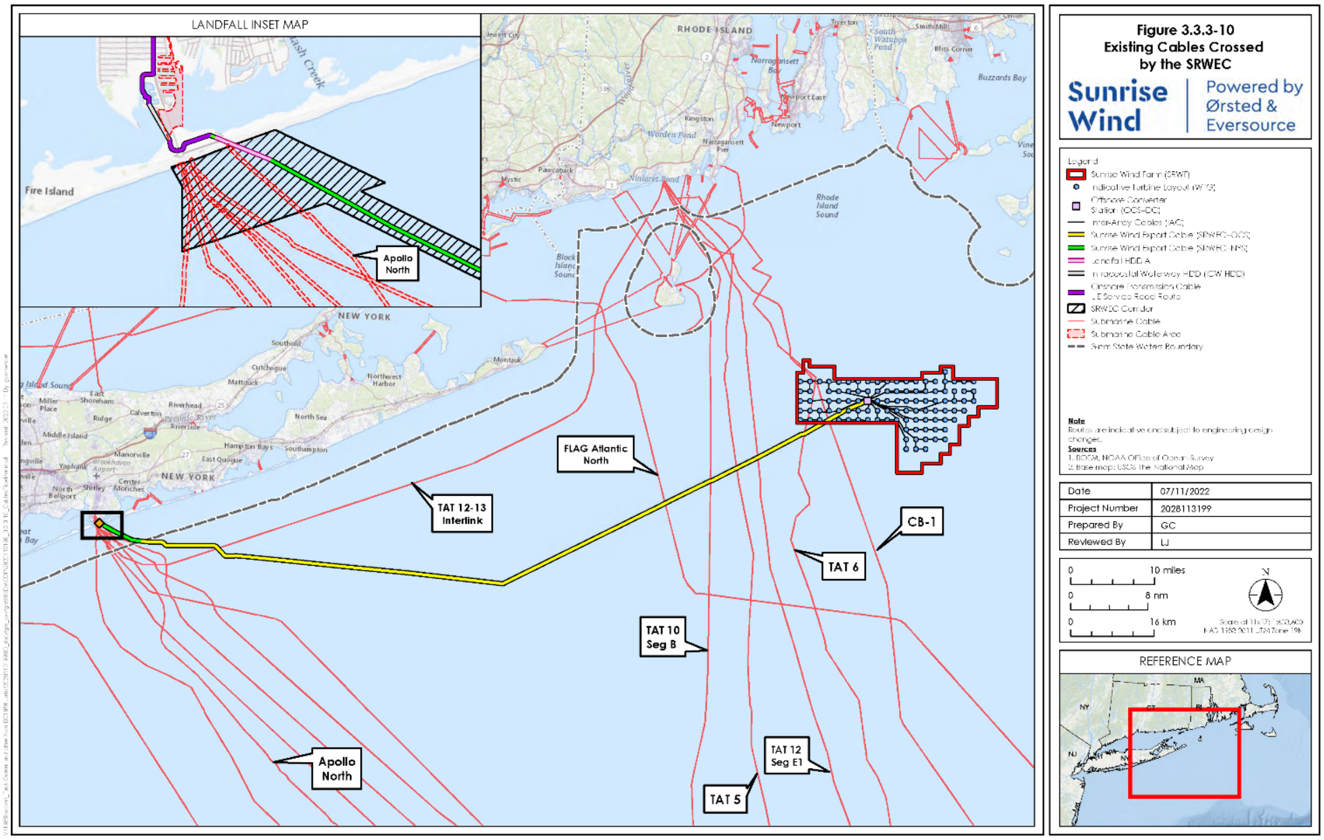


Figure 2-7 Existing Cables in the SRWF Project Area

Rock Placement

Rock placement involves dumping or placing rock overtop of a cable to cover and protect it from physical damage. Rocks would most likely be placed on the seafloor via a fall pipe vessel.

Mattressing

Standard mattresses are composed of concrete blocks linked together by ropes to form a flexible, articulated map, which can be placed on the seafloor over a cable. Alternatively, Frond Mattresses incorporate aerated polyethylene fronds, which essentially mimic natural seaweed. The purpose of this arrangement is to trap sediment and mitigate scour erosion around the vicinity of the mattress. A standard mattress size is 9.8 ft x 19.6 ft x 0.9 ft (3 m x 6 m x 0.3 m).

Rock Filter Bags

Rock filter bags consist of a mesh fabric, in which rocks can be deployed subsea. Rock filter bags are suitable for low-density coverage and allow more precise placement of material and limit rock mitigation relative to dumped rock.

Grout Bags

Grout bags are suitable for low-density coverage.

The location of cable protection associated with the SRWEC would be provided to NOAA's Office of Coast Survey after installation is completed so that they may be marked on nautical charts (COP Section 3.3.3; Sunrise Wind 2022b).

2.2.3 Port Facilities

Sunrise Wind is evaluating the use of several existing port facilities located in New York, Connecticut, and Rhode Island to support offshore construction, assembly and fabrication, crew transfer and logistics, and other activities as necessary. Of the ports being considered, several would require no upgrades or modifications at existing port facilities. To the extent that upgrades or modifications would be necessary, such work would either: (1) be permitted and undertaken by port owners/operators and/or government or quasi-government entities in conjunction with state economic development initiatives relating to the broader U.S. offshore wind industry or (2) evaluated as part of BOEM's review of other projects being developed by Sunrise Wind's fellow subsidiaries of North East Offshore, LLC. Construction port facilities are expected to serve multiple offshore wind projects (COP Section 3.3.10; Sunrise Wind 2022b). The Proposed Action would not require any construction to ports. Existing ports that can support the activities would be chosen.

2.3 Operations and Maintenance

2.3.1 Overview

The Proposed Action is anticipated to have an operating period of 35 years. Sunrise Wind is considering one of several ports to support O&M activities, including the Port of Montauk, NY, Port Jefferson, NY, Port of Davisville, RI, and Quonset Point, RI. The O&M plan for both the Project's onshore and offshore infrastructure would be finalized as a component of the facility design report/fabrication and installation report (FDR/FIR) review process. However, a preliminary O&M plan for the plan is described in the COP (COP Section 3.5; Sunrise Wind 2022b). The Proposed Action would include a comprehensive maintenance program, including preventative maintenance based on statutory requirements and industry best practices. To support O&M, the Project would be controlled 24/7 via a remote surveillance system. Sunrise Wind would inspect WTGs, OCS-DC, foundations, offshore export cables, IAC, onshore export cables, and other parts of the Proposed Action using methods appropriate for the location and element.

2.3.2 Offshore Activities and Facilities

Routine maintenance is expected for WTGs, foundations, and the OCS-DC. Sunrise Wind would conduct annual maintenance of WTGs, including routine service & safety surveys/check, oil and high-voltage maintenance, and visual blade inspections. Other maintenance activities would be conducted as needed. Foundation inspections and maintenance would be conducted above water annually. Subsea inspections would be conducted every 3 to 5 years, based on risk. Major maintenance activities to foundations would be completed every 8 years. A seafloor survey would be completed 1 year after commissioning, 2-3 years after commissioning, and 5-8 years after commissioning, with frequency thereafter depending upon findings of the initial surveys. The original coating system on the WTGs is designed to last the lifetime of the structures. Therefore, no painting activities would be anticipated over the life of the WTGs, other than to repair minor surface damage (COP Section 4.3.3; Sunrise Wind

2022b). The offshore export cables and IAC typically have no maintenance requirements unless a failure occurs (COP Section 3.5; Sunrise Wind 2022b).

The OCS-DC would be normally unmanned, with planned 12-month maintenance activities. Annual maintenance activities would consist of periodic maintenance, including oil changes/lubrication analysis, visual inspection, and function testing of various equipment. Examples of equipment which would be subject to function test: main crane, davit cranes, UPS (Battery bank/battery management system). Platform shutdown is planned to be performed every 2nd year and is planned to last 3 days. During the platform shutdown, general overhaul besides the annual maintenance would be performed. Examples of equipment which would be subject to general overhaul every other year includes change out of seawater lift pump, overhaul of various cooling pumps.

Short visits to the platform for minor maintenance activities may occur at more frequent intervals (i.e., every six months for less than 12 hours). Refueling of diesel generators and minor ad hoc maintenance would be the scope for these visits. All major maintenance would likely be planned in the summer, while other periodic visits may occur all around the year.

Sunrise Wind expects to use a variety of vessels to support O&M, including service operating vessels (SOVs) with deployable work boats, crew transfer vessels (CTVs), jack-up vessels, and cable-laying vessels. Annually, the Proposed Action would require 1 SOV, 1 offshore-based CTV, 1 daughter craft operating from SOV, and individual jack-up vessels to be chartered for individual events or annual campaigns. The type and number of vessels and helicopters would vary over the operational lifetime of the Project. For each vessel type the route plan for the vessel operation area would be developed to meet industry guidelines and best practices in accordance with International Chamber of Shipping guidelines, vessels would install operational automatic identification systems (AIS), and all vessels would operate in accordance with applicable rules and regulations.

The offshore export cables and IAC typically have no maintenance requirements unless a fault or failure occurs. Cable failures would be mainly anticipated as a result of damage from external influences, such as anchors and fishing gear. To evaluate the integrity of the assets, Sunrise Wind intends to conduct a bathymetry survey along the entirety of the cable routes immediately following installation and at 1 year after commissioning, 2-3 years after commissioning, and 5-8 years after commissioning. Survey frequency thereafter would depend on the findings of the initial surveys. A survey may also be conducted after a major storm event. Should the periodic bathymetry surveys completed during the operational lifetime of the Project indicate that the cables no longer meet an acceptable burial depth, the following actions may be taken alert the necessary regulatory authorities, as appropriate; undertake an updated cable burial risk assessment to establish whether cable is at risk from external threats; survey monitoring campaign for the specific zone around the shallow buried cable; and assess the risk to cable integrity. Based on the outcome of these assessments, several options may be undertaken as feasible, permitted, and practical. These options include remedial burial, installation of secondary protection, and increased frequency of bathymetry surveys to assess reburial. It is anticipated that a maximum of 10 percent of the cable protection placed during installation may require replacement/remediation over the lifetime of the Project. These activities would result in a short-term disturbance of the seafloor similar to or less than what is anticipated during construction (COP Section 3.5; Sunrise Wind 2022b).

2.4 Project Decommissioning

Pursuant to 30 CFR 585 and other BOEM requirements, Sunrise Wind would be required to remove or decommission all installations and clear the seabed of all obstructions created by the Project. A separate

EFH consultation would be conducted for the decommissioning phase of the Project. All facilities would need to be removed to a depth of 15 ft (4.6 m) below the mudline, unless otherwise authorized by BOEM (30 CFR § 585.910(a)). Care would be taken to handle waste in a hierarchy that prefers re-use or recycling and leaves waste disposal as the last option. Absent permission from BOEM, Sunrise Wind would complete decommissioning within two years of termination of the lease. Sunrise Wind would develop a final decommissioning and removal plan for the facility that complies with all relevant permitting requirements. This plan would account for changing circumstances during the operational phase of the Project and would reflect new discoveries, particularly in the areas of marine environment, technological change, and any relevant amended legislation. The Proposed Action is anticipated to have an operational life of 35 years, but it is possible that some installations and components may remain fit for continued service after this time. Sunrise Wind would have to apply for and be granted an extension if it wanted to operate the Proposed Action for more than the 25-year operations term stated in their lease.

BOEM would require Sunrise Wind to submit a decommissioning application upon the earliest of the following dates: 2 years before the expiration of the lease, 90 days after completion of the commercial activities on the commercial lease, or 90 days after cancellation, relinquishment, or other termination of the lease (see 30 CFR 585.905). A separate EFH consultation would be conducted for the decommissioning phase of the Project. Upon completion of the technical and environmental reviews, BOEM may approve, approve with conditions, or disapprove the Lessee's decommissioning application. This process would include an opportunity for public comment and consultation with municipal, state, and federal management agencies. Sunrise Wind would need to obtain separate and subsequent approval from BOEM to retire in place any portion of the Proposed Action. Approval of such activities would require compliance under the National Environmental Policy Act and other federal statutes and implementing regulations.

If the COP is approved or approved with modifications, Sunrise Wind would have to submit a bond (or another form of financial assurance) that would be held by the U.S. government to cover the cost of decommissioning the entire facility in the event that Sunrise Wind would not be able to decommission the facility.

3.0 Existing Environment

This section describes the existing environment within each SRWF Project component, including the Lease Area (SRWF), offshore export cable routes (SRWEC), the landing area and ICW-HDD crossing, and interior coastal Project components, all of which have the potential to be used by EFH-designated species. Sunrise Wind conducted detailed benthic habitat surveys of the Project area to support preparation of the COP, detailed in Appendix A of this document and COP Appendices M1– *Benthic Resources Characterization Report – Federal Waters* and Appendix M2 – *Benthic Resources Characterization Report – New York State Waters*, respectively. An additional supporting Technical Report, Appendix M3 – *Benthic Habitat Mapping Report* maps the habitats present across the marine portions of the Project area, to inform EFH consultation (Sunrise Wind 2022a). The surveys and data presented in this section represent the most current information available for characterizing existing conditions in the Project area. Supplemental information related to habitat characterization and benthic habitat mapping are provided in Section 10.2 of this document.

The Project area occurs within the Northeast U.S. Shelf Ecosystem, which extends from the Gulf of Maine to Cape Hatteras, North Carolina (Guida et al. 2017). The Wind Development Area (WDA) and offshore export cable corridor (OECC) are within the Southern New England sub-region of the Northeast U.S. Shelf Ecosystem, distinguished from other regions by differences including productivity, species assemblages and structure, and habitat features (Cook and Auster 2007). Similar to much of the Northeast U.S. Shelf Ecosystem, the southern sub-region habitat is dominated by sandy substrate, a characteristic reflected in the finfish and invertebrate species assemblages found there. Benthic habitat in the eastern portion of the Project area is predominantly sand or sand-dominated substrate and becomes increasingly coarse toward the west and northwest. The Rhode Island-Massachusetts WEA (RI-MA WEA) and the Massachusetts WEA are designated offshore on the northeastern Atlantic continental shelf in Rhode Island Sound. The waters in the vicinity of the SRWF and SRWEC are transitional waters that separate Narragansett Bay and Long Island Sound from the OCS. In general, the benthic communities of these OCS areas are diverse, with lower densities of organisms than in the northern portion of the Mid-Atlantic Bight and in deeper areas of the OCS (MMS 2007). The RI-MA WEA and the Massachusetts WEAs are characterized by a mix of soft and hard bottom environments defined by dominant sediment grain size and composition. These habitats are described in detail and mapped in reports that present Project-specific surveys in the OCS (Appendix B) for the Project area.

To support Sunrise Wind site investigations, high-resolution MBES and SSS surveys were conducted in the Project area in 2019, 2020, and 2021 (Sunrise Wind 2022a). An additional geophysical survey was conducted by Gardline in 2019 in the southeast portion of the SRWF. The geophysical surveys for offshore wind development are designed to support engineering and construction design and, therefore, the MBES was optimized for bathymetric data and backscatter data were collected as an ancillary data product. Bathymetric data were derived from the MBES and processed to a resolution of 50 cm (Sunrise Wind 2022a). Bathymetric data provide information on depth and seafloor topography and are mapped for SRWF in Figure 3-1 and for SRWEC-OCS and SRWEC-NYS waters in Figure 3-2. Backscatter data were derived from the MBES and processed to a resolution of 25 cm. These data are based on the strength of the acoustic return to the instrument so that softer, fine-grained sediments absorb more of the acoustic signal and a weaker signal is returned to the MBES, providing information on seafloor sediment composition and texture. A combination of backscatter over hill-shaded bathymetry and SSS data were used to detect large- and small-scale bedforms, such as megaripples and ripples, mapped for SRWF in Figure 3-3 and for SRWEC-OCS and SRWEC-NYS waters in Figure 3-4. Boulders present in the Lease Area and along the SRWEC corridor are depicted in Figure 3-5. Seabed morphology in the vicinity of the Project area generally consists of a gently sloping seabed; within the Lease Area, the seafloor slopes are predominantly less than one degree and seabed contours are a series of low megaripples (Guida et al. 2017). Bottom temperatures in the New York Lease Area ranged 2-22°C between 2003 and 2016. Sand shrimp and sand dollars were reported to dominate benthic epifauna (beam trawl) samples in the Lease Area; little skate dominated the 14-year megafauna records year-round, joined by longfin squid and sea scallop in the warm season, and by Atlantic herring in the cold season (Guida et al. 2017). The same authors report that taxa for which there may be concern regarding possible habitat disturbance from offshore wind construction and operation activities include black sea bass and longfin squid egg mops (warm season), and sea scallop, surfclam, ocean quahog (year-round). Refer to COP Appendices M1-M3 for detailed benthic habitat analyses and mapping.

Benthic resources were characterized by assessing the physical sediment composition and the biological benthic components using Sediment Profile and Plan View Imaging (SPI/PV) analysis and using the Coastal and Marine Ecological Classification Standard (CMECS) classifications and other variables that aid in describing baseline conditions (see Appendix A for detailed CMECS classification). A total of 408 stations were surveyed, which included 252 stations at the SRWF, 107 stations along the outer continental shelf section of the export cable (SRWEC– OCS), 35 stations in the NYS section of the export cable (SRWEC-NYS), and eights stations along the path of the ICW-HDD. Additionally, 20 stations were surveyed across four reference areas to serve as a comparison. Samples were collected at intervals of 1,000 ft. Details of sampling methods are provided in COP Appendices M1-M3. Select physical and biotic characteristics of benthic habitats for each of the Project components are summarized in Table 3-1 and described in the following sections.

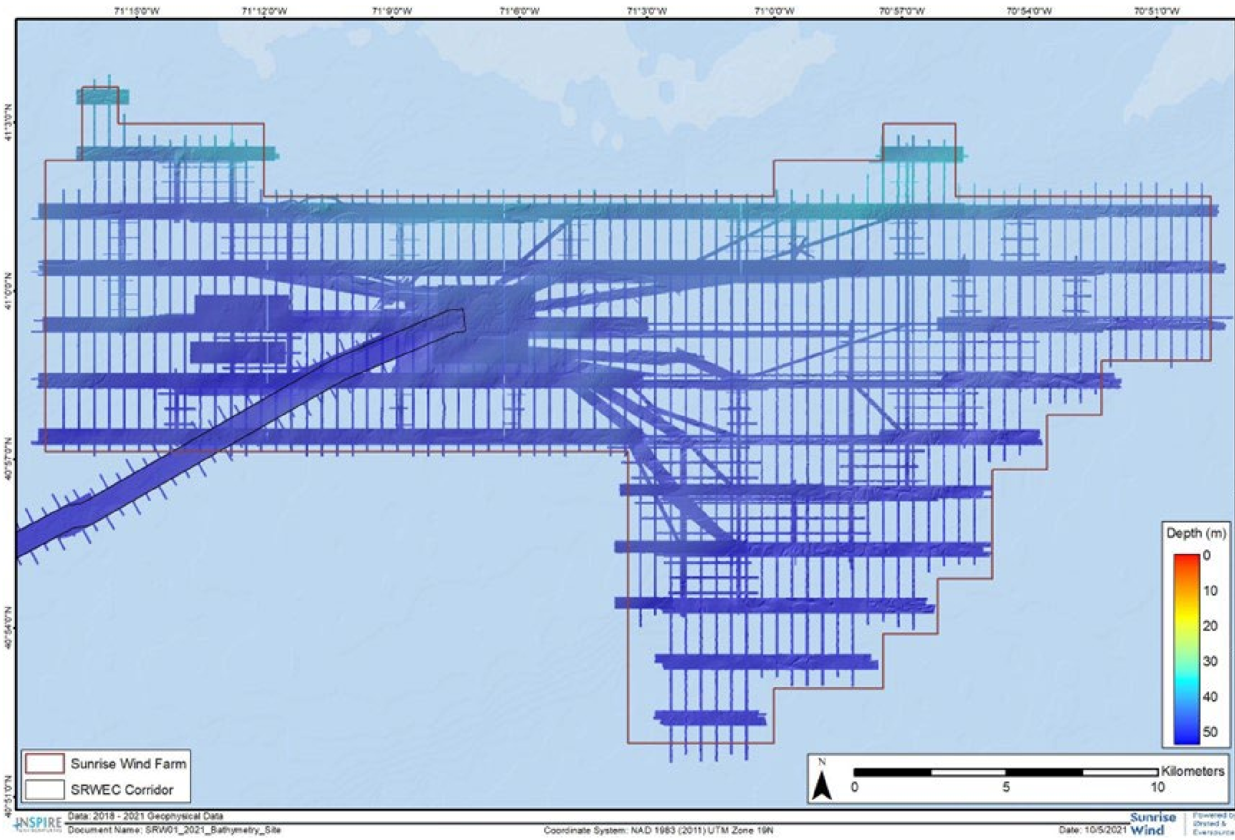


Figure 3-1. Bathymetric Data at the SRWF

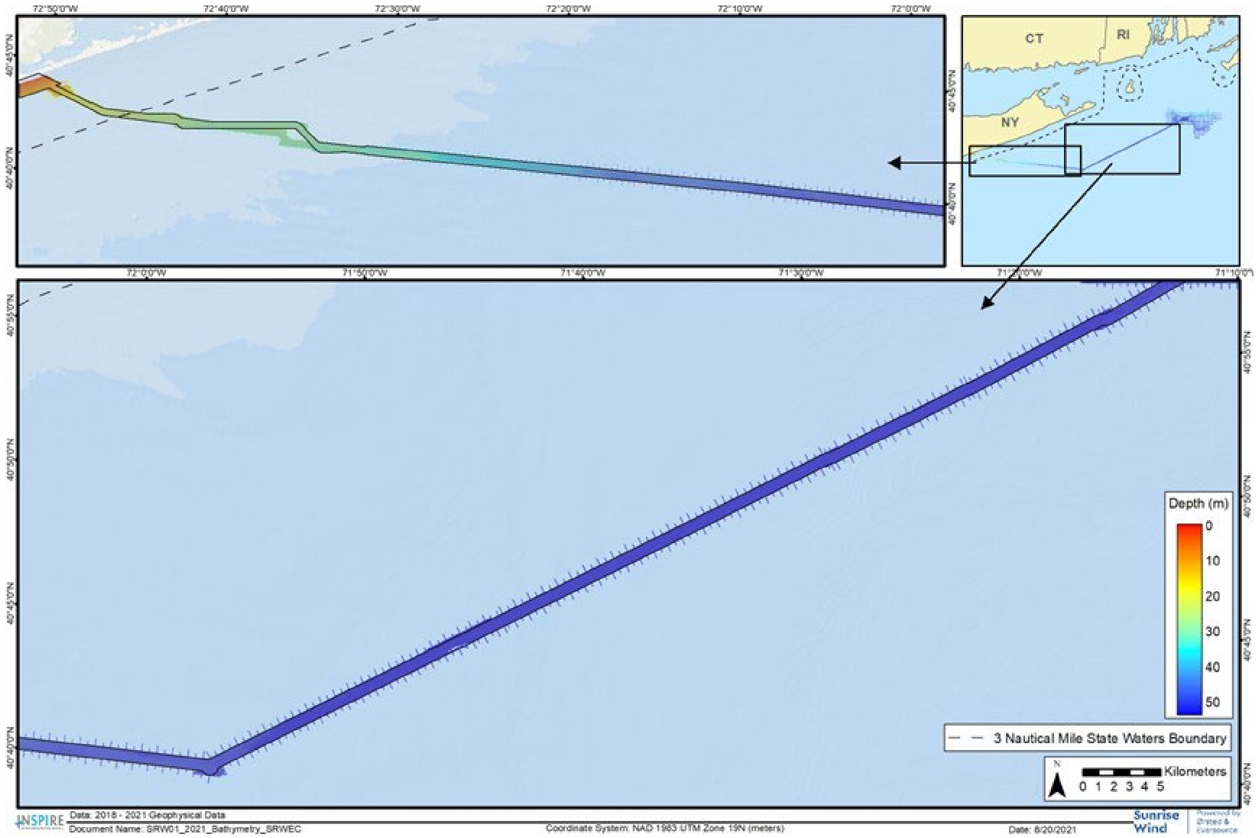


Figure 3-2. Bathymetric Data Along the SRWEC-OCS and SRWEC-NYS

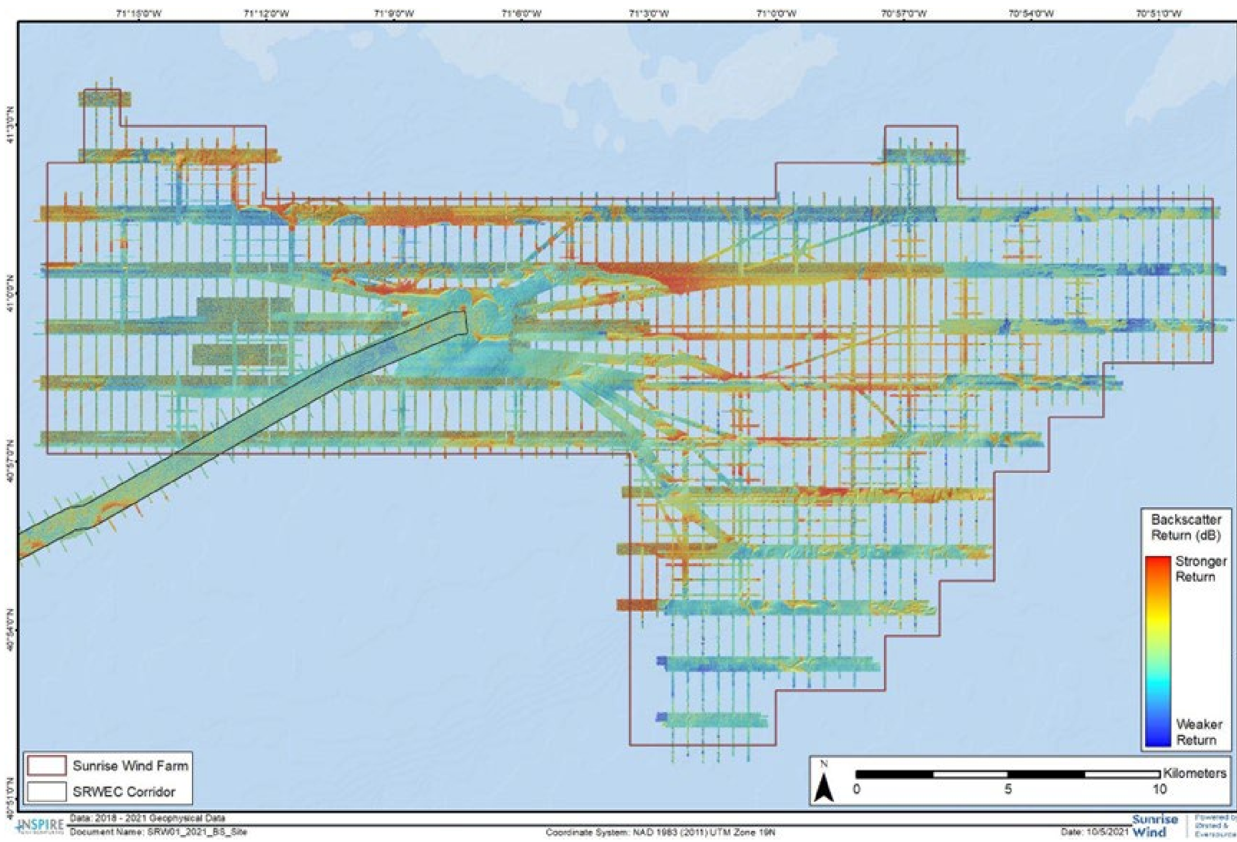


Figure 3-3. Backscatter Data Over Hill-shaded Bathymetry at the SRWF and SRWEC-OCS

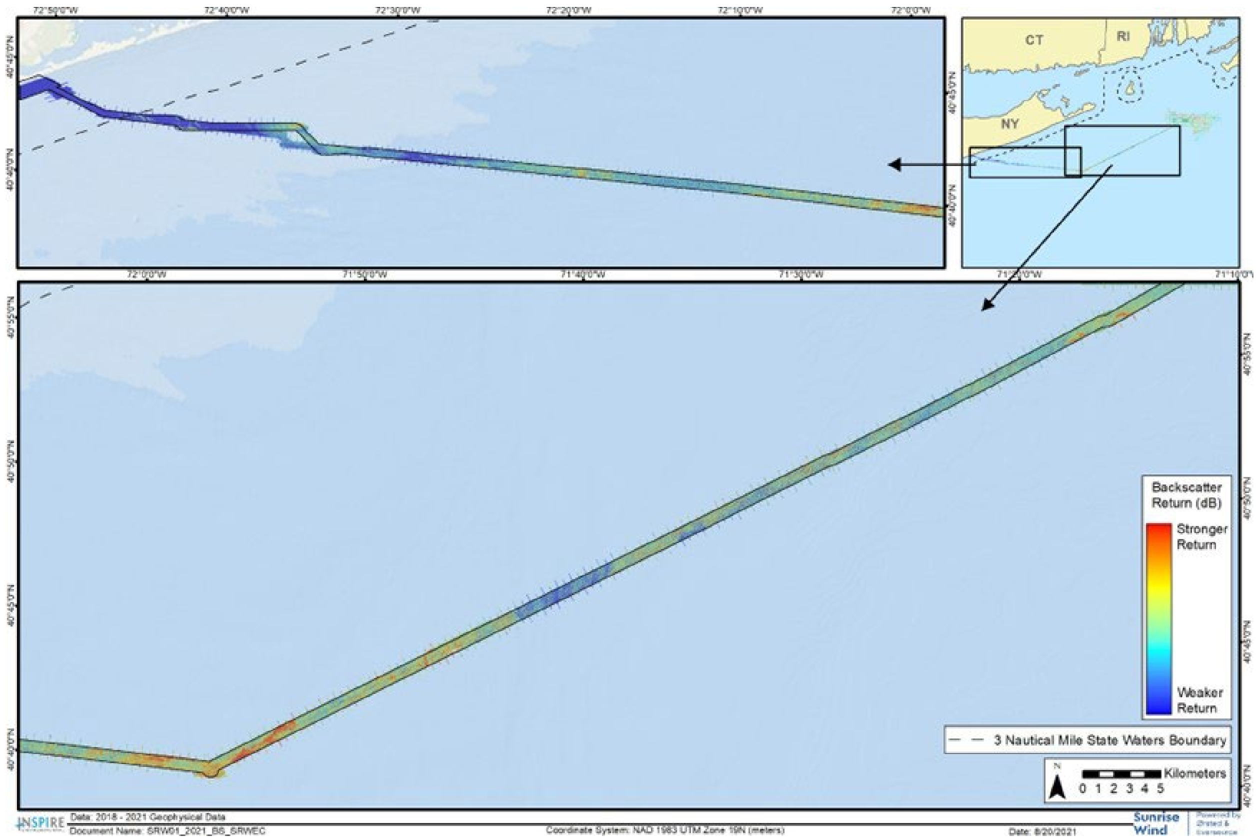


Figure 3-4. Backscatter Data Over Hill-shaded Bathymetry at the SRWEC-OCS and SRWEC-NYS

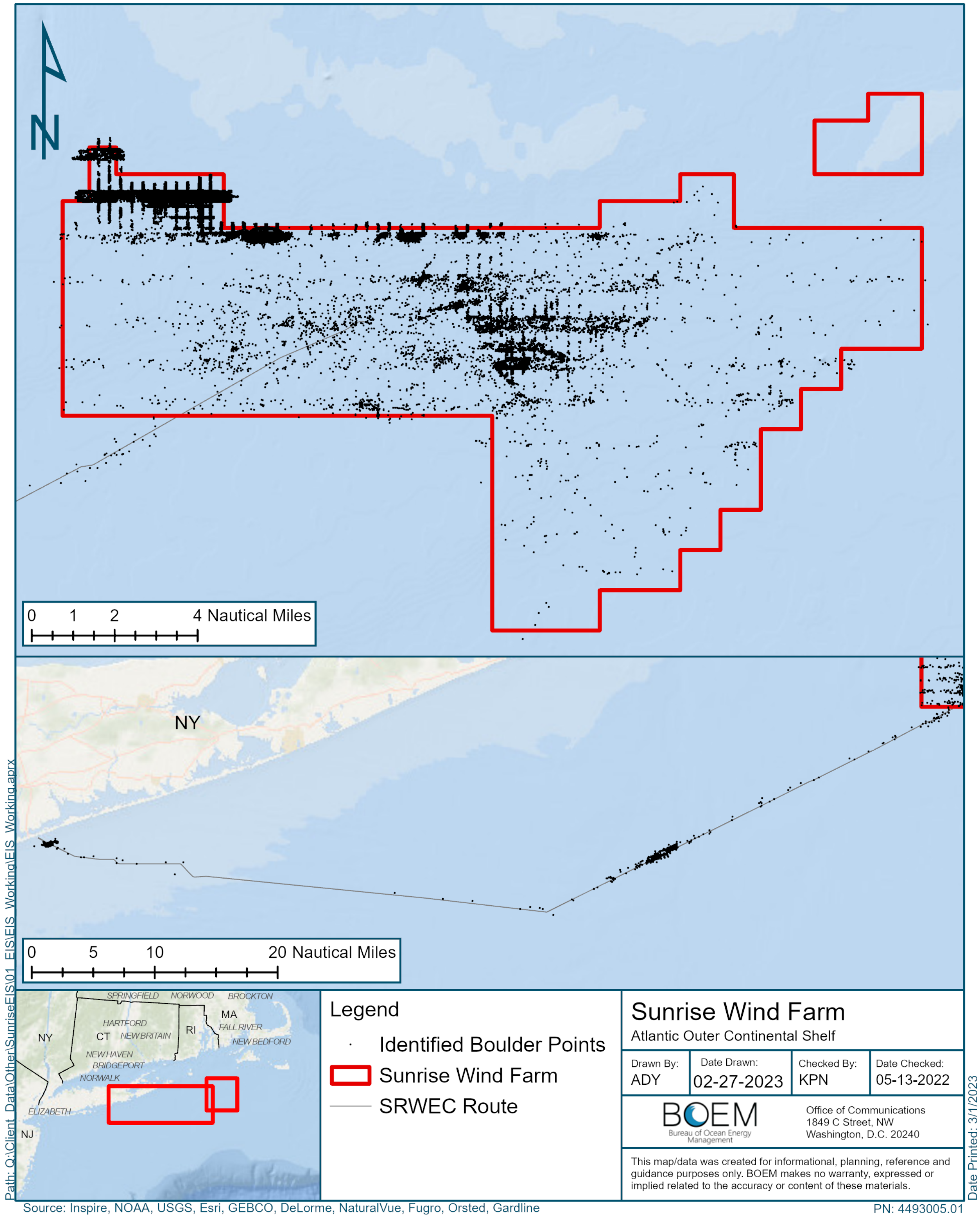


Figure 3-5 Boulders Present in the SRWF Lease Area and SRWEC Corridor

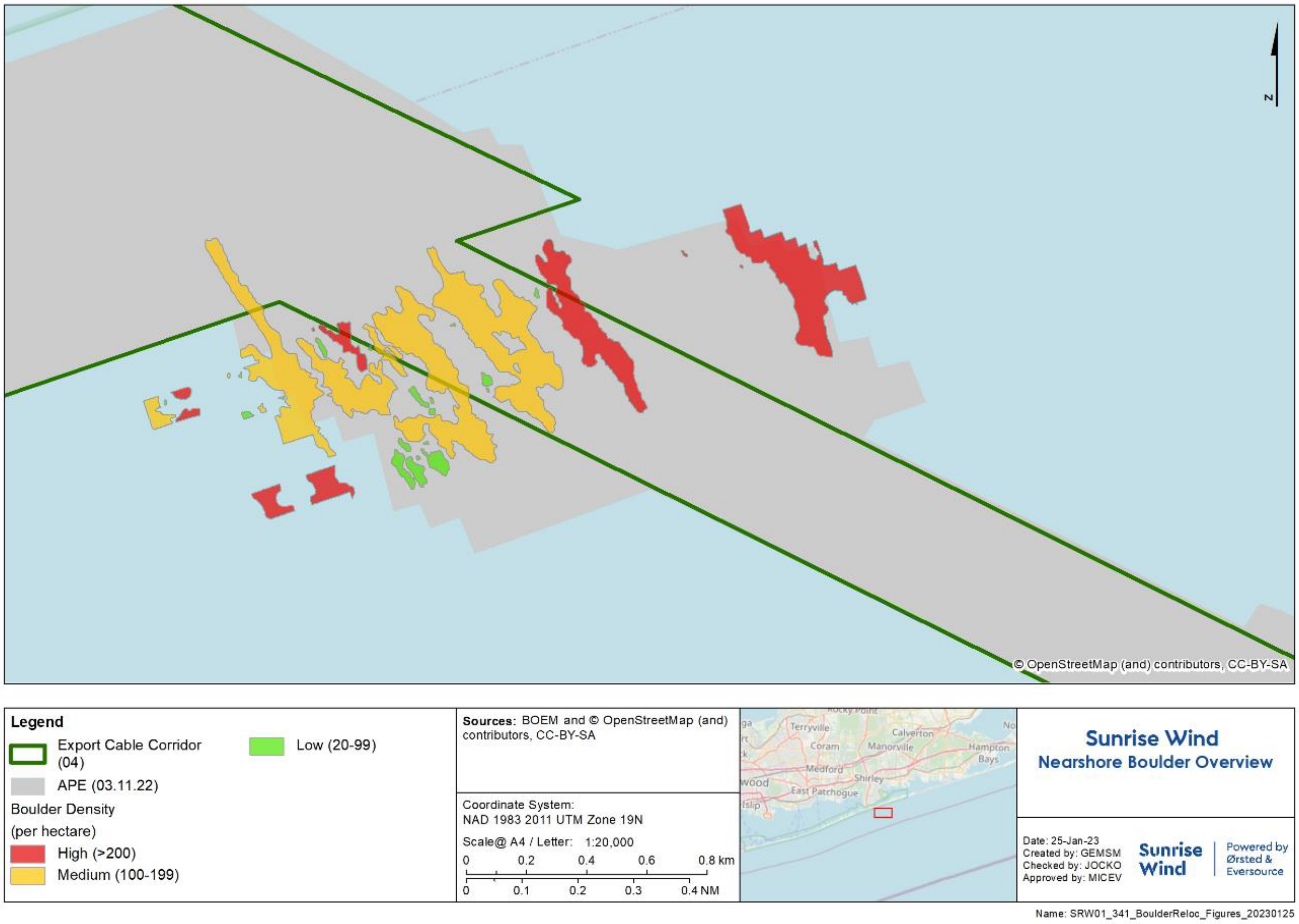


Figure 3-6 Boulder Density near the Onshore Portion of the Export Cable

Table 3-1. Select Physical and Biotic Characteristics of Benthic Habitats Summarized by Proposed Project Component Areas

Area	No. of Samples	Water Depth ft (m)			Dominant Substrate		Biotic Subclass	Common Taxa Observed
		Minimum	Maximum	Average	Group	Subgroups		(n = # Stations)
SRWF	252	128 (39.0)	259.1 (79.0)	161.7 (49.3)	Sand or finer, gravel/gravel mixes	Very fine sand, fine sand	Soft sediment fauna; attached fauna	Sabelid (n=4) Cerianthid (n=10) Sand Dollar (n=11)

Area	No. of Samples	Water Depth ft (m)			Dominant Substrate		Biotic Subclass	Common Taxa Observed
		Minimum	Maximum	Average	Group	Subgroups		(n = # Stations)
SRWEC-OCS	107	89.9 (27.4)	224.1 (68.3)	161.7 (42.3)	Sand or finer, gravel/gravel mixes	Very fine sand, fine sand	Soft sediment fauna; attached fauna	Dioptera (n=2) Cerianthid (n=10) Sand Dollar (n=42)
SRWEC-NYS	35	15 (4.6)	88 (26.8)	57.1 (17.4)	Sand or finer	Very fine sand, fine sand	Soft sediment fauna	Dioptera (n=7) Ceriantlid (n=10) Sand Dollar (n=21)
ICW-HDD	8	NR	NR	NR	Sand or finer and gravel	Sandy gravel	Soft sediment fauna; attached fauna	None (n=8)

Notes: NR = not recorded

Sources: COP, Appendices M-1, M-2, and M-3 {Sunrise Wind, LLC 2021).

Seven benthic macrohabitat types were documented during the site-specific SPI/PV survey as characterized from the comprehensive SPI/PV analyses of selected physical and biological attributes: (1) sand and mud, (2) sand, (3) sand and mud with ripples, (4) sand with ripples, (5) sand with mobile gravel, (6) patchy cobbles and boulders on sand, and (7) cobbles and boulders on sand. The organisms found in these types of benthic habitats are typically described as infaunal species (those living in the sediment, e.g., polychaetes, amphipods, mollusks), and epifaunal species (those living on the seafloor surface (mobile), e.g., sea stars, sand dollars, sand shrimp, or attached (sessile) to substrates, e.g., barnacles, anemones, tunicates). Sediment grain size distribution is an important factor of benthic habitats and influences benthic community distributions and can be used to infer benthic taxa that are likely present in a particular environment. Linking the physical substrate characteristics with the biological functional and taxonomic composition is accomplished using the CMECS, a standard means to categorize the physical (substrate) and biological (biotic) components of environments. NOAA Habitat Complexity Categories, defined by NOAA for the purposes of EFH consultation in their 2021 recommendations (NOAA Habitat 2021), include soft bottom, complex, heterogeneous complex, and large-grained complex. NOAA has defined complex habitats as submerged aquatic vegetation (SAV), shell substrate, and sediments with greater than 5 percent gravel of any size (pebbles to boulders; CMECS Substrate of Rock, Groups of Gravelly, Gravel Mixes, and Gravels) (NOAA Habitat 2021). Heterogenous complex is used for habitats with a combination of soft bottom and complex features (NOAA Habitat 2021).

A crosswalk between the benthic habitat types with modifiers identified in surveys of the Project area and other descriptors (CMECS subclass, Habitat Type, and NOAA Habitat Complexity) is provided in Appendix A. A comprehensive crosswalk for habitat and CMECS (biotic indicators) is provided in Table A-3. Seventeen benthic habitat types with modifiers were cross-walked to the “complex” category in the SRWF Project area. The sand and mud habitat types were classified as “soft bottom” habitat groups. Habitat complexity ranged from complex to large-grained complex to soft bottom. Those soft bottom habitats with low-density boulder fields were categorized as complex. Not all benthic habitats were present in each portion of the Project area.

Benthic habitat groups (with modifiers) are quantified for each Project component in Table 3-2. NOAA Habitat Complexity categories included anthropogenic, large-grained complex, complex, and soft bottom. The largest category by far was soft bottom (sand and muddy sand habitat), making up a total of 53,133 acres (54 percent) of the total 98,220 acres, followed by 24,290 acres of complex (coarse sediment-mobile) with a total of made up 14,495 acres of soft bottom (sand and muddy sand-mobile). Five primary benthic habitat groups were mapped in the Project area: glacial drift, mixed sediment-small gravel and sand, coarse sediment, sand and muddy sand, and mud and sandy mud (Figure 3-7). Habitats updated with modifiers resulted in a total of 22 habitat types (16 within the SRWF, 6 in the SRWEC-OCS, 10 in the SRWEC-NYS, and 7 in the vicinity of the ICW-HDD). The SRWF, SRWEC, and ICW-HDD Project components all include complex, soft bottom, and anthropogenic Complexity categories, but only SRWF includes the glacial category (large-grained complex). A few anthropogenic features (e.g., piers) were also mapped within the ICW-HDD but not included in the counts of habitat types. Descriptions of habitat types found in each Project component are summarized below and followed by brief descriptions of each habitat type as observed for each Project component. Detailed accounts of observations are provided in COP Appendix M3.

Table 3-2. Total Area (acres) of NOAA Habitat Complexity Categories and Benthic Habitat Groups (with modifiers) within the Sunrise Wind Farm Area (SRWF), Sunrise Wind Export Cable Route Corridors in NY State Waters (SRWEC-NYS), SRWEC in Offshore Waters (SRWEC-OCS), and SRWEC in the Intracoastal Waterway (ICW-HDD)

NOAA Habitat Complexity Category	Habitat Group with Modifiers	SRWF	SRWEC-NYS	SRWEC-OCS	ICW-HDD	Total
Anthropogenic	Anthropogenic	0	0	0	1	1
Large-grained complex	Glacial Drift	684	0	0	0	684
Complex	Coarse Sediment	240	1	7	9	258
Complex	Coarse Sediment – Mobile	22,723	348	1,218	0	24,290
Complex	Coarse Sediment – Mobile with High Density Boulder Field	70	7	0	0	77
Complex	Coarse Sediment – Mobile with Low-Density Boulder Field	598	0	0	0	598
Complex	Coarse Sediment – Mobile with Medium Density Boulder Field	499	13	0	0	512
Complex	Coarse Sediment – with Low-Density Boulder Field	87	0	0	0	87
Complex	Coarse Sediment – with Medium Density Boulder Field	11	0	0	0	11
Complex	Mixed Sediment – Small Gravel & Sand	0	0	301	0	301
Complex	Mud and Sandy Mud – with High Density Boulder Field	2	0	0	0	2
Complex	Sand and Muddy Sand – with Benthic Macroalgae	0	0	0	1	1
Complex	Sand and Muddy Sand – with High Density Boulder Field	11	28	0	0	40
Complex	Sand and Muddy Sand – with Low-Density Boulder Field	162	2	0	0	164
Complex	Sand and Muddy Sand – with Medium Density Boulder Field	24	48	0	0	72
Complex	Sand and Muddy Sand – with Potential Benthic Macroalgae-	0	0	0	8	8
Complex	Sand and Muddy Sand – with Potential SAV	0	0	0	11	11
Complex	Sand and Muddy Sand – with Potential SAV and Benthic Macroalgae	0	0	0	3	3
Complex	Sand and Muddy Sand – with SAV and Benthic Macroalgae	0	0	0	2	2
Soft bottom	Sand and Muddy Sand	33,710	1,573	17,752	98	53,133
Soft bottom	Sand and Muddy Sand – Mobile	1,375	324	12,796	0	14,495
Soft bottom	Mud and Sandy Mud	147	1	3,321	0	3,470
Soft bottom	Mud and Sandy Mud – Mobile	0	0	0	0	0
Total		**60,346**	**2,346**	**35,396**	**133**	**98,220**

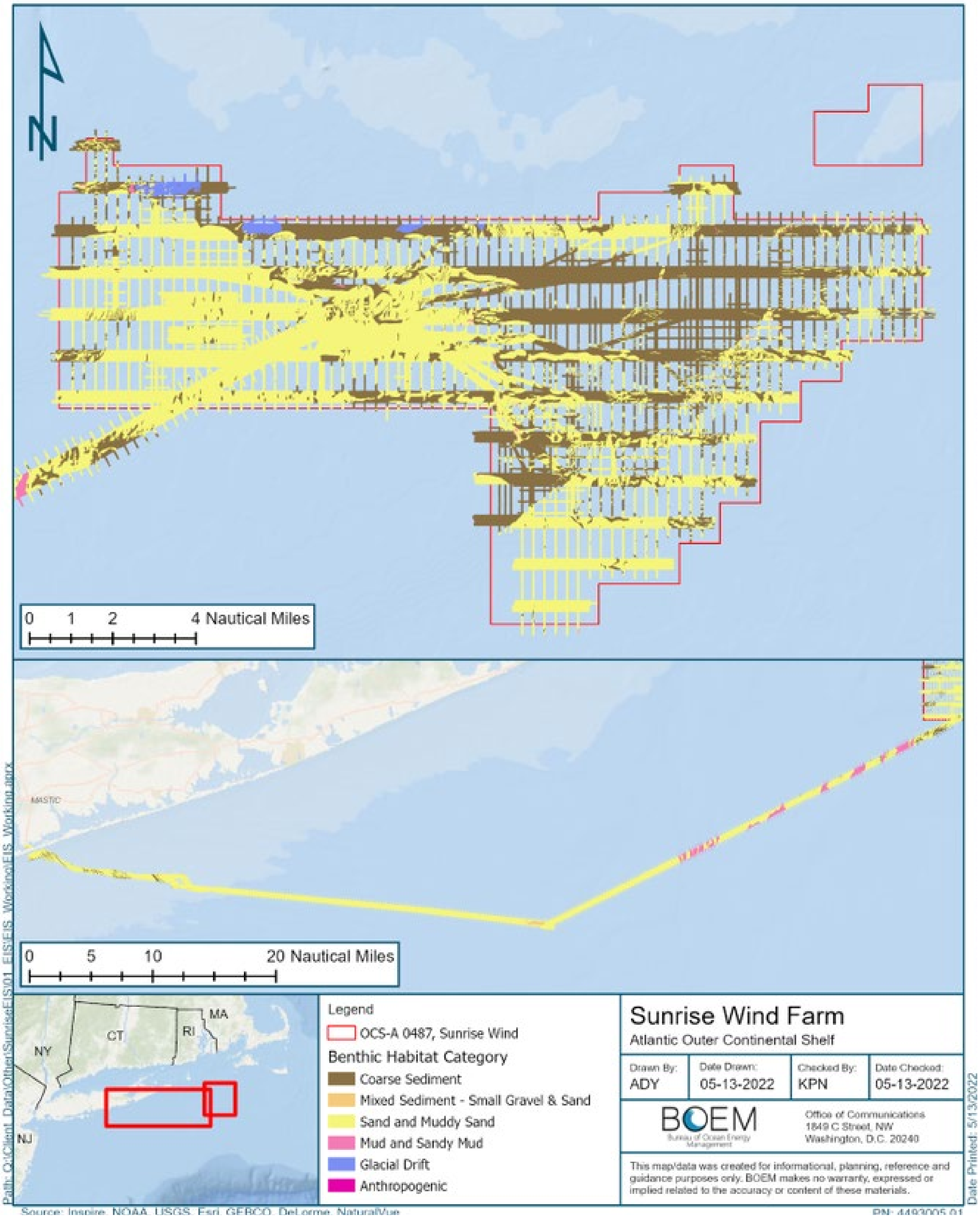


Figure 3-7 Primary Benthic Habitats for the SRWF and SRWEC Corridor

3.1 SRWF Lease Area

Seabed slopes in the SRWF are generally very low, with an average gradient of less than 0.1 degrees (0.15 percent). Within glacially deposited boulder fields, rugosity can be high, with seabed gradients locally exceeding 5 degrees. Sediment bedforms develop in finer grained sediments as a response to hydrodynamic conditions induced by currents and wave action. Sediment bedforms identified in inner and outer shelf sandy sediments include ripples (less than 1.6 ft [0.5 m] in height), megaripples (1.6 to 5 ft [0.5 to 1.5 m] in height), and occasionally sand waves (more than 5 ft [1.5 m] in height). Water depths averaged 161.7 ft (49.3 m) and range from 128 ft (39 m) to 259 ft (79.0 m) in the SRWF. The shallower portions are along the north side of the SRWF (Figure 3-1).

The SRWF included all primary benthic habitat types except the mixed sediment- small gravel and sand (Table 3-2) but was characterized primarily by sandy and muddy sand and coarse sediments (Figure 3-7. Benthic habitats categorized by NOAA complexity category in the SRWF (Figure 3-8) indicate large-grained complex habitat is restricted to the northwestern portions of the SRWF where glacial drift was mapped. Habitats cross-walked to the complex category were predominantly in the north and east portions of the SRWF and in discrete areas along the western edge of the SRWF. Habitats cross-walked to soft bottom habitats were generally found in central, west, and southwestern portions of the SRWF and in the southeastern corner of the SRWF.

The central, west, southeastern tip, and southwestern portions of the SRWF were mostly sand and muddy sand habitats with small areas of coarse sediment habitats. The eastern portion of the SRWF was primarily coarse sediment habitats. With habitat biotic subclass modifiers, sand and muddy sand was the most prevalent habitat type mapped at the SRWF (56 percent), followed by coarse sediment – mobile (38 percent), and sand and muddy sand – mobile. All habitat types were dominated by soft sediment fauna biotic subclass, except for glacial drift habitats where the attached fauna biotic subclass was also recorded (Figure 3-9). The non-reef building hard coral *Astrangia poculata*, a sensitive taxon, was observed at five stations associated with glacial drift and boulders in coarse sediment – mobile habitats. Cerianthids (burrowing anemones) were observed across habitat types at the SRWF and were most prevalent in the sand and muddy sand habitat in the eastern portion of the SRWF.

Boulder fields were found coincident with and near the glacial drift habitats, which occurred at 12 of the total 213 SPI/PV ground-truth sites. A high incidence of clusters of scattered boulders were located immediately east of the center of the SRWF in habitats cross-walked to complex; scattered boulders were also present and dispersed in soft bottom habitats in the center and west of the SRWF (Figure 3-9). Sand and muddy sand benthic habitats (108 sites), the primary habitat of the SRWF, was characterized by CMECS subgroups of medium, fine, and very fine sand, and silt/clay (Figure 3-10). Coarse sediments (78 sites) included the same subgroups as sand and muddy sand habitats but also included gravelly and very coarse, sands. The remaining habitats were very minor, ranging from very fine sands to coarse sands and silt/clay.

Species that inhabit the benthic habitats of the OCS include infaunal species, those living in the sediments (e.g., polychaetes, amphipods, mollusks); and epifaunal species, those living on the seafloor surface (mobile; e.g., sea stars, sand dollars, sand shrimp) or attached to substrates (sessile; e.g., barnacles, anemones, tunicates). In addition to trophic links and biogenic structure, benthic species can also serve important roles in facilitating nutrient and carbon cycling in the sediments through functions such as water filtration, biodeposition, bioirrigation, and bioturbation.

Benthic habitats within the SRWF are described from INSPIRE Environmental (2022). The physical sediment composition and the biological benthic components were assessed through SPI/PV analysis using the CMECS classifications, as described earlier. The SRWF area includes the proposed WTGs, OCS-DC, and IAC. Habitats occurring in the SRWF include rocky habitat (24,913 acres), soft bottom mud (149 acres), soft bottom sand (35,283 acres), pelagic habitat (60,207 acres), along with the presence of biogenic habitat and habitat for sensitive life stages. SAV (summer flounder HAPC), tidal marsh, shellfish reefs and beds, and shell accumulations were not found in the SRWF component area during benthic surveys.

Spatial trends in sediment composition were apparent in the SRWF data. For example, the northwest region had a higher frequency of stations with gravels; the southeast and west-central regions were characterized by finer substrata and limited small-scale sediment mobility; the northeast region was generally composed of fine to coarse sand with sand ripples common. Boulders were infrequently observed at the SRWF but did occur at 12 of the 252 stations, all of which were in the northwest region, with the exception of Station 085, which was located along the southern border at approximate longitude of 71.1°West. The biological attributes of the SRWF followed similar spatial trends to the physical features. The northwest portion of the SRWF was the only area where gravel was observed consistently across stations. Gravel in this area ranged in size from “washed” pebbles and granules to patchy cobbles and boulders on sand, which were encrusted by epifauna (e.g., bryozoa and hydroids). CMECS biotic classes, (e.g., soft sediment fauna, attached fauna, inferred fauna) are mapped in Figure 3-9.

Stations in the southeast region of the SRWF were predominantly very fine sand (CMECS Substrate Subgroup) (Figure 3-9) and sand and mud (macrohabitat type) and had high occurrences of burrowing anemones and sabellid worms. Stations in the northeast region of the SRWF, which were predominantly medium sand or fine sand (CMECS Substrate Subgroup) and sand with ripples (macrohabitat type), had high occurrences of sand dollars. The northwest region of the SRWF was more heterogenous in seabed composition than other portions but included a higher frequency of gravelly sand and sandy gravel (CMECS Substrate Subgroups) compared to the rest of the SRWF and was generally more complex in macrohabitat types (e.g., sand with mobile gravel, patchy cobbles and boulders on sand), was inhabited by attached epifauna (e.g., hydroids [*Tubularia* spp.], sea stars, and bryozoa).

Soft sediment macrohabitats (i.e., mud and sand, with and without small-scale bedforms [i.e., ripples]) were the primary benthic macrohabitats observed across the SRWF. However, sand with mobile gravel and patchy cobbles and boulders on sand were two habitat types that were generally observed in the northwest corner of the SRWF, interspersed with the soft sediment macrohabitats. A video survey was conducted in August 2020 in areas where complex bottom, specifically large gravel (i.e., boulders and cobbles), was observed during the SPI/PV survey and indicated by the high-resolution acoustic data. The results from this video survey would be used to inform habitat mapping efforts.

The northern star coral, *Astrangia poculata*, a non-reef-building hard coral, was the only sensitive taxa observed across the surveyed area, occurring at five stations, all of which were located within the SRWF (Stations 003, 085, 227, 702, and 721). The sea scallop, *Placopecten magellanicus*, a species of concern in the region, was found at 21 stations across the surveyed area interspersed at the SRWF and along the eastern portion of the SRWEC-OCS. An ocean quahog (*Arctica islandica*), another species of concern in the region, was observed at one station (Station 130), while several stations had dead clam shell valves on the sediment surface. Additionally, the Jonah crab, a notable species given its increasing importance as a targeted species by the fishing industry, was observed at two stations within the SRWF (Stations 091 and 121), both of which were characterized by the sand and mud macrohabitat type.

Cobble and boulder habitat can serve as structure for hard and soft corals, nursery ground for juvenile lobster, and as preferable benthic habitat for squid to deposit their eggs. Taxa considered sensitive with respect to this habitat include corals, squid eggs, and American lobster. Biogenic habitats included the non-reef building hard coral and burrowing anemones. The northern star coral was found at five stations, all in the northwest corner of the SRWF. Generally, the western portion of the SRWEC-OCS was characterized by high densities of sand dollars while the eastern portion of the SRWEC-OCS was inhabited by burrowing anemones and sea stars, and 52 percent of SPI/PV stations included burrowing anemones.

3.2 Offshore/Onshore Export Cables

3.2.1 SRWEC-OCS

Primary habitats along the SRWC-OCS were characterized primarily by sandy and muddy sand (Table 3-2, Figure 3-7). Water depths along the SRWEC-OCS range from 89.9 feet (27.4m) to 224.1 feet (68.3 m) and average 161.7 feet (42.3 m) (Figure 3-2). The average and maximum depth are very similar to those in the SRWF.

The SRWEC-OCS included large-grained, complex, and soft bottom primary habitats (Figure 3-11). Coarse sediment habitats were observed along the export corridor near the SRWF and near the state water boundary, but the majority of the mapped area was sand and muddy sand habitats with discrete areas of mud and sandy mud habitats and one area of mixed sediment – small gravel and sand habitat near where the corridor shifts to the west. Considering habitats with modifiers, sand and muddy sand was the most prevalent habitat type mapped at the SRWEC-OCS (50 percent), followed by sand and muddy sand – mobile (36 percent), and mud and sandy mud (9.4 percent). Coarse sediment – mobile made up 3.4 percent of the SRWEC-OCS. No boulder fields were mapped although individual boulders were identified in the portions of the corridor located further offshore.

Biotic subclasses in the SRWEC-OCS were soft sediment fauna and attached fauna (Figure 3-12). The hard coral *Astrangia poculata*, a sensitive taxon, was not observed. Cerianthids (burrowing anemones) were observed at two stations in sand and muddy sand habitat where the corridor shifts to the west.

The sand and muddy sand habitats in the SRWEC-OCS were characterized by CMECS subgroups medium, fine, and very fine sand and accounted for 40 of the 81 SPI/PV ground-truth sites (Figure 3-13). Sand and muddy sand (mobile) included a coarse sand in the subgroup and accounted for 29 of the survey sites. The subgroup of very fine sand was present intermittently (9 sites) along the OCS corridor, coincident with mud and sandy mud. Gravelly sand, very coarse and coarse sand subgroups occurred at a total of 3 survey sites.

The offshore/onshore export cable area includes the SRWEC-OCS in federal waters, the SRWEC-NYS, and the HDD. A summary of the infrastructure associated with the offshore/onshore export cables is presented in Table 3-3.

Table 3-3. Infrastructure Associated with the SRWEC

SRWEC
• One 320-kV DC export cable bundle buried to a target depth of 3 to 7 ft (1 to 2 m) • Maximum total corridor length of up to 104.6 mi (168.4 km) • Maximum individual cable diameter of 7.8 in (200 mm) • Maximum disturbance corridor width of 98 ft (30 m) • Maximum seafloor disturbance for HDD exit pits of 61.8 ac (25 ha) • Maximum disturbance for Landfall Work Area (onshore) of up to 6.5 ac (2.6 ha)
Onshore Transmission Cable and Onshore Interconnection Cable
• Onshore Transmission Cable, including associated TJB and fiber optic cable, up to 17.5 mi (28.2 km) long, with a temporary disturbance corridor of 30 ft (9.1 m) and maximum duct bank target burial depth of 6 ft (1.8 m) • Maximum cable diameter of 6 in (152 mm) • Onshore Interconnection Cable to connect to Holbrook Substation

The SRWEC – OCS corridor is dominated by soft bottom sand habitat. Acres of habitat in the SRWEC-OCS corridor include:

- Rocky (368 acres)
- Soft bottom mud (3,321 acres)
- Soft bottom sand (30,548 acres)
- Biogenic habitat present (burrowing anemones)
- Pelagic habitat (35,396 acres)

The remaining habitats (SAV/summer flounder HAPC, tidal marsh, shellfish reefs and beds, shell accumulations, and sensitive life stage habitats, and HAPCs) were not found during surveys.

SPI/PV analysis was conducted at 107 stations along the outer continental shelf section of the export cable (SRWEC– OCS). There were two distinct regions of the SRWEC-OCS based on sediment composition and benthic community: (1) the western stations extending from the three-mile NYS waters boundary to where the planned cable corridor redirects northeastward, and (2) the eastern stations that include the remaining stations along the SRWEC-OCS extending to the SRWF (INSPIRE 2022 (COP Appendix M1)). There were spatial trends associated with the physical features along the SRWEC-OCS, notably a transition from medium sand and fine sand (CMECS Substrate Subgroups) with ripples in the western extent to very fine sand with limited small-scale bedforms along the eastern portion of the SRWEC-OCS.

The spatial distribution of seabed composition was also reflected in the biological component of the benthic environment along the SRWEC-OCS. Generally, the western portion of the SRWEC-OCS was characterized by high densities of sand dollars while the eastern portion of the SRWEC-OCS was inhabited by burrowing anemones and sea stars. Gravel was not a substantial proportion of the sediments along the SRWEC-OCS and was not greater than 5 percent cover at any station, with the exception of two stations both of which were composed of gravelly sand (CMECS Substrate Subgroup; i.e., 5-30 percent cover of gravel), with pebble/granule being the largest gravel at these two stations. A total of 19 percent of the SPI/PV sample stations included burrowing anemones.

3.2.2 SRWEC-NYS

SRWEC-NYS waters were characterized by soft sediments ranging from very fine sand to medium sand Table 3-2,Figure 3-5) with evidence of generally low organic matter content and evidence of benthic microalgae at many survey stations. Macrohabitat characteristics indicated greater bedload transport nearer to shore with more distinct ripples in the sand as well as greater suspended material which contributed to higher turbidity. This trend indicates decreasing wave action effects proceeding from shallower waters out into deeper areas. Water depths ranged from 15 to 88 ft (5 to 27 m) and averaged 57.1 ft (17.4m) with shallower areas nearer to shore (Figure 3-1).

SRWEC-NYS mapping included all primary benthic habitats except glacial drift. Coarse sediment habitats were found near the point where the SRWEC-NYS portion of the Project area widens nearshore (Figure 3-11). The majority of the SRWEC-NYS was composed of sand and muddy sand habitats. Of the habitats with modifiers, sand and muddy sand was the most prevalent, followed by coarse sediment – mobile, and sand and muddy sand – mobile. Coarse sediment – mobile with medium/high density boulder fields made up less than 1 percent of the SRWEC-NYS. Biotic subclasses (Figure 3-12) were dominated by soft sediment fauna. The hard coral *Astrangia poculata*, a sensitive taxon, was not observed, but cerianthids (burrowing anemones) were observed and were prevalent in sand and muddy sand habitats just inshore of the state waters boundary.

The sand and muddy sand habitat in the SRWEC-NYS waters were characterized by CMECS subgroups fine and very fine sand and accounted for 22 of the 35 SPI/PV ground-truth sites (Figure 3-13). Fine sand subgroups occurred at the single sand and muddy sand with boulder field site nearer shore and the sand and muddy sand (mobile site). Coarse sediment (mobile) habitat (7 sites) was characterized by the medium, fine, and very fine sand subgroups.

The landing (landfall) area for the SRWEC includes up to 6.5 ac (2.6 ha) for up to three HDD ducts, temporary anchoring walls, and drilling rig, in addition to 2.5 ac (1 ha) for the beach stringing area and trenching to the ICW-HDD crossing. Coastal habitats in the landing area relevant to the EFH assessment include those located within state waters and inland to the mainland, inclusive of bays and back-barrier lagoons (USFWS 1997) that separate the barrier islands from the coastal mainland on the Long Island south shore. At landfall, the cables intercept coastal habitats associated with the landfall/ICW-HDD work areas on Fire Island including maritime beaches, dunes, and grasslands, although the landfall/ICW work area on the mainland is primarily developed. The onshore facilities correspond with existing developed areas including parking lots and paved roadways.

The SRWEC-NYC intercepts the soft bottom sand before it reaches shore and emerges in the paved parking area at Smith Point County Park. From there, the cable corridor follows roadways and existing infrastructure until it meets the location of the ICW-HDD.

The benthic habitat delineation ends a few hundred meters from shore and the pelagic habitat was estimated based on the distance from the shore to the extent of the delineated benthic habitat. The pelagic habitat in the export cable corridor associated with landfall totals 173 acres.

Surficial sediment characteristics along the SRWEC and in the SRWF were provided from grab samples collected in January 2020 in support of the Project in federal waters (Appendix M1, Sunrise Wind 2022a). A single grab sample and the United States Geological Survey (USGS) East Coast Sediment Texture Database was used to define the surficial seafloor sediments along the SRWEC in NYS waters and at the HDD exit pit representative location. Sediment grab samples collected along the SRWEC-NYS were overwhelmingly dominated by sand (greater than 90 percent) with minor silt/clay and gravel. Small-scale mobility, as inferred from the presence of sand ripples in PV images, was more prevalent at the stations closer to shore.

Three macrohabitat types were observed along the SRWEC-NYS based on the sediment composition (CMECS Substrate Subgroup) and inferred small-scale mobility (i.e., bedforms): *sand with ripples*, *sand*, and *sand and mud*. Although considered distinct, these three macrohabitats are similar in characteristics; specifically, all three consist of sandy sediments ranging from very fine sand to medium sand (CMECS Substrate Subgroup) with no gravel. All three macrohabitats were characterized by the biotic subclass of soft sediment fauna.

The soft sediment fauna communities along the SRWEC-NYS were generally inferred by the presence of small burrows, tubes, and tracks. Sand dollars, burrowing anemones, and *Diopatra* sp. were frequently observed in the SPI/PV images along the SRWEC-NYS and a total of 26 percent of the SPI/PV stations included burrowing anemones. Benthic community analysis of the sediment grab samples showed three taxa made up the majority of individuals observed across all replicates along the SRWEC-NYS: (1) the polychaete, *Polygordiidae* (Family) *Polygordius* (Genus, LPIL), (2) the polychaete *Capitellidae (*Family) *Mediomastus* (Genus, LPIL), and (3) the amphipod *Haustoriidae* (Family) *Protohaustorius wigleyi.*

In the SRWEC-NYS area, species of ecological concern and/or concern regarding possible habitat disturbance from offshore wind construction and operation activities include black sea bass, Atlantic cod, sea scallop, and ocean quahog (Guida et al. 2017). No sensitive taxa or non-native species were observed at any of the stations along the SRWEC-NYS.

3.2.3 ICW-HDD and Interior Coastal Components

3.2.3.1 ICW-HDD

The ICW is maintained for vessel traffic to a depth of 6 ft (2 m) and dredge material redistribution occurs regularly (Figure 3-1). The ICW-HDD crossing included 133 mapped acres, comprising the two primary habitats sand and muddy sand and coarse sediment. Sand and muddy sand was the dominant habitat type mapped and coarse sediment habitats were found along the ICW west of the bridge, coincident with the dredged navigational channel, and was represented by coarse sediment (Table 3-2).

Benthic habitat complexity categories were complex and soft bottom (Figure 3-14). Complex categories included present/potential presence of benthic macroalgae and/or SAV. Of the habitats with modifiers, sand and muddy sand was the most prevalent habitat type mapped within the ICW-HDD crossing, followed by sand and muddy sand with recent and/or potential SAV and/or benthic macroalgae, and coarse sediment (7 percent). Sands were observed except in coarse sediment habitats where gravelly sand and sandy gravel was recorded. Sand and muddy sand habitats were dominated by areas of potential and occurring benthic macroalgae and SAV, primarily on the west side of the ICW bridge (Figure 3-12).

Biotic subclasses included attached and soft sediment fauna (Figure 3-15). The non-reef-building hard coral *Astrangia poculata* and the burrowing anemone ceranthids, were not observed within the ICW-HDD area. Coarse sand habitats in the ICW-HDD channel included 3 of the 8 SPI/PV ground-truth sites and were characterized by the sandy gravel, gravelly sand CMECS subgroup (Figure 3-16). Vegetated habitats (2 sites) and sand and muddy sand (3 sites) occurred along the shore were both characterized by sand or finer CMECS subgroups.

Three of eight ICW-HDD stations were more than 5 percent cover of gravel and were classified with the CMECS substrate group of either gravel mixes or gravelly. The remaining five ICW-HDD stations were classified as sand or finer. The biotic subclass of attached fauna occurred at stations composed of gravel (Stations 802, 805, and 808), and the mobile sand present at the other stations in the ICW-HDD were classified with the biotic subclass of soft sediment fauna. Habitats surveyed in the ICW-HDD included:

- Rocky (9.34 acres)
- Soft bottom (122 acres)
- Tidal marsh (less than 2 acres)
- Pelagic (132 acres)
- Habitat for sensitive life stages of bryozoa and serpulid tubes at several stations at the ICW-HDD
- SAV and macroalgae

Rocky habitat, soft bottom sand and mud, SAV, and other biogenic habitats (bryozoa and serpulid tubes) were found in the survey area. SAV, biogenic habitat, and other biogenic habitats (bryozoa and serpulid tubes) were observed in the ICW-HDD.

The physical seabed and sediment composition at stations sampled in the ICW-HDD were more variable than along the SRWEC-NYS. Three ICW-HDD stations contained more than 5 percent cover of gravel and were classified with the CMECS substrate group of either gravel mixes or gravelly. The remaining five ICW-HDD stations were classified as sand or finer. No boulders or cobbles were observed in replicate images of the ICW-HDD. The sediment grab grain size analysis corroborated the Substrate Subgroup classifications of sandy gravel at the stations where grabs were collected (Stations 802 and 805); sediment grab replicates were composed mainly of sand mixed with approximately 20 percent gravel and a minor fraction of silt/clay.

The variability in physical features across stations corresponded with the variability in biotic subclass designations. The biotic subclass of attached fauna occurred at stations composed of gravel (Stations 802, 805, and 808), and the mobile sand present at the other stations in the ICW-HDD were classified with the biotic subclass of soft sediment fauna. The benthic community analysis of the sediment grab replicates collected at Stations 802 and 805 revealed similar community compositions between the two sites. Five taxa accounted for just over 60 percent of the total benthic infaunal abundance across all replicates at the ICW HDD: (1) an oligochaete, Naididae (Family, LPIL), (2) the amphipod *Eobrolgus spinosus*, (3) the polychaete *Exogone dispar*, (4) the amphipod *Elasmopus levis*, and (5) the amphipod *Gammaropsis* (Genus, LPIL).

Within the estuarine environment of the ICW-HDD, seagrass beds, characterized by continuous or patchy seagrass (SAV), are considered sensitive and ecologically important benthic habitat. Attached fauna were documented at only 4 stations (corresponded with coarser Substrate Groups/ Subgroups), all of which were during the ICW-HDD survey. SAV was documented in the cable corridor in 2018, was not found in the 2020 survey, but was found again in the 2022 survey (see Section 3.3.5 Submerged

Aquatic Vegetation for more detail). SAV beds are limited to shallow depths (due to light requirements) and areas with low energy (i.e., low turbidity) and thus do not occur within the SRWF or along the SRWEC. SAV beds are found in parts of Bellport Bay, the eastern part of Great South Bay, NY, near the proposed ICW-HDD of the Onshore Transmission Cable (NYDOS 2020). Great South Bay lies between Fire Island and Long Island and is connected to the Atlantic Ocean via breaches in the barrier islands, e.g., Fire Island. Great South Bay is the largest protected, shallow, coastal bay in New York and is forage and nursery habitat for a variety of species identified as commercially or recreational important, including summer flounder (*Paralichthys dentatus*), winter flounder (*Pleuronectes americanus*), bluefish (*Pomatomus saltatrix*), and black sea bass (USFWS 1991).

Summer flounder has designated HAPC in the vicinity of the SRWF Project area (Bellport Bay). Summer flounder HAPC includes “All native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH” (MAFMC 2016). These areas have been identified as important for shelter, predation, nursery habitat, and, potentially, reproduction (MAFMC 1998a) and any loss of areas with SAV and macroalgae along the Atlantic Seaboard may negatively affect summer flounder stocks (Laney 1997). SAV and macroalgae have been shown to attract common summer flounder prey for both adults and juveniles (Packer et al. 1999a) and summer flounder appear to effectively capture prey by using seagrass as a “blind” to ambush prey (Lascara 1981). Recent surveys of the Project area found no significant SAV-forming patches or meadows within the proposed temporary landing site, although eelgrass was identified at six different locations in the northeastern area of the proposed temporary landing site (see Section 3.3.5 Submerged Aquatic Vegetation for more detail). Four of the observed SAV locations consisted of single eelgrass shoots emerging from a dense mat of algae and did not appear rooted. The remaining two SAV observations consisted of multiple shoots of eelgrass (less than six shoots per site) emerging from an algal mat on the sediment surface, but, compared to the single eelgrass plants observed, these clusters of plants appeared more likely to be rooted. Juvenile Atlantic cod can also be found in the region and occurs between the mean high water line and a depth of 66 ft (20 m) in rocky habitats, in SAV, or in sandy habitats adjacent to rocky and SAV habitats for foraging from Maine through Rhode Island (NEFMC 2017). Newly designated HAPC for cod spawning includes the entire Lease Area.

SAV beds provide important ecosystem functions in shallow marine environments. SAV beds are important sources of primary production and nitrogen fixation, the leaves provide habitat for multiple fish and invertebrate species, and their physical structure provides sediment stabilization and enhances sedimentation (Thayer, Kenworthy and Fonseca, 1984). SAV in New York is primarily eelgrass (*Zostera marina*). Eelgrass is a marine flowering plant that lives below the surface in less than 16.4 ft (5 m) of water. Eelgrass beds provide (1) nursery ground and refuge for commercially important organisms, such as bay scallops (*Argopecten irradians*), flounders, striped bass (*Morone saxatilis*), tautog (*Tautoga onitis*), and seahorses; (2) habitat and food for waterfowl, shellfish, and finfish; and (3) sediment and shoreline stabilization (Heck et al. 1989).

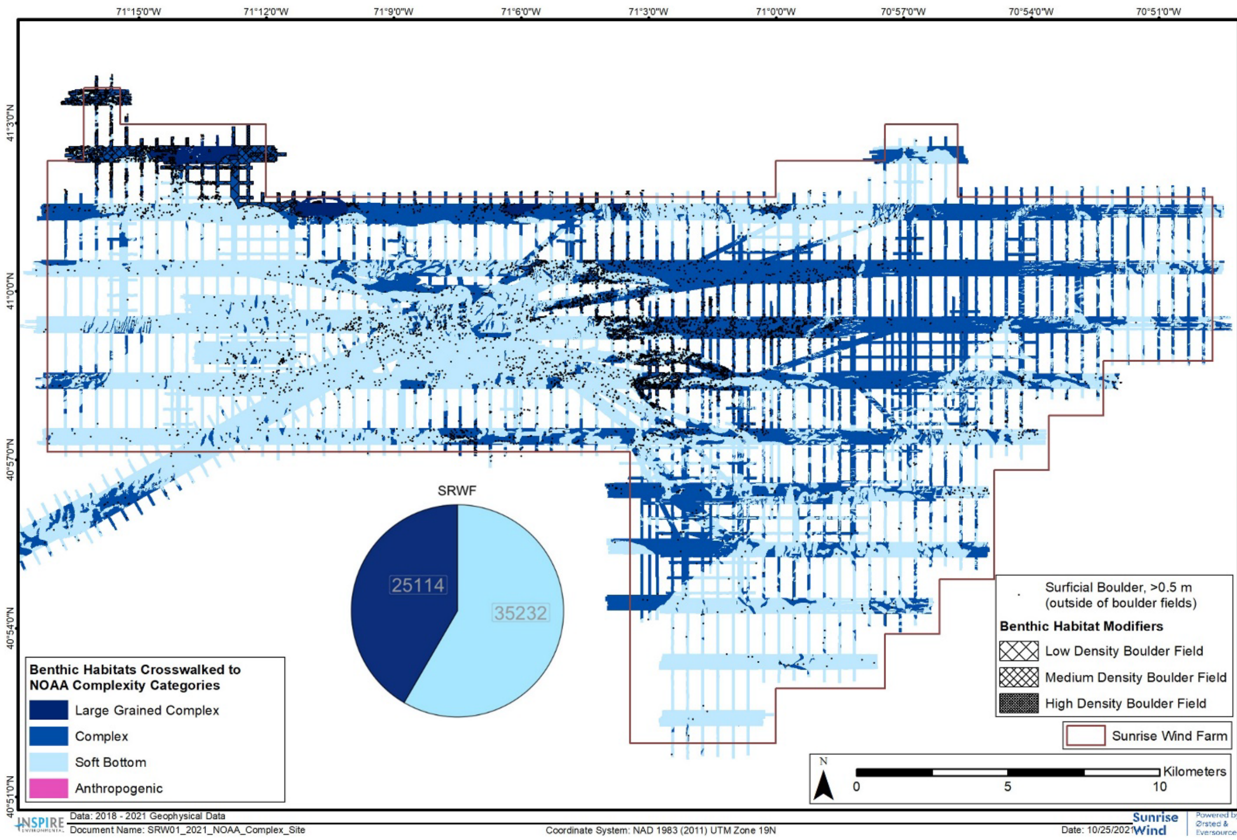


Figure 3-8 Benthic Habitats Categorized by NOAA Complexity Category at SRWF and a Pie Chart of NOAA Complexity Category Composition with Total Acres Presented as Values

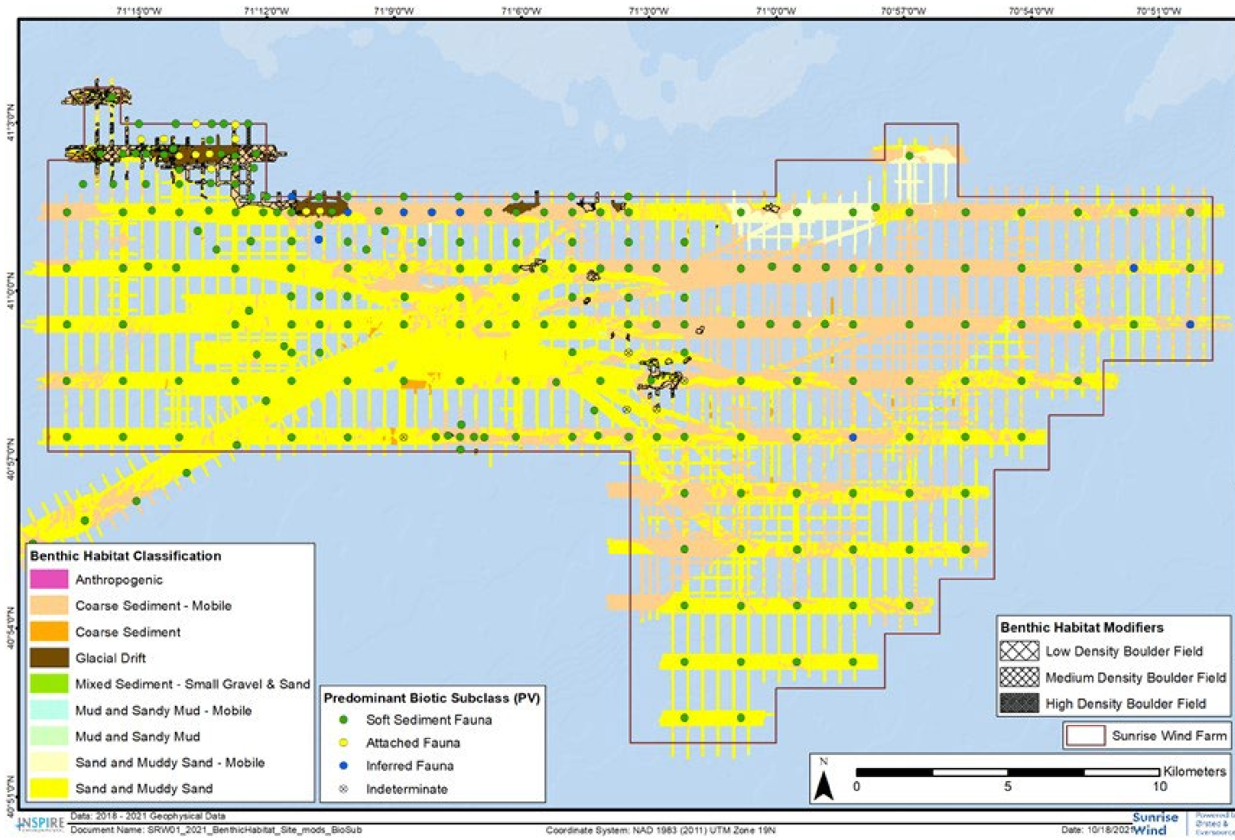


Figure 3-9. Benthic Habitat Groups with Modifiers and Ground-Truth CMECS Biotic Subclass in the SRWF

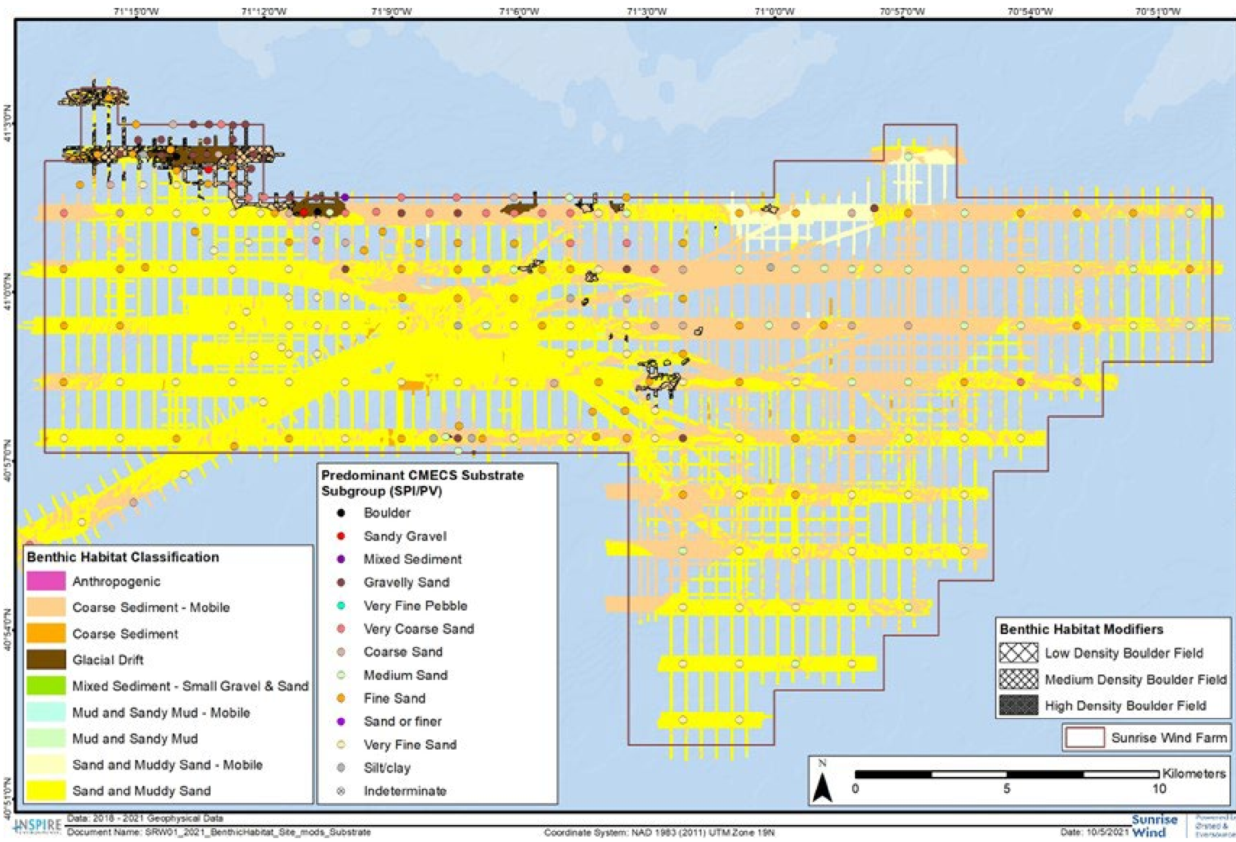


Figure 3-10. Benthic Habitat Groups with Modifiers and Ground-Truth CMECS Biotic Subgroups in the SRWF

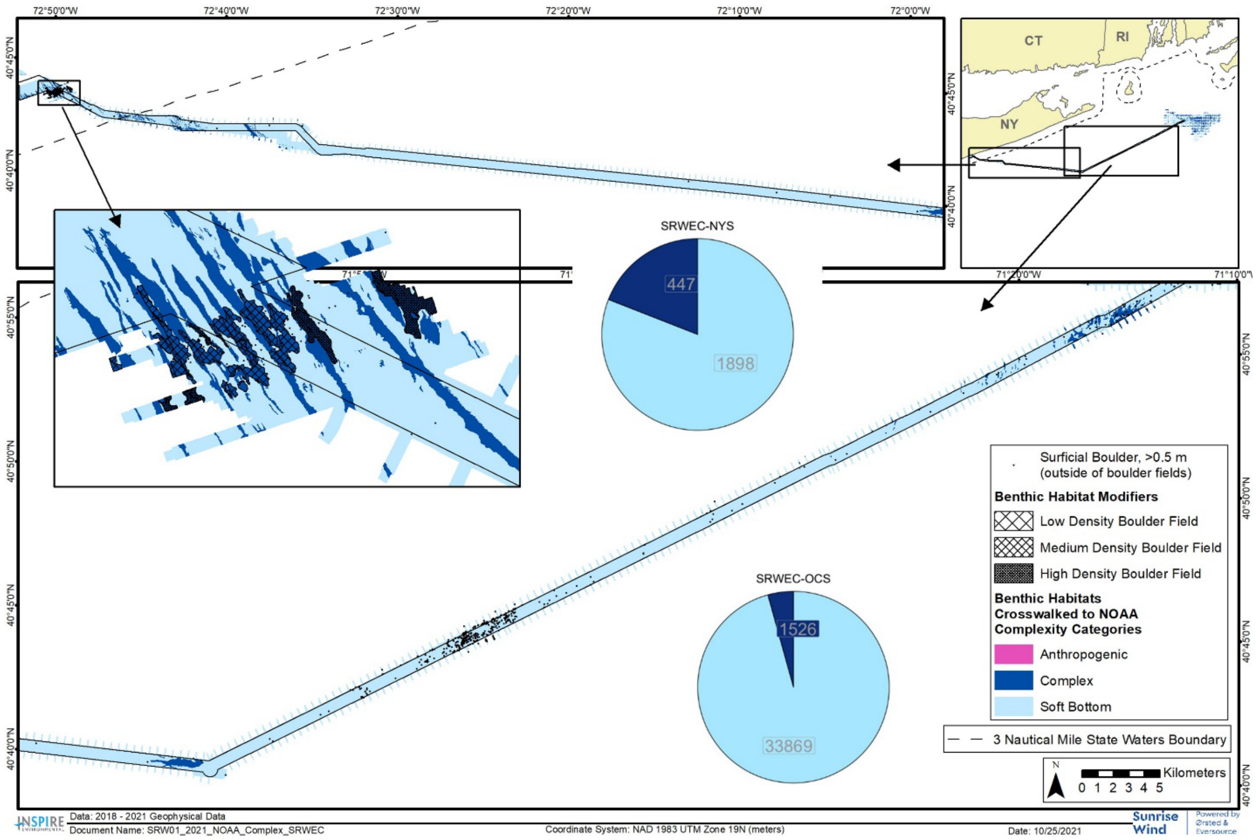


Figure 3-11. Benthic Habitats Categorized by NOAA Complexity Category at SRWEC-OCS and NYS Waters and a Pie Chart of NOAA Complexity Category Composition with Total Acres Presented as Values

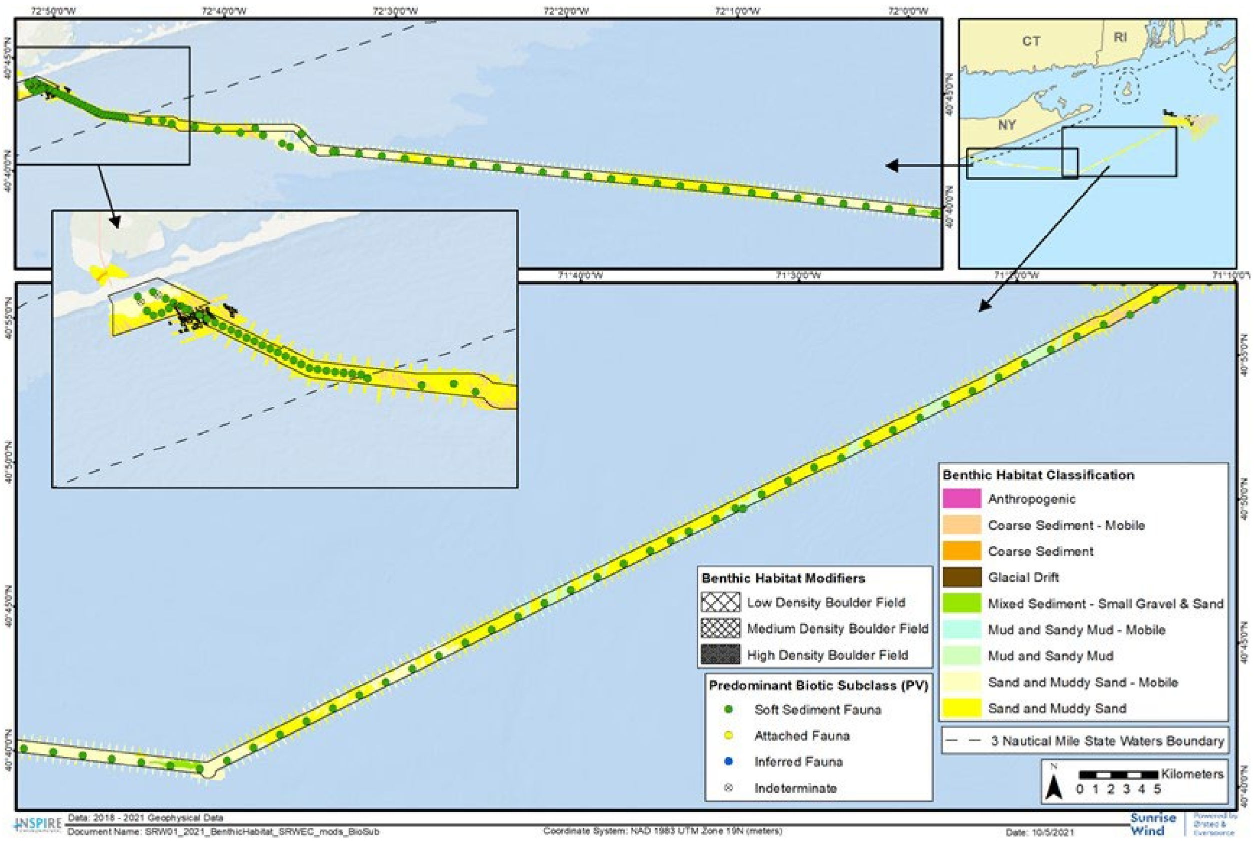


Figure 3-12. Benthic Habitat Types with Modifiers and Ground-Truth CMECS Biotic Subclass Along the SRWEC-OCS and NYS Waters

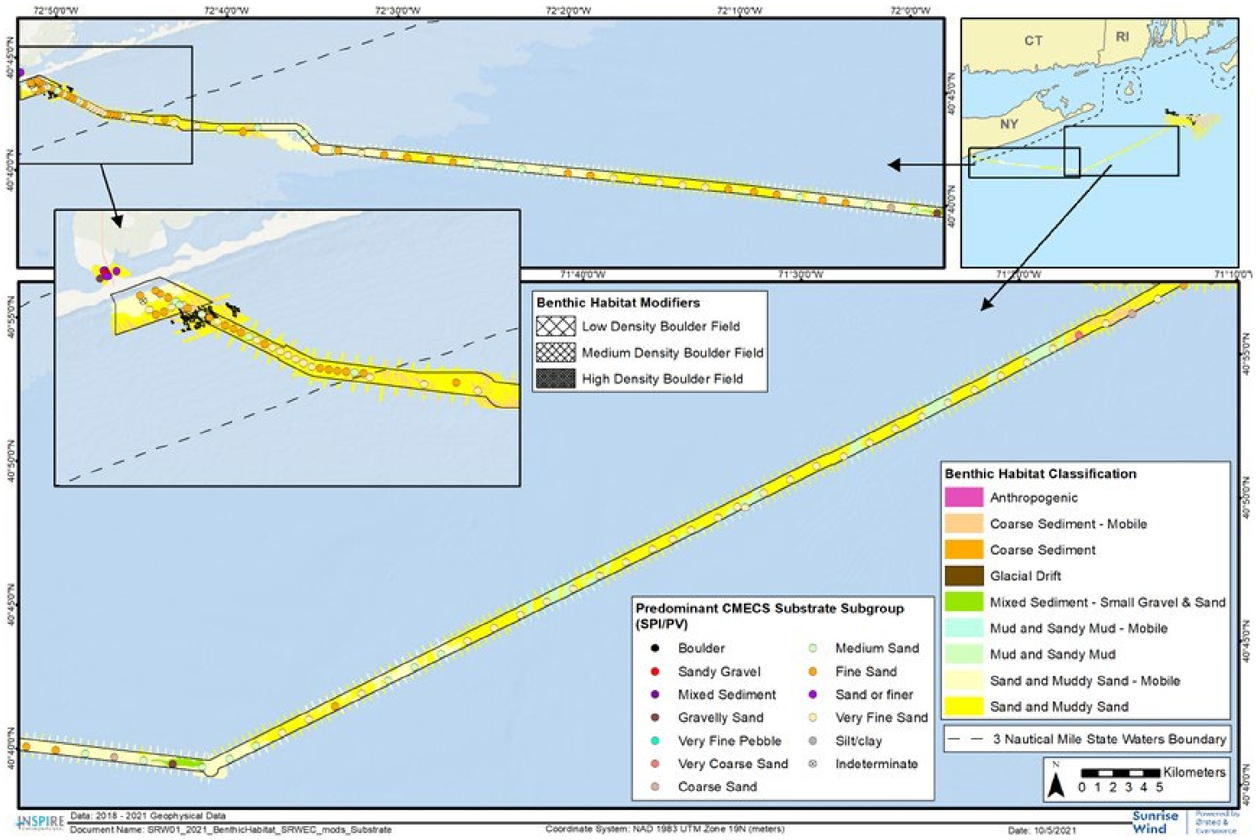


Figure 3-13. Benthic Habitat Groups with Modifiers and Ground-Truth CMECS Biotic Subgroups in the SRWEC-OCS and SRWE-NYS Waters

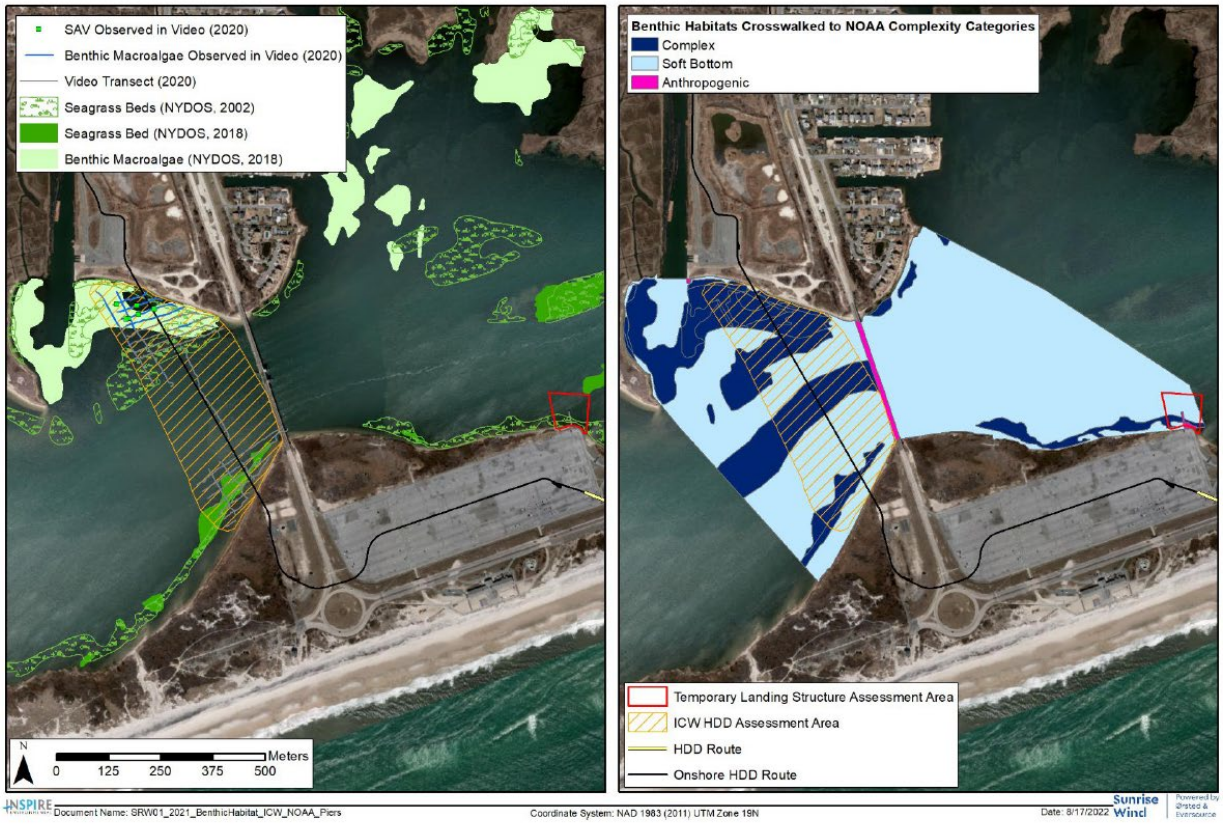


Figure 3-14 Benthic Habitats Categorized by NOAA Complexity Category and SAV at the ICW-HDD and a Pie Chart of NOAA Complexity Category Composition with Total Acres Presented as Values

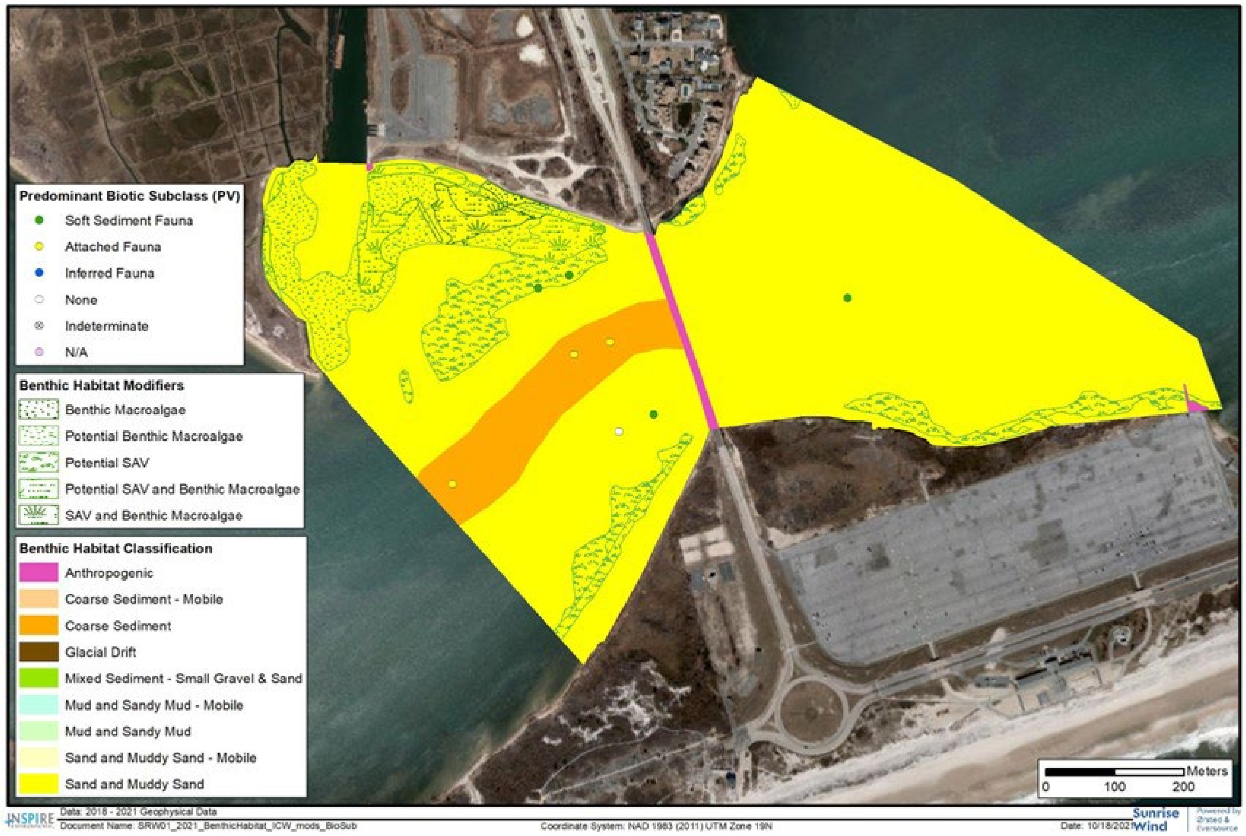


Figure 3-15. Benthic Habitat Types with Modifiers and Ground-Truth CMECS Biotic Subclass in the SRW ICW-HDD

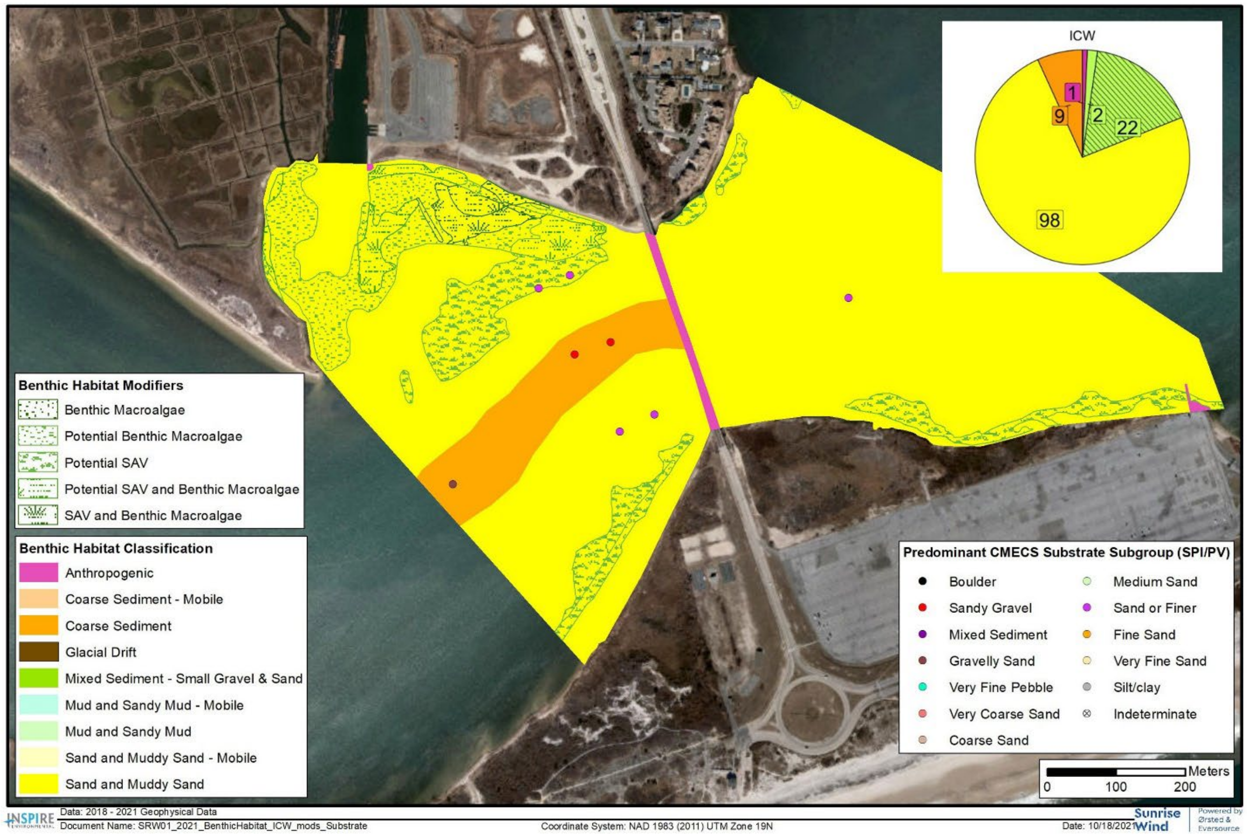


Figure 3-16. Benthic Habitat Groups with Modifiers and Ground-Truth CMECS Biotic Subgroups in the SRW ICW-HDD

3.2.3.2 Interior Coastal

The SRWEC-NYS is proposed to make landfall at the HDD TJB on the eastern portion of Smith Point County Park and then run parallel to Fire Island Beach Road within the paved Smith Point County Park parking lot, crossing under the William Floyd Parkway to a recreational area located to the west of William Floyd Parkway. The cable would then be routed across the ICW (Great South Bay) via an HDD, avoiding impacts to tidal wetlands and SAV, to a paved parking lot within the Smith Point Marina along East Concourse Drive. The Onshore Transmission Cable would also cross Carmans River; however, the Onshore Transmission Cable would cross Carmans River in areas that are designated as freshwater and are outside of the scope of this assessment.

Great South Bay lies between Fire Island and Long Island, where it is connected to the Atlantic Ocean through breaches in the barrier beaches of Fire Island. The area of Great South Bay and Moriches Bay adjacent to the landfall/ICW work area is classified as a marine back-barrier lagoon surrounded by developed lands. The protected shores of the lagoons support grass beds, mudflats, and salt marshes. Great South Bay is the largest protected, shallow, coastal bay in New York and provides forage and nursery habitat for a variety of species identified as commercially or recreational important, including summer flounder, winter flounder, bluefish, and black sea bass (USFWS 1991). The tidal marshes, mud and sand flats, SAV, and broad shallows of this estuarine environment support finfish, shellfish, waterfowl, and other wildlife in the South Shore Estuary Reserve. Tidal wetlands are present along the low energy bay side of Fire Island in broad overwash areas and common species include saltmarsh cord grass (*Spartina alterniflora*), salt-meadow cordgrass (*S. patens*) and coastal salt grass (*Distichlis spicata*), depending on the level of tidal inundation. The trenchless construction methods currently proposed to install the Onshore Transmission Cable would avoid and minimize potential impacts to this habitat. Tidal wetlands also occur within the vicinity where the temporary landing structure would be installed at Smith Point County Park. Temporary impacts to the tidal wetlands may occur should the floating modules be grounded at low tide and from the installation of the spuds. Impacts that occur during construction activities would be temporary, localized and would be expected to recover completely.

Interior coastal habitats associated with the SRWF include up to 17.5 mi (28.2 km) of onshore transmission cable within a corridor 30 ft (9.1 m) wide with an operational ROW of 60 ft (18.3 m), and TJBs (Table 3.3.2-4 in the COP, Sunrise Wind 2022b). The interior transmission cable includes an OnCS-DC with a disturbance footprint of up to 7 ac (2.8 ha) and an operational footprint of 6 acres (2.4 ha). Benthic habitat types identified in the interior coastal component of the Project area include:

- Tidal marsh (5 acres)
- Summer flounder HAPC

Tidal marsh and summer flounder HAPC were the only benthic habitat types mapped for the interior coastal component of the Project area. Tidal marshes are associated the bay side coast in the Project area. Summer flounder HAPC includes all of Long Island Sound, Great South Bay, and Great Peconic Bay within the Project area, bounded on the Atlantic side by barrier islands, including Fire Island. Relevant coastal habitats along the mainland transmission cable corridor range from salt to brackish marshes. Tidal wetlands have numerous ecological functions important to fish and shellfish, including spawning and nursery habitat, refuge for both adults and juveniles in the vegetation, water filtration, flood dampening, and habitat connectivity.

Delineated wetlands and areas of known SAV in the coastal interior component of the SRWEC are mapped in Figure 3-22. These coastal habitats are important to mammals, birds, herpetofauna, and invertebrates that depend on these habitats for food, water, shelter, and reproduction. For example, flounder (e.g., summer, winter), red hake, and little skate all use intertidal habitat for at least one life stage. SAV beds provide important ecosystem functions in shallow marine environments, including primary production and nitrogen fixation, habitat for multiple fish and invertebrate species, and sediment stabilization (Thayer, Kenworthy and Fonseca 1984). SAV in New York is primarily eelgrass, which provide (1) nursery ground and refuge for commercially important organisms, such as bay scallops, flounders, striped bass, tautog, and seahorses and habitat and food for waterfowl, shellfish, and finfish (Heck et al. 1989).

HAPC for summer flounder includes all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, wherever they may occur within adult and juvenile summer flounder EFH.

National Wetlands Inventory (NWI) data were used to identify the potential presence of wetlands in and near the vicinity of the Project area and are displayed in conjunction with delineated tidal wetland in Figure 3-17. Tidal wetlands include both estuarine and marine wetlands and are associated with the ICW and the Atlantic Ocean. NWI polygons indicate the presence of 23.6 acres of marine and estuarine wetland habitat, 99 percent of which are marine intertidal areas along the Atlantic coast. The Project area includes 8.8 acres identified by the NWI as estuarine and marine deepwater (subtidal) areas, including 0.2 acres of submerged aquatic bed in the ICW. Field surveys identified 5 acres of tidal wetlands adjacent to the ICW within the Project area, occurring along the low energy bay side of Fire Island. The three delineated tidal wetlands were estuarine, intertidal wetlands of shrub scrub (SS) and emergent (EM) vegetation (E1SS/EM). Common plant species include Jesuit's bark (*Iva frutescens*), common reed (*Phragmites australis*), rambler rose (*Rosa multiflora*), and groundsel tree (*Baccharis halimifolia*), which occur above the mean high water line, and are therefore not considered EFH.

The ICW HDD would cross under several NYS Department of Environmental Conservation-designated tidal wetland categories in the Great South Bay-East SCFWH, including littoral zone and coastal shoals, bars, and mudflats before reaching the ICW HDD Work Area at Smith Point Marina. These tidal wetlands are also mapped by the NWI as estuarine wetlands (E1AB3L (estuarine, subtidal, aquatic bottom, rooted vascular, subtidal), E1UBL (estuarine, subtidal, unconsolidated bottom, subtidal), and E2USN (estuarine intertidal unconsolidated shore, regularly flooded)). EFH is designated within the tidal portions of the Carmans River; however, the Onshore Transmission Cable would cross Carmans River in areas that are designated as freshwater, and thus do not have designated EFH.

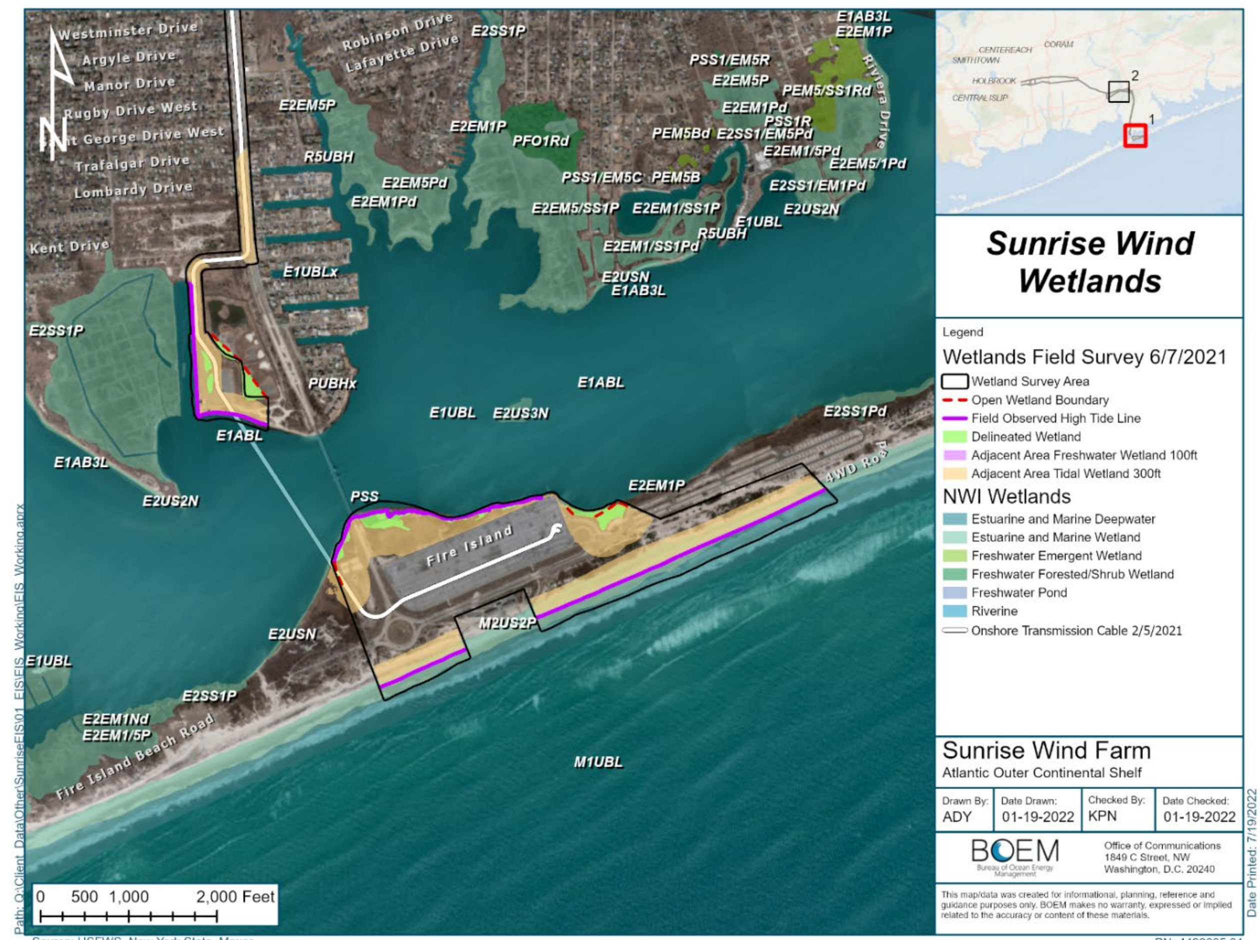


Figure 3-17. NWI and Field-Surveyed Wetlands in the Coastal Interior Portion of the SRWF Project Area

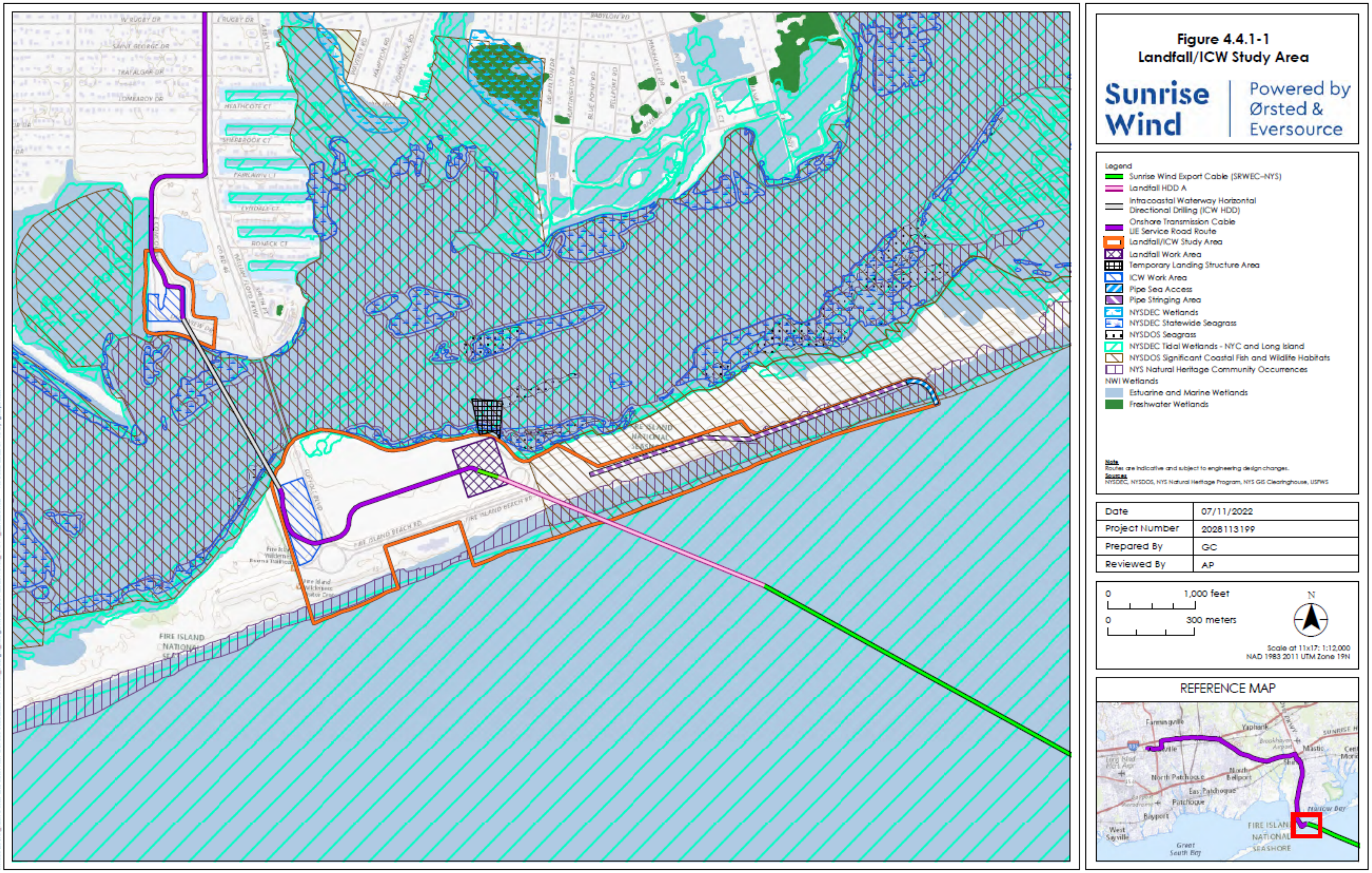


Figure 3-18. SAV, Tidal Wetlands, and Other Coastal Habitats in the Vicinity of the SRWEC-NYS

3.3 Habitat Types within the Project Area

This section provides detailed discussions of habitat types within the Project area for each project component, including the Lease Area, the offshore cable corridors of the open ocean, and the inshore cable corridors within the estuarine environment of Bellport Bay and tributary wetlands. Habitat types, including Habitat Areas of Particular Concern (HAPC), are listed and quantified in Table 3-4 and described in the sections that follow.

Table 3-4. Habitat Areas by Project Component

	Project Component Area					
Habitat Types	**Lease Area (SRWF)**	**Offshore / Onshore Export Cable: Export Cable Route (SRWEC – OCS)**	**Offshore / Onshore Export Cable: Export Cable Route (SRWEC – NYS)**	**Offshore / Onshore Export Cable: Landing Area**	**ICW-HDD**	**Offshore / Onshore Export Cable: Interior Coastal**
Rocky (total area that is 5 percent or greater of all: granule-pebble, cobble, boulder, ledge/bedrock)	24,913 acres	368 acres	1,526 acres	Not present	9.34 acres	Not present
Soft bottom mud (intertidal, shallow-water, and deep)	149 acres	3,321 acres	1 acre	Not present	Not present	Not present
Soft bottom sand (with and without sand ripple, shoals, waves/ridges)	35,283 acres	30,548 acres	1,976 acres	Present	122 acres	Not present
Submerged Aquatic Vegetation (SAV)	Not present	Not present	Not present	Grass beds not present; 2 rooted, 4 unrooted plants found	1.69 acres with SAV; 14.3 acres with 'Potential SAV'	Not present
Tidal Marsh (e.g., saltmarsh and brackish marsh)	Not present	Not present	Not present	Not present	Not present	5 acres
Shellfish reefs and beds (e.g., hard clams, Atlantic surfclam, mussels, oysters)	Not present	Not present	Not present	Not present	Not present	Not present
Shell accumulations	Not present	Not present	Not present	Not present	Not present	Not present
Other biogenic (e.g., cerianthids, corals, emergent tubes – polychaetes)	5 SPI/PV stations with non-reef building hard coral; 52 percent of SPI/PV stations had cerianthids	19 percent of SPI/PV stations had cerianthids	26 percent of SPI/PV stations had cerianthids	Not present	Bryozoa and serpulid tubes present	Not present
Pelagic (offshore and estuarine)	60,207 acres	35,396 acres	2,346 acres	173 acres	132 acres	Not Present
Habitat for sensitive life stages (i.e., demersal eggs, spawning activity-discrete areas) –	Complex hard bottom (large gravel, i.e., boulders and cobbles) – 25,114 acres	Complex hard bottom (large gravel, i.e., boulders and cobbles) – 1,526 acres	Complex hard bottom (large gravel, i.e., boulders and cobbles) – 447 acres	Complex hard bottom (large gravel, i.e., boulders and cobbles)	SAV (1.69 acres with SAV; 14.3 acres with 'Potential SAV'), tidal marsh	Tidal marsh - (5 acres)
Habitat Areas of Particular Concern (HAPC) for summer flounder**	25,114 acres	1,526 acres	447 acres	Not present	14.3 acres	5 acres

Habitat Types	Project Component Area					
	Lease Area (SRWF)	Offshore / Onshore Export Cable: Export Cable Route (SRWEC – OCS)	Offshore / Onshore Export Cable: Export Cable Route (SRWEC – NYS)	Offshore / Onshore Export Cable: Landing Area	ICW-HDD	Offshore / Onshore Export Cable: Interior Coastal
Proposed HAPC for cod spawning***	25,114 acres	1,526 acres	447 acres	Not present	14.3 acres	5 acres

* Estimated based on distance from mean high tide out to extent of delineated benthic habitat.
** Potential HAPC based on NOAA EFH Mapper includes entire Project area
***Proposed HAPC includes entire Project area.

3.3.1 Rocky Habitat

Rocky habitat types are limited on the Northwest Atlantic OCS compared to sandy and soft bottom habitats (CoastalVision and Germano and Associates 2010, Greene et al. 2010). These habitats account for approximately 26,517 acres (27 percent) of the total 98,220 acres in the survey area, second only to soft bottom sand and include coarse sediments, glacial drift, and mixed sediments. These habitats are commonly referred to as "live bottom" when encrusted by attached epifauna, typically communities of bryozoa, hydroids, tunicates, and sponges in this region. In the Project area, *Tubularia* hydroids were common at hard bottom stations. Stations with coarser sediments and gravel (boulders and cobble) tended to have more diverse epifaunal assemblages including bryozoa, sponges, barnacles, and mobile crustaceans.

These rocky habitats are structurally complex habitats and considered potentially valuable and sensitive for regionally important taxa including targeted species, such as Atlantic cod, longfin squid, and American lobster (Scott 1982; Gotceitas and Brown 1993). The structure provided by the cobbles and boulders in these habitats can serve as nursery habitat for juvenile lobster, feeding ground for fish such as cod and black sea bass, and substrate upon which squid (including longfin squid, *Doryteuthis (Amerigo) pealeii*) lay their egg "mops" (Griswold and Prezioso 1981; Roper et al. 1984). The presence of boulders in mixed bottom types is also considered important for understanding the distribution of lobsters (*Homarus americanus*) and Jonah crab (*Cancer borealis*) in the vicinity of the SRWF (Collie and King 2016). Both lobster and squid have highly specific habitat requirements and are also economically important species in New England. For these reasons, federal and state agencies consider evidence of these taxa to indicate the presence of potentially sensitive habitats (BOEM 2019).

Both juvenile and adult cod use hard bottom habitats, with juveniles preferring cobble substrates, and adults preferring structurally complex hard bottom habitats composed of gravel, cobble, and boulder substrates (Lough 2004). Cobble habitats are essential for the survival of juvenile cod in that they may assist with avoiding predation by older year classes (Gotceitas and Brown 1993) and recent studies suggest that rocky, hard bottom habitats may be important for reproduction (DeCelles et al. 2017).

The SRWF and SRWEC-OCS are located immediately south of submerged end moraines, in what was an extensive glacial outwash plain. These habitats were limited to about 1.1 percent in the SRWF and were not observed for any of the other Project component areas studied. The glacial drift is made up of stratified deposits of glacial sediments that have been re-worked and sorted by the movement of water. Glacial drift provides a similar benthic habitat for invertebrates and demersal fish as do unconsolidated glacial moraine habitats found to the north of the SRWF. This habitat type ranged from gravelly sand to gravel, with numerous individual boulders noted in each type. Habitats also ranged from sand and mud to more continuous cover of gravel with boulders and the percent cover of attached fauna was mostly dense (70-90 percent) and a range of sessile and mobile epifauna were observed, including the sensitive taxa of the northern star coral.

Mixed sediment – small gravel and sand habitats were observed only along the OCS portion of the export cable and limited to approximately 301 acres (0.85 percent). Ripples and trawl marks were prevalent in this habitat type. At the single ground-verified station, the CMECS subgroup was gravelly sand, the CMECS biotic subclass was soft sediment fauna, and bryozoans and sand dollars were observed.

Coarse sediment habitat types are sands with 5 to 8 percent gravel surface composition. These habitats occur where the seafloor is subjected to small, frequent currents and storm events and are common on the OCS. The mobile modifier indicates ripples, which were present throughout most of the habitat. Trawl marks were observed in 35 – 50 percent of the habitat in the SRWF and SRWEC-OCS that did not intersect with boulder fields. Coarse sediment – mobile habitats made up a total of 38 percent of the mapped area at the SRWF and 15 percent of the SRWEC-NYS. Coarse sediment habitat types accounted for 41 percent of the mapped SRWF, approximately 16 percent of the habitats in the SRWEC-NYS, and approximately 3 and 7 percent in the SRWEC-OCS and ICW-HDD areas, respectively.

Ground verification stations included a range of sandy and gravelly sediments with variable cover of gravel (as expected per definition, see Section 2.2) that supported a variety of sessile and mobile epifauna, including cerianthids (burrowing anemones). The predominant percent cover of attached fauna ranged from none in coarse sediment and coarse sediment – mobile habitats to sparse (1 to less than 30 percent) in coarse sediment with boulder fields. Ground verification stations were characterized by the CMECS Substrate Subgroups very fine sand, fine sand and medium sand in NYS waters and coarse sand and very coarse sand and a mix of CMECS biotic subclasses soft sediment fauna and inferred fauna in the SRWEC-OCS.

3.3.2 Soft Bottom Mud (Mud and Sandy Mud) Habitats

The mud and sandy mud habitat types consist of relatively featureless mud and sand, except where described by modifiers for boulder fields and mobility. Mud and sandy mud habitat types had a small presence in the SRWEC-NYS and even less so in the SRWF. The CMECS biotic subclasses of soft sediment fauna and inferred fauna (epifaunal tracks and trails) were the predominant biotic subclass within the sand and muddy sand habitats. Sessile and mobile epifauna generally included amphipods, corymorpha and *Tubularia* hydroids, and mobile crustaceans and mollusks.

3.3.3 Soft Bottom Mud and Sand

Soft bottom habitats, consisting of sand and mud with less than 5 percent gravel, are the primary habitat found in the Project area and combined, account for 71,702 acres (73 percent) of the total acres included in the benthic survey. Separately, soft bottom sand accounts for 67,929 acres (69 percent) of the survey area. Local hydrodynamic conditions largely determine sediment types in the survey area, with finer materials in low-current areas and coarser materials in high-current areas.

Soft bottom habitats in the Northwest Atlantic OCS are generally inhabited by deep-burrowing polychaetes, tube-building amphipods and polychaetes, and epifaunal species such as sand, shrimp, and sand dollars (Guida et al. 2017; NYSERDA 2017c; Stokesbury 2012, 2014; Deepwater Wind South Fork, LLC 2019; DWW Rev I, LLC 2020). During the site-specific SPI/PV survey, sand dollars were observed with high frequency, particularly in regions where mobile sand was documented, consistent with results from New York State Energy Research and Development Authority (NYSERDA 2017c). The region experiences strong seasonal variations in water temperature and phytoplankton concentrations, with corresponding seasonal changes in the densities of benthic organisms. The spatial and temporal variation in benthic prey organisms can affect the growth, survival, and population levels of fish and other organisms. Benthic organisms are commonly characterized by size (e.g., megafauna, macrofauna, or meiofauna). In soft bottom habitats, these organisms are also characterized by whether they live on (epifauna) or within (infauna) the substrate (Rutecki et al. 2014). Soft sediment fauna common to the Project area included mobile epifauna including hermit crabs, sand dollars, shrimp, and sea stars as well as sessile infauna including burrowing anemones (cerianthids), tube-building worms (*Diopatra* sp.), and deep-burrowing worms.

3.3.4 Soft Bottom Sand (Sand and Muddy Sand) Habitats

The sand and muddy sand habitat type consists of sand that has been subjected to a wide range of oceanic processes and are common on the OCS and were widespread throughout the entire Project area. These habitats are subjected to small but frequent currents and storm events and ripples and/or megaripples, linear depressions, and trawl marks and were common in offshore waters. Sand and muddy sand habitats made up most of the area mapped at the SRWF (with smaller portions of sand and muddy sand and a minor component of sand and muddy sand– mobile and with boulder fields), the majority of the SRWEC-OCS, the greatest proportion of the SRWEC-NYS (followed by sand and muddy sand – mobile, and a minor component with boulder fields), and most of the ICW-HDD study area (with smaller proportions of sand and muddy sand with historical and/or recent SAV and/or benthic macroalgae). The sediments within these habitats were generally composed of very fine, fine and medium sands, with fewer ground-truth stations classified as coarse sand and as silty/clay with no gravel present. The CMECS biotic subclass of soft sediment fauna was the predominant biotic subclass within sand and muddy sand habitats, with inferred fauna (epifaunal tracks and trails) and attached fauna present. Sessile and mobile epifauna were generally composed of amphipods, sand dollars, and mobile crustaceans and mollusks and common infauna observed included cerianthids (burrowing anemones) and, close to shore, decorator worms *Diopatra* spp.

3.3.5 Submerged Aquatic Vegetation

Sand and muddy sand habitats with potential (historical) or recently confirmed (data from 2020) presence of SAV and/or benthic macroalgae were mapped within the area of the temporary landing structure for the ICW-HDD component of the Project area (Figure 3-19). Areas of seagrass and other coastal habitats are mapped in Figure 3-22. Eelgrass (*Zostera marina*) was generally observed as single strands or groups of strands, often among thick patches of benthic macroalgae. Dense macroalgal beds were observed across numerous transects mainly along the northern side of the channel. In 2018, SAV beds were documented in waters adjacent to the proposed temporary landing site at Smith Point County Park (NYDOS 2020a and 2020b) (Figure 3-20 and Figure 3-21). The individual SAV shoots that were observed occurred on the north side of the channel in dense macroalgal beds. For the purposes of summary and EFH crosswalk, these are considered collectively as “vegetated habitats.”

An additional SAV survey was conducted in the area of the temporary landing at Smith Point County Park by Cornell Cooperative Extension (CCE) of Suffolk County on October 12, 2022. SAV surveys were made using underwater video and a GPS-enabled Seaviewer drop camera along pre-established east-west and north-south transect lines covering the proposed temporary landing site (Figure 3-16).

No SAV-forming patches or meadows were observed during the survey. However, eelgrass (*Zostera marina*) was identified at six different locations in the northeastern area of the proposed temporary landing site (Figure 3-20 and Figure 3-21). Four of the SAV observations (NS6-1, NS6-2, EW6-1, and EW7-1) were single eelgrass shoots emerging from a dense mat of algae and a determination of whether these plants were rooted or uprooted. Based on extensive experience with eelgrass restoration and monitoring, CCE scientists considered these plants as uprooted shoots that had drifted into the area from an eelgrass meadow in Narrow Bay and subsequently became entangled in the algal mat. The remaining two SAV observations, NS6-3 and EW7-2, were multiple shoots of eelgrass (less than six shoots per site) that also emerged from an algal mat on the sediment surface, but, compared to the single eelgrass plants observed, appeared more likely to be rooted. Due to the small number of shoots observed at both locations, these plants are not part of a larger eelgrass patch at the site, but rather they likely arose from seed that had been deposited by drifting eelgrass flower shoots. CCE staff has observed similar, isolated eelgrass growth at significant distances from existing eelgrass meadows that were generated by drifting/rafting eelgrass flower shoots.

Results from the video transects indicate no significant populations of eelgrass in the proposed temporary landing site at Smith Point County Park. Most (four of six observations) of the observed eelgrass occurred as single, unrooted shoots that were likely the result of drifting/rafted eelgrass flower shoots.

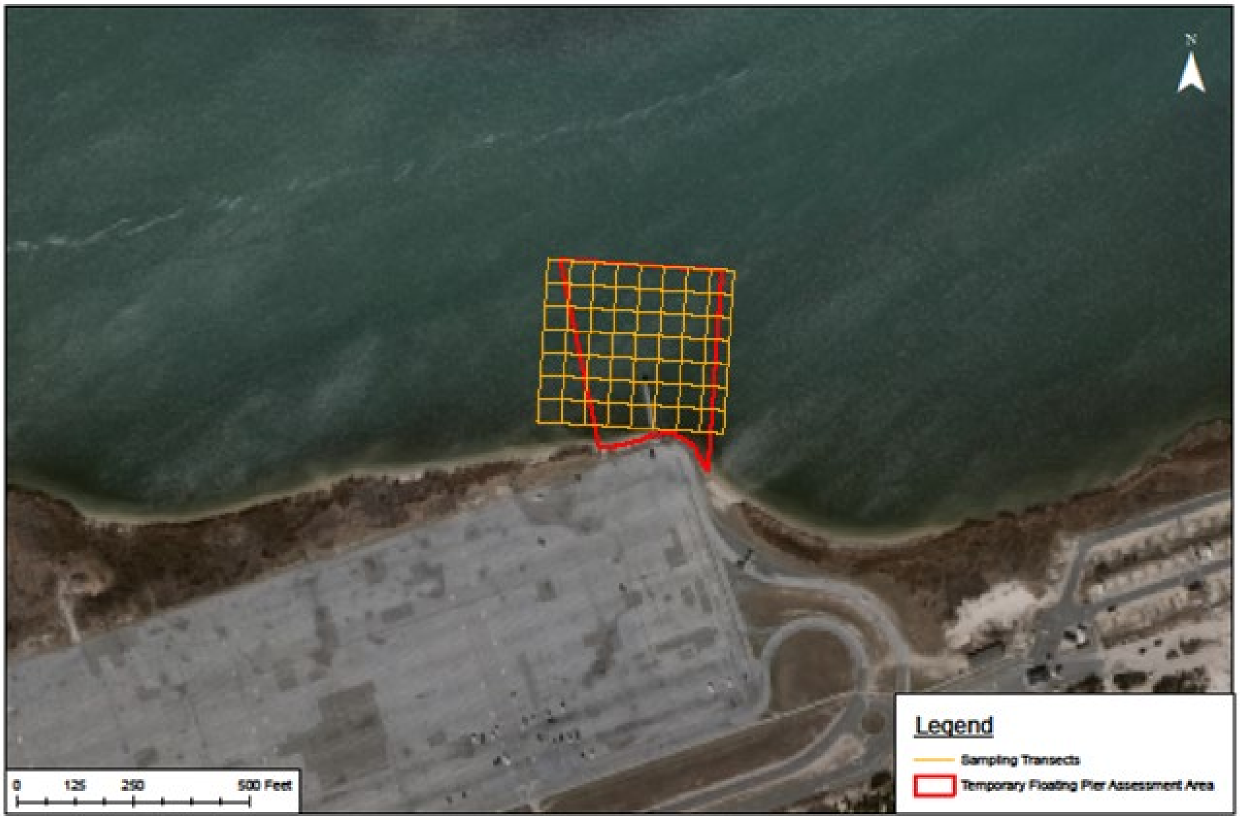


Figure 3-19. Sampling grid used for Sunrise Wind SAV survey of the proposed temporary landing structure and vicinity. Transects run east-west and north-south and are spaced approximately 50 feet apart.

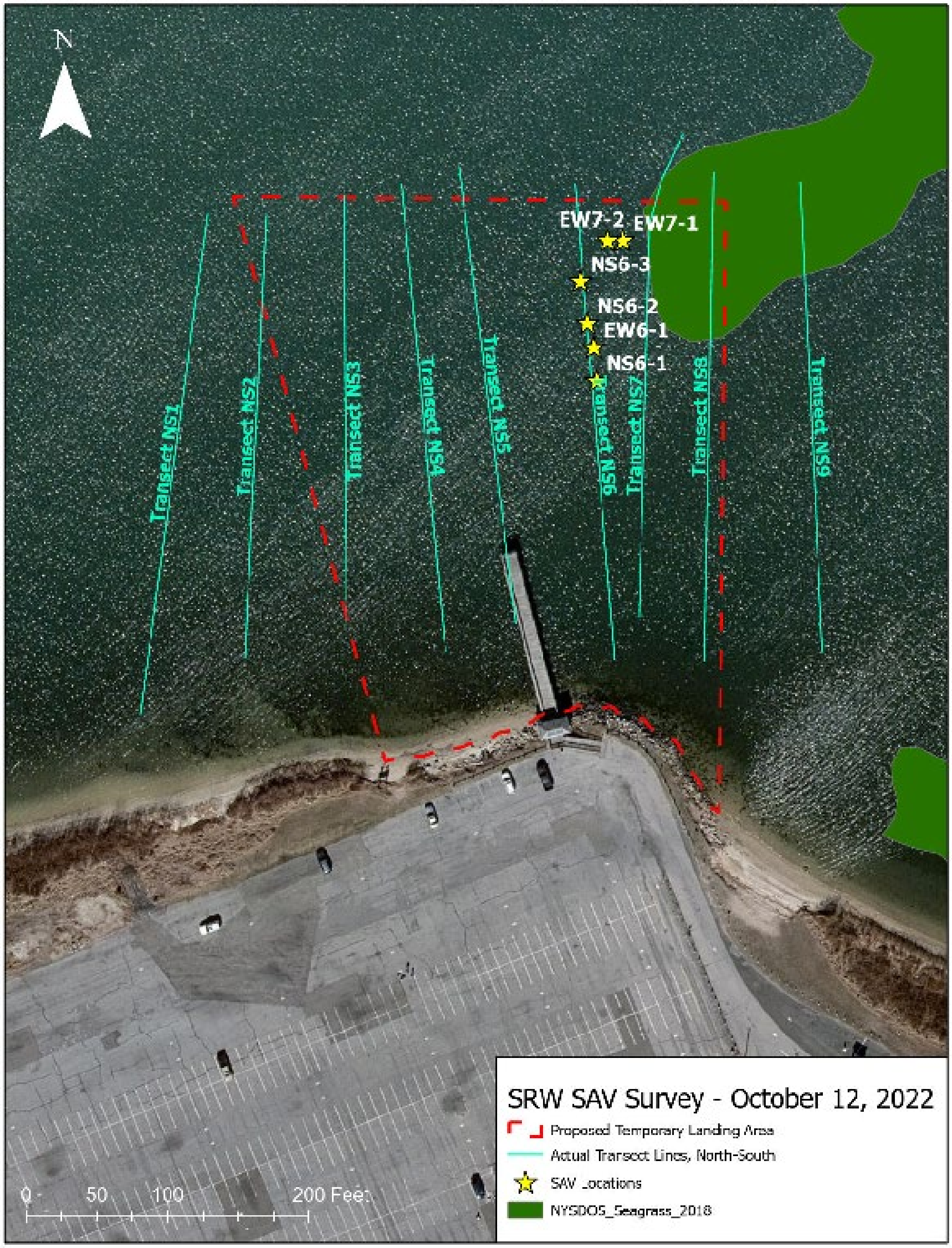


Figure 3-20. The paths of the North-South video transects that were completed on October 12, 2022 for the SRW SAV Survey at Smith Point County Park.

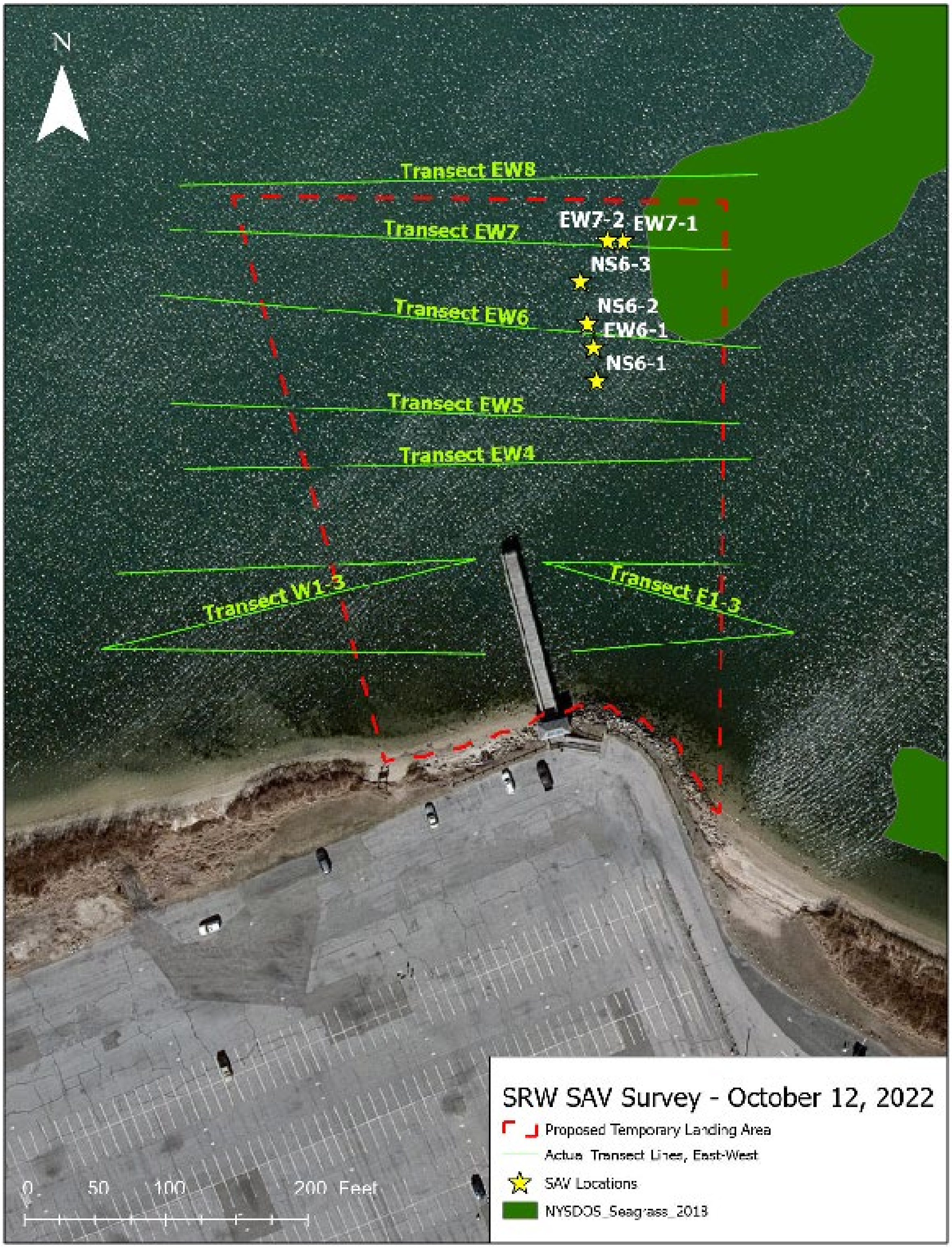


Figure 3-21. Paths of the East-West video transects that were completed on October 12, 2022 for the Sunrise Wind SAV Survey at Smith Point County Park.

3.3.6 Tidal Marsh (e.g., Saltmarsh and Brackish Marsh)

Marsh, mapped as emergent wetland, is present throughout the low tidal energy areas of South and Moriches Bays along the ICW, including in the Project area (Figure 3-22). Tidal marshes may be salt, brackish, or freshwater and are periodically to continuously inundated by salt water from tides. These marshes are characterized by emergent herbaceous vegetation (e.g., grasses, sedges, and rushes) tolerant of both salinity and saturated soil conditions. Because of their high productivity, tidal marshes provide critical spawning and nursery habitat, as well as refuge, for many different fish species. These species, in turn, are important prey for valuable commercial and recreational fish species such as striped bass, bluefish, and winter flounder. Fish species found in the tidal creeks include common mummichog (*Fundulus heteroclitus*), striped killifish (*Fundulus majalis*), sheepshead minnow (*Cyprinodon variegatus*), American eel (*Anguilla rostrata*), Atlantic silverside (*Menidia menidia*), and young-of-the-year winter flounder. Marshes provide important foraging habitat for a variety of fish species, in turn serving an important trophic link between the highly productive marsh and near-shore estuarine waters.

Some species, such as summer flounder juveniles use several estuarine habitats as nursery areas, including salt marsh creeks, seagrass beds, and mudflats, as well as open bay areas. EFH for summer flounder juveniles has been identified in the SRWEC-OCS, SRWEC-NYS, and Onshore Transmission Cable (interior coastal component).

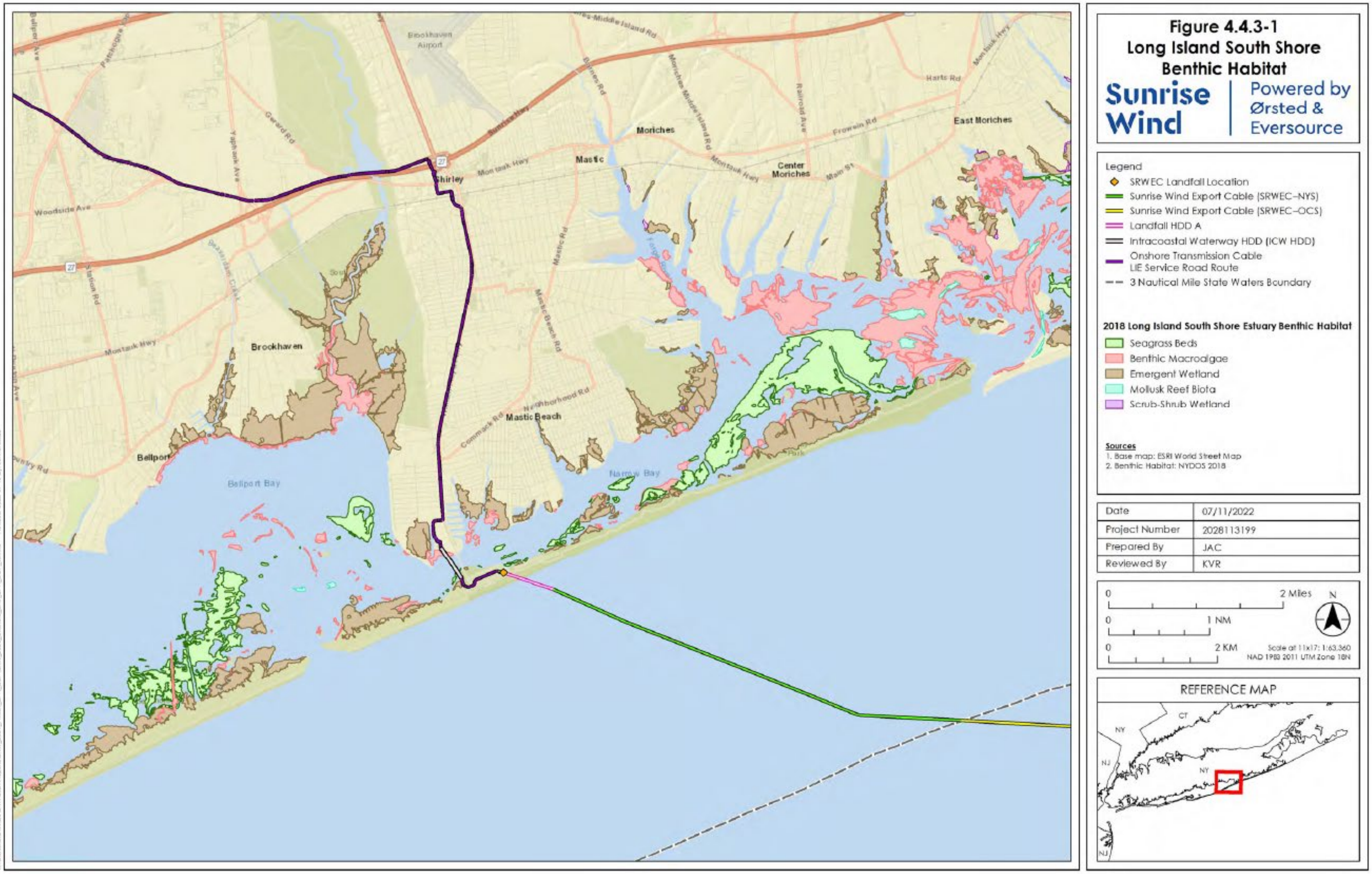


Figure 3-22. Seagrass, Macroalgae, Marsh (Emergent Wetland), Shellfish Reef, and Shrub/Scrub Habitats in the Vicinity of the SRWF Project Components (source: Appendix L of the COP, Sunrise Wind 2022b)

3.3.7 Shellfish Reefs and Beds and Accumulations

No shellfish reefs or beds were observed in the Project area but were found in Belport Bay to the west of Smith Point Bridge (Figure 3-22). Soft bottom habitats, including those documented during the site-specific benthic surveys (e.g., sand and mud, sand with ripples, and sand with pebbles/granules) are suitable for the following ecologically and economically important shellfish species: Atlantic sea scallop (*Placopecten magellanicus*), Jonah crab (*Cancer borealis*), Atlantic rock crab (*Cancer irroratus*), channeled whelk (*Busycotypus canaliculatus)*, ocean quahog clam (*Arctica islandica*), Atlantic surfclam (*Spisula soliddissima)*, and horseshoe crab (*Limulus polyphemus*).

Commercially harvested bivalves including sea scallops, ocean quahogs, and surfclams inhabit soft bottom habitats in the Northwest Atlantic OCS. Ocean quahogs are known to be distributed across the planned SRWEC-OCS and the SRWF, with their EFH overlapping with portions of the SRWF (NOAA Fisheries 2020a) and were reported within the SRWF during the Bay State Wind benthic assessments (Bay State Wind 2019). EFH for sea scallop overlaps with the planned SRWEC corridor as well as the western portion of the SRWF (NOAA Fisheries 2020b). Atlantic sea scallops occur along the continental shelf, typically at depths ranging from 59 to 360 ft (18 to 110 m) and are generally found in seabed areas with coarse substrates consisting of firm sand, gravel, shells, and rocks (Hart and Chute 2004).

EFH for Atlantic surfclam is present around the nearshore portions of the SRWEC corridor. Surfclams prefer sandy habitats along the continental shelf (Cargnelli et al. 1999), and are most abundant on Georges Bank, the south shore of Long Island, and along the coasts of New Jersey and the Delmarva Peninsula (NOAA Fisheries 2020c). Surfclams generally occur from the beach zone to a depth of about 200 ft (61 m), but abundance is low beyond about 125 ft (38 m). Surfclams can be found up to 3 ft (1 m) below the sediment–water interface. The most recent data collected during the Atlantic Surfclam and Ocean Quahog Survey by the Northeast Fisheries Science Center (NEFSC) was in 2018 and reported densities of ocean quahogs and Atlantic surfclams ranging from 0 to 0.375 per m^2 and 0 to 1.25 m^2, respectively (NOAA Fisheries 2022c; Figure 3-23).

EFH for sea scallop overlaps with the planned SRWEC corridor as well as the western portion of the SRWF (NOAA Fisheries 2020b). Atlantic sea scallops occur along the continental shelf, typically at depths ranging from 59 to 360 ft (18 to 110 m) and are generally found in seabed areas with coarse substrates consisting of firm sand, gravel, shells, and rocks (Hart and Chute 2004). More detailed information on the distribution of these commercially fished bivalve species is provided in COP Appendix N, which describes the EFH associated with the Project.

Project-specific field survey and current public data sources related to benthic and shellfish resources, including state and federal agency-published papers and databases (e.g., LaFrance Bartley et al. 2022, NYSERDA 2017a, Popper et al. 2014); online data portals and mapping databases (e.g., Northeast Ocean Data 2020); environmental studies; published scientific literature relating to relevant benthic habitat distribution; and correspondence and consultation with federal and state agencies. A summary of the results from a site-specific benthic assessment survey in the SRWF and along the SRWEC is provided below. More detailed information concerning the results of site-specific benthic assessment surveys and additional details on benthic resources in OCS and NYS waters are presented in COP Appendices M1-M3. Habitat mapping integrates high-resolution acoustic data from the site investigation surveys, the SPI/PV results, and results of a video survey that targeted possible complex bottom locations in the SRWF.

Benthic community structure within this region has been assessed by several studies including benthic characterization surveys associated with the development of nearby wind leases including Bay State Wind (Bay State Wind 2019), Revolution Wind (DWW Rev I, LLC 2020), South Fork Wind Farm (Deepwater Wind South Fork, LLC 2019), in addition to other regional benthic assessments (Guida et al. 2017, Greene et al. 2010, Stokesbury 2012, 2014, NYSERDA 2017b). Most relevant to the RI-MA WEA are the CMECS biotic subclasses attached fauna and soft sediment fauna, which are broad-scale categories for these seafloor habitats (COP Appendices M1 and M2, Sunrise Wind 2022b).

Benthic invertebrates such as crustaceans, polychaetes, and bivalves serve as forage for EFH species South Bay. Although little information is available relating to the distribution and abundance of these species within Great South Bay, natural hard clam populations in Bellport Bay are evaluated biannually by the Town of Brookhaven; most recent data show densities range from 0 to 16 clams/m^2 within the Bay. More detailed information on shellfish distribution within Great South Bay is provided in COP Section 4.4.2.2 *Benthic and Shellfish Resources*.

Previous hard clam restoration efforts in Bellport Bay failed likely due to stressors including high nitrogen levels that fuel frequent brown tides (*Aureococcus anophagefferens*) in the area and are detrimental to hard clams (Bricelj et al. 2001). However, the recent breach (Hurricane Sandy in 2012) that created an inlet from the Atlantic Ocean into Bellport Bay may improve water quality and support bivalve production (Gobler et al. 2019). Natural hard clam populations in Bellport Bay are evaluated biannually by the Town of Brookhaven; most recent data show densities range from 0 to 16 clams/m^2 within the Bay (Figure 3-23).

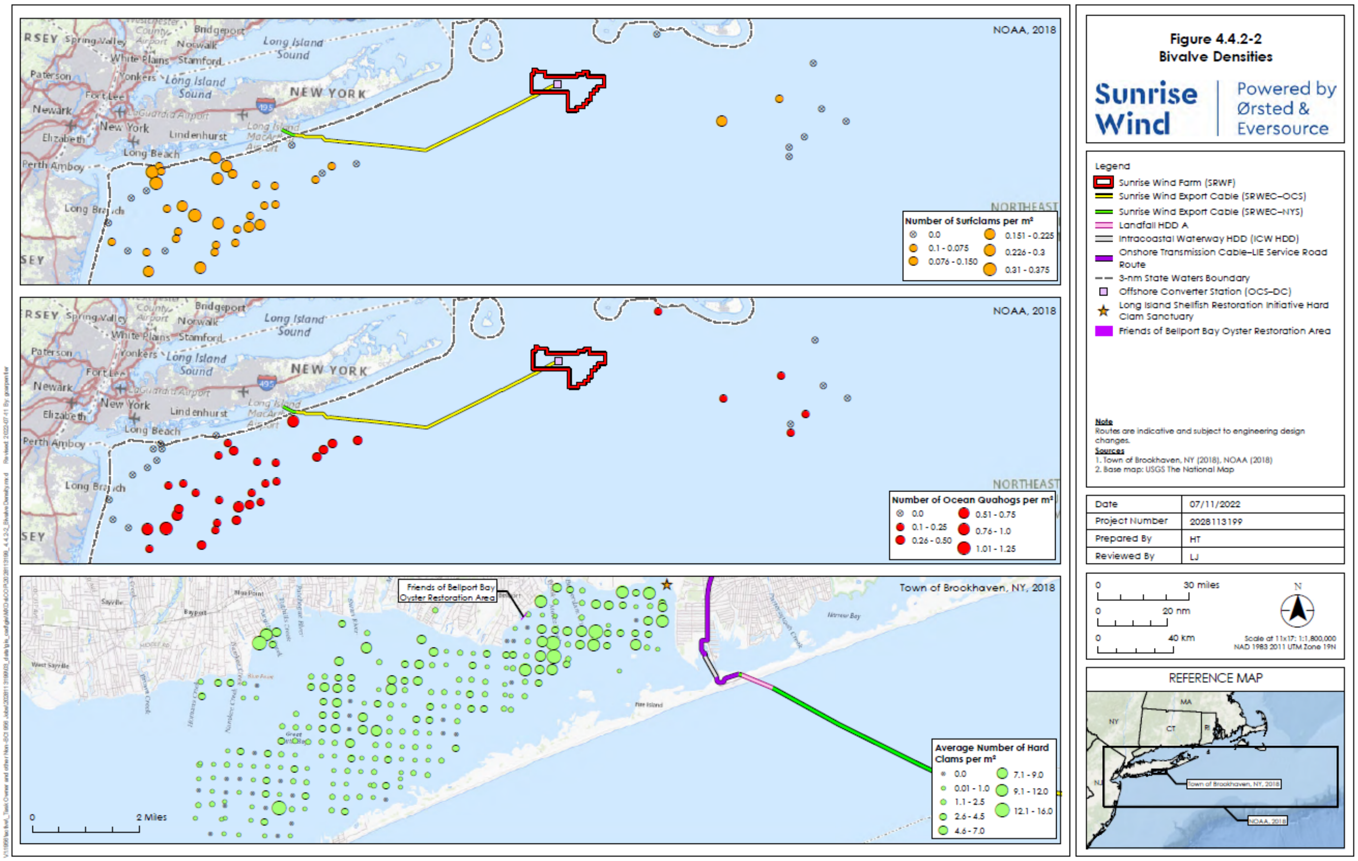


Figure 3-23. Densities of Bivalves in the Vicinity of the SRWF Project Components

EFH for ecologically and economically important shellfish (bivalves) species are also present in Project components SRWF, SREC-OCS and SREC-NYS. Soft bottom habitats (e.g., mud and sand with and without ripples, sand with and without ripples, and sand with mobile gravel) are suitable for the shellfish species Atlantic sea scallop (*Plactopecten magellanicus*), ocean quahog (*Artica islandica*), and surfclam (*Spisula solidissima*) (COP Appendix N, Sunrise Wind 2022b). Shellfish beds also provide habitat various life stages of finfish species such as juvenile black sea bass, which are usually found in association with rough bottom, shellfish and eelgrass beds, and man-made structures in sandy-shelly areas; offshore clam beds and shell patches may also be used for over-wintering.

Ocean quahogs are present across the SRWEC-OCS and the SRWF. Ocean quahogs are considered a species of concern regarding possible habitat disturbance from offshore wind construction and operation activities in this region (Guida et al. 2017) and are managed shellfish species (NOAA Fisheries 2020a). Although difficult to detect using SPI/PV, the presence of ocean quahogs in the survey area was inferred based on the frequent presence of empty quahog shells on sandy and muddy sediment surfaces as well as large siphons detected in PV images, indicating live buried quahog.

Sea scallops were observed at 13 stations at the SRWF and 6 stations along the eastern portion of the SRWEC-OCS and EFH for this species is present in the SRWF Project component (NOAA Fisheries 2020b). Atlantic sea scallops typically occur along the continental shelf and are found from mean low water to depths of 656 ft (200 m) on sand, gravel, shells, and other rocky habitat. Scallop larvae settle on gravel and rocky substrate. This species has designated EFH in the SRWF and along the SRWEC-OCS and SRWEC-NYS. During the site-specific SPI/PV survey, sea scallops were observed at 13 stations at the SRWF and 6 stations along the eastern portion of the SRWEC-OCS.

Atlantic surfclams were not found during site-specific SPI/PV survey, although whole clam valves were observed on the sediment surfaces at some stations. EFH is designated for this species in in the nearshore portions of the SRWEC-NYS. Surfclams prefer sandy habitats along the continental shelf (Cargnelli et al. 1999a) and are abundant on Georges Bank and the south shore of Long Island (NOAA Fisheries 2020c). Surfclams generally occur from the beach zone to a depth of about 200 ft (656 m), but beyond about 125 ft (52 m) abundance is low. The surfclam prefers depths from 26 to 216 ft (8 to 66 m) in medium-grained sand but may also occur in finer grained sediments. Burrows to 3 ft (0.9 m) below the sediment–water interface. This species also has designated EFH along the SRWEC-OCS route. Although no live surfclams were observed during the site-specific SPI/PV survey, whole clam valves were observed on the sediment surfaces at some stations.

3.3.8 Other Biogenic Habitats

Marine biogenic habitats are habitats created by living organisms such as corals, seagrass beds, burrowing anemones, and polychaetes, and provide fish habitat as well as other essential ecosystem functions and services, such as physical structuring, nutrient cycling, biodiversity support, and increases in primary, secondary, and tertiary production. For example, the biogenic structure created by seagrass beds is important to the physical, chemical and biological processes of shallow coastal and estuarine waters. The three-dimensional structure modifies water flow and reduces wave turbulence and storm surge. The root systems of established seagrass meadows also serve to stabilize bay sediments and reduce erosion. The grass beds serve as spawning and feeding habitat as well as refuge for fisheries and benthic habitat. Within the estuarine environment of the ICW-HDD, the presence of continuous or patchy SAV are considered sensitive and ecologically important benthic habitat. Soft Sediment Fauna in this environment includes mobile epifauna such as hermit crabs, sand dollars, shrimp, and sea stars as well as sessile infauna including burrowing anemones and tube-building worms (*Diopters sp*.), and deep-burrowing worms.

The spatial distribution of sand dollars and burrowing anemones, two commonly observed species, closely tracked the patterns observed in macrohabitat types and CMECS Substrate Subgroups. Stations predominately composed of CMECS Substrate Subgroup Medium Sand and macrohabitat type sand with ripples or sand and mud with ripples, were characterized by high densities of sand dollars, while high densities of burrowing anemones were found in the macrohabitat type sand and mud.

3.3.9 Pelagic (Offshore and Estuarine) Habitat

Localized changes in pelagic habitat, such as increased vertical mixing of the water column and subsequent declines in seasonal stratification and shelf-wide changes of tidal amplitudes, demonstrate that pelagic habitats are subject to change. Recent evidence indicates vertical mixing of the water column in offshore wind farms can also lead to a doming of the thermocline, resulting in nutrient transport to the surface mixed layer, rapid nutrient uptake, and primary production in the entire water column as well as changes in copepod dominated plankton communities (Floeter et al. 2017), without showing any effects on the distribution of pelagic fish.

Pelagic waters in the Project area are characterized by large temperature fluctuations and summer stratification, with depths up to 79 m recorded in offshore waters during SPI/PV sampling. The general pattern in the annual temperature cycle indicates seasonal fluctuations of as much as 20°C at the surface and 12°C at the bottom, with thermal stratification beginning in April and increasing into August, when maximum surface to bottom gradients can reach up to 10°C. Vertical turnover occurs in September or October, at which time maximum bottom temperatures occur. This is followed by a drop in temperatures of up to 12°C throughout the water column by the next January. Actual surface and bottom temperatures vary substantially from year to year, particularly during the fall, as does the date of that turnover event. Surface to bottom temperature gradients were invariably negative (warmer at the surface, cooler at the bottom) and often large in spring and summer (stratified condition), but usually nonexistent to positive and small following the fall turnover and during the winter (isothermal or nearly so). Large changes in temperature have important physiological and behavior consequences, e.g., inducing migrations, in addition to influencing seawater density and water column structure, in fact, this temperature pattern is likely the major driver for seasonal migrations and redistribution of highly mobile demersal nekton and mobile epibenthos and perhaps the settlement of new demersal and benthic organisms of all types from the plankton. No persistent hydrographic fronts appear to be present in the Project area (Guida et al. 2017).

Median salinity measured in the RI-MA WEA during the survey period, including all depths, was 32.297 grams per kilogram (g/kg), with a full range spanning 30.939 to 33.509 g/kg (n=3,570), despite strong seasonal changes in other parameters. These salinities are entirely within anticipated range of salinities and the magnitude of the fluctuation is unlikely to be a driver of organismal distributions.

3.3.9.1 Habitat for Sensitive Life Stages

Potentially sensitive seafloor habitats, such as corals, SAV beds, and ecologically valuable cobble and boulder habitat can provide important habitat for various fish and other marine species. Cobble and boulder habitat can serve as nursery ground for juvenile lobster and as preferred habitat for squid to deposit their eggs. Both lobster and squid are specific in their habitat requirements and are also economically important species in New England. SAV beds are designated as HAPC for summer flounder in this region. For these reasons, federal and state agencies consider evidence of these taxa to indicate potentially sensitive habitats. Some habitats are sensitive to environmental changes and loss of habitat can affect various life stages of benthic invertebrates and fish.

Sensitive seafloor habitats include corals, SAV beds, and valuable cobble and boulder habitat (BOEM 2019). Cobble and boulder habitat can serve as structure for hard and soft corals, nursery ground for juvenile lobster, and as preferable benthic habitat for squid to deposit their eggs. Taxa considered sensitive for this region include corals, seagrass beds, squid eggs, and American lobster.

In the SRWEC-NYS area, species of ecological concern and/or concern regarding possible habitat disturbance from offshore wind construction and operation activities include black sea bass, Atlantic cod, sea scallop, and ocean quahog (Guida et al. 2017). Within the estuarine environment of the ICW-

HDD, the presence of seagrass beds, characterized by continuous or patchy seagrass (SAV), are considered sensitive and ecologically important benthic habitat. Northeastern marine, estuarine, and riverine habitat types were reported to be moderately to highly vulnerable to stressors resulting from climate change (Farr et al. 2021), thereby also affecting life stages that require these habitats. In general, rocky and mud bottom, intertidal, kelp, coral, and sponge habitats were considered the most vulnerable habitats to climate change in marine ecosystems (Farr et al. 2021). Similarly, estuarine habitats considered most vulnerable to climate change include intertidal mud and rocky bottom, shellfish, kelp, SAV, and native wetland habitats (Farr et al. 2021). Riverine habitats found to be most vulnerable to climate change include native wetland, sandy bottom, water column, and SAV habitats (Farr et al. 2021). Examples of habitat for sensitive life stages in the Project area include:

- Atlantic cod in the SRWF Project area are present as eggs, larvae, juveniles, and adults. They spawn near the seafloor in early winter and high-salinity zones of bays, estuaries, and in pelagic habitats, while juveniles use eelgrass habitats. Newly designated HAPC for spawning Atlantic cod is described in Section 3.3.10, below, and includes the entire Lease Area.
- Winter flounder offshore spawning habitat potentially in the WEA (Siemann and Smolowitz 2017) deposit their eggs on sandy bottoms and algal mats at night, usually about 40 times every spawning season. EFH for winter flounder eggs includes mud, muddy sand, sand, gravel, macroalgae, and submerged aquatic vegetation. Bottom habitats are unsuitable if exposed to excessive sedimentation which can reduce hatching success. EFH for winter flounder eggs has been identified in the SRWEC-NYS and Onshore Transmission Cable corridor.
- Ocean pout eggs are demersal and are laid in gelatinous masses, generally in sheltered nests, holes, or rocky crevices within hard bottom habitats in the SRWF and along the transmission corridors.
- Black sea bass juveniles and adults have well documented associations with structured habitats, including natural and artificial reefs, shellfish beds, shell hash, vegetated bottom, cobble, gravel, and boulder habitats (Drohan et al. 2007). Both juveniles and adults have strong site fidelity (Able and Hales 1997, Briggs 1979) and may be vulnerable to disruptions to structured habitats.
- Tidal marshes and SAV provide important habitat for many fish for breeding, spawning, and/or predator avoidance. Eelgrass beds are important to various life stages of species such as pollock (*Pollachius* spp.), red hake (*Urophycis chuss*), white hake (*Urophycis tenuis*), and other species in the Project area.

3.3.10 Habitat Areas of Particular Concern

HAPCs are discrete subsets of EFH that provide important ecological functions or are especially vulnerable to degradation (50 C.F.R. Part 600). Summer flounder HAPC occurs within the Project area near the ICW-HDD. It also occurs in the vicinity of the Project area (several miles from the ICW-HDD in Bellport Bay) (Figure 3-22).

Although not approved yet by NOAA, the New England Fishery Management Council (NEFMC) approved a new HAPC designation on July 20, 2022, that would include the SRWF. The proposed Southern New England HAPC comprises all large-grained complex and complex benthic habitats used by Atlantic herring, Atlantic sea scallop, little skate, monkfish, ocean pout, red hake, silver hake, windowpane flounder, winter flounder, winter skate, and yellowtail flounder, wherever present within the area bounded by a 10-km (6.2-mile) buffer around the RI-MA and MA WEAs (Plante 2022), as shown in Figure 3-24. HAPCs are discussed further in Section 4.3.

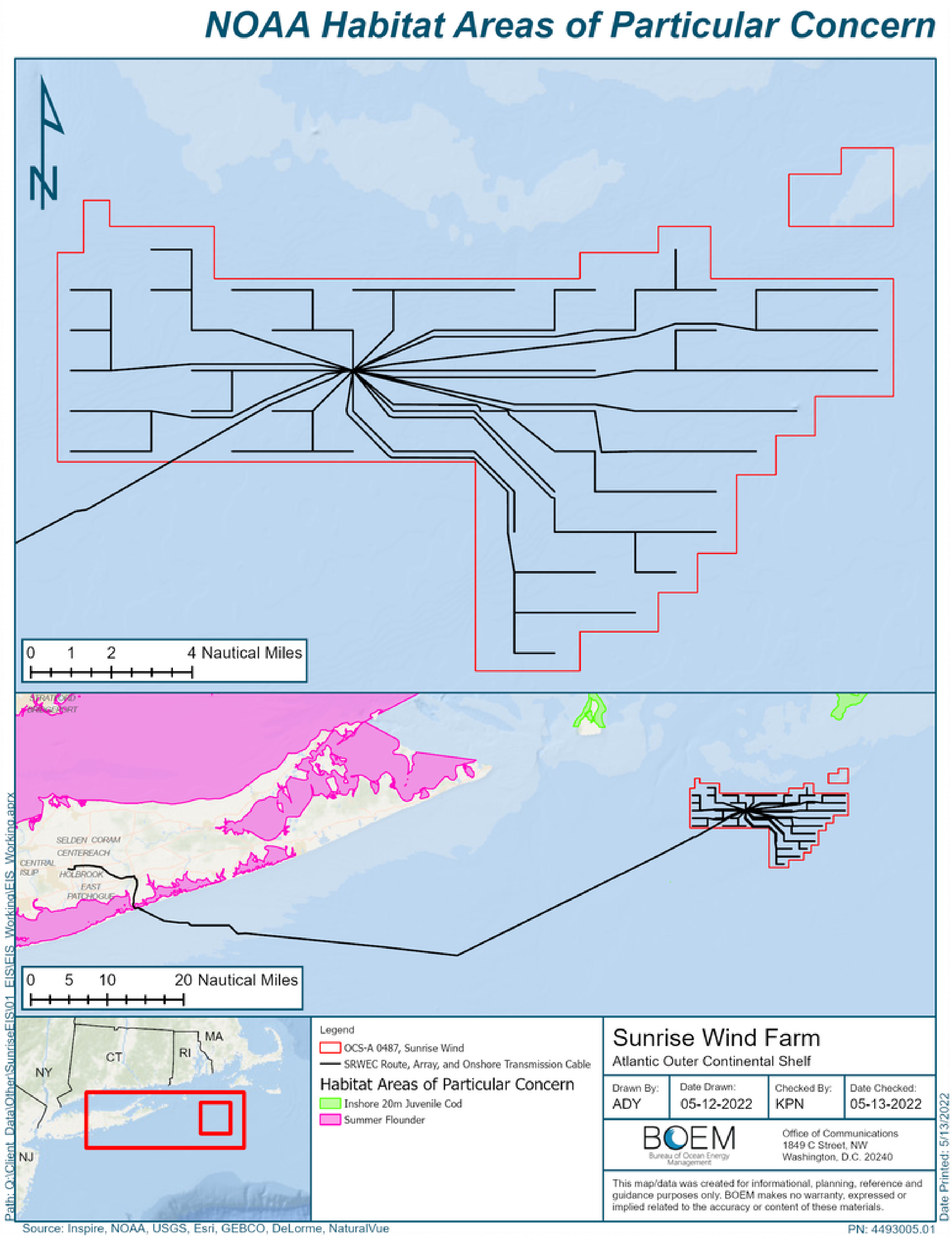


Figure 3-24. NOAA Habitat Areas of Particular Concern

A video survey was completed in October 2022 to document the presence and extent of SAV beds within 100 m of the ICW-HDD. There were six observations of SAV, and specifically eelgrass, all located on the north side of the channel. The density of the eelgrass was very low: a maximum of one to three shoots were observed within a single video frame. All eelgrass observations were within dense macroalgal beds and often the eelgrass shoots appeared to be uprooted and deposited within the macroalgal bed. SAV was not observed on the south side of the channel, despite an SAV bed being documented in this area previously (NYDOS 2020). Results from video transects completed in October 2022 confirmed the presence of some seagrass but did not indicate any significant populations of eelgrass in the proposed temporary landing site at Smith Point County Park. Most (four of six observations) of the observed eelgrass occurred as single, unrooted shoots that were likely the result of drifting/rafted eelgrass flower shoots. Further detail is provided in Section 3.3.5 *Submerged Aquatic Vegetation*.

4.0 Designated Essential Fish Habitat

The Project area includes EFH designations developed by the NEFMC, the Mid-Atlantic Fisheries Management Council (MAFMC), and NMFS.

Within the SRWF area, 42 species of fish and invertebrates have designated EFH for various life stages (Table 4-1, Figure 3-14). Within the 0.5-mi (800-m) corridor around the SRWEC centerline, 45 species of fish and invertebrates have designated EFH within the SRWEC-OCS, 32 species have designated EFH within the SRWEC-NYS, and 17 species have designated EFH within the Onshore Transmission Cable. EFH-designated species descriptions and their habitat designations presented in this assessment were drawn from the following sources:

- Species descriptions provided in COP, Appendix N (Sunrise Wind 2022b)
- Final Omnibus Essential Fish Habitat Amendment 2 (NEFMC 2017)
- MAFMC Fishery Management Plans (FMPs)
- NEFMC FMPs
- Final Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species FMP (NMFS 2017)
- Essential Fish Habitat Mapper species descriptions from November 1 - November 18, 2021

Also discussed below are subsets of EFH known as Habitat Areas of Particular Concern (HAPC). These areas are considered high priority for conservation, management, and research due to their status as rare, sensitive, stressed by development, or important to ecosystem function. The only designated HAPCs that are known to potentially occur in the Project area and vicinity are specific habitats to all life stages of summer flounder. HAPC descriptions for summer flounder and occurrence within the Project area are described in Section 4.2.

4.1 Essential Fish Habitat Designations within the Project Area

The Project area includes designated EFH for 42 fish and invertebrate species, with varying species and life stage distribution throughout the Project area. Resources are managed under various FMPs. NEFMC FMPs include Northeast Multispecies FMP, Sea Scallop FMP, Monkfish FMP, Atlantic Herring FMP, Skate FMP, and Small-Mesh Multispecies FMP. MAFMC FMPs include Summer Flounder, Scup, Black Sea Bas FMP, Mackerel, Squid, and Butterfish FMP, Surfclams and Ocean Quahogs FMP, Bluefish FMP, and Monkfish FMP. NMFS FMPs include the Highly Migratory Species FMP. Designated EFH occurrence by taxonomic grouping, individual species, and life stage is summarized in Table 4-1 and Table 4-2.

Table 4-1. Designated EFH Based on Taxonomic Group, Species, and Life Stage Within the Sunrise Wind Project Area

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Gadids																	
Atlantic Cod *Gadus morhua*	X	X	X	-	X	X	X	-	X	X	-	-	X	X	X	-	**General habitat description**: Prefers muddy, gravelly, or rocky substrates. In state waters, cod can be found year-round but peak in winter and spring both nearshore and offshore. Cod typically move south and into deeper water in the winter and spring, and spawn nearshore in the winter months (Collette and Klein-MacPhee 2002) **Eggs/Larvae**: Pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, and in the high-salinity zones of the bays and estuaries (NEFMC 2017). **Juvenile:** Intertidal and subtidal benthic habitats in the Gulf of Maine, southern New England, and on Georges Bank, to a maximum depth of 120 meters, including high-salinity zones in the bays and estuaries listed in Table 19. Structurally complex habitats, including eelgrass, mixed sand and gravel, and rocky habitats (gravel pavements, cobble, and boulder) with and without attached macroalgae and emergent epifauna, are essential habitats for juvenile cod. In inshore waters, young-of-the-year juveniles prefer gravel and cobble habitats and eelgrass beds after settlement, but in the absence of predators also utilize adjacent un-vegetated sandy habitats for feeding. Survival rates for young-of-the-year cod are higher in more structured rocky habitats than in flat sand or eelgrass; growth rates are higher in eelgrass. Older juveniles move into deeper water and are associated with gravel, cobble, and boulder habitats, particularly those with attached organisms. Gravel is a preferred substrate for young-of-the-year juveniles on Georges Bank and they have also been observed along the small boulders and cobble margins of rocky reefs in the Gulf of Maine (NEFMC 2017). **Adults:** Subtidal benthic habitats in the Gulf of Maine, south of Cape Cod, and on Georges Bank, between 30 and 160 meters, including high-salinity zones in the bays and estuaries. Structurally complex hard bottom habitats composed of gravel, cobble, and boulder substrates with and without emergent epifauna and macroalgae are essential habitats for adult cod. Adult cod are also found on sandy substrates and frequent deeper slopes of ledges along shore. South of Cape Cod, spawning occurs in nearshore areas and on the continental shelf, usually in depths less than 70 meters (NEFMC 2017).
Haddock *Melanogrammus aeglefinus*	-	-	-	-	X	X	X	-	X	X	-	-	-	X	-	-	**General habitat description**: Haddock are a demersal gadoid species which are distributed from Greenland to Cape Hatteras, North Carolina along the western Atlantic (Cushing 1986). Haddock prefer gravel sand substrate which is abundant on Browns and Georges Banks (NOAA, 1999). **Larvae**: Pelagic habitats in coastal and offshore waters in the Gulf of Maine, the Mid-Atlantic, and on Georges Bank (NEFMC 2017). **Juvenile / Adults:** Subtidal benthic habitats between 40 and 140 meters in the Gulf of Maine, on Georges Bank and in the Mid-Atlantic region, and as shallow as 20 meters along the coast of Massachusetts, New Hampshire, and Maine. Essential fish habitat for adult haddock occurs on hard sand (particularly smooth patches between rocks), mixed sand and shell, gravelly sand, and gravel. Young-of-the-year juveniles settle on sand and gravel on Georges Bank but are found predominantly on gravel pavement areas within a few months after settlement. As they grow, they disperse over a greater variety of substrate types on the bank. Young-of-the-year haddock do not inhabit shallow, inshore habitats (NEFMC 2017). Subtidal benthic habitats between 50 and 160 meters in the Gulf of Maine, on Georges Bank, and in southern New England. Essential fish habitat for adult haddock occurs on hard sand (particularly smooth patches between rocks), mixed sand and shell, gravelly sand, and gravel substrates. They also are found adjacent to boulders and cobbles along the margins of rocky reefs in the Gulf of Maine (NEFMC 2017).

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Pollock *Pollachius*	X	X	-	-	X	X	X	-	X	X	X	X	-	-	-	-	**General habitat description:** Atlantic pollock are found in pelagic habitats on the Scotian Shelf, Georges Bank, in the Great South Channel, and in the Gulf of Maine (Cargnelli et al. 1999a). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-131 (Cargnelli et al. 1999a). **Larvae:** Pelagic inshore and offshore habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, including the bays and estuaries (NEFMC 2017). **Juvenile:** Inshore and offshore pelagic and benthic habitats from the intertidal zone to 180 meters in the Gulf of Maine, in Long Island Sound, and Narragansett Bay, between 40 and 180 meters on western Georges Bank and the Great South Channel and in mixed and full salinity waters in a number of bays and estuaries north of Cape Cod. Essential fish habitat for juvenile pollock consists of rocky bottom habitats with attached macroalgae (rockweed and kelp) that provide refuge from predators. Shallow-water eelgrass beds are also essential habitats for young-of-the-year pollock in the Gulf of Maine. Older juveniles move into deeper water into habitats also occupied by adults (NEFMC 2017).
Offshore Hake *Merluccius albidus*	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	**General habitat description:** Offshore hake are found on the continental shelf and slope of the Northwest Atlantic Ocean. Additionally, they are found on the Florida slope community, and the edge of the Scotian Shelf (Markle et al. 1980). **Larvae:** Larvae are found in association with water temperatures ranging from 5-13 °C on the outer continental shelf. Most Offshore hake larvae were observed at depths of 70-130 m (NOAA, 1999).
Red Hake *Urophycis chuss*	X	X	X	-	X	X	X	-	X	X	X	-	-	-	-	-	**General habitat description:** Groundfish species that prefers deep water environments with bottom habitat consisting of both soft and pebbly substrate. Red hake range from Newfoundland to North Carolina, but most are concentrated around Georges Bank. In inland waters of New Jersey, red hake are rare. **Eggs/Larvae:** Pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region south to Cape Hatteras, and selected bays and estuaries. **Juveniles/ Adults:** Demersal life stages that inhabit sandy or muddy substrates. Juveniles are found in intertidal and subtidal areas to a maximum depth of 263 feet (80 meters). Benthic habitats providing shelter are essential for juveniles, including mud substrates with depressional features, substrates providing biogenic complexity, and artificial reefs. Adults are found where water temperatures are below 60.8°F (16°C), at depths from 32.8 to 426.5 feet (10 to 130 meters), and within a salinity range from 31 to 33 parts per thousand (ppt). Older juveniles are commonly associated with shelter or structure and often inside live bivalves.

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Silver Hake *Merluccius bilinearis*	x	x	x	-	x	x	x	-	x	x	-	-	-	x	-	-	**General habitat description:** Groundfish species that prefers deep water environments and are concentrated in deep basins in the Gulf of Maine and along the continental slope in winter and spring. Silver hake have been found associated with all bottom types, from gravel to fine silt and clay, but mainly with silts and clay (Scott 1982), but mainly with silts and clay (Scott 1982). **Eggs/Larvae:** Pelagic habitats from the Gulf of Maine to Cape May, New Jersey, including Cape Cod and Massachusetts Bays (NEFMC 2017). **Juveniles/ Adults:** Pelagic and benthic habitats in the Gulf of Maine, including the coastal bays and estuaries and on the continental shelf as far south as Cape May, New Jersey, at depths greater than 10 meters in coastal waters in the Mid-Atlantic and between 40 and 400 meters in the Gulf of Maine, on Georges Bank, and in the middle continental shelf in the Mid-Atlantic, on sandy substrates. Juvenile silver hake are found in association with sand waves, flat sand with amphipod tubes, and shells, and in biogenic depressions. Juveniles in the New York Bight settle to the bottom at mid-shelf depths on muddy sand substrates and find refuge in amphipod tube mats (NEFMC 2017). Pelagic and benthic habitats at depths greater than 35 meters in the Gulf of Maine and the coastal bays and estuaries between 70 and 400 meters on Georges Bank and the outer continental shelf in the northern portion of the Mid-Atlantic Bight, and in some shallower locations nearer the coast, on sandy substrates. Adult silver hake are often found in bottom depressions or in association with sand waves and shell fragments. They have also been observed at high densities in mud habitats bordering deep boulder reefs, resting on boulder surfaces, and foraging over deep boulder reefs in the southwestern Gulf of Maine. This species makes greater use of the water column (for feeding, at night) than red or white hake (NEFMC 2017).
White Hake *Urophycis tenuis*	-	-	-	-	-	-	-	-	x	x	x	-		x			**General habitat description:** Groundfish species that prefers deep water environments and are concentrated in deep basins in the Gulf of Maine and along the continental slope in winter and spring. Silver hake have been found associated with all bottom types, from gravel to fine silt and clay, but mainly with silts and clay (Scott 1982), but mainly with silts and clay (Scott 1982). **Eggs/Larvae:** Pelagic habitats from the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the Mid-Atlantic south to Cape Hatteras (NEFMC 2017). **Juveniles/ Adults:** Juveniles are found in association with sand waves, flat sand with amphipod tubes, and shells, and in biogenic depressions. Juvenile EFH is the pelagic and benthic habitats in the Gulf of Maine, including selected coastal bays and estuaries, and on the continental shelf as far south as Cape May, New Jersey, at depths greater than 32.8 feet (10 meters) in coastal waters in the Mid-Atlantic and between 131.2 and 1,312.3 feet (40 and 400 meters) in the Gulf of Maine, Georges Bank, and in the middle continental shelf in the Mid-Atlantic, on sandy substrates. Adults are usually found in water temperatures below 71.6°F (22°C) and at depths between 66 and 886 feet (20 and 270 meters), in benthic habitats of all substrate types in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the Mid-Atlantic south to Cape Hatteras (NEFMC 2017).

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Flatfish																	
Summer Flounder *Paralichthys dentatus*	x	x	x	-	x	x	x	-	-	x	x	x	x	x	x	x	**General habitat description:** This demersal fish species has a range from Maine to South Carolina but is predominantly concentrated south of Cape Cod. Present in Mid-Atlantic waters during summer and fall and has been found at depths between 48 and 450 feet (15 and 137 meters). Prefer sandy or muddy bottom habitats. Spawning is believed to occur offshore in open ocean along the continental shelf (Packer et al. 1999a). HAPC for summer flounder includes all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, wherever they may occur within adult and juvenile summer flounder EFH. **Eggs:** North of Cape Hatteras, EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the Exclusive Economic Zone (EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90 percent of the all the ranked ten-minute squares for the area where summer flounder eggs are collected in the marine resource monitoring, assessment, and prediction (MARMAP) survey. South of Cape Hatteras, EFH is the waters over the continental shelf (from the coast out to the limits of the EEZ), from Cape Hatteras, North Carolina to Cape Canaveral, Florida, to depths of 360 ft. In general, summer flounder eggs are found between October and May, being most abundant between Cape Cod and Cape Hatteras, with the heaviest concentrations within 9 miles of shore off New Jersey and New York. Eggs are most commonly collected at depths of 30 to 360 ft (MAFMC 1998b). **Larvae:** North of Cape Hatteras, EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90 percent of all the ranked ten-minute squares for the area where summer flounder larvae are collected in the MARMAP survey. South of Cape Hatteras, EFH is the nearshore waters of the continental shelf (from the coast out to the limits of the EEZ), from Cape Hatteras, North Carolina to Cape Canaveral Florida, in nearshore waters out to 50 miles from shore. Inshore, EFH is all the estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the Estuarine Living Marine Resources (ELMR) database, in the "mixing" (defined in ELMR as 0.5 to 25.0 ppt) and "seawater" (defined in ELMR as greater than 25 ppt) salinity zones. In general, summer flounder larvae are most abundant nearshore (12-50 miles from shore) at depths between 30 to 230 ft. They are most frequently found in the northern part of the Mid-Atlantic Bight from September to February, and in the southern part from November to May (MAFMC 1998b). **Juveniles:** North of Cape Hatteras, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90 percent of all the ranked ten-minute squares for the area where juvenile summer flounder are collected in the NEFSC trawl survey. South of Cape Hatteras, EFH is the waters over the continental shelf (from the coast out to the limits of the EEZ) to depths of 500 ft, from Cape Hatteras, North Carolina to Cape Canaveral, Florida. Inshore, EFH is all of the estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database for the "mixing" and "seawater" salinity zones. In general, juveniles use several estuarine habitats as nursery areas, including salt marsh creeks, seagrass beds, mudflats, and open bay areas in water temperatures greater than 37 °F and salinities from 10 to 30 ppt range (MAFMC 1998b). **Adults:** North of Cape Hatteras, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90 percent of all the ranked ten-minute squares for the area where adult summer flounder are collected in the NEFSC trawl survey. South of Cape Hatteras, EFH is the waters over the continental shelf (from the coast out to the limits of the EEZ) to depths of 500 ft, from Cape Hatteras, North Carolina to Cape Canaveral, Florida. Inshore, EFH is the estuaries where summer flounder were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
																	zones. Generally, summer flounder inhabit shallow coastal and estuarine waters during warmer months and move offshore on the outer continental shelf at depths of 500 ft in colder months (MAFMC 1998b).
Windowpane Flounder *Scophthalmus aquosus*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**General habitat description:** This groundfish fish species is typically associated with non-complex benthic habitats (Collette and Klein-MacPhee 2002) and is found from the Gulf of Saint Lawrence to Florida (Gutherz 1967). In New Jersey, windowpane flounder are abundant in inland bay systems and offshore near waters around Atlantic City (Stone et al. 1994; Chang et al. 1999). Spawning occurs from April to December along areas of the northwest Atlantic. **Eggs/Larvae:** Pelagic habitats on the continental shelf from Georges Bank to Cape Hatteras and in mixed and high-salinity zones of coastal bays and estuaries throughout the region (NEFMC 2017). **Juveniles:** Intertidal and subtidal benthic habitats in estuarine, coastal marine, and continental shelf waters from the Gulf of Maine to northern Florida, including mixed and high-salinity zones in the bays and estuaries. Essential fish habitat for juvenile windowpane flounder is found on mud and sand substrates and extends from the intertidal zone to a maximum depth of 60 meters. Young-of-the-year juveniles prefer sand over mud (NEFMC 2017). **Adults:** Intertidal and subtidal benthic habitats in estuarine, coastal marine, and continental shelf waters from the Gulf of Maine to Cape Hatteras, including mixed and high-salinity zones in the bays and

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
																	estuaries. Essential fish habitat for adult windowpane flounder is found on mud and sand substrates and extends from the intertidal zone to a maximum depth of 70 meters (NEFMC 2017).
Winter Flounder *Pseudopleuronectes americanus*	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**General habitat description:** This groundfish fish species inhabit deep waters in their range from coastal waters in the Strait of Belle Isle, Newfoundland, south to Georgia (Collette and Klein- MacPhee 2002) and are known to occur regularly in New Jersey waters. They prefer muddy, sandy, cobbled, gravely, or boulder substrates (Pereira et al. 1999). Adult females spawn on sandy bottom in shallow habitats. **Eggs/Larvae:** Subtidal estuarine and coastal benthic habitats in New Jersey inland bay systems. Essential habitats for winter flounder eggs include mud, muddy sand, sand, gravel, macroalgae, and SAV. Larvae hatch in nearshore waters and estuaries or are transported shoreward from offshore spawning sites where they metamorphose and settle to the bottom as juveniles. They are initially planktonic but become increasingly less buoyant and occupy the lower water column as they get older. **Juveniles:** Subtidal benthic habitats in coastal waters from eastern Maine to Delaware Bay and on the continental shelf in southern New England and the Mid-Atlantic region, and on Georges Bank, from the shoreline to a maximum depth of 90 meters, including the high-salinity zones of the bays and estuaries. Essential fish habitat for juvenile winter skates occurs on sand and gravel substrates, but they are also found on mud. (NEFMC 2017). **Adults:** Subtidal benthic habitats in coastal waters in the southwestern Gulf of Maine, in coastal and continental shelf waters in southern New England and the Mid-Atlantic region, and on Georges Bank, from the shoreline to a maximum depth of 80 meters, including the high-salinity zones of the bays and estuaries. Essential fish habitat for adult winter skates occurs on sand and gravel substrates, but they are also found on mud (NEFMC 2017).
Witch Flounder *Glyptocephalus cynoglossus*	X	X	X	-	X	X	X	-	-	X	-	-	X	X	X	-	**General habitat description:** This groundfish species range from the Gulf of Maine to Cape Hatteras, North Carolina (Cargnelli et al. 1999b), and tend to concentrate near the southwest portion of the Gulf of Maine (Collette and Klein-MacPhee 2002). Spawning occurs from May through September and peaks in July and August. **Eggs/Larvae:** Pelagic habitats on the continental shelf throughout the northeast region. Eggs are most often observed from March through October, whereas, larvae are most often observed from March through November, with peaks from May through July. **Juveniles:** : Subtidal benthic habitats between 50 and 400 meters in the Gulf of Maine and as deep as 1500 meters on the outer continental shelf and slope, with mud and muddy sand substrates (NEFMC 2017). **Adults:** Subtidal benthic habitats between 35 and 400 meters in the Gulf of Maine and as deep as 1500 meters on the outer continental shelf and slope, with mud and muddy sand substrates (NEFMC 2017).

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Yellowtail Flounder *Limanda ferruginea*	x	x	x	-	x	x	x	-	x	x	-	-	x	x	x	-	**General habitat description:** This groundfish species range along the Atlantic coast of North America from Newfoundland to the Chesapeake Bay, with the majority located on the western half of Georges Bank, the western Gulf of Maine, east of Cape Cod, and southern New England (Collette and Klein-MacPhee 2002). Present on Georges Bank from March to August. Spawning occurs in both inshore areas as well as offshore on Georges Bank in July. **Eggs/Larvae:** For these pelagic lifestages, EFH is subtidal benthic habitats between 15 and 1,312 feet (35 and 400 meters) depth in the Gulf of Maine, on Georges Bank, and the Mid-Atlantic region (for eggs) and coastal marine and continental shelf pelagic habitats in the Gulf of Maine, and from Georges Bank to Cape Hatteras, including the high-salinity zones of bays and estuaries (for larvae) (NEFMC 2017). **Juveniles:** Subtidal benthic habitats in coastal waters in the Gulf of Maine and on the continental shelf on Georges Bank and in the Mid-Atlantic including the high-salinity zones of the bays and estuaries. Essential fish habitat for juvenile yellowtail flounder occurs on sand and muddy sand between 20 and 80 meters. In the Mid-Atlantic, young-of-the-year juveniles settle to the bottom on the continental shelf, primarily at depths of 40-70 meters, on sandy substrates (NEFMC 2017). **Adults:** Subtidal benthic habitats in coastal waters in the Gulf of Maine and on the continental shelf on Georges Bank and in the Mid-Atlantic, including the high-salinity zones of the bays and estuaries listed in Table 25. Essential fish habitat for adult yellowtail flounder occurs on sand and sand with mud, shell hash, gravel, and rocks at depths between 25 and 90 meters (NEFMC 2017).
Other Finfish																	
American Plaice *Hippoglossoides platessoides*	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	**General habitat description:** American Plaice is an Arctic-boreal pleuronectid flatfish that is found in the Western Atlantic. They range from the outer coast of Labrador all the way south to Montauk Point, NY (Bigelow and Schroeder 1953; Smith et al. 1975). **Larvae:** American Plaice larvae are mostly found at temperatures ranging from 4-14 °C. Additionally, larvae were found at depths of 30-210 m, with most located between 50-90 m. (NOAA 2022).

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Atlantic Herring *Clupea harengus*	X	-	-	-	X	X	X	-	X	X	X	X	X	X	X	X	**General habitat description:** Atlantic herring is a schooling, pelagic, commercially important coastal species that ranges from northern Labrador, Canada to Cape Hatteras, North Carolina, in the western Atlantic and, depending on feeding, spawning, and wintering, migrates extensively north and south of their range. **Eggs:** Inshore and offshore benthic habitats in the Gulf of Maine and on Georges Bank and Nantucket Shoals in depths of 5 – 90 meters on coarse sand, pebbles, cobbles, and boulders and/or macroalgae at the locations shown in Map 98. Eggs adhere to the bottom, often in areas with strong bottom currents, forming egg “beds” that may be many layers deep (NEFMC 2017). **Larvae:** Inshore and offshore pelagic habitats in the Gulf of Maine, on Georges Bank, and in the upper Mid-Atlantic Bight, and in the bays and estuaries listed in Table 30. Atlantic herring have a very long larval stage, lasting 4-8 months, and are transported long distances to inshore and estuarine waters where they metamorphose into early stage juveniles (“brit”) in the spring (NEFMC 2017). **Juveniles/Adults:** Intertidal and subtidal pelagic habitats to 300 meters throughout the region, including the bays and estuaries. One and two-year old juveniles form large schools and make limited seasonal inshore-offshore migrations. Older juveniles are usually found in water temperatures of 3 to 15°C in the northern part of their range and as high as 22°C in the Mid-Atlantic. Young-of-the year juveniles can tolerate low salinities, but older juveniles avoid brackish water (NEFMC 2017).
Atlantic Wolffish *Anarhichas lupus*	X	-	-	-	X	-	-	-	X	-	-	-	X	-	-	-	**General habitat description:** The Atlantic wolffish is found on both sides of the North Atlantic and infrequently in the Arctic. In the northwestern Atlantic, they range from Davis Strait, Canada, to Cape Hatteras, North Carolina (Fisheries and Oceans Canada 2018a). Adult Atlantic wolffish generally move inshore to spawn during the spring and summer, establishing nesting sites on boulders and in rocky crevices, which are guarded by the males until the eggs hatch in late summer and early fall (Fisheries and Oceans Canada 2018a). **Eggs:** Eggs are deposited in subtidal benthic habitats at depths less than 328 ft (100 m). Egg masses have been collected on the Scotian Shelf in depths of 328 to 426 ft (100 to 130 m), indicating that spawning is not restricted to coastal waters. **Larvae:** EFH includes pelagic and subtidal benthic habitats. Atlantic wolffish larvae remain near the bottom for up to six days after hatching, but gradually become more buoyant as the yolk sac is absorbed. **Juveniles:** EFH includes subtidal benthic habitats at depths of 230 to 604 ft (70 to 184 m) and Juvenile Atlantic wolffish do not have strong substrate preferences. **Adults:** Adult Atlantic wolffish have been observed spawning and guarding eggs in rocky habitats in less than 98 ft (30 m) of water in the Gulf of St. Lawrence and Newfoundland and in deeper (164 to 328 ft [50 to 100 m]) boulder reef habitats in the Gulf of Maine. Adults are distributed over a wider variety of sand and gravel substrates once they leave rocky spawning habitats, but are not caught over muddy bottom.

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Monkfish *Lophius americanus*	X	X	-	-	X	X	X	-	X	X	X	-	X	X	X	-	**General habitat description:** Monkfish can be on the Mid-Atlantic OCS from the tideline down to 2,159 feet (658 meters) during summer and fall (Collette and Klein-MacPhee 2002). Monkfish are common and are found in abundance on Georges Bank. Monkfish prefer hard sand, pebbly bottom, gravel, and broken shells for their habitats (Collette and Klein-MacPhee 2002). **Eggs/Larvae:** Pelagic habitats in inshore areas, and on the continental shelf and slope throughout the Northeast region. Monkfish eggs are shed in very large buoyant mucoidal egg “veils.” Monkfish larvae are more abundant in the Mid-Atlantic region and occur over a wide depth range, from the surf zone to depths of 1000 to 1500 meters on the continental slope (NEFMC 2017). **Juveniles:** Subtidal benthic habitats in depths of 50 to 400 meters in the Mid-Atlantic, between 20 and 400 meters in the Gulf of Maine, and to a maximum depth of 1000 meters on the continental slope. A variety of habitats are essential for juvenile monkfish, including hard sand, pebbles, gravel, broken shells, and soft mud; they also seek shelter among rocks with attached algae. Juveniles collected on mud bottom next to rock-ledge and boulder fields in the western Gulf of Maine were in better condition than juveniles collected on isolated mud bottom, indicating that feeding conditions in these edge habitats are better. Young-of-the year juveniles have been collected primarily on the central portion of the shelf in the Mid-Atlantic, but also in shallow nearshore waters off eastern Long Island, up the Hudson Canyon shelf valley, and around the perimeter of Georges Bank. They have also been collected as deep as 900 meters on the continental slope (NEFMC 2017). **Adults:** Subtidal benthic habitats in depths of 50 to 400 meters in southern New England and Georges Bank, between 20 and 400 meters in the Gulf of Maine, and to a maximum depth of 1000 meters on the continental slope, as shown on Map 84. Essential fish habitat for adult monkfish is composed of hard sand, pebbles, gravel, broken shells, and soft mud. They seem to prefer soft sediments (fine sand and mud) over sand and gravel, and, like juveniles, utilize the edges of rocky areas for feeding (NEFMC 2017).
Atlantic Butterfish *Peprilus triacanthus*	X	X	X	-	X	X	X	-	X	X	-	-	X	X	X	-	**General habitat description:** The Atlantic butterfish is a pelagic, surface-dwelling fish that tends to form schools and ranges from the Gulf of St. Lawrence to Florida, (Bigelow and Schroeder 1953; Overholtz 2006). These finfish are found in the Mid-Atlantic shelf in the summer and autumn but migrate to the edge of the continental shelf where they aggregate in response to seasonal cooling of water temperatures (Grosslein and Azarovitz 1982). Preference for sandy benthic habitat and spawning occurs on the continental shelf and nearshore areas. **Eggs:** EFH is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to the south shore of Long Island, New York, in Chesapeake Bay, and on the continental shelf and slope, primarily from Georges Bank to Cape Hatteras, North Carolina. EFH for Atlantic butterfish eggs is generally found over bottom depths of 1,500 meters or less where average temperatures in the upper 200 meters of the water column are 6.5-21.5°C (MAFMC 2011). **Larvae:** EFH is pelagic habitats in inshore estuaries and embayments in Boston harbor, from the south shore of Cape Cod to the Hudson River, and in Delaware and Chesapeake bays, and on the continental shelf from the Great South Channel (western Georges Bank) to Cape Hatteras, North Carolina. EFH for Atlantic butterfish larvae is generally found over bottom depths between 41 and 350 meters where average temperatures in the upper 200 meters of the water column are 8.5-21.5°C (MAFMC 2011). **Juveniles:** EFH is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound, North Carolina, in inshore waters of the Gulf of Maine and the South Atlantic Bight, and on the inner and outer continental shelf from southern New England to South Carolina. EFH for juvenile Atlantic butterfish is generally found over bottom depths between 10 and 280 meters where bottom water temperatures are between 6.5 and 27°C and salinities are above 5 ppt. Juvenile butterfish feed mainly on planktonic prey (MAFMC 2011). **Adults:** EFH is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
																	Sound, North Carolina, inshore waters of the Gulf of Maine and the South Atlantic Bight, on Georges Bank, on the inner continental shelf south of Delaware Bay, and on the outer continental shelf from southern New England to South Carolina. EFH for adult Atlantic butterfish is generally found over bottom depths between 10 and 250 meters where bottom water temperatures are between 4.5 and 27.5°C and salinities are above 5 ppt. Spawning probably does not occur at temperatures below 15°C. Adult butterfish feed mainly on planktonic prey, including squids and fishes (MAFMC 2011).
Atlantic Mackerel *Scomber scombrus*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**General habitat description:** Atlantic mackerel ranges from the Gulf of St. Lawrence to Cape Lookout, North Carolina (MAFMC 2011), tending to congregate in open waters toward the surface and in nearshore environments. These finfish spawn in in deeper waters off the coast (between Cape Hatteras to the Gulf of St. Lawrence) in early summer and continue spawning until the water temperature reaches 46.4°F (8 °C). **Eggs:** EFH is pelagic habitats in inshore estuaries and embayments from Great Bay, New Hampshire to the south shore of Long Island, New York, inshore and offshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina (mostly north of 38°N). EFH for Atlantic mackerel eggs is generally found over bottom depths of 100 meters or less with average water temperatures of 6.5-12.5°C in the upper 15 meters of the water column (MAFMC 2011). **Larvae:** EFH is pelagic habitats in inshore estuaries and embayments from Great Bay, New Hampshire to the south shore of Long Island, New York, inshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina (mostly north of 38°N). EFH for Atlantic mackerel larvae is generally found over bottom depths between 21 and 100 meters with average water temperatures of 5.5-11.5°C in the upper 200 meters of the water column (MAFMC 2011). **Juveniles:** EFH is pelagic habitats in inshore estuaries and embayments from Passamaquoddy Bay and Penobscot Bay, Maine to the Hudson River, in the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina. EFH for juvenile Atlantic mackerel is generally found over bottom depths between 10 and 110 meters and in water temperatures of 5 to 20°C. Juvenile Atlantic mackerel feed primarily on small crustaceans, larval fish, and other pelagic organisms (MAFMC 2011). **Adults:** EFH is pelagic habitats in inshore estuaries and embayments from Passamaquoddy Bay, Maine to the Hudson River, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina. EFH for adult Atlantic mackerel is generally found over bottom depths less than 170 meters and in water temperatures of 5 to 20°C. Spawning occurs at temperatures above 7°C, with a peak between 9 and 14°C. Adult Atlantic mackerel are opportunistic predators feeding primarily on a wider range and larger individuals of pelagic crustaceans than juveniles, but also on fish and squid (MAFMC 2011).

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Black Sea Bass *Centropristis striata*	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	**General habitat description:** This demersal finfish species is found in the western Atlantic, ranging from southern Nova Scotia to Florida (Drohan et al. 2007), within a depth range from the tide line down to 420 feet (128 meters). Prefers structured habitats such as reefs, shipwrecks, and lobster pots along the continental shelf (Steimle et al. 1999a). Adults spawn from the middle of May until the end of June in New Jersey, New York, and southern New England waters (Collette and Klein- MacPhee 2002). **Juveniles:** Offshore, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90 percent of all the ranked squares of the area where juvenile black sea bass are collected in the NEFSC trawl survey. Inshore, EFH is the estuaries where black sea bass are identified as being common, abundant, or highly abundant in the ELMR database for the mixing" and "seawater" salinity zones. Juveniles are found in the estuaries in the summer and spring. Generally, juvenile black sea bass are found in waters warmer than 43°F with salinities greater than 18 ppt and coastal areas between Virginia and Massachusetts, but winter offshore from New Jersey and south. Juvenile black sea bass are usually found in association with rough bottom, shellfish and eelgrass beds, man-made structures in sandy-shelly areas; offshore clam beds and shell patches may also be used during the wintering (MAFMC 1998). **Adults:** Offshore, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90 percent of all the ranked ten-minute squares of the area where adult black sea bass are collected in the NEFSC trawl survey. Inshore, EFH is the estuaries where adult black sea bass were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and seawater" salinity zones. Black sea bass are generally found in estuaries from May through October. Wintering adults (November through April) are generally offshore, south of New York to North Carolina. Temperatures above 43°F seem to be the minimum requirements. Structured habitats (natural and man-made), sand and shell are usually the substrate preference (MAFMC 1998).
Bluefish *Pomatomus saltatrix*	X	X	-	-	X	X	-	-	-	X	X	X	X	X	X	X	**General habitat description:** Bluefish range from Nova Scotia to Bermuda and seasonally migrate to the Mid-Atlantic Bight during the spring (Fahay et al. 1999), returning to deeper offshore water of southeastern Florida in November (Grosslein and Azarovitz 1982; Stone et al. 1994). **Eggs/Larvae:** Eggs are found in mid-shelf waters ranging from 98 to 230 feet (30 to 70 meters) in southern New England to Cape Hatteras, in temperatures ranging from 64.4°F to 71.6°F (18°C to 22°C), with salinities greater than 31 ppt (Hardy 1978; Fahay et al. 1999). Eggs are not found in estuarine waters. Larvae are found in oceanic waters in temperatures of 18°C, with salinities of greater than 30 ppt (Able and Fahay 1998; Shepherd and Packer 2006). Larvae are transported across the shelf to estuarine nurseries via active migration presumably facilitated by oceanographic features or Eckman transport, which is critical for recruitment success. Bluefish larvae consume primarily copepods (Shepherd and Packer 2006). **Juveniles/Adults:** Juveniles inhabit pelagic, nearshore areas and estuaries in temperatures between 66.2°F and 75.2°F (19°C and 24°C), with salinities that range from 23 to 36 ppt (Shepherd and Packer 2006). Juveniles are found in the inland waters of New Jersey from May through November, with peak abundances observed from June through October (Stone et al. 1994). Adults are found in oceanic, nearshore, and continental shelf waters and prefer temperatures above 14- 16°C and salinities above 25 ppt (Fahay et al. 1999). Adults are observed in the inland bays of New Jersey from May through October and are not associated with a specific substrate (Stone et al. 1994). The species migrates extensively and is distributed based on season and size of the individuals within the schools (Shepherd and Packer 2006). There are two predominant spawning areas on the east coast: one during the spring that is located offshore from southern Florida to North Carolina and the other during summer in the Mid-Atlantic Bight (Wilk 1982). Juveniles prey on locally abundant macroinvertebrates and fish, whereas, adults prey on schooling species.

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Scup *Stenotomus chrysops*	-	-	-	-	-	-	-	-	x	x	x	x	x	x	x	x	**General habitat description:** This demersal finfish range from the Gulf of Maine to North Carolina. Scup are known to congregate in nearshore areas of New England from early April to December, at depths between 269 and 420 feet (82 and 128 meters) (Collette and Klein-MacPhee 2002). Scup are an important food species for other commercially important species (Collette and Klein-MacPhee 2002). Preference for smooth to rocky bottom habitats and these fish usually form schools around such bottoms. Spawning occurs nearshore and in relatively shallow waters over sandy bottom between May and August (Steimle et al. 1999b). **Juveniles:** Offshore, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ, from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90 percent of all the ranked ten-minute squares of the area where juvenile scup are collected in the NEFSC trawl survey. Inshore, EFH is the estuaries where scup are identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. In general, juvenile scup are found during the summer and spring in estuaries and bays between Virginia and Massachusetts, in association with various sands, mud, mussel and eelgrass bed type substrates and in water temperatures greater than 45 °F and salinities greater than 15 ppt (MAFMC 1998). **Adults:** Offshore, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90 percent of all the ranked ten-minute squares of the area where adult scup are collected in the NEFSC trawl survey. Inshore, EFH is the estuaries where scup were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing and "seawater" salinity zones. Generally, wintering adults (November through April) are usually offshore, south of New York to North Carolina, in waters above 45 °F (MAFMC 1998).
Highly Migratory Species																	
Albacore Tuna *Thunnus alalunga*	-	-	-	-	-	-	-	-	x	x	x	-	x	x	-	-	**General habitat description:** Pelagic species with a wide range, north to Newfoundland and south to the Gulf of Mexico, and east from the western Atlantic west to the Mediterranean (NOAA 2009). Spawn in the spring and summer in the western tropical areas of the Atlantic, and they move northward to the central and northern portions of the Atlantic as wintering areas. EFH includes offshore pelagic regions of the Atlantic Ocean from north of Cape Hatteras, North Carolina, to Cape Cod. **Juveniles:** Offshore, pelagic habitats of the Atlantic Ocean from the outer edge of the U.S. EEZ through Georges Bank to pelagic habitats south of Cape Cod, and from Cape Cod to Cape Hatteras, North Carolina. EFH also includes offshore pelagic habitats near the outer U.S. EEZ between North Carolina and Florida, and offshore pelagic habitats associated with the Blake Plateau. EFH also includes offshore pelagic habitats in the western and central Gulf of Mexico (NOAA 2017). **Adults:** Offshore, pelagic habitats of the Atlantic Ocean from the outer edge of the U.S. EEZ through Georges Bank to pelagic habitats south of Cape Cod, and from Cape Cod to Cape Hatteras, North Carolina. EFH also includes offshore pelagic habitats near the outer U.S. EEZ between North Carolina and Florida, and offshore pelagic habitats associated with the Blake Plateau. EFH also includes offshore pelagic habitats in the western and central Gulf of Mexico (NOAA 2017).

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Bluefin Tuna *Thunnus thynnus*	-	-	-	-	-	-	-	-	X	X	X	-	X	X	-	-	**General habitat description:** Bluefin tuna range from Labrador south to the Gulf of Mexico (NOAA 2009) and inhabit open ocean environments with variable temperature and salinity levels. They migrate north from the Gulf of Mexico spawning ground in the spring to New England and Canada through the summer and beginning of fall. In June they can be found off the coast of New Jersey, Long Island, and southern New England (Collette and Klein-MacPhee 2002). These fish are found at depths ranging from near the surface to 300 feet (91 meters) deep. Bluefin tuna is considered overfished but remains an important commercial and recreational target species (NOAA 2009). **Juveniles:** Coastal and pelagic habitats of the Mid-Atlantic Bight and the Gulf of Maine, between southern Maine and Cape Lookout, 110 from shore (excluding Long Island Sound, Delaware Bay, Chesapeake Bay, and Pamlico Sound) to the continental shelf break. EFH in coastal areas of Cape Cod are located between the Great South Passage and shore. EFH follows the continental shelf from the outer extent of the U.S. EEZ on Georges Bank to Cape Lookout. EFH is associated with certain environmental conditions in the Gulf of Maine (16 to 19 °C; 0 to 40 m deep). EFH in other locations associated with temperatures ranging from 4 to 26 °C, often in depths of less than 20 m (but can be found in waters that are 40-100 m in depth in winter) (NOAA 2017). **Adults:** EFH is located in offshore and coastal regions of the Gulf of Maine the mid-coast of Maine to Massachusetts; on Georges Bank; offshore pelagic habitats of southern New England; from southern New England to coastal areas between the mouth of Chesapeake Bay and Onslow Bay, North Carolina; from coastal North Carolina south to the outer extent of the U.S. EEZ, inclusive of pelagic habitats of the Blake Plateau, Charleston Bump, and Blake Ridge. EFH also consists of pelagic waters of the central Gulf of Mexico from the continental shelf break to the seaward extent of the U.S. EEZ between Apalachicola, Florida and Texas (NOAA 2017).
Skipjack Tuna *Katsuwonus pelamis*	-	-	-	-	-	-	-	-	X	X	X	-	X	X	X	-	**General habitat description:** Global, pelagic species that has a range from Newfoundland to Brazil (NOAA 2009). They spawn opportunistically in warm waters near the equator from spring to fall, with most spawning occurring in the summer. Although, this species is commercially and recreationally important, the overfishing status of this tuna is unknown. Designated EFH for spawning, eggs, and larvae is restricted to the Gulf of Mexico and Atlantic waters off the coast of Florida. **Juveniles:** Offshore pelagic habitats are located seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank; coastal and offshore habitats between Massachusetts and South Carolina; localized in areas off Georgia and South Carolina; and from the Blake Plateau through the Florida Straits. Juveniles are also found in offshore waters in the central Gulf of Mexico from Texas through the Florida panhandle. In all areas juveniles are found if water is greater than 65.6 feet (20 meters) (NOAA 2017). **Adults:** Coastal and offshore pelagic habitats between Massachusetts and Cape Lookout, North Carolina and localized areas are in the Atlantic off South Carolina and Georgia, and the northeast coast of Florida. EFH in the Atlantic Ocean also is located on the Blake Plateau and in the Florida Straits through the Florida Keys. EFH also includes areas in the central Gulf of Mexico, offshore in pelagic habitats seaward of the southeastern edge of the West Florida Shelf to Texas (NOAA 2017).

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Yellowfin Tuna *Thunnus albacares*	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	-	**General habitat description:** Global species with a wide range from the central region of the Gulf of Mexico from Florida to Southern Texas and from the mid-east coast of Florida and Georgia to Cape Cod. They are also located south of Puerto Rico. Yellowfin tuna travel in schools and prefer the water surface in open ocean. Spawning occurs throughout the year between 15°N and 15°S latitude and in the Gulf of Mexico and the Caribbean in May through November and are believed to spawn serially. **Juveniles:** Offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank and Cape Cod, Massachusetts. Offshore and coastal habitats from Cape Cod to the mid-east coast of Florida and the Blake Plateau. Locally distributed in the Florida Straits and off the southwestern edge of the West Florida Shelf. In the central Gulf of Mexico from Florida panhandle to southern Texas. Localized EFH southeast of Puerto Rico (NOAA 2017). **Adults:** Offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank and Cape Cod, Massachusetts. Offshore and coastal habitats from Cape Cod to North Carolina, and offshore pelagic habitats of the Blake Plateau. EFH in the Gulf of Mexico spans throughout much of the offshore pelagic habitat from the West Florida Shelf to the continental shelf off southern Texas (NOAA 2017).
Invertebrates																	
Atlantic Sea Scallop *Placopecten magellanicus*	X	X	X	-	X	X	X	-	X	X	X	-	X	X	X	-	**General habitat description:** The Atlantic sea scallop occurs along the continental shelf at depths ranging from 59 to 360.9 feet (18 to 110 meters) and is generally found in seabed areas with coast substrates consisting of gravel, shells, and rocks (Packer et al. 1999b). They spawn in September and rely on the currents to spread eggs and larvae in different areas. They often occur in aggregations called beds which may be sporadic or essentially permanent, depending on how suitable the habitat conditions are (temperature, food availability, and substrate) and whether oceanographic features (fronts, currents) keep larval stages near to the spawning population. **Eggs:** Benthic habitats in inshore areas and on the continental shelf in the vicinity of adult scallops. Demersal eggs remain on the seafloor until they develop into the first free-swimming larval stage. **Larvae:** Benthic (demersal) and water column (pelagic) habitats in inshore and offshore areas throughout the greater Atlantic region south to Cape Hatteras. Any hard surface can provide an essential habitat for settling pelagic larvae ("spat"), including shells, pebbles, gravel, and macroalgae and other benthic organisms. Spat have greatest survival rates when they attach to sedentary branching organisms or any hard surface substrate (NOAA EFH Mapper 2022). Spat that settle on shifting sand do not survive. In laboratory studies, maximum survival of juvenile scallops occurred between 1.2°C and 15°C and above salinities of 25 ppt. **Juveniles/Adults:** Demersal benthic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic in depths of 59 to 360.9 feet (18 to 110 meters) for adults and older juveniles. Younger juveniles (0.2- to 0.5-inch [5- to 12-mm] shell height) leave the original substrate on which they settle (see spat, above) and attach themselves by byssal threads to shells, gravel, and small rocks (pebble, cobble), preferring gravel. Juvenile scallops are relatively active and swim to escape predation when they can be carried long distances by currents. Age 1 juveniles on Georges Bank are less dispersed than older juveniles and typically associate with gravel-pebble deposits (NEFMC 2017). Essential habitats for older juvenile and adult sea scallops are found on sand and gravel substrates in depths of 18 to 110 meters, but they are also found in shallower water and as deep as 180 meters in the Gulf of Maine. In the Mid-Atlantic they are found primarily between 45 and 75 meters and on Georges Bank they are more abundant between 60 and 90 meters. They often occur in aggregations called beds which may be sporadic or essentially permanent, depending on how suitable the habitat conditions are (temperature, food availability, and substrate) and whether oceanographic features (fronts, currents) keep larval stages in the vicinity of the spawning population. Bottom currents stronger than 25 cm/sec

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
																	(half a knot) inhibit feeding. Growth of adult scallops is optimal between 10 and 15°C and they prefer full strength seawater (NEFMC 2017).
Atlantic Surfclam *Spisula solidissima*	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-	**General habitat description:** The Atlantic surfclam occupies areas along the continental shelf from southern portions of the Gulf of St. Lawrence to Cape Hatteras, North Carolina (Cargnelli et al. 1999c). Preference for sandy habitats and spawns in the summer and early fall. **Juveniles and Adults:** Inhabits demersal benthic habitat throughout the substrate, to a depth of 3.3 feet (1 meter) below the water/sediment interface, within federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ. Generally occur from the beach zone to a depth of about 200 feet (61 meters), but beyond about 125 feet (38 meters), abundance is low.
Ocean Quahog *Arctica islandica*	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	-	**General habitat description:** The ocean quahog is a bivalve mollusk that is slow to mature and is found in a range from Newfoundland to Cape Hatteras distributed along the continental shelf (Cargnelli et al. 1999d). The highest concentrations of quahogs are offshore south of Nantucket to the Delmarva Peninsula. The quahog prefers medium to fine sandy bottom with mud and silt. Spawning occurs from spring to fall with multiple annual spawning events (Cargnelli et al. 1999d). **Juveniles and Adults:** Throughout the substrate, to a depth of three feet below the water/sediment interface, within federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90 percent of all the ranked ten-minute squares for the area where ocean quahogs were caught in the NEFSC surfclam and ocean quahog dredge surveys. Distribution in the western Atlantic ranges in depths from 30 feet to about 800 feet. Ocean quahogs are rarely found where bottom water temperatures exceed 60 °F, and occur progressively further offshore between Cape Cod and Cape Hatteras (MAFMC 1998).

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Longfin Inshore Squid *Doryteuthis pealeii*	-	X	X	X	-	-	-	-	X	X	X	X	X	X	-	-	**General habitat description:** Pelagic, schooling species that has a general range from Newfoundland to the Gulf of Venezuela but is abundant enough to be considered commercially important from Georges Bank to Cape Hatteras (Cargnelli et al. 1999e). Typically found in waters that have a temperature of at least 48.2°F (9°C); therefore, they move with a pattern of seasonal migrations. They move offshore in late fall and overwinter along the edge of the continental shelf; they move both inshore and north as the water temperatures raise with the seasons. Most eggs are spawned in May and hatch in July, although there are two broods, an early spring and late summer (Cargnelli et al. 1999e). **Eggs:** EFH for Doryteuthis pealeii eggs occurs in inshore and offshore bottom habitats from Georges Bank southward to Cape Hatteras, generally where bottom water temperatures are between 10°C and 23°C, salinities are between 30 and 32 ppt, and depth is less than 50 meters. Doryteuthis pealeii eggs have also been collected in bottom trawls in deeper water at various places on the continental shelf. Like most loliginid squids, D. pealeii egg masses or "mops" are demersal and anchored to the substrates on which they are laid, which include a variety of hard bottom types (e.g., shells, lobster pots, piers, fish traps, boulders, and rocks), submerged aquatic vegetation (e.g., *Fucus sp*.), sand, and mud (MAFMC 2011). **Juveniles (Recruits):** EFH is pelagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, in the southwestern Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, and Raritan Bay. EFH for recruit longfin inshore squid is generally found over bottom depths between 6 and 160 meters where bottom water temperatures are 8.5-24.5°C and salinities are 28.5-36.5 ppt. Prerecruits migrate offshore in the fall where they overwinter in deeper waters along the edge of the shelf. They make daily vertical migrations, moving up in the water column at night and down in the daytime. Small immature individuals feed on planktonic organisms while larger individuals feed on crustaceans and small fish (MAFMC 2011). **Juveniles (Recruits):** EFH is pelagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, in inshore waters of the Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, Raritan Bay, and Delaware Bay. EFH for recruit longfin inshore squid is generally found over bottom depths between 6 and 200 meters where bottom water temperatures are 8.5-14°C and salinities are 24-36.5 ppt. Recruits inhabit the continental shelf and upper continental slope to depths of 400 meters. They migrate offshore in the fall and overwinter in warmer waters along the edge of the shelf. Like the prerecruits, they make daily vertical migrations. Individuals larger than 12 cm feed on fish and those larger than 16 cm feed on fish and squid. Females deposit eggs in gelatinous capsules which are attached in clusters to rocks, boulders, and aquatic vegetation and on sand or mud bottom, generally in depths less than 50 meters (MAFMC 2011).
Northern Shortfin Squid *Illex illecebrosus*	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	**General habitat description:** Highly migratory species distributed in the northwest Atlantic Ocean between the Sea of Labrador and the Florida Straits. Its range is from Newfoundland to Cape Hatteras, North Carolina (Hendrickson and Holmes 2004). **Adult:** Adult Northern Shortfin Squid have been observed at temperatures ranging from -0.5 to 27.3 °C, salinities of 30 to 36.5 ppt and depths from the surface to as great as 1000 m. During the winter, adults migrate to offshore habitats (NOAA 2022).
Skates																	
Barndoor Skate *Dipturis laevis*	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	-	**General habitat description:** Demersal species that ranges from Newfoundland, the Gulf of St. Lawrence, off Nova Scotia, the Gulf of Maine and the northern sections of the Mid-Atlantic Bight down to North Carolina. Some populations move inshore to shallow waters during spring and autumn seasons (NOAA 2022). **Juvenile:** Juvenile barndoor skate have mostly been observed at Georges bank, Gulf of Maine, southern New England, and Mid-Atlantic Bight down to the Hudson Canyon. Juveniles were observed in depths of 41-400 m and in temperatures from 3-18 °C (NOAA 2022).

Common Name/ Scientific Name	EFH Habitat within Project Area																EFH Description
	EGG				LARVAE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
																	Adults: Adult barndoor skate have been observed in the Gulf of Maine, Georges Bank, in southern New England and in the Mid-Atlantic Bight down to the Hudson Canyon. Lower abundance of adults was observed in the summer, as adults move into inshore waters (NOAA 2022).
Little Skate *Leucoraja erinacea*	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	**General habitat description:** Demersal species that has a range from Nova Scotia to Cape Hatteras and is highly concentrated in the Mid-Atlantic Bight and on Georges Bank. Found year-round on Georges Bank and tolerates a wide range of temperatures (Packer et al. 2003a). Prefers sandy or pebbly bottom but can also be found on mud and ledges (Collette and Klein-MacPhee 2002). **Juveniles/Adults:** Intertidal and subtidal benthic habitats in coastal waters of the Gulf of Maine and in the Mid-Atlantic region as far south as Delaware Bay, and on Georges Bank, extending to a maximum depth of 80 meters, as shown on Map 90, and including high-salinity zones in the bays and estuaries. Essential fish habitat for juvenile little skates occurs on sand and gravel substrates, but they are also found on mud (NEFMC 2017). Intertidal and subtidal benthic habitats in coastal waters of the Gulf of Maine and in the Mid-Atlantic region as far south as Delaware Bay, and on Georges Bank, extending to a maximum depth of 100 meters, and including high-salinity zones in the bays and estuaries listed in Table 28. Essential fish habitat for adult little skates occurs on sand and gravel substrates, but they are also found on mud (NEFMC 2017).
Winter Skate *Leucoraja ocellata*	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	**General habitat description:** Demersal species that has a range from the southern coast of Newfoundland to Cape Hatteras and has concentrated populations on Georges Bank and the northern section of the Mid-Atlantic Bight (Packer et al. 2003b). The winter skate has very similar temperature ranges and migration patterns as the little skate. **Juveniles:** Subtidal benthic habitats in coastal waters from eastern Maine to Delaware Bay and on the continental shelf in southern New England and the Mid-Atlantic region, and on Georges Bank, from the shoreline to a maximum depth of 295.3 feet (90 meters), including the high-salinity zones of selected bays and estuaries. EFH for juvenile winter skates occurs on sand and gravel substrates, but also mud, where they are found. **Adults:** Subtidal benthic habitats in coastal waters in the southwestern Gulf of Maine, in coastal and continental shelf waters in southern New England and the Mid-Atlantic region, and on Georges Bank, from the shoreline to a maximum depth of 262.5 feet (80 meters), including the high-salinity zones of selected bays and estuaries. EFH for adult winter skates occurs on sand and gravel substrates, but also mud, where they are found.

Table 4-2. Designated EFH Based on Shark Species and Life Stage Within the Sunrise Wind Project Area

Common Name/ Scientific Name	EFH Habitat within Project Area												EFH Description
	NEONATE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Sharks													
Basking Shark *Cetorhinus maximus*	X	X	-	-	X	X	-	-	X	X	-	-	**General habitat description:** In the northwestern and eastern Atlantic, basking sharks occur in coastal regions from April to October, usually with a peak in sightings from May until August (Kenney et al. 1985; Southall et al. 2005; Witt et al. 2012). The temporal and spatial distribution of basking sharks in both the northwestern and eastern Atlantic are thought to be influenced by seasonal water stratifications, temperature, and prey abundance (Owen 1984; Sims and Merrett 1997; Sims and Quayle 1998; Sims 1999; Sims et al. 2003; Skomal et al. 2004; Cotton et al. 2005; Witt et al. 2012). Basking sharks are filter-feeders and are known to migrate from the Northern to the Southern Hemisphere (Skomal et al. 2009). **Neonates, Juveniles, and Adults:** Insufficient data is available to differentiate EFH between size classes; therefore, EFH designations for all life stages have been combined and are considered the same. EFH for basking shark includes the Atlantic east coast from the Gulf of Maine to the northern Outer Banks of North Carolina, following the mid-South Carolina to coastal areas of northeast Florida (NMFS 2017). Aggregations of basking sharks have been observed south and southeast of Long Island, east of Cape Cod, and along the coast of Maine. Aggregations have been associated with persistent thermal fronts within areas of high prey density (NMFS 2017). These aggregations tend to be associated with persistent thermal fronts within areas of high prey density (NOAA 2017).
Blue Shark *Prionace glauca*	X	X	-	-	X	X	-	-	X	X	-	-	**General habitat description:** The blue shark is a pelagic, highly migratory species, occurring in temperate and tropical inshore and offshore waters, and ranging from Newfoundland and the Gulf of St. Lawrence south to Argentina (DFO 2018). Prefers deep, clear waters with temperatures ranging from 50°F to 68°F (10°C to 20°C) (Castro 1983). **Neonates:** EFH is in the Atlantic in areas offshore of Cape Cod through New Jersey, seaward of the 98.4-foot (30-meter) bathymetric line (and excluding inshore waters such as Long Island Sound). EFH follows the continental shelf south of Georges Bank to the outer extent of the U.S. EEZ in the Gulf of Maine (NOAA 2017). **Juveniles and Adults:** EFH is localized areas in the Atlantic Ocean in the Gulf of Maine, from Georges Bank to North Carolina, South Carolina, Georgia, and Florida (NOAA 2017).
Common Thresher Shark *Alopias vulpinus*	X	X	X	-	X	X	X	-	X	X	X	-	**General habitat description:** The common thresher shark is found in both coastal and oceanic and cool and warm waters (Natanson and Gervelis 2013) and has a range from the south Atlantic to the Gulf of Maine. Females give birth to young once a year in the spring. **Neonates, Juveniles, and Adults:** EFH is located in the Atlantic Ocean, from Georges Bank (at the offshore extent of the U.S. EEZ boundary) to Cape Lookout, North Carolina; and from Maine to locations offshore of Cape Ann, Massachusetts. EFH occurs with certain habitat associations in nearshore waters of North Carolina, especially in areas with temperatures from 64.8°F to 69.6°F (18.2°C to 20.9°C) and at depths from 15.1 to 44.5 feet (4.6 to 13.7 meters) (McCandless et al. 2002).

Common Name/ Scientific Name	EFH Habitat within Project Area												EFH Description
	NEONATE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Dusky Shark *Carcharhinus obscurus*	X	X	X	-	X	X	X	-	X	X	X	-	**General habitat description:** The dusky shark has a range among warm and temperate coastal waters in the Atlantic, Pacific, and Indian oceans (McCandless et al. 2014). Prefers both inshore waters and deeper waters along the continental shelf edge and often uses coastal waters as nurseries. The shark species gives birth in the Chesapeake Bay in Maryland in June and July (NOAA 2009). **Neonates:** EFH in the Atlantic Ocean includes offshore areas of southern New England to Cape Lookout, North Carolina. Specifically, EFH is associated with habitat conditions including temperatures from 18.1 to 22.2 °C, salinities of 25 to 35 ppt and depths at 4.3 to 15.5 m. Seaward extent of EFH for this life stage in the Atlantic is 60 m in depth (NOAA 2017). **Juveniles / Adults:** Coastal and pelagic waters inshore of the continental shelf break (< 200 meters in depth) along the Atlantic east coast from habitats offshore of southern Cape Cod to Georgia, including the Charleston Bump and adjacent pelagic habitats. Inshore extent for these life stages is the 20 meter bathymetric line, except in habitats of southern New England, where EFH is extended seaward of Martha's Vineyard, Block Island, and Long Island. Pelagic habitats of southern Georges Bank and the adjacent continental shelf break from Nantucket Shoals and the Great South Channel to the eastern boundary of the United States EEZ. Adults are generally found deeper (to 2000 meters) than juveniles, however there is overlap in the habitats utilized by both life stages. Offshore waters of the western and north Gulf of Mexico, at and seaward of the continental shelf break (a buffer is included ~10 nautical miles north of the 200 meter bathymetric line), and in proximity to numerous banks along the continental shelf edge (e.g., Ewing and Sackett Bank). The continental shelf edge habitat from Desoto Canyon west to the Mexican border is important habitat for adult dusky sharks (NOAA 2017).
Porbeagle Shark *Lamna nasus*	X	X	-	-	X	X	-	-	X	X	-	-	**General habitat description:** The porbeagle shark is a lamnid shark common in deep, cold temperate waters of the North Atlantic, South Atlantic, and South Pacific Oceans (NOAA Fisheries 2017). **Neonate / Juvenile / Adult:** At this time, available information is insufficient for the identification of EFH by life stage, therefore all life stages are combined in the EFH designation. EFH in the Atlantic Ocean includes offshore and coastal waters of the Gulf of Maine (not including Cape Cod Bay and Massachusetts Bay) and offshore waters of the Mid-Atlantic Bight from Georges Bank to New Jersey. EFH for all life stages of porbeagle shark has been identified in the SRWF and SRWEC-OCS

Common Name/ Scientific Name	EFH Habitat within Project Area												EFH Description
	NEONATE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Sandbar Shark *Carcharhinus plumbeus*	-	X	X	-	X	X	X	X	X	X	X	X	**General habitat description:** The sandbar shark ranges within subtropical and warm-temperate waters with the North Atlantic population ranging from Cape Cod to the western Gulf of Mexico. Prefers bottom habitats and is most common in 65.6 to 180.4 feet (20 to 55 meters) of water, but occasionally found at depths of about 656.2 feet (200 meters). In the United States, sandbar shark nursery areas consist of shallow coastal waters from Cape Canaveral, Florida, to Martha's Vineyard, Massachusetts. **Neonates:** Atlantic coastal areas from Long Island, New York to Cape Lookout, North Carolina, and from Charleston, South Carolina to Amelia Island, Florida. Important neonate/young-of-the-year (YOY) EFH includes: Delaware Bay (Delaware and New Jersey) and Chesapeake Bay (Virginia and Maryland), where the nursery habitat is limited to the southeastern portion of the estuaries (salinity is greater than 20.5 ppt and depth is greater than 5.5 m); Great Bay, New Jersey; and the waters off Cape Hatteras, North Carolina. In all nursery areas between New York and North Carolina, unless otherwise noted, EFH is associated with water temperatures that range from 15 to 30 °C; salinities that vary from 15 to 35 ppt; water depths that range from 0.8 to 23 m; and sand, mud, shell, and rocky sediments/benthic habitat. 170 EFH in the Gulf of Mexico includes localized coastal areas on the Florida panhandle (Indian Pass and St. Andrew Sound, Florida) in water temperatures from 20 to 31 °C at salinities from 19 to 39 ppt and depths of 2.1 to 5.2 m in silt/clay habitats (NOAA 2017). **Juveniles:** EFH includes coastal portions of the Atlantic Ocean between southern New England (Nantucket Sound, Massachusetts) and Georgia in water temperatures ranging from 20 to 24 °C and depths from 2.4 to 6.4 m. Important nurseries include Delaware Bay, Delaware and New Jersey; Chesapeake Bay, Virginia; Great Bay, New Jersey; and the waters off Cape Hatteras, North Carolina. For all EFH, water temperatures range from 15 to 30 °C, salinities range from 15 to 35 ppt, water depth ranges from 0.8 to 23 m, and substrate includes sand, mud, shell, and rocky habitats. EFH in the Gulf of Mexico includes localized areas off Apalachicola Bay, Florida (NOAA 2017). **Adults:** EFH in the Atlantic Ocean includes coastal areas from southern New England to the Florida Keys, ranging from inland waters of Delaware Bay and the mouth of Chesapeake Bay to the continental shelf break. EFH in the Gulf of Mexico includes coastal areas between the Florida Keys and Anclote Key, Florida; areas offshore of the Big Bend region; coastal areas of the Florida panhandle and Gulf coast between Apalachicola and the Mississippi River; and habitats surrounding the continental shelf between Louisiana and south Texas. Adults commonly use habitats in the West Florida Shelf, off Cape San Blas, and cool, deep, clear water offshore of Texas and Louisiana (NOAA 2017).

Common Name/ Scientific Name	EFH Habitat within Project Area												EFH Description
	NEONATE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Sand Tiger Shark *Carcharias taurus*	X	X	X	X	X	X	X	X	-	-	-	-	**General habitat description:** Sand tiger shark are a large, coastal species found in tropical and warm-temperate waters around the world, often in very shallow water (13 ft [4 m]) (NOAA Fisheries 2017). In the northwestern Atlantic, mature sand tiger shark males and juveniles are found between Cape Cod and Cape Hatteras, and mature and pregnant females are found between Cape Hatteras and Florida (NOAA Fisheries 2017). **Neonate / Juveniles:** Neonate EFH ranges from Massachusetts to Florida, specifically the PKD bay system, Sandy Hook, and Narragansett Bays as well as coastal sounds, lower Chesapeake Bay, Delaware Bay (and adjacent coastal areas), Raleigh Bay and habitats surrounding Cape Hatteras. Juveniles EFH includes habitats between Massachusetts and New York (notably the PKD bay system), and between mid-New Jersey 253 and the mid-east coast of Florida. EFH can be described via known habitat associations in the lower Chesapeake Bay and Delaware Bay (and adjacent coastal areas) where temperatures range from 19 to 25 °C, salinities range from 23 to 30 ppt at depths of 2.8-7.0 m in sand and mud areas, and in coastal North Carolina habitats with temperatures from 19 to 27 °C, salinities from 30 to 31 ppt, depths of 8.2-13.7 m, in rocky and mud substrate or in areas surrounding Cape Lookout that contain benthic structure (NOAA 2017). **Adults:** In the Atlantic along the mid-east coast of Florida (Cape Canaveral) through Delaware Bay. Important habitats include lower Chesapeake Bay and Delaware Bay (and adjacent coastal areas) where sand tiger sharks spend 95 percent of their time in waters between 17 and 23 °C. EFH is restricted off the coast of Florida to habitats that are less than 200 meters in depth (NOAA 2017).
Shortfin Mako Shark *Isurus oxyrinchus*	X	X	-	-	X	X	-	-	X	X	-	-	**General habitat description:** Oceanic species found in warm and warm-temperate waters throughout all oceans. It feeds on fast- moving fishes such as swordfish, tuna, and other sharks (Castro 1983), as well as clupeids, needlefishes, crustaceans, and cephalopods (Maia et al. 2007). MacNeil et al. (2005) found evidence of a dietary shift from cephalopods to bluefish in the spring. **Neonates, Juveniles, and Adults:** EFH in the Atlantic Ocean includes pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank (off Massachusetts) to Cape Cod (seaward of the 200m bathymetric line); coastal and offshore habitats between Cape Cod and Cape Lookout, North Carolina; and localized habitats off South Carolina and Georgia. EFH in the Gulf of Mexico is seaward of the 200 m isobaths in the Gulf of Mexico, although in some areas (e.g., northern Gulf of Mexico by the Mississippi delta) EFH extends closer to shore. EFH in the Gulf of Mexico is located along the edge of the continental shelf off Fort Meyers to Key West (southern West Florida Shelf), and also extends from the northern central Gulf of Mexico around Desoto Canyon and the Mississippi Delta to pelagic habitats of the western Gulf of Mexico that are roughly in line with the Texas/Louisiana border (NOAA 2017).
Smoothhound Shark Complex (Atlantic Stock) *Mustelus canis*	X	X	X	X	X	X	X	X	X	X	X	X	**General habitat description:** Common coastal shark species found from Massachusetts to northern Argentina. They are primarily demersal sharks that inhabit coastal shelves and inshore waters to a maximum depth of 656.2 feet (200 meters) (NMFS 2017). Smooth dogfish is a migratory species that responds to water temperature and congregates between southern North Carolina and the Chesapeake Bay in the winter. **Neonates, Juveniles, and Adults:** At this time, available information is insufficient for the identification of EFH for this life stage, therefore all life stages are combined in the EFH designation. Smoothhound shark EFH identified in the Atlantic is exclusively for smoothdogfish. EFH in Atlantic coastal areas ranges from Cape Cod Bay, Massachusetts to South Carolina, inclusive of inshore bays and estuaries (e.g., Pamlico Sound, Core Sound, Delaware Bay, Long Island Sound, Narragansett Bay, etc.). EFH also includes continental shelf habitats between southern New Jersey and Cape Hatteras, North Carolina (NOAA 2017).

Common Name/ Scientific Name	EFH Habitat within Project Area												EFH Description
	NEONATE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
Spiny Dogfish *Squalus acanthias*	-	-	-	-	-	X	-	-	X	X	X	X	**General habitat description:** The spiny dogfish is widely distributed throughout the world, with populations existing on the continental shelf of the northern and southern temperate zones, which includes the North Atlantic from Greenland to northeastern Florida, with concentrations from Nova Scotia to Cape Hatteras. Individuals travel in schools by size until maturity, at which point they form schools segregated by size and sex (Collette and Klein-MacPhee 2002; Nammack et al. 1985; Bigelow and Schroeder 1953). Spawning occurs offshore during the winter (Bigelow and Schroeder 1953). Based on seasonal temperatures, spiny dogfish migrate up to 994.2 miles (1,600 km) along the east coast, and Spiny dogfish have been observed along the New Jersey coast in March (Bigelow and Schroeder 1953). **Juveniles:** Pelagic and epibenthic habitats, primarily in deep water on the outer continental shelf and slope between Cape Hatteras and Georges Bank and in the Gulf of Maine. Young are born mostly on the offshore wintering grounds from November to January, but newborns (neonates or "pups") are sometimes taken in the Gulf of Maine or southern New England in early summer (MAFMC 2014). **Female Adults:** Pelagic and epibenthic habitats throughout the region. Adult females are found over a wide depth range in full salinity seawater (32-35 ppt) where bottom temperatures range from 7 to 15°C. They are widely distributed throughout the region in the winter and spring when water temperatures are lower, but very few remain in the Mid-Atlantic area in the summer and fall after water temperatures rise above 15°C (MAFMC 2014). **Male Adults:** Pelagic and epibenthic habitats throughout the region. Adult males are found over a wide depth range in full salinity seawater (32-35 ppt) where bottom temperatures range from 7 to 15°C. They are widely distributed throughout the region in the winter and spring when water temperatures are lower, but very few remain in the Mid-Atlantic area in the summer and fall after water temperatures rise above 15°C (MAFMC 2014).
Tiger Shark *Galeocerdo cuvier*	-	-	-	-	X	X	-	-	X	X	-	-	**General habitat description:** The tiger shark is found from Cape Cod, Massachusetts, to Uruguay, including the Gulf of Mexico and the Caribbean Sea. They are found near inshore coastal waters to the OCS, as well as offshore including oceanic island groups. The tiger shark inhabits warm waters in both deep oceanic and shallow coastal regions (Castro 1983). They occur in the western North Atlantic, but rarely occur north of the Mid-Atlantic Bight (Skomal 2007). **Juveniles and Adults:** EFH in the Atlantic Ocean extends from offshore pelagic habitats associated with the continental shelf break at the seaward extent of the U.S. EEZ boundary (south of Georges Bank, off Massachusetts) to the Florida Keys, inclusive of offshore portions of the Blake Plateau. EFH in the Gulf of Mexico includes pelagic and coastal habitats between Tampa Bay, Florida Bay and Florida Keys, and the edge of the West Florida Shelf; and an area extending from off eastern Louisiana, Mississippi, and Alabama to offshore pelagic habitats in the central Gulf of Mexico. Grass flats in the Gulf of Mexico are considered feeding areas and are included as EFH. EFH also includes coastal and pelagic habitats surrounding Puerto Rico (except on the northwest side of the island) and the U.S. Virgin Islands (NOAA 2017).

Common Name/ Scientific Name	EFH Habitat within Project Area												EFH Description
	NEONATE				JUVENILE				ADULT				
	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	SRWF	SRWEC-OCS	SRWEC-NYS	Onshore Cable	
White Shark *Carcharodon carcharias*	X	X	X	X	X	X	X	-	X	X	X	-	**General habitat description:** The white shark ranges within all temperate and tropical belts of oceans, including the Mediterranean Sea. The white shark occurs in coastal and offshore waters and has a very sporadic presence. Because of the shark's sporadic presence, very little is known about its breeding habits. Sightings of the white shark in the Mid-Atlantic Bight occur from April to December. The white shark prefers open ocean habitat. **Neonates:** EFH includes inshore waters out to 65.2 miles (56.7 nm, 105 km) from Cape Cod, Massachusetts, to an area offshore of Ocean City, New Jersey (NOAA 2017). **Juveniles and Adults:** EFH includes inshore waters to habitats 65.2 miles (56.7 nm, 105 km) from shore, in water temperatures ranging from 9 to 28 °C, but more commonly found in water temperatures from 57.2°F to 73.4°F (14°C to 23 °C) from Cape Ann, Massachusetts, including parts of the Gulf of Maine, to Long Island, New York, and from Jacksonville to Cape Canaveral, Florida. (NOAA 2017).

4.2 Vulnerable Species, Life Stages, and Habitat

Many EFH species are highly mobile and pelagically oriented and therefore less susceptible to adverse effects from project construction and operation because they can leave a given area to avoid exposure to project impacts. However, certain EFH species and life stages of some species are more likely to be exposed to certain Project-related impacts because they are either immobile, slow-moving, or planktonic. These include:

- Winter flounder eggs and larvae, which are demersal and found in estuaries in late winter through spring
- Sessile or slow-moving benthic/epibenthic invertebrates (bivalve juveniles and adults, squid egg mops)
- Skate egg cases
- Ocean pout eggs and larvae
- Tidal saltmarshes, especially those dominated by *Spartina alterniflora* and/or *Spartina patens*. Marshes dominated by *Phragmites australis*, while still providing important wetlands functions, are not as sensitive to disturbance
- SAV, especially beds dominated by *Zostera marina*

In addition to the above, the spawning Atlantic cod life stage is considered sensitive and vulnerable for the purpose of this EFH assessment. While juvenile and adult Atlantic cod are highly mobile, this species demonstrates high fidelity to specific spawning sites, meaning they return to the same location year after year, and can be sensitive to anthropogenic disturbances during spawning (Dean et al. 2022). Atlantic cod exhibit courtship and spawning behavior, including vocalizations, primarily at night (Dean et al. 2014, Zemeckis et al. 2019), with peak spawning communication occurring approximately 4 – 6 hours after sunset (Zemeckis et al. 2019).

Southern New England, including Cox Ledge is known to support cod spawning aggregations (Clucas et al., 2019) during the winter months, primarily from December through May (Langan et al. 2020), but the status of cod populations and spatiotemporal distribution of spawning in this region is not as well understood as other regions in the northwestern Atlantic (e.g., Gulf of Maine and Georges Bank). The infrequency of cod observed in fishery-independent trawl surveys contributes to the poor understanding of stocks in in this region (Langan et al., 2020). However, there is information indicating that, unlike other spawning stocks, cod in Southern New England have increased in abundance during the last 20 years (Langan et al., 2020). Existing (DeCelles et al. 2017; INSPIRE Environmental 2018; 2019) and emerging (BOEM pers. comm. 2022) data also indicate that cod spawning occurs throughout the Southern New England region.

BOEM and other researchers have been conducting monitoring surveys in Southern New England, including within and around the SRWF to document cod spawning activity using acoustic telemetry, grunts detected using PAM at fixed stations and on gliders, and hook and line sampling to assess reproductive condition of adults. Recent unpublished results, including acoustic telemetry detections, spawning cod detections using PAM, and hook and line sampling and supporting information sources, are presented in Figure 4-1. During the studies, Atlantic cod have been detected in the northwest corner of the SRWF where fixed station telemetry receivers have been installed. However, to date, no cod grunts have been detected in the SRWF area.

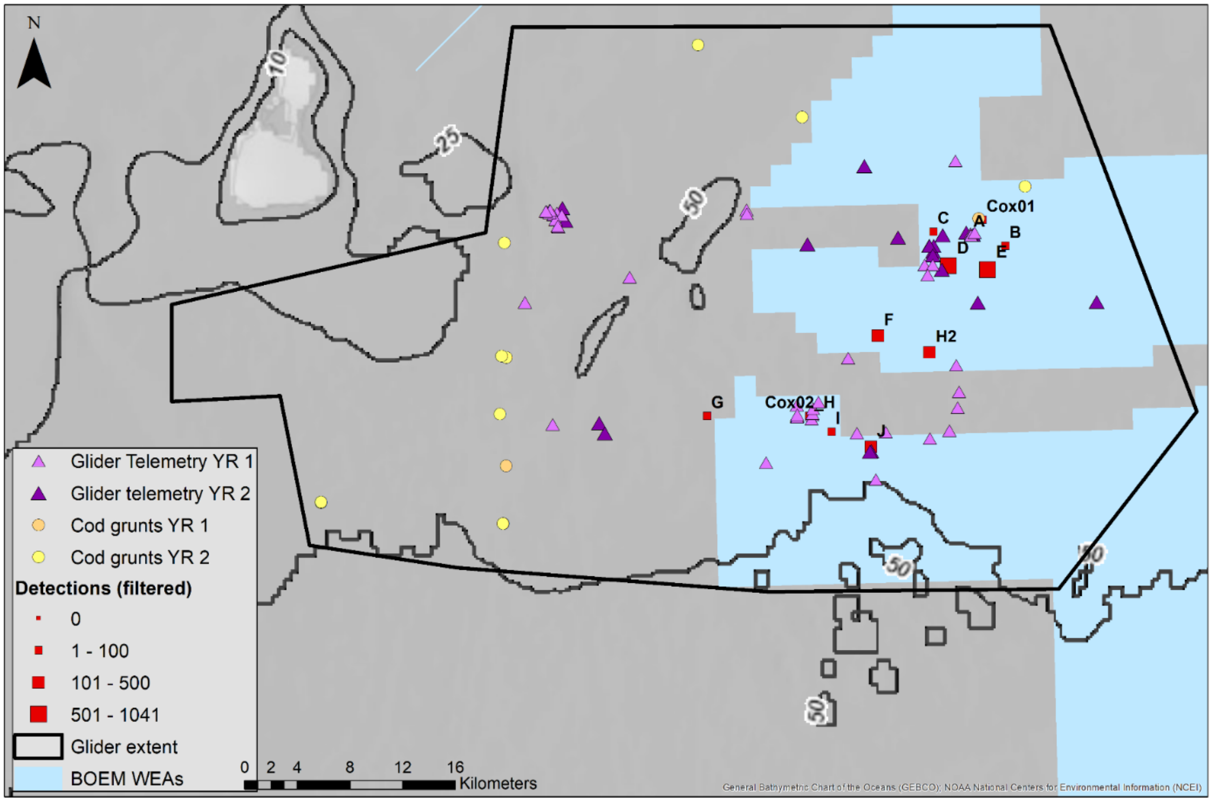


Figure 4-1. Preliminary results from Atlantic cod monitoring surveys conducted in 2021 and 2022 in the Cox Ledge area.

Atlantic cod continue to be managed in U.S. waters as two units: the Gulf of Maine and the Georges Bank management units. An Atlantic Cod Stock Structure Working Group (ACSSWG) formed in 2018 recently carried out a multidisciplinary evaluation of cod structure in U.S. waters and identified a number of mismatches between the current management units and biological stock structure. Using evidence from an evaluation of early life history characteristics, an examination of genetic analyses, fishermen's ecological knowledge, and tagging studies, the ACSSWG concluded that cod in Southern New England represent a unique biological stock, with demographics that are largely independent of neighboring populations (McBride and Smedbol 2022). In general, tagging studies have indicated that spawning groups in southern New England exhibit a high degree of residency; however, some tagging efforts have indicated extensive movements of cod from the Great South Channel to the western Gulf of Maine, with some movement into Southern New England (Wise 1963; Tallack 2009; 2011; McBride and Smedbol 2022). A subsequent working group convened by the NEFMC is currently reviewing the available data and evaluating whether cod in Southern New England should be managed as a discrete stock. A decision to recognize cod in Southern New England (and other regions in the Northeast) as a unique biological stock will have fisheries management implications, including the development of new stock/population assessments, that would allow managers to better work towards rebuilding Atlantic cod populations.

Recent findings from NEFMC concluded "However, insufficient information is available to determine the source populations of cod larvae and juveniles occurring in Southern New England waters and it is uncertain if the area is fully supported by self-recruitment"(NEFMC 2022). Further, cod spawning appears to occur throughout the Southern New England region (DeCelles et al., 2017; BOEM pers. comm. 2022), which could help buffer against any potential impacts to planktonic eggs and larval transport. While hydrodynamic effects on these species could potentially be more significant, the available information does not suggest that such effects are likely.

4.3 Habitat Areas of Particular Concern

NMFS and the regional fisheries management councils have identified subsets of EFH as HAPCs. These are habitat types and/or geographic areas identified as priorities for habitat conservation, management, and research that provide extremely important ecological functions or are especially vulnerable to degradation, but this designation does not confer any specific protections (MAFMC 2016). The councils identify HAPCs based on one or more of the following considerations: (1) the importance of the ecological function provided by the habitat, (2) the extent to which the habitat is sensitive to human-induced environmental degradation, (3) whether, and to what extent, development activities are, or would be, stressing the habitat type, and (4) the rarity of the habitat type (MAFMC 2016).

4.3.1 Summer Flounder HAPC

The MAFMC has identified HAPC for summer flounder as “All native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH” (MAFMC 2016). These areas have been identified as important for shelter, predation, nursery habitat, and, potentially, reproduction (MAFMC 1998a). Lascara (1981) demonstrated an increased ability of summer flounder to effectively capture prey by utilizing the seagrass as a “blind” to ambush prey. SAV and macroalgae have been shown to attract common summer flounder prey for both adults and juveniles (Packer et al. 1999a). Additionally, it has been concluded that any loss of areas containing SAV and macroalgae along the Atlantic Seaboard may negatively affect summer flounder stocks (Laney 1997).

Within the Project area, the Onshore Transmission Cable corridor may cross some portion of mapped HAPC for summer flounder in NYS waters specifically near the ICW-HDD, off the south shore of the channel. SAV was also mapped in the vicinity of the SRW Project area (several miles away in Bellport Bay). but those areas would be completely avoided by the existing cable route. October 2022 surveys found no significant SAV-forming patches or meadows in the proposed SRW temporary landing site for the temporary equipment to be used for the ICW-HDD but identified eelgrass at six locations (see section 3.3.5 for more detail). Four of the six locations included eelgrass shoots in macroalgae but shoots appeared unrooted. Two locations of eelgrass emerged from an algal mat on the sediment surface, but, compared to the single eelgrass plants observed, these clusters of plants appeared more likely to be rooted.

The use of HDD would avoid impacts to SAV habitats and macroalgal mats; however, impacts could occur in the unlikely event of an inadvertent release of drilling fluid. The potential for a significant loss of drilling fluid in this inshore environment is considered to be low. Any unanticipated discharges or releases during construction are expected to result in minimal, temporary impacts; activities are heavily regulated, and discharges and releases are considered accidental events that are unlikely to occur. Additionally, where HDD is utilized, an Inadvertent Return Plan would be prepared and implemented to minimize the potential risks associated with release of drilling fluids. See also Section 2.2.2.

4.3.2 Juvenile Atlantic Cod HAPC

HAPC for juvenile Atlantic cod is defined as occurring between the mean high water line and a depth of 66 ft (20 m) in rocky habitats, in SAV, or in sandy habitats adjacent to rocky and SAV habitats for foraging, from Maine through Rhode Island. Juvenile Atlantic cod HAPC can be found in the region, but it does not occur within the footprint of the SRWF, SRWEC, ICW-HDD, nor its immediate vicinity (see Table 3-1 and Table 3-2).

4.3.3 Southern New England HAPC

On July 30, 2022, the NEFMC approved a new HAPC designation to address concerns over potential adverse impacts from offshore wind development on sensitive hard-bottom habitats and cod spawning activity. The Southern New England HAPC comprises all large-grained complex and complex benthic habitats wherever present within the area bounded by a 10-km (6.2-mile) buffer around the RI/MA and MA WEAs (Plante 2022), as shown in Figure 4-2. The designation is intended to protect high value complex habitats within this area, emphasizing currently known and potentially suitable areas used by Atlantic cod for spawning (Bachman and Couture 2022; NEFMC 2022). This EFH designation was informed by the findings of a three-year, BOEM-funded study investigating the use of Cox Ledge and surroundings by spawning Atlantic cod (#AT-19-08) (BOEM pers. comm. 2021).

The designation would also apply to large-grained complex and complex benthic habitats used by Atlantic herring, Atlantic sea scallop, little skate, monkfish, ocean pout, red hake, silver hake, windowpane flounder, winter flounder, winter skate, and yellowtail flounder. This new HAPC designation has not yet been implemented and is pending final approval by NMFS. The habitat alternative has been developed by BOEM to avoid and minimize impacts to this HAPC from the construction and operation of the SRWF and is described in Section 6.3.

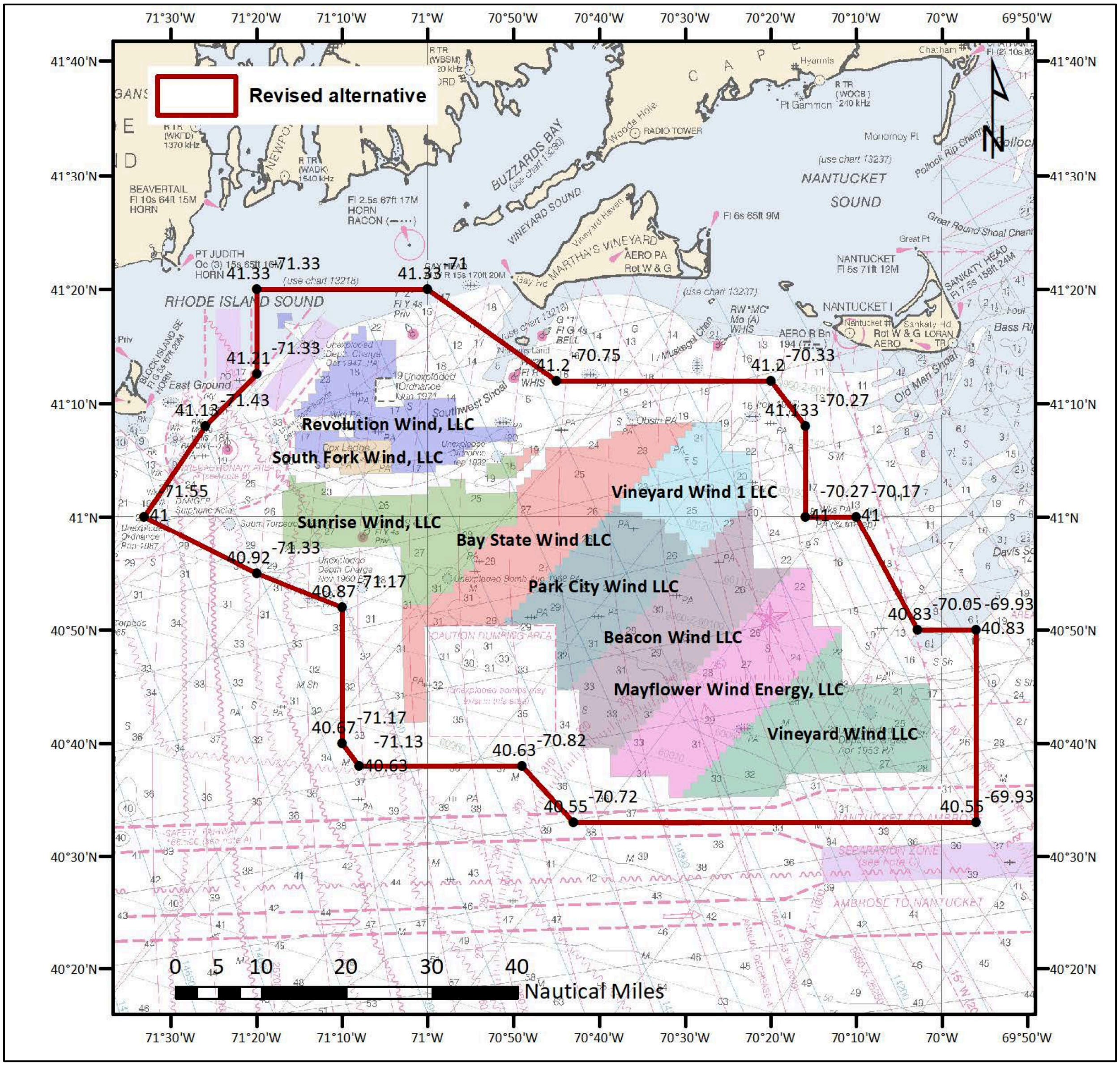


Figure 4-2. Proposed Southern New England HAPC Designation

4.4 Prey Species

Prey species are those species consumed by EFH fish and invertebrate species as prey and are thus a component of EFH. Species include forage fish such as sand lance, anchovy, river herring, as well as invertebrates such as clams, crabs and worms. Impacts to prey species may lead to indirect impacts to EFH and EFH species and life stages due to lost foraging opportunities.

4.5 Species Groups

Species groups will be used throughout this assessment. Species groups are groups of EFH species and/or life history stages that predominantly share the same habitat type. Benthic/epibenthic species groups are sorted into two habitat types (soft bottom or complex) based on the benthic habitat with which the species is most typically associated, with the potential for any species to be found in heterogenous complex as that habitat type could include both soft bottom and complex habitat.

Prey species are included as species groups because they are consumed by managed fish and invertebrate species as prey, and thus are a component of EFH.

Note that for acoustic impacts, acoustic groups are defined according to Popper et al. (2014). See Section 5.1.1.2 for more information.

Sessile Benthic/Epibenthic – Soft Bottom

(Includes slow-moving benthic/epibenthic species and/or life stages; could include heterogenous complex habitat)

- Atlantic scallop (eggs, larvae, juveniles, adults)
- Atlantic surfclam (juveniles, adults)
- Flatfish (eggs, larvae, juveniles, adults)
- Longfin inshore squid (eggs, juvenile, adults)
- Northern shortfin squid (adults)
- Ocean quahog (juveniles, adults)
- Skates (juveniles, adults)

Mobile Benthic/Epibenthic – Soft Bottom (could include heterogenous complex habitat)

- Flatfish (eggs, larvae, juveniles, adults)
- Monkfish (eggs, larvae, juveniles, adults)
- Red hake (eggs, larvae)
- Scup (juveniles, adults)
- Sharks (neonates, juveniles, adults)
- Skates (juveniles, adults)
- Silver hake
- White hake

Sessile Benthic/Epibenthic – Complex Habitat

(Includes slow-moving species and/or life stages; could include heterogenous complex habitat)

- Atlantic cod (post-settlement larvae)
- Longfin inshore squid (eggs, juvenile, adults)
- Northern shortfin squid (adults)
- Skates (juveniles, adults)

<u>Mobile Benthic/Epibenthic – Complex Habitat</u> (could include heterogenous complex habitat)

- Atlantic cod (juvenile, adult)
- Black sea bass (juveniles, adults)
- Haddock (juveniles, adults)
- Offshore Hake (larvae)
- Scup (juveniles, adults)
- Sharks (neonates, juveniles, adults)
- White hake

<u>Pelagic</u>

- American plaice (Larvae)
- Atlantic butterfish (eggs, larvae, juveniles, adults)
- Atlantic herring (eggs, larvae, juveniles, adults)
- Atlantic mackerel (eggs, larvae, juveniles, adults)
- Bluefish (eggs, larvae, juveniles, adults)
- Haddock (larvae)
- Highly migratory species (HMS) (eggs, larvae, juveniles, adults)
- Longfin inshore squid (eggs, juvenile, adults)
- Northern shortfin squid (adults)
- Pollock (larvae, juveniles)
- Sharks (neonates, juveniles, adults)
- All other finfish, flatfish, and except winter flounder (eggs, larvae for both)

4.6 NOAA Trust Resources

NOAA Trust Resources have also been identified in the vicinity of the SRWF, SRWEC-NYS and Onshore Cable. NOAA Trust Resources are summarized in Table 4-3 and discussed in detail in Section 7.

Table 4-3 NOAA Trust Resources within the Project Area

Species	Life Stage within Project Area			
	Egg	Larvae	Juvenile	Adult
River herring (alewife, blueback herring)			x	x
American eel		x	x	x
Striped bass			x	x
Blackfish/tautog			x	x
Weakfish			x	x
Forage species (Atlantic menhaden, bay anchovy, sand lance)	x	x	x	x
American shad			x	x
Blue crab	x	x	x	x
Horseshoe crab	x	x	x	x
Bivalves (blue mussel, eastern oyster, ocean quahog, soft-shell clam)	x	x	x	x
Spot	x	x	x	x
Atlantic croaker	x	x	x	x
Spotted hake	x	x	x	x
Smallmouth flounder	x	x	x	x
Longfin and Shortfin squid	x	x	x	x
Northern kingfish	x	x	x	x
Sea robin	x	x	x	x

5.0 Adverse Effects

This section provides an analysis of the effects of the Proposed Action on designated EFH for managed species and life stages in the Project area defined in Section 4. As defined by NOAA, adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate as well as the loss of and/or injury to benthic organisms, prey species, their habitat, and other ecosystem components. Adverse effects may be site-specific or habitat-wide impacts including individual, cumulative, or synergistic consequences of actions (50 CFR § 600.810).

The Project area encompasses the maximum impacts resulting from the SRWF, SRWEC-OCS, SRWEC-NYS and Onshore Cable footprints. Potential adverse effects on EFH habitat may include noise, water quality changes, alterations to substrates used by EFH-designated species during specific life stages, and impairments to pelagic or benthic organisms. If a Project component is likely to result in a short-term, long-term, or permanent impairment of designated EFH or HAPC for a managed species and life stage, this would constitute an adverse effect on EFH. Impacts to EFH species are summarized in Table A- 1 and Table A- 2 in Appendix A.

The following sections summarize potential impacts of the Proposed Action on EFH during construction, O&M, and decommissioning of the Proposed Action. Temporal classifications of impacts include short-term (less than 2 years), long-term (2 years to less than the life of the project), or permanent (life of the project) effects such as habitat alterations, sediment deposition, and noise.

5.1 Construction & Operation Activities

Project construction would generate short-term, long-term, or permanent direct and indirect effects on EFH through vessel activity, pile driving, seabed preparation, and installation of scour protection. noise; crushing, burial, and entrainment effects; and suspended sediments and turbidity from bed disturbance. These effects would occur intermittently and at varying locations in the Project area over the duration of project construction. Thus, the suitability of EFH for managed species may be reduced depending on the nature, duration, and magnitude of each effect. Impacts of Project activities on EFH and EFH species are discussed below.

The O&M of the SRWF would generally result in the short-term, long-term or permanent alteration of water column and benthic habitats within the construction and installation footprint. Those short-term, long-term, or permanent direct or indirect effects would occur over the approximate 35-year lifespan of the project from the completion of construction and installation through decommissioning. For example, placement of boulder scour protection during construction would have a direct effect. But that boulder scour protection may develop into complex fisheries habitat over the life of the project, an indirect beneficial effect. Additionally, the benefits of maintaining that complex fisheries habitat may outweigh the removal of these features to return the habitat to its original condition. Those decisions and any associated direct and indirect effects on EFH would be addressed through separate consultation for project decommissioning.

The permanent impacts of project O&M that could alter the suitability of EFH for managed species are as follows:

- Alteration of water column and benthic habitat composition by monopile foundations, scour protection and cable protection.

- Operational noise effects on habitat suitability in the vicinity of the WTGs
- EMF effects on benthic and demersal habitat suitability in the vicinity of the inter-array cable and SRWEC
- Hydrodynamic effects on pelagic habitat suitability in the vicinity of the monopile foundations
- Food web effects resulting from permanent habitat alteration, including the colonization of new hard substrates introduced to the offshore environment.

5.1.1 Installation of WTG/OSS Structures and Foundations, including Converter Stations, as Applicable

Project installation would generate short-term to long-term and potentially permanent, direct and indirect effects on EFH through vessel activity; pile driving and seabed preparation/boulder relocation/dredging; and installation of scour protection. These effects would occur intermittently at varying locations in the Project area over the duration of project construction and installation. Depending on the nature, extent, and severity of each effect, this may reduce the suitability of EFH for managed species. This would constitute short-term to long-term and potentially permanent adverse effects on EFH.

The construction and installation of the SRWF involves activities that would generate underwater noise exceeding established thresholds for mortality and permanent or short-term injury, temporary threshold shift (TTS), and behavioral effects. Underwater noise would render the affected habitats unsuitable for EFH species over the short-term and could have short-term impacts on prey availability for EFH species. The extent, duration, and severity of noise effects on EFH would vary depending on the noise source and the sensitivity of the affected EFH species and their prey to noise impacts during their life cycle. These effects are detailed by project component in the following sections (i.e., vessel activity, pile driving).

The assessment of noise impacts provided in the following sections emphasizes direct noise effects on EFH species based on the sensitivity of different hearing groups and life stages. However, these results are also applicable to prey resources important to EFH species. Fish eggs and larvae are prey and forage resources for some EFH species during certain life stages. Fish and invertebrates from any hearing group may provide prey for EFH species. Accordingly, short-term noise impacts that temporarily reduce habitat suitability for EFH species may also have localized effects on the availability of their prey resources. Individual prey organisms available to EFH species may increase or decrease depending on the nature of the noise effect and species-specific sensitivity. In contrast, short-term injury, auditory masking, or behavioral effects may limit the ability of EFH species to detect and locate prey organisms.

Spatial trends in sediment composition were found in the SRWF area. For example, the northwest region had a higher frequency of gravels; the southeast and west-central regions were characterized by finer substrata and limited small-scale sediment mobility; and the northeast region was generally composed of fine to coarse sand with sand ripples common. Boulders were infrequently observed at the SRWF but did occur in the northwest region, with the exception of an area located along the southern border at approximate longitude of 71.1°W. The biological attributes of the SRWF followed similar spatial trends to the physical features. The northwest portion of the SRWF was the only area where gravel was observed consistently across stations. Gravel in this area ranged in size from “washed” pebbles and granules to patchy cobbles and boulders on sand, which were encrusted by epifauna (e.g., bryozoa and hydroids). CMCES biotic classes, e.g., soft sediment fauna, attached fauna, inferred fauna) are mapped in Figure 3-11.

The southeast region of the SRWF were predominantly Very Fine Sand (CMECS Substrate Subgroup) and sand and mud (macrohabitat type) and had high occurrences of burrowing anemones and sabellid worms. The northeast region of the SRWF, which were predominantly medium sand or fine sand (CMECS Substrate Subgroup) and sand with ripples (macrohabitat type), had high occurrences of sand dollars. The northwest region of the SRWF was more heterogenous in seabed composition than other portions but included a higher frequency of gravelly sand and sandy gravel (CMECS Substrate Subgroups) compared to the rest of the SRWF and was generally more complex in macrohabitat types (e.g., sand with mobile gravel, patchy cobbles and boulders on sand), was inhabited by attached epifauna (e.g., hydroids [*Tubularia* spp.], sea stars, and bryozoa).

Cobble and boulder habitat can serve as structure for hard and soft corals, nursery ground for juvenile lobster, and as preferable benthic habitat for squid to deposit their eggs. Taxa considered sensitive with respect to this habitat include corals, squid eggs, and American lobster. Biogenic habitats included the non-reef building hard coral and burrowing anemones. The northern star coral was found at five stations, all in the northwest corner of the SRWF. Generally, the western portion of the SRWEC-OCS was characterized by high densities of sand dollars while the eastern portion of the SRWEC-OCS was inhabited by burrowing anemones and sea stars, and 52 percent of SPI/PV stations included burrowing anemones.

5.1.1.1 Vessel Activity

Habitat Loss/Conversion

During installation of the 87 WTGs and the OCS-DC and associated foundations, 13 wind turbine vessels would be deployed simultaneously during foundation installation and 6 wind turbine vessels would be deployed simultaneously during structure installation. Anchoring (other than jack-up vessels) would not be anticipated during construction or O&M activities. Jacking-up on the OCS would only be expected to occur during the WTG installation and certain WTG and OCS-DC non-routine O&M scopes of the Project, though anchoring of support vessels for contingency purposes could happen during the scopes for WTG, monopile and piled jacket foundation, OCS-DC topside, and/or cable installation/O&M. These emergency contingency situations could include mechanical issues with the vessel, loss of steering, or an onboard emergency. Certain construction vessels such as jack-up vessels would require stabilization spuds. These activities would occur intermittently during installation of WTG and OCS-DC foundation installation. In addition, 2 wave (measurement) buoys, one proximate to the WTGs in the eastern part of the wind farm (approximately 5 nautical miles east of the OCS-DC) and a second at the HDD exit pit location in NYS waters, and up to 3 ADCPs would be installed and remain in place during cable installation. The buoys would be anchored by a single line (Dyneema rope) that would remain taut and minimize the potential for anchor sweep without necessitating mid-line buoys. Buoys would be placed in areas to avoid complex habitat and marine archaeological resources. Mooring of these buoys would be expected to have impacts similar to anchoring as described below.

Anticipated benthic habitat disturbing activities during WTG and OCS-DC installation include contingency anchor placement, anchor chain sweep, and spud placement. These activities would take place within the SRWF, including all three of the NOAA Habitat Complexity Categories. Vessels that could utilize anchors (rather than spud cans) to hold position generally have a greater potential to disturb the seabed and result in crushing or burial impacts and habitat loss or conversion. Benthic habitat types within the SRWF that are subject to disturbance from vessel activities mentioned above include rocky habitat (24,913 acres), soft bottom mud (149 acres), and soft bottom sand (35,283 acres). The Proposed Action currently includes up to 87 WTG positions. Of those, 30 WTGs (34.5 percent) are proposed to be installed in complex habitat, 55 WTGs (63.2 percent) in soft bottom sand and muddy sand habitats, and 2 WTGs (2.3 percent) are located mostly within habitats categorized as soft bottom with a smaller area on one side of each foundation footprint within habitats categorized as complex (Personal communication, M. Evans, 2023b).

The precise extent and location of anchoring impacts anticipated at each foundation is not currently known as vessel positioning and contingency anchoring requirements are affected by wind and current conditions in real time. The applicant proposes to use appropriate installation technology designed to minimize disturbance to the seabed and sensitive habitat (such as beaches and dunes, wetlands and associated buffers, streams, hard-bottom habitats, seagrass beds, and the near-shore zone); avoid anchoring on sensitive habitat including no anchoring in SAV during the construction of the temporary trestle-supported pier; and implement turbidity reduction measures to minimize impacts to sensitive habitat from construction activities (see Applicant Proposed Measures [APMs] in Table 6-1). For the purpose of this consultation, BOEM assumes that the entirety of the 722-foot (220-meter) impact radius around each foundation could potentially experience some degree of contingency anchoring disturbance. This equates to approximately 37.6 acres (15.2 ha) of potential anchoring disturbance at each of the monopile foundation sites and 37.6 acres (15.2 ha) for the piled jacket foundation of the OCS-DC. In addition, benthic habitat would be disturbed by jack-up vessel anchoring during foundation construction and installation.

Impacts to soft bottom benthic habitat are expected to recover within 18 to 24 months following initial disturbance via bedform recovery through natural sediment transport processes and recolonization by habitat forming organisms from adjacent habitats. This estimate is based on observed recovery rates from seabed disturbance at the nearby BIWF (HDR 2020). In contrast, anchoring activities in large-grained complex, complex, and heterogenous complex benthic habitats could change the composition of benthic habitat by creating furrows of soft-bottomed habitat through boulder and cobble substrates. This would permanently modify the distribution of substrates in the affected area, resulting in a long-term to permanent effects on benthic habitat composition. This would constitute a long-term effect on benthic habitat structure. General construction vessel anchoring would occur within a 722-foot (220-meter) radius around each foundation. Actual anchoring impacts would occur within a subset of this area and would avoid large-grained complex and complex habitat to the extent practicable. The acreage shown is the total area of the impact radii around each foundation, minus overlapping jack-up vessel anchoring impacts.

Medium- and low-density boulder fields present in large-grained complex and complex habitats within the area are important EFH for several managed species, including Atlantic cod (adults and spawning adults), longfin squid (i.e., benthic squid mops), ocean pout (all life stages), winter flounder (adults), and monkfish (adults and juveniles). Damage caused to medium- and low-density boulder fields, as well as associated biogenic features and attached, habitat forming organisms that provide shelter, attachment surfaces, and prey resources for the aforementioned EFH species would incur direct, long-term impacts from anchors, anchor chains, and spuds as these habitats generally take several years to decades to fully recover (Auster and Langton 1999; Collie et al. 2005; Tamsett et al. 2010). EFH species could also incur short-term to long-term, indirect impacts from a loss of benthic epifauna/prey, such as crabs, shrimps, and sea stars. Anchoring could also result in the direct mortality of immobile, longfin squid egg mops and damage and/or disturb nests guarded by ocean pout, a currently overfished species of federally managed finfish.

Anchors, anchor chain sweep, and spuds could directly impact gravelly sand, sandy gravel, and slightly gravelly sand substrates, which are the dominant CMECS substrates found in large-grained complex and complex habitats within the area. Gravelly substrates are a preferred spawning substrate of Atlantic herring that deposit benthic eggs. The crushing of herring eggs would constitute an indirect impact to EFH species such as Atlantic cod, which feed on Atlantic herring, a species of commercially valuable schooling fish that is significantly below target population levels. Atlantic sea scallops (adults, juveniles, and larvae), a commercially valuable and relatively immobile, benthic species of invertebrates also inhabits gravelly sand, sandy gravel, and slightly gravelly sand substrates. This species would be vulnerable to both direct, permanent (crushing) and indirect, short-term (sedimentation and turbidity causing reductions in habitat quality) anchoring impacts. Hydroids, a prey item of winter skates (adults and juveniles) could also be crushed; however, hydroids are ubiquitous organisms in ocean ecosystems. Lastly, shell hash substrates, a biogenic substrate present in both large-grained and complex are important EFH for juvenile and larval red hake, young-of-the-year (YOY) and juvenile winter flounder, and larval and juvenile Atlantic sea scallops, which could be crushed or caused to flee these sheltering habitats.

Dominant bedform features and CMECS substrates within the soft bottom habitats in the Lease Area include ripples, linear depressions, trawl scars, and megaripples, and medium to fine sands, respectively. Winter flounder (larvae, YOY, juvenile, and adults) and winter skates (adults and juveniles) are soft bottom EFH species known to utilize medium to fine sandy substrates. Anchoring in these substrates could result in short-term (i.e., fleeing the area) or permanent (crushing of YOY winter flounder and/or attached hydroids) impacts to soft bottom associated EFH species and prey. Ripples and megaripples, which are important bedform features for soft bottom associated EFH species, including adult Atlantic cod (Gerstner et al., 1998), that can be found sheltering in these areas from currents, could also be damaged.

Effects on EFH and EFH species:

- Direct
    - Short-term loss/conversion of EFH (Plan for avoidance of sensitive habitat when anchoring): EFH for Sessile Benthic/Epibenthic – Soft Bottom, Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex; Mobile Benthic/Epibenthic – Complex; Pelagic species groups; Prey Species – Benthic; Prey Species – Pelagic, Summer Flounder HAPC; Summer Flounder HAPC.
    - Permanent, localized crushing and burial of EFH species: Sessile Benthic/Epibenthic – Soft Bottom, Sessile Benthic/Epibenthic – Complex; Prey –Benthic/Epibenthic species groups.
    - Short-term avoidance of anchoring activities by EFH species: Mobile Epibenthic/Benthic – Soft Bottom; Mobile Epibenthic/Benthic – Complex; Pelagic;

Prey Species – Benthic and Prey Species – Pelagic species groups.

- Indirect
  - Short-term loss of benthic prey items: Mobile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Complex.

Sediment Suspension

Only certain Project vessel activities, such as those associated with anchoring (e.g., anchor placement and retrieval, chain sweep, and/or spud placement) would likely result in sediment suspension, a concomitant increase in turbidity in the water column, and sedimentation. Sediments within the SRWF are generally medium- to coarse-grained with areas of sand and muddy sand deposits. Hydrodynamic and sediment transport modeling were conducted to assess the sediment suspension and resulting deposition from proposed construction activities associated with the SRWF and SRWEC (COP Appendix H). The sediment disturbance was evaluated for: 1) excavation of HDD exit pits using a mechanical dredge in NY state (NYS) waters, 2) installation of the SRWEC using jet plowing in NYS (SRWEC-NYS) and federal (SRWEC-OCS) waters, and 3) installation of the IAC using jet plowing in federal waters. Hydrodynamic and sediment transport modeling to assess the sediment suspension and resulting deposition from proposed construction activities are detailed in Section 5.1.2.3.

Sessile benthic/epibenthic EFH species have a range of susceptibility to sediment suspension, turbidity, and sedimentation based on life stage, mobility, and feeding mechanisms. Increases in sediment suspension and deposition may cause short-term adverse impacts to EFH by decreasing habitat quality for benthic species and life stage: small sessile or slow-moving benthic EFH species and life stages (e.g., benthic eggs and larvae) would experience greater impacts from deposition when compared with larger, mobile species and life stages. Filter-feeding invertebrates could experience a reduction in feeding ability and food quality. Benthic prey species could experience sedimentation, such as clams in shellfish beds could experience short-term increases in turbidity and sedimentation but would be expected to recover. Resuspended sediment in the water column would reduce the quality of EFH for mobile benthic/epibenthic and pelagic EFH species, but water column EFH would be expected to recover quickly following sedimentation. Temporary loss of foraging opportunities and displacement of mobile benthic/epibenthic and pelagic EFH species and pelagic prey species due to increased turbidity could also occur, but recovery would be expected following settlement of sediments.

Effects on EFH and EFH species:

- Direct
  - Short-term decrease in quality of EFH due to suspended sediments and increased turbidity: EFH for Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; and Pelagic species groups; Summer Flounder HAPC.
  - Short-term, local impacts due to sedimentation: Sessile Benthic/Epibenthic – Soft Bottom; Prey Species – Benthic.
- Indirect
  - Short-term loss of foraging opportunities: Mobile Epibenthic/Benthic – Soft Bottom; and Pelagic species groups.
  - Short-term decrease in quality of EFH in areas adjacent to Project activities for:

Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Summer Flounder HAPC; Prey Species – Benthic.

Vessel Noise

Vessel noise may interfere with feeding and breeding, alter schooling behaviors and migration patterns (Buerkle 1973; Schwarz and Greer 1984; Soria et al. 1996; Vabø et al. 2002; Mitson and Knudsen 2003; Ona et al. 2007; Sarà et al. 2007) and induce endocrine stress response (Wysocki et al. 2006). Fish communication is mainly in the low-frequency (<1000 hertz [Hz]) range (Ladich and Myrberg 2006; Myrberg and Lugli 2006) so masking is a particular concern because many fish species have unique vocalizations that allow for inter- and intra-species identification, and because fish vocalizations are generally not loud, usually ~120 decibels (dB) sound pressure level (SPL) with the loudest sounds reaching 160 dB SPL (Normandeau Associates 2012). As such, anthropogenic sound sources that occur in lower frequency ranges could result in auditory masking effects. Behavioral responses in fishes differ depending on species and life stage, with younger, less mobile age classes being the most vulnerable to vessel noise impacts (Popper and Hastings 2009; Gedamke et al. 2016).

Underwater sound from vessels can cause avoidance behavior, which has been observed for Atlantic herring (*Clupea harengus*) and Atlantic cod (*Gadus morhua*) and is a likely behavior of other species as well (Handegard et al. 2003). Spawning cod present in the area would be particularly vulnerable to this impact as they are sensitive to anthropogenic disturbances (Dean et al. 2022), which likely includes underwater sound. Spawning cod present in the Lease Area would be exposed to elevated acoustic levels which may elicit a short-term behavioral response, however, recent studies examining spawning cod behavior in response to seismic airgun sound found that cod did not abandon the spawning site (McQueen et al. 2022). Fish may respond to approaching vessels by diving towards the seafloor or by moving horizontally out of the vessel's path, with reactions often initiated well before the vessel reaches the fish (Ona et al. 2007; Berthe and Lecchini 2016). The avoidance of vessels by fish has been linked to high levels of infrasonic and low-frequency sound (~10 to 1,000 Hz) emitted by vessels.

Nedelec et al. (2016) investigated the response of reef-associated fish by exposing them in their natural environment to playback of vessel engine sounds. They found that juvenile fish increased hiding and ventilation rate after a short-term vessel sound playback, but responses diminished after long-term playback, indicating habituation to sound exposure over longer durations. These results were corroborated by Holmes et al. (2017) who also observed short-term behavioral changes in juvenile reef fish after exposure to vessel noise as well as desensitization over longer exposure periods. While sounds emitted by vessel activity are unlikely to injure fish, vessel sound has been documented to cause short-term behavioral responses (Holmes et al. 2017).

Analysis of vessel noise related to the Cape Wind Energy Project found that noise levels from construction vessels at 10 feet (3 meters) were loud enough to elicit an avoidance response, but not loud enough to do physical harm (MMS 2008). Pelagic species, certain life stages, and prey species that occur high in the water column (e.g., Atlantic butterfish, Atlantic herring, Atlantic mackerel, bluefish, and some highly migratory pelagic species) would be the most likely impacted species by vessel and construction noise, although the behavioral avoidance impacts would be short-term. However, in inshore, shallow waters benthic species and life stages could also be impacted. Demersal and benthic invertebrates would not be anticipated to be impacted as a result of increased noise from vessels associated with construction of the Proposed Action. Therefore, EFH-designated fish within the SRWF may initially exhibit a negative behavioral response to vessel activity; however, as vessel traffic increases throughout the Project timeline, habituation to vessel noise by EFH-designated species are likely to occur. Project-related vessel noise would be intermittent and of short duration, so the overall impacts to fish are expected to be low. Vessel and pile driving noise effects on specific hearing categories for EFH-designated species are combined and detailed further in Section 5.1.1.2.

Effects on EFH and EFH species:

- Direct
    - Short-term, local avoidance responses due to vessel noise: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Benthic/Epibenthic; Prey Species – Pelagic.

Potential Introduction of Exotic/Invasive Species

Invasive species can be accidentally released in the discharge of ballast water and bilge water during vessel activities. Increasing vessel traffic throughout the construction duration of the Project would increase the risk of accidental releases of invasive species. Vessels are required to adhere to existing state and federal regulations related to ballast and bilge water discharge, including U.S. Coast Guard ballast discharge regulations (33 CFR 151.2025) and U.S. Environmental Protection Agency National Pollutant Discharge Elimination System (NPDES) Vessel General Permit standards, both of which aim at least in part to prevent the release and movement of invasive species. Adherence to these regulations would reduce the likelihood of discharge of ballast or bilge water contaminated with invasive species. Although the likelihood of invasive species becoming established due to Project-related activities is low, the impacts of invasive species could be strongly adverse, widespread, and permanent if the species were to become established and out-compete native fauna. Indirect impacts could result from competition with invasive species for food or habitat, and/or loss of foraging opportunities if preferred prey is no longer available due to competition with invasive species.

Effects:

- Direct
    - Low likelihood, but potentially long-term and widespread impacts to any or all EFH and EFH species: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Benthic/Epibenthic; Prey Species – Pelagic.
- Indirect
    - Low likelihood of competition with invasive species, loss of foraging opportunities: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Benthic/Epibenthic; Prey Species – Pelagic.

5.1.1.2 Pile Driving

Underwater Sound

Acoustic impacts from construction of the Proposed Action would result primarily from pile driving activities related to installing the WTGs monopile and OCS jacket foundations and the temporary pile-supported trestle. The assessment of acoustic impacts provided in the following section emphasizes direct acoustic effects on EFH-designated species and their life stages. These results are also applicable to prey resources used by EFH-designated species. Accordingly, short-term acoustic impacts that reduce prey availability constitutes an adverse effect on EFH.

Underwater sounds are composed of both pressure and particle motion components and are perceived by fish in different ways. An underwater sound originates from a vibrating source, which causes the particles of the surrounding medium (water) to oscillate, which causes adjacent particles to move and transmit the sound wave. Particle motion can be measured in terms of displacement (m), velocity (m s^{-1}), or acceleration (m s^{-2}); however, there is not an internationally accepted standard unit for particle motion (Nedelec et al. 2016). Sound pressure is the variation in hydrostatic pressure caused by the compression and rarefaction of the particles caused by the sound and is measured in terms of decibels (dB) relative to 1 microPascal (µPa).

All fish perceive the particle motion component of sound and have sensory structures in the inner ear that function to detect particle motion (Popper and Hawkins 2018; Nedelec et al. 2016). Particle motion is an important part of a fish's ability to orient itself in its environment and perceive biologically relevant sounds of prey, predators, and other environmental cues (Popper and Hawkins 2018). Fish with a swim bladder or other air-containing organ can detect the pressure component of sound as the pressure wave causes the compression and vibration of the air-filled swim bladder. The extent to which the pressure component contributes to a fish's ability to hear varies from species to species and is related to the structures in the fish's auditory system, ability to process the signal from the swim bladder, the size of the swim bladder, and its location relative to the inner ear.

Impacts from sound vary based on the intensity of the noise and the method of sound detection used by the animal. However, severe impacts could include physiological reactions such as ruptured capillaries in fins, hemorrhaging of major organs, or burst swim bladders (Popper et al. 2014), which could lead to mortality or behavioral reactions such as temporary displacement or temporary disruption of normal activities such as feeding or movement. Assessment of the potential for underwater noise to injure or disturb a fish or invertebrate requires acoustic thresholds against which received sound levels can be compared. The most conservative available injury thresholds for fish were developed by the Fisheries Hydroacoustic Working Group (2008) and Popper et al. (2014) and are provided in Table 5-1.

Noise thresholds for adult invertebrates have not been developed because of a lack of available data. In general, mollusks and crustaceans are less sensitive to noise related injury than many fish because they lack internal air spaces and are less susceptible to over-expansion or rupturing of internal organs, the typical cause of lethal noise related injury in vertebrates (Popper et al. 2001). Current research suggests that some invertebrate species groups, such as cephalopods (e.g., octopus, squid), crustaceans (e.g., crabs, shrimp), and some bivalves (e.g., scallops, ocean quahog) are capable of sensing sound through particle motion (Carroll et al. 2016; Edmonds et al. 2016; Hawkins and Popper 2014). Particle motion effects dissipate rapidly and are highly localized around the noise source. Studies of the effects of intense noise sources on invertebrates, similar in magnitude to those expected from the Project construction, found little or no measurable effects even in test subjects within 3.3 feet (1 meter) of the source (Edmonds et al. 2016; Payne et al. 2007). Jones et al. (2020, 2021) evaluated squid sensitivity to high-intensity impulsive sound comparable to monopile installation. They observed that squid displayed behavioral responses to particle motion effects within 6.6 feet (2 meters) of high-intensity impulsive noise. They further theorized that squid in proximity to the seabed might be able to detect particle motion from impact pile driving imparted through sediments several hundred meters from the source, eliciting short-term behavioral responses lasting for several minutes. Other researchers have found evidence of cephalopod sensitivity to continuous low-frequency sound exposure comparable to sound sources like vibratory pile driving (Andre et al. 2011).

Very little is known about the sensitivity of aquatic animals to the energy that is generated within and close to the substrate (Hawkins et al. 2021). Roberts et al. (2015) observed behavioral changes to blue mussels (*Mytilus edulis*) in response to experimental seabed vibration stimulus. The responses show that a vibration is likely to impact the overall fitness of both individuals and beds of blue mussels. It is not known how energetically costly the behaviors exhibited in their experimental work were, or to what extent they would affect the long-term fitness of the animals (Roberts et al. 2015). Sound-detection organs vary widely among fishes and invertebrate species, and it is likely that detection capabilities and sensitivities may differ substantially between species (Hawkins et al. 2021).

The current threshold classification considers effects on fish mainly through sound pressure without taking into consideration the effect of particle motion. Popper et al. (2014) and Popper and Hawkins (2018) suggest that extreme levels of particle motion induced by various impulsive sources may also have the potential to affect fish tissues and that proper attention needs to be paid to particle motion as a stimulus when evaluating the effects of sound on aquatic life. However, lack of evidence for any source due to extreme difficulty of measuring particle motion and determining fish sensitivity to particle motion renders establishing guidelines or thresholds for particle motion exposure currently not possible (Popper et al. 2014; Popper and Hawkins 2018). Spawning longfin squid that aggregate to spawn could be startled and potentially flee the area and/or cease spawning activity, which could indirectly affect other EFH species in the Project area that prey on this species (e.g., Atlantic cod, pollock, haddock, silver hake, and flounder). However, as this would be a localized effect, it is unlikely to have population-level impacts on these species.

Table 5-1. Acoustic Metrics and Thresholds for Fish for Impulsive Pile Driving

Fish Type	Physiological Effects		Behavioral Disturbance[c]
	L_{pk} (dB re 1 µPa)	L_e, 24 hr (dB re 1 µPa^{2}s)	L_p (dB re 1 µPa)
	Impulsive	Impulsive	Impulsive/Non-Impulsive
Fish (≥ 2 grams)[a]	206	187	150
Fish (< 2 grams)[a]	206	183	150
Fish without swim bladder[b]	213	216	150
Fish with swim bladder not involved in hearing[b]	207	203	150
Fish with swim bladder involved in hearing[b]	207	203	150

Notes: [a] FHWG 2008; [b] Popper et al. 2014; [c] Andersson et al. 2007, Wysocki et al. 2007, Mueller-Blenkle et al. 2010, Purser and Radford 2011

> = greater than; < less than; dB re 1 µPa = decibels relative to 1 micropascal; dB re 1 μPa^2s = decibels relative to 1 micropascal squared second

L_{pk} = peak sound pressure level; $L_{E,24h}$ = cumulative sound exposure level over 24 hours L_p = sound pressure level

Impact Pile Driving

Underwater noise generated by impact pile driving is one of the predominant impact producing factors that could result in potential physiological and behavioral impacts on EFH species due to the relatively high source levels produced by impact pile driving and the large distances over which the noise is predicted to propagate. Up to 87 WTG foundations and 1 OCS-DC foundation with four legs would be installed. The typical SRWF WTG foundation pile installation would require approximately 1 to 4 hours of impact pile driving to a final embedment depth of 164 ft (50 m) below the seafloor, with some difficult installations potentially taking up to 12 hours to install due to more difficult substrate conditions. After installation, the WTG would be placed on top of the foundation pile and the vessels would be repositioned to the next site. Between one and three WTG monopile foundations may be installed per day.

Monopile foundations for WTGs would be up to 7/12 m in diameter and installed using an impact pile driver with a maximum hammer energy of up to 4,000 kilojoules (kJ). The pin piles used to secure the OCS-DC piled jacket foundation would be up to 13 ft (4 m) in diameter and installed using an impact pile driver with a maximum hammer energy of up to 4,000 kJ. The exact location and number of piles to be installed each day is uncertain, thus five scenarios are summarized in the following list. The first two scenarios assumed consecutive (non-simultaneous) pile installation while the third through fifth scenarios assumed concurrent (simultaneous) pile installations:

1. Sequential installation of two WTG monopiles a day with 1 day of three monopiles and the four OCS-DC pin piles consecutively in 1 day for 45 days
2. Sequential installation of three WTG monopiles a day and the four OCS-DC pin piles consecutively in 1 day for 31 days
3. Concurrent and sequential operations; proximal assumptions for concurrent piling of WTG foundations (two vessels, each installing two monopiles per day) and sequential piling of the remaining WTG foundations (one vessel installing three monopiles per day) and the OCS-DC foundation for a total of 24 days
4. Concurrent and sequential operations; distal assumptions for concurrent piling of WTG foundations (two vessels, each installing two monopiles per day), and sequential piling of the remaining WTG foundations (one vessel installing three monopiles per day) and the OCS-DC foundation for a total of 24 days
5. Concurrent and sequential operations; proximal assumptions for concurrent piling of WTG foundations (one vessel installing two monopiles per day) and the OCS-DC foundation (one vessel installing four pin piles per day), and sequential piling of the remaining WTG foundations (one vessel installing two monopiles per day and one vessel installing the remaining three monopiles per day) for a total of 43 days

For the OCS-DC foundation, the jacket foundation would be placed first, with the pin pile placed through the jacket and driven to its penetration depth (295 ft [90 m]). Pile driving of each pin pile may take up to 48 hours. Because separate vessels are anticipated to be used for WTG and OCS-DC foundation installations, these activities may occur concurrently. Pile driving activities would occur on up to 43 days between May 1 and December 31; no pile driving activities would occur between January 1 and April 30.

The applicant proposes a number of APMs to reduce noise propagation during pile driving. The Project would use bubble curtains, plus AdBm with air flow optimization, to reduce noise propagation during monopile foundation pile driving. The Project is committed to achieving ranges associated with 10 dB of noise attenuation. The final selection of the single or suite of technologies that comprise Noise Attenuation Systems (NAS) would be dependent upon the pile and environmental characteristics of the piling location. In addition, PAM for protection of cetaceans which would also be protective of EFH and EFH species and would monitor for cod vocalizations as well. There would be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods, piling, and post-piling monitoring periods. During pile-driving activities, ramp up procedures would be used, allowing mobile resources to leave the area before full-intensity pile driving begins. No pile installation would occur from January 1 to April 30.

Acoustic impacts on fish and invertebrates due to pile driving would vary depending on the ability of the organism to detect sound pressure and whether the air bladder and auditory system are linked, making the species more sensitive to sound impacts (Popper et al. 2014). Fish hearing categories from least sensitive to most sensitive are organisms without swim bladders (invertebrates, flatfish, some tunas, and sharks), fish with swim bladders not involved in hearing (sturgeons, striped bass, yellowfin and bluefin tuna), and fish with swim bladders involved in hearing (some tuna species, gadids, herring; Popper et al. 2014). These categories are shown in Table 5-2.

Table 5-2. Fish and Invertebrates Categorized by Hearing and Susceptibility to Sound Pressure

Category	Description	Examples	Hearing and Susceptibility to Sound Pressure
1	Fish without swim bladder or hearing associated gas chamber, invertebrates (shellfish, cephalopods), fish eggs and larvae	Flatfish, monkfish, sharks, and some tunas,	Species are less susceptible to barotrauma. Detect particle motion but not sound pressure, but some barotrauma may result from exposure to sound pressure. Invertebrate species have no air bladder or associated gas chamber for hearing. Invertebrate susceptibility to noise impacts is likely similar to fish with no swim bladder.
2	Fish with swim bladder that does not affect hearing	Bluefish, butterfish, scup, some tunas	Species have a swim bladder, but hearing is not connected to it or other associated gas chamber. Species detect only particle motion but are susceptible to barotrauma.

Category	Description	Examples	Hearing and Susceptibility to Sound Pressure
3	Fish with swim bladder or gas chamber associated with hearing (hearing generalist)	Atlantic herring, black sea bass, gadids.	Hearing connected to swim bladder or other associated gas chamber. Species detect sound pressure as well as particle motion and are most susceptible to barotrauma.

Source: Popper et al. 2014

Noise from impact pile driving for the installation of WTGs and OCS foundations would occur intermittently during the installation of offshore structures. Up to 87 foundations for WTGs and one for the OCS are anticipated for the Proposed Action. Each WTG requires one monopile and each pile requires 1 to 4 hours of continuous driving to install, with a maximum continuous driving time of 12 hours. The OCS-DC would be placed on an up to four-legged piled jacket foundation. Acoustic propagation modeling of the impact pile-driving activities was undertaken by JASCO Applied Sciences to determine distances to the established injury and disturbance thresholds for fish (Küsel et al. 2022.). Dimensions of the piles considered during modeling were: 8 to 12-meter tapered monopiles (23 feet [7 meters] at the waterline and 39 feet [12 meters] at the mudline. Impact hammer installation of the monopile foundations would produce the most intense underwater noise impacts with the greatest potential to cause injury-level effects on fish; therefore, these effects are the focus of the assessment below. Sound fields from 7/12-meter monopiles were modeled at one representative location in the offshore Project area using IHC S-4000 impact hammers. The modeling also used a 10-decibel (dB)-per-hammer-strike noise attenuation to incorporate the use of a single noise-abatement system[3] (e.g., one or multiple bubble curtain[s]). This attenuation is considered achievable with currently available technologies (Bellmann et al. 2020). The resulting values represent a radius extending around each pile where potential injurious-level or behavioral effects could occur and are presented in Table 5-3.

Soft start during impact pile driving is a mitigation technique that involves the gradual increase in hammer blow energy to allow marine life to leave the area.

Although some fish may move during pile driving, they were considered static receivers and acoustic distances where sound levels could exceed fish regulatory thresholds were determined using a maximum-over-depth approach and finding the distance that encompasses at least 95 percent of the horizontal area that would be exposed to sound at or above the specified level (Küsel et al. 2022).

Table 5-3. Acoustic Ranges to Fish Thresholds for Monopile and Pin Pile Foundation Installation with 10 dB Attenuation (Two Monopiles/24 Hours or Three Pin Piles/24 Hours)

Faunal Group	Metric	Threshold	Monopiles - R95% (km)[a]	Pin Piles - R95% (km)[b]
Fish ≥ 2 grams	LE,24h	187	8.66	4.05
	Lpk	206	0.07	0.06

3 Note that the noise-abatement system implemented must be chosen, tailored, and optimized for site-specific conditions.

Faunal Group	Metric	Threshold	Monopiles - R95% (km)[a]	Pin Piles - R95% (km)[b]
	Lrms	150	7.54	5.32
Fish < 2 grams	LE,24h	183	11.59	5.69
	Lpk	206	0.07	0.06
	Lrms	150	7.54	5.32
Fish without swim bladder	LE,24h	216	0.43	0.06
	Lpk	213	0.02	0.01
Fish with swim bladder not involved in hearing	LE,24h	203	2.38	0.64
	Lpk	207	0.07	0.05
Fish with swim bladder involved in hearing	LE,24h	203	2.38	0.64
	Lpk	207	0.07	0.05

Source: Küsel et al. 2022

a Maximum R95% (km): hammer energy 4000kJ, penetration depth 50 meters. Monopile foundations have 8- to 11- meter diameter. Assumes two monopiles per 24 hours. Results presented are for location G10 (Küsel et al. 2022).

b Maximum R95% (km): hammer energy 2500kJ, penetration depth 60 meters, winter scenario. Jacket foundations have 2.44-meter diameter. Assumes 3 pin piles per 24 hours.

dB = decibels; kJ = kilojoules; km = kilometers; R95% = maximum acoustic range at which the sound level was encountered after the 5% farthest points were excluded; LE,24h = cumulative sound exposure level over 24 hours; Lpk = peak sound pressure level; Lrms = sound pressure level root mean squared

The single strike (or peak sound pressure level [L_{pk}]) injury distances represent how close a fish would have to be to the source to be instantly injured by a single pile strike. The cumulative injury distances consider total estimated daily exposure, meaning a fish would have to remain within that threshold distance over an entire day of exposure to experience injury. The exposure distances for behavioral effects are instantaneous values, meaning that any animal within the effect radius is assumed to have experienced behavioral effects.

The likelihood of injury from monopile installation depends on proximity to the noise source, intensity of the source, effectiveness of noise attenuation measures, and duration of noise exposure. Results from the modeling show that injury from a single strike is limited to 70 meters from the pile for both winter and summer seasons and injury from prolonged cumulative exposure (over 24 hours) extends as far as 9.35 kilometers from the pile during the winter water profile. Modeling indicates that behavioral effects on fish could occur up to 7.54 kilometers from the pile source during the winter and 5.18 kilometers from the pile source during the summer. Within this area, it is likely that some level of behavioral reaction is expected and could include startle responses or migration out of areas exposed to underwater noise (Hastings and Popper 2005). Behavioral disturbance to fish from pile driving noise is therefore considered temporary for the duration of the activity. To mitigate impacts to the extent practicable, the Project would employ a bubble curtain. Additionally, the Project would employ soft starts during impact piling, allowing a gradual increase of hammer blow energy, thus allowing mobile marine life to leave the area. Soft starts would be employed on the Project such that prior to the commencement of any impact pile driving.

Noise from pile driving would cause short-term stress and behavioral changes to some EFH-designated species. Sound transmission depends on many environmental parameters, such as the sound speed in the water and substrates. It also depends on the sound production parameters of a pile and how it is driven, including the pile material, size (length, diameter, and thickness), and the make and energy of the hammer (Küsel et al. 2022). Fish response would be highest near impact pile driving (within tens of meters), moderate at intermediate distances (within hundreds of meters), and low at further distances from the pile (within thousands of meters) (Küsel et al. 2022). During active pile driving activities, highly mobile finfish likely would be displaced from the area, most likely showing a behavioral response; however, fish in the immediate area of pile driving activities could suffer injury or mortality. Affected areas would likely be recolonized by finfish in the short-term following completion of pile driving activity. Early sessile life stages of finfish, including eggs and larvae, could experience mortality or developmental issues as a result of noise; however, thresholds of exposure for these life stages are not well studied (Weilgart 2018).

Species occurring in the SRWF that are most sensitive to noise associated with pile driving activities would be fishes that have a swim bladder involved with hearing (Category 3, i.e., Atlantic herring, gadids such as Atlantic cod). With no attenuation (0 dB), these species are potentially subject to mortality or mortal injury at over a thousand meters from the noise source, depending on the type of monopile or jacket being installed. Mortality appears to occur most often when fish are within 30 ft (9.1 m) of driving of relatively large diameter piles (Küsel et al. 2022). Studies conducted by California Department of Transportation (2001) resulted in some mortality for several different fish species exposed to driving of steel piles 8 ft (2.4 m) in diameter, whereas Ruggerone et al. (2008) found no mortality to caged yearling coho salmon (*Oncorhynchus kisutch*) placed as close as 2.0 ft (0.6 m) from a 1.5-ft (0.45-m) diameter pile and exposed to more than 1,600 strikes.

Popper et al. (2014) identified specific injury thresholds for hearing specialist fish species. Hearing specialists are species such as Atlantic cod and other gadids that have a swim bladder that is directly connected to the inner ear through physiological structures or is in direct proximity to hearing organs and involved in hearing. Hearing specialization is often associated with intra-specific communication that can be disrupted by changes in the ambient noise environment. For example, spawning Atlantic cod communicate using low-frequency grunts to locate potential mates and signal fertility. Changes in ambient noise can interfere with communication and potentially disrupt spawning activity (Rowe and Hutchings 2006). Underwater noise sufficient to alter behavior or cause TTS could have disruptive effects on cod spawning (Dean et al. 2012), such as actively occurring pile driving.

Environmental stressors such as noise can cause masking, which could interfere with communication and potentially disrupt spawning activity (Rowe and Hutchings 2006). Underwater noise sufficient to alter behavior could have disruptive effects on Atlantic cod spawning (Dean et al. 2012), especially at night, as Atlantic cod courtship and spawning behaviors occur primarily at night (Dean et al. 2014; Zemeckis et al. 2019). However, once the environmental stressor (noise) is discontinued, the masking stops. Foundation installation for the Project is the most likely to produce impacts that would temporarily disturb aggregated Atlantic cod during spawning season. A few species with an air bladder not involved in hearing have designated EFH in the SRWF (Category 2, i.e., yellowfin tuna, bluefin tuna).

Mortality and potential mortal injuries from cumulative pile-driving noise to species with an air bladder not involved in hearing could occur within a maximum range of 3,786 to 4,829 feet (1,154 to 1,472 meters) from the source with no attenuation (Popper et al. 2014). Included in this category are fish eggs and larvae. While eggs and larvae may be less vulnerable to the impacts of sound pressure, their inability to escape would likely subject those within the radial distance to injury and mortality.

The least-impacted species with EFH designation in the SRWF include those species in Category 1, such as invertebrates, sharks, flounders, and some tunas. These species do not have an air bladder and rely on particle motion for hearing, reducing any damage induced by sound pressure (Popper et al. 2014). Mortality and potential mortal injury from pile driving sound for these species has the smallest radius, ranging from 755 to 1,152 ft (230 to 351 m) with no attenuation. Included in this group are sessile species (Atlantic surfclam and ocean quahog). Although these species are less sensitive to sound pressure, they are similar to eggs and larvae in that they cannot avoid or retreat from potentially damaging sound pressure and would be subject to injury and mortality when sound pressure occurs within a certain radial distance from pile driving.

Hearing Categories: Impact pile driving would produce acoustic impacts that would adversely affect EFH for Hearing Category 1, Hearing Category 2, and Hearing Category 3 (Table 5-2). Species in these groups could exhibit physiological and behavioral impacts depending on intensity and duration of the acoustic impact, distance from the sound source, and hearing sensitivity. Hearing Category 1 includes those species and life stages least sensitive to acoustic stressors so would have the least impacts; Hearing Category 2 would exhibit moderate impacts, and Hearing Category 3 would be impacted the greatest. The noise levels would temporarily make the habitat less suitable and cause individuals to vacate the area of Project activities. Pile driving during site preparation activities is anticipated to cause adverse impacts to EFH for both pelagic and demersal life stages; however, this impact would be short-term and EFH is expected to return to pre-pile driving conditions.

Effects on EFH and EFH species:

- Direct
    - Short-term, direct effects on EFH and EFH species and life stages for all Hearing Categories, with greatest impacts to Hearing Category 3 species and life stages.
    - Short-term, direct effects on EFH of all Species Groups: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Benthic/Epibenthic; Prey Species – Pelagic.

Habitat Loss/Conversion

Development of the SRWF would include installation of up to 87 WTGs and their foundations, and one OCS-DC and foundation. The installation of the WTGs and OCS-DC would permanently alter benthic habitat by introducing new hard surfaces to the seabed. Additionally, these vertical structures, extending from the seabed to the water surface would alter the character of pelagic habitats used by many EFH-designated species and their prey and foraging resources. Over time, these new hard structures would become colonized by sessile organisms, creating complex habitats that effectively serve as artificial reefs within the SRWF.

Impact footprints for WTG foundations intersect complex, large grain complex and soft bottom habitat types. Impact footprints for OCS-DC foundations intersect complex and soft bottom habitat types. WTG foundation footprints would permanently impact all three habitat types, with each 39-ft (12-m) turbine foundation footprint permanently altering approximately 0.03 acres (121.41 m^2) of benthic substrate, for a total of 2.61 acres (1.06 ha) of benthic impacts. OCS-DC foundation footprints would permanently alter approximately 0.24 acres (0.097 ha).

The WTG and OCS foundations would displace approximately 0.85 acres (0.34 ha) of complex habitat, 0 acres of large-grained complex habitat, and 1.58 acres (0.64 ha) of soft bottom habitat. These habitats would no longer be available to EFH species such as gadids, flatfish, and skates for the life of the Project.

An estimated 32.94 acres (13.33 ha) of complex habitat, 0.11 acres (0.04 ha) of large-grained complex habitat, and 55.8 acres (22.58 ha) of soft bottom habitat would be modified by placement of scour protection around the WTG and OCS foundations. These natural habitats would no longer be available to EFH species for the entire life of the Project and could potentially be permanent if scour protection is not retrieved from benthic habitat after project decommissioning.

If concrete mattresses are used for scour protection, it could take 3 to 12 months to fully cure after placement. Curing concrete can have surface pH levels as high as 11 or 12, rendering the surfaces of these structures toxic to sessile eggs, larvae, and invertebrates (Lukens and Selberg 2004). As such, the installation of these project features would result in a diminishing intermediate-term adverse effect on EFH. These features may or may not be removed when the project is decommissioned, depending on the habitat value they provide.

Potential effects to the food web from the loss or modification of benthic habitat would be limited to increases in biomass and slight shifts in community composition. Stable isotope analysis of colonizing organisms on wind turbines in the Belgian North Sea suggests that the trophic structure is differentiated by depth, likely associated with different food sources (Mavraki 2020; Mavraki et al. 2020). Around the base of the monopiles, colonizing organisms on the surface of the pile would likely enhance food availability and food web complexity through an accumulation of organic matter (Degraer et al. 2020; Mavraki et al. 2020). This accumulation could lead to an increased importance of the detritus-based food web but is unlikely to result in significant broad-scale changes to the local trophic structure (Raoux et al. 2017). Modification of benthic habitat is not expected to significantly impact the food web for EFH species.

The artificial reef effect created by offshore structures like WTGs is well documented and can have a beneficial effect on many marine species (Reubens et al 2013; Wilhelmsson et al. 2006). This can lead to localized increases in fish abundance and changes in community structure. In a meta-analysis of studies on windfarm reef effects, McCandless et al. (2014) observed an almost universal increase in the abundance of epibenthic and demersal fish species. Effects on pelagic fish species are less clear (Floeter et al. 2017; McCandless et al. 2014). On balance, and due to the relatively localized spatial extent of the project, the reef effect of offshore windfarms is likely to produce a neutral effect on EFH. Any potential beneficial effects could be offset if the colonizable habitats provided by offshore wind energy structures aggregate predators and prey, increasing predation risk, or provide steppingstones for non-native species invasions (Gill 2005; Raoux et al. 2017). The net effect of WTGs on pelagic EFH is likely to be neutral to adverse depending on species-specific responses, with the recognition that beneficial effects could be negated should these structures inadvertently promote the establishment of invasive species. In addition to reef effects, the WTGs are likely to create localized hydrodynamic effects that could have localized effects on food web productivity and pelagic eggs and larvae. Hydrodynamic effects on EFH are described further in Section 5.1.3.3. Over time, the attractive effects of the structures and complex habitats formed by the maturing reef effect are also expected to alter food web dynamics in ways that may be difficult to predict. Colonization of the new hard surface habitat typically begins with suspension feeders and progresses through intermediate and climax stages (6+ years) characterized by the codominance of plumose anemones and blue mussels (Degraer et al. 2020; Kerckhof et al. 2019). Suspension feeders can act as biofilters, transferring pelagic nutrient resources to the benthic community and decreasing pelagic primary productivity (Slavik et al. 2018). The trophic resources used by suspension feeders could include pelagic eggs or larvae of EFH species, as well as ichthyoplankton prey resources. This could result in a local decrease of eggs and larvae but is unlikely to impact the reproductive success of the affected species as a whole or have more than a localized effect on prey availability for EFH species. As noted above, the colonization of the WTGs could also attract fish due to the increase in resource availability and shelter. This aggregation and change in resource availability could lead to shifts in food web dynamics. While localized effects are possible, ecosystem modeling studies of a European windfarm showed little difference in key food web indicators before and after construction (Raoux et al. 2017). Even though the biomass of certain taxa increased in proximity to the wind farm, trophic group structure was functionally similar between the before and after scenarios. Thus, large-scale food web shifts are not expected due to the installation of WTGs and conversion of pelagic habitat to hard surface. EFH and life stages likely to experience adverse to neutral impacts from the long-term alteration of pelagic habitats by the WTG and OCS foundations include gadid eggs and larvae, flatfish eggs and larvae, pelagic juvenile and adult fishes, all life stages of various shark species, and squid juveniles and adults.

Effects on EFH and EFH species:

- Direct
  - Long-term adverse effects to EFH and EFH species/life stages due to decrease in preferred habitat for: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Prey Species – Benthic/Epibenthic species groups.
  - Long-term beneficial effect to EFH and EFH species/life stages due to increase in preferred habitat: Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Benthic/Epibenthic; Prey Species – Pelagic.
- Indirect
  - Long-term adverse effects to EFH and EFH species due to potential increased predation risk associated with aggregation effect: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Pelagic; Prey Species – Benthic/Epibenthic species groups.

- Long-term beneficial effects to EFH and EFH species.

Drilling

In typical situations, piles are driven until the target embedment depth is met, then the pile hammer is removed and the monopile is released from the pile gripper. If unfavorable sediment conditions do not allow pile driving, a drive-drill-drive solution could be required. In some cases, instead of hammer piling or drilling, vibropiling could be used to embed the foundation with vibration.

If pile driving for the entire piling installation is not possible due to the presence of rock or hard sediment in some lower part of the substrate, the drive and drill method would be used. When the pile meets a point where it cannot be advanced (referred to as refusal), the monopile would be drilled out below the pile tip (typically several feet). Then, the piling would be resumed and piled to its final position. If refusal occurs again, the drilling/driving would continue until the monopile has reached its final position.

If drilling occurs during WTG and OCS foundation installation, direct impacts to benthic EFH and sessile or slow-moving EFH would occur. It is unclear whether or not the sound emitted by marine drilling activities impacts fish. The available literature suggests that noise effects on fish produced by continuous drilling operations may mask acoustic signals conveying important environmental information (McCauley 1998, Popper et al. 2014). Masking may arise when sounds exceed the hearing thresholds of fish and it is probable that, within close proximity to drilling operations, sounds would reach above the recommend thresholds. McCauley (1998) determined that any noise effects to fish from marine drilling activity would likely be temporary behavioral changes within a few hundred meters of the source. For instance, measured source levels during drilling operations reached 120 dB at 3–5 km, which may have caused fish avoidance (McCauley 1998). Recordings of planktivorous fish choruses were still active during drilling operations off the coast of the Timor Sea; however, it is likely that partial masking of their calls would have occurred (McCauley 1998). The sounds emitted by marine drilling operations for wind farm construction are expected to be short-term and intermittent. It is therefore unlikely that the acoustic characteristics of this source would cause prolonged acoustic masking to fish and the risk of impact from this activity is expected to be low.

There are no data on the effect of sound from drilling on marine invertebrates. However, evidence from research on the levels of particle motion associated with behavioral responses in blue mussels indicates that the threshold of sensitivity in this species falls within vibration levels measured near blasting, pile driving, and impact drilling (Roberts et al. 2015). Only a small number of studies have indicated reception of vibration in bivalves and an associated behavioral response, which included closing siphons and, in more active mollusks, moving away from the substrate (Mosher 1972, Ellers 1995, Kastelein 2008). Anticipated drilling for the Project is typically short duration and intermittent, so it is unlikely that drilling has more than short-term consequences. Risk of impact to invertebrates from sounds emitted by marine drilling are expected to be low.

Drill spoils could cause short-term and localized increases in turbidity through sediment suspension and localized direct impacts to sessile or slow-moving organisms through sediment deposition and burial. Moreover, drill spoil would cause direct, short-term impacts on benthic habitat through habitat conversion around the perimeter of each foundation.

Effects on EFH and EFH species:

- Direct
  - Short-term, local increases in turbidity: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Benthic/Epibenthic; Prey Species – Pelagic.
  - Short-term, local deposition and burial: Sessile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Prey Species – Benthic/Epibenthic.
- Indirect
  - Short-term decrease in prey availability and foraging opportunities: Mobile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Pelagic.

5.1.1.3 Seabed Preparation (including UXO Removal/Boulder Relocation/Dredging)

Prior to installation of the SRWF WTG and OCS-DC foundations, the seabed around each foundation site would be prepared for construction by relocation of large boulders. This would result in both immediate crushing, burial, and entrainment impacts on EFH species and longer duration disturbance to habitat. This section considers the impacts to EFH species and habitats from short-term impacts associated with project construction. Construction-related disturbance, specifically boulder relocation and the installation of foundations and scour protection, would also result in long-term to permanent impacts to EFH species and habitats by modifying the structure and composition of pelagic and benthic habitat.

Habitat Loss/Conversion

Foundation preparation activities may be required depending on the seabed and the foundation type. Foundation preparation, if required, may include leveling and removal of surface or subsurface debris such as boulders and sandwaves, or in-situ UXO/MEC disposal (refer to Section 2.2.2 for discussion of the likelihood of encountering UXO/MEC and Sunrise Wind's plans to avoid UXO/MEC). Each 39-foot (12-meter) turbine foundation footprint would permanently alter approximately 0.07 acres (0.03 hectares) of benthic substrate, for a total of 2.43 acres (0.98 ha) of benthic impacts. OCS-DC foundation footprints would permanently alter approximately 1.58 acres (0.64 ha). Prior to installation of WTG and OCS foundations, seabed surface preparation may be required. An estimated 32.94 acres (13.33 ha) of complex habitat, 0.11 acres (0.04 ha) of large-grained complex habitat, and 55.8 acres (22.58 ha) of soft bottom habitat would be modified by placement of scour protection around the WTG and OCS foundations. These natural habitats would no longer be available to EFH species for the entire life of the Project and could potentially be permanent if scour protection is not retrieved from benthic habitat after project decommissioning. To prepare the seabed prior to installation, excavation may be required where debris is buried or partially buried.

Sand and Muddy Sand was the primary habitat type mapped within the SRWF (33,710 acres; approximately 56 percent of the area); Coarse Sediment was also mapped within the SRWF (22,723 acres; approximately 38 percent of the area) (see Table 3-2).

The occurrence of boulders is often an indicator of the presence of glacial moraine. Any boulders within close proximity to each monopile and the IAC centerline would need to be relocated to prepare the seabed for pile installation and jet plow. Foundation preparation activities prior to installation of WTG and OCS foundations may be required depending on the seabed and the foundation type. Other foundation preparation activities would include leveling of sand waves and removal of surface or subsurface debris. Excavation may be required where debris is buried or partially buried. Depending on micrositing of each foundation, short-term seafloor disturbance would take place within an approximately 3,206-acre (1,297.43 ha) area, comprised of 1,348.19 acres of complex habitat, 22.77 acres of large grain complex habitat, and 1,835.04 acres of soft bottom habitat.

Boulders would only be relocated in a sub-area of the 220 m (722 ft) radius, as subsequent pre-construction surveys at the site provide information on the relevant area for installation and operation. These sub-areas are defined based on the needs of the different installation and operation activities, including the WTG installation, the cable installation, operational and maintenance activities, and the possible replacement of major WTG components. The heading of the different vessels working around the positions (especially the jack-up vessel) must account for typical wind-wave climate at site, the cables around the position and the avoidance of pUXO/pMEC, cultural resources, or other exclusion zones, as well as avoiding boulder fields where possible. Since the cable layout and the boulders fields vary greatly for each position, the preferred heading and the required buffers of the installation vessels vary accordingly. The sub-areas of the 220 m (722 ft) radius boulder relocation area around each WTG have not yet been identified for Sunrise Wind, but they would be included in the applicable Seabed Preparation Facility Design Report/ Fabrication and Installation Report submission.

Boulders were identified based on the collected survey data and appear for 70 out of 87 potential WTG positions and the OCS-DC. Of these 70, a majority (49) have less than 10 boulders in a 220 m (722 ft) radius around the turbine center point area so minimal relocation would be required (personal communication, M. Evans, 2023b). Note that additional boulders may be identified during construction and may also require relocation/clearance. Relocated boulders that are within the designated boulder relocation area would be moved to the nearest point outside of the boulder relocation area to minimize the distance boulders are transported, to the extent practicable, and away from sensitive benthic habitat. Boulders may be relocated longer distances where technically necessary; however, exact locations where this could be warranted have not yet been identified.

Sensitive taxa and attached fauna are often associated with boulders. Boulder relocation would potentially alter the composition of both the original and relocated habitat. Over time, the relocated boulders would be recolonized, contributing to the habitat function provided by existing complex benthic habitat of relocated boulders. Benthic sessile or slow-moving organisms, such bivalves, eggs, or larvae that are within the area of impact would experience direct impacts from burial or removal. Benthic habitat that is not directly buried by WTGs and OCS foundations is expected to recover quickly. Long-term to permanent impacts of artificial structures associated with the Project, as well as affected species are discussed further in Section 5.1.3.1.

The affected areas would be rendered temporarily unsuitable for EFH species associated with complex, large grain complex, and soft bottom benthic habitats during one or more life stages. IAC, interconnection cables, and offshore export cable installation would therefore result in a short-term adverse effect on EFH lasting through surface preparation activities and installation but would be expected to recover shortly after installation.

Benthic or epibenthic eggs that occur within the SRWF Project area could be exposed to lethal crushing, burial, or entrainment effects. This includes eggs and larvae of selected EFH species, and eggs and larvae that provide prey for EFH species. Pelagic eggs and larvae of Atlantic cod and the pelagic eggs of red hake, two species of federally managed fish that are currently below target population levels and that have rebuilding plans in place, would be particularly vulnerable to mortality from entrainment effects. Crushing and burial impacts result from the placement of material on the substrate and would be lethal for benthic and epibenthic eggs and larvae that do not have the ability to avoid the area. The following EFH species with benthic, epibenthic, or pelagic eggs or larvae that may be exposed to crushing, burial, or entrainment effects during SRWF construction and installation.

EFH species with benthic or epibenthic adults that occur within the SRWF Project area could be exposed to lethal crushing, burial, or entrainment effects. Adults of EFH species in the area are likely to exhibit behavioral avoidance responses and would not be subject to lethal crushing, burial, or jet plow entrainment effects. However, during placement of material on the substrate, there is potential for adult fish utilizing benthic or epibenthic habitats to be crushed or buried. For example, Ocean pout, monkfish, winter flounder, winter skates, little skates, Atlantic cod, and red hake are benthic or epibenthic EFH species known to be associated with the various bedform features (i.e., low- to medium-boulder fields, ripples, and linear depressions) and CMECS Substrate Subgroup types (e.g., gravelly sand, sandy gravel, coarse sand, medium sand, and fine sand) present in each Lease Area zone and subject to impacts from seabed preparation for WTG and OSS foundations. Ocean pout, a species of fish that guards benthic nests, could be seasonally vulnerable to being crushed or buried. Benthic invertebrates and other prey organisms targeted by these species would be killed or otherwise rendered inaccessible by burial and entrainment effects. While unlikely, use of the jet plow during the inter-array cable installation could result in lethal entrainment of adult fish within the disturbance area. EFH species having benthic or epibenthic adult life stages that are known or likely to occur within the spatial extent of crushing, burial, and jet plow entrainment effects from SRWF construction and installation include:

Effects on EFH and EFH species:

- Direct
    - Long-term localized adverse effects to EFH and EFH species/life stages due to decrease in preferred habitat for: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Prey Species – Benthic/Epibenthic species groups.
    - Long-term localized adverse effects to EFH and EFH species/life stages due to decrease in preferred habitat for: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Prey Species – Benthic/Epibenthic species groups.
- Indirect
    - Short-term loss of benthic prey items: Mobile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Complex.

Sediment Suspension

Seabed preparation activities (e.g., removal of debris or seabed leveling) would result in short-term and localized resuspension and sedimentation of finer grain sediments. Hydrodynamic and sediment transport modeling were conducted to assess the sediment suspension and resulting deposition from proposed construction activities and are detailed in Section 5.1.1.1. Modeling demonstrated that sediments within the SRWF would return to ambient levels within 0.4 hours after the disturbance was completed. These effects would occur intermittently at varying locations in the Project area over the duration of project construction but are not expected to cause permanent effects on EFH quality. Depending on the nature, extent, and severity of each effect, this may temporarily reduce the suitability of EFH for managed species, which would result in short-term adverse effects on EFH for those species. Indirect impacts to EFH could occur as a result of sediment suspension, temporarily decreasing foraging success due to increased turbidity. It would be expected that normal foraging behavior would resume following completion of installation and settlement of suspended sediments.

Although Sunrise Wind plans to avoid all pUXO/pMEC targets, encountering UXO/MEC is still a potential emergent situation. Low order (deflagration) or high order (detonation) in-situ disposal of UXO/MEC has the potential to affect benthic resources. UXO/MEC disposal has the potential to cause disturbances to the seafloor (sediment suspension and deposition) as well as noise. Impacts would be expected to be short-term and direct, with the potential to cause injury or mortality to benthic species within the direct vicinity of the disposal activities.

Changes to the project design and additional impacts that were not considered in the EFH assessment could occur in the unlikely event that UXO/MEC are discovered in the project footprint. These changes could include additional micrositing of monopile foundations and cable routes to avoid UXO/MEC hazards, and/or the removal and relocation of UXO/MEC to other locations on the seabed where avoidance is not practicable. The relocation of project features would result in the same type of short-term construction-related and long-term operational impacts as those described in the EFH assessment, but the location, extent, and distribution of those impacts by habitat type may vary. These changes could, in theory, limit the ability to avoid impacts to complex benthic habitat in specific circumstances. The removal and relocation of UXO/MEC would result suspended sediment effects from mechanical disturbance of the seabed as those described for project construction in the EFH assessment, but the extent of those impacts would marginally increase as a result of UXO/MEC relocation.

Regardless of mitigation strategy, any change in impact area resulting from potential UXO/MEC risk avoidance remains unknown but would likely to be small relative to the effects of project construction. Those effects would be similar in nature to the short-term crushing and burial effects considered in the EFH assessment and would not alter the effect determination in the EFH assessment for any EFH species. Further coordination with the appropriate federal agencies (e.g., NMFS) would occur as appropriate if UXO/MEC mitigation requires action that was not considered in this consultation. Detailed information on UXO/MEC is provided in *Technical Memorandum: Underwater Acoustic Modeling of Detonation of Unexploded Ordnance (UXO) for Ørsted Wind Farm Construction, U.S. East Coast* (Hannay and Zykov 2022).

Underwater Sound (UXO/MEC Detonation)

Sunrise Wind is planning to avoid all known pUXO/pMEC targets; however, they may encounter unexpected UXO/MEC on the seabed in the Lease Area and along export cable routes. While low impact deflagration is proposed to remove these items, as discussed above, some may need to be removed by explosive detonation. Underwater explosions of this type generate high pressure levels that could kill, injure, or disturb fish. Sunrise Wind conducted modeling of acoustic fields for UXO detonations and ranges to physiological injury were calculated (Hannay and Zykov 2022). Recent evidence has indicated large areas of continuous, large-grained and complex habitats, including medium- and low-density boulder fields in the SRWF support spawning cod (BOEM pers. comm. 2022). Direct mortality, disturbance of spawning cod aggregations, and damage to complex habitats (including attached fauna and epifauna present that support adult cod) could negatively impact Atlantic cod. Table 5-4 summarizes the maximum ranges to physiological injury per charge weight for fish in all hearing groups.

Table 5-4. Maximum Ranges to Onset of Potential Mortal Injury and Mortality for Fish for UXO Charge Sizes with 10 dB Mitigation

Fish Hearing Group	Threshold	All sites: Maximum (m)				
		E4 (2.3 kg)	E6 (9.1 kg)	E8 (45.5 kg)	E10 (227 kg)	E12 (454 kg)
All Fish Hearing Groups	L_{pk}, 0-pk, flat: 229 dB	49	80	135	230	290

Source: Hannay and Zykov 2022. Note: Water Depth 50 m
*Minimum threshold (Popper et al. 2014)
dB = decibels; dB re 1 µPa = decibels relative to 1 micropascal; kg = kilograms; L_{pk} = peak sound pressure level

Modeling indicates that the distance for a UXO detonation to result in potential mortal injury and mortality for all fish hearing groups ranges between 49 m and 290 m (depending on charge weight). Fish in proximity to the UXO could be exposed to a detonation, potentially resulting in behavioral changes, physiological effects, potential mortal injury, or mortality. An APM of a dual noise mitigation system with a 10 dB attenuation would be implemented during all detonation events (Table 6-1). Distances in Table 5-4 were modeled with 10 dB mitigation. This APM, coupled with the unlikely detonation of UXO, the conservative approach to modeling distances (see Hannay and Zykov 2022), and the low number of potential detonations required for the Project (unknown, but modeled for no more than 10), reduces the potential for impacts.

For fish species that use swim bladders for hearing, Popper et al. (2014) suggests a high likelihood of TTS and recoverable injury at near and intermediate distances, where near refers to within a few tens of meters and intermediate refers to a few hundreds of meters. For fish species with swim bladders not used for hearing, the guidelines indicate high likelihood of recoverable impairment at near and intermediate distances but low levels of TTS at intermediate distances. For fish without swim bladders the guidelines indicate low likelihood of recoverable injury at intermediate distances and moderate likelihood of TTS at intermediate distances, and low levels of both effects at far distances of a few kilometers (Hannay and Zykov 2022). Hearing Categories: Impact pile driving would produce acoustic impacts that would adversely affect EFH for Hearing Category 1, Hearing Category 2, and Hearing Category 3 (Table 5-2). Species in these groups could exhibit physiological impacts depending on size of the UXO, distance from the sound source, and hearing sensitivity. Hearing Category 1 includes those species and life stages least sensitive to acoustic stressors so would have the least impacts; Hearing Category 2 would exhibit moderate impacts, and Hearing Category 3 would be impacted the greatest. The noise levels would temporarily make the habitat less suitable and cause individuals to vacate the area of Project activities. UXO demolition during site preparation activities is anticipated to cause adverse impacts to EFH for both pelagic and demersal life stages; however, this impact would be short-term and EFH exposed to acoustic impacts from UXOs is expected to return to pre-demolition conditions.

The applicant has proposed APMs to mitigate noise exposure from UXO detonation events. These include no UXO detonations from December through April and UXO detonations during nighttime hours. Sunrise Wind would use an NAS for all UXO detonation events and is committed to achieving the modeled ranges associated with 10 dB of noise attenuation. If a NAS system is not feasible, Sunrise Wind would implement mitigation measures for the larger unmitigated zone sizes, with deployment of vessels or use of an aerial platform adequate to cover the entire clearance zones.

Effects

- Direct
  - Short-term, direct effects on EFH and EFH species and life stages for all Hearing Categories, with greatest impacts to Hearing Category 3 species and life stages.
  - Short-term, direct effects on EFH of all Species Groups: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Benthic/Epibenthic; Prey Species – Pelagic.

Underwater Sound (Vessels)

The impacts and direct and indirect effects to EFH and EFH species due to underwater sound from vessels associated with seabed preparation would be similar to those impacts analyzed in Section 5.1.1.1 Vessel Activity.

5.1.1.4 Installation of Scour Protection

Habitat Conversion

The WTGs would extend up to 459 feet (140 meters) AMSL with the upper blade tip height of 787 ft (240 m) AMSL, with a spacing of 1.15 by 1.15 miles between WTGs in an east-west/north-south orientation that aligns with other proposed adjacent offshore wind projects in the RI-MA WEA and MA WEA within the 5,743.8-acre SRWF. The WTGs would be mounted on monopile foundations, and OCS would be placed piled jacket foundations. The WTG foundations would have a maximum seabed penetration of 164 feet (50 meters). Where required, scour protection would be placed around foundations to stabilize the seabed near the foundations, as well as the foundations themselves. The scour protection for the monopile foundations would be a maximum of 13.1 feet (4 meters) in height (inclusive of scour and rock protection) and would extend radially from the foundation approximately 5 times the monopile radius. For the OCS-DC piled jacket foundation, scour protection, if required, would extend a maximum of 66 feet (20 meters) from the base of the foundation and would total up to 13.1 feet (4 meters) in height.

Each WTG would contain about 1,850 gallons (7,000 liters) of transformer oil and 238 gallons (900 liters) of general oil (for hydraulics and gearboxes). Other chemicals used would include diesel fuel, coolants, refrigerants, grease, paints, and sulfur hexafluoride.

Development of the SRWF would include installation of up to 87 WTGs and their foundations, and the OCS-DC and foundation. The installation of the WTG and OCS-DC foundations would permanently alter 92.85 acres (37.6 ha) of benthic habitat per structure by introducing new hard surfaces to the seabed and water column. These vertical structures would extend from the seabed to the water surface and would alter the character of pelagic habitats used by many EFH-designated species and their prey and foraging resources. Over time, these new hard structures would become colonized by sessile organisms, creating complex habitats that effectively serve as artificial reefs within the SRWF.

In general, impacts from seabed disturbance would be localized and short-term with the exception of habitat conversion and/or loss due to the installation of the WTGs and OCS-DC foundations and associated scour protection, where required. It is anticipated that mobile life stages would move out of the area to avoid potential impacts. However, as more wind farms are installed the construction impacts become additive and species may not be able to entirely avoid effects. Demersal non-mobile life stages would be impacted due to the placement of foundations and scour protection in the immediate area of installation. Most juvenile and adult finfish would actively avoid all construction activities. However, immobile finfish life stages such as demersal eggs and larvae, and sessile organisms could experience mortality as a result of being crushed or buried by the foundations, scour protection, and vessel anchors within the SRWF footprint. Changes in distribution of finfish eggs and larvae caused by scour protection could potentially change estimated entrainment at the OCS-DC; however, these changes should not lead to population impacts. EFH-designated species that would likely be impacted by crushing and burial effects of installation of scour protection are similar to those listed in Section 5.1.1.1.

Effects on EFH and EFH species:

- Direct
    - Long-term adverse effects to EFH and EFH species/life stages due to decrease in preferred habitat for: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Prey Species – Benthic/Epibenthic species groups.
    - Long-term beneficial effect to EFH and EFH species/life stages due to increase in preferred habitat: Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Benthic/Epibenthic; Prey Species – Pelagic.
- Indirect
    - Long-term adverse effects to EFH and EFH species due to potential increased predation risk associated with aggregation effect: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Pelagic; Prey Species – Benthic/Epibenthic species groups.
    - Long-term beneficial effects to EFH and EFH species.

Sediment Suspension

Installation of the WTGs and the OCS-DC, as well as scour protection, would disrupt 108.12 acres (43.7 ha) of benthic habitat. Hydrodynamic and sediment transport modeling were conducted to assess the sediment suspension and resulting deposition from proposed construction activities and are detailed in Section 5.1.1.1. Modeling demonstrated that sediments within the SRWF would return to ambient levels within 0.4 hours after the disturbance was completed. A fall pipe is anticipated to be used to install scour protection around the foundations. Placement of scour protection may temporarily increase suspended sediments due to resuspension of bottom sediments. These benthic disturbances would increase turbidity and suspend sediment in the water column. Impacts to benthic habitat would occur locally and temporarily at each of the proposed WTG and OCS-DC locations. EFH-designated species that would likely be impacted sediment suspension due to the of scour protection are similar to those listed in Section 5.1.1.1.

Effects on EFH and EFH species:

- Direct
  - Short-term decrease in quality of EFH due to suspended sediments and increased turbidity: EFH for Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; and Pelagic species groups.
  - Short-term, local impacts due to sedimentation: Sessile Benthic/Epibenthic – Soft Bottom; Prey Species – Benthic.
- Indirect
  - Short-term loss of foraging opportunities: Mobile Epibenthic/Benthic – Soft Bottom; and Pelagic species groups.
  - Short-term decrease in quality of EFH in areas adjacent to Project activities for: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Summer Flounder HAPC; Prey Species – Benthic.

5.1.2 Inter-Array and Offshore Export Cable Installation

IAC and offshore export cable impact footprints would be dominated by the sand and muddy sand benthic habitat type. Cable impact footprints would include areas that could be impacted by seafloor preparation activities, cable installation, and cable protection. Impact footprints were calculated along indicative cable centerlines. Short-term disturbance activities to prepare the seafloor and lay the cables may potentially impact approximately 1,394.6 acres (564.4 ha), primarily categorized as soft bottom (56 percent) with some area categorized as complex (44 percent) and no large grain complex (0 percent). Cable protection may be required for up to 15 percent of the export cable route (up to 139 acres [56.3 ha]), with the project design envelope allowing for up to a maximum of 155 mi (249 km) with a maximum disturbance corridor width of 98 ft (30 m) per circuit for the IAC. The majority of the area that could be impacted by cable protection is classified as soft bottom.

Prior to cable installation, PLGR would be undertaken to remove any seafloor debris along the cable routes. The PLGR would be performed along the entire length of the cable routes, such that avoidance of complex habitat by the PLGR is not feasible. However, continued micrositing and engineering of cable routes would further avoid or minimize impacts to complex habitats. Preliminary micrositing of foundation locations and cables routes has been completed to minimize impacts to sensitive bottom habitat, and additional micrositing would be required as Sunrise Wind continues to review results of geophysical and geotechnical surveys.

The impact footprints associated with the SRWEC-OCS and SRWEC-NYS intersect 368 acres complex substrate, and 33,869 acres (13,706.3 ha) of soft bottom habitat. Impact footprints include those for seabed preparation activities, cable installation, installation of cable protection, and anchoring and sediment excavation associated with HDD at landfall. Short-term disturbance activities to prepare the seafloor and lay the cable may potentially impact approximately 2,150 acres (870.1 ha) of the seafloor, primarily soft bottom habitat (61 percent) with the remainder classified as complex (39 percent). Cable protection may be required for up to 15 percent of the route (up to 139 acres [56.3 ha]), Most of the area that could be impacted by cable protection was classified as soft bottom. HDD activities would result in less than 6.5 acres (2.6 ha) of short-term disturbance.

Primary habitats along the SRWC-OCS were characterized primarily by sandy and muddy sand (Table 3-2, Figure 3-6). The SRWEC-OCS included large-grained, complex, and soft bottom primary habitats (Figure 3-11). Coarse sediment habitats were observed along the export corridor near the SRWF and near the state waters boundary, but the majority of the mapped area was sand and muddy sand habitats with discrete areas of mud and sandy mud habitats and one area of mixed sediment – small gravel and sand habitat near where the corridor shifts to the west. Considering habitats with modifiers, sand and muddy sand was the most prevalent habitat type mapped at the SRWEC-OCS (50 percent), followed by sand and muddy sand – mobile (36 percent), and mud and sandy mud (9.4 percent). Coarse sediment – mobile consisted of 3.4 percent of the SRWEC-OCS. No boulder fields were mapped although individual boulders were identified in the portions of the corridor located further offshore. All IAC would be installed in a 30-m wide corridor. Boulders within 0.3 m (1 ft) to 2.4 m (7.9 ft) would typically be relocated just outside of the installation corridor with the boulder grab. Boulders maybe relocated larger distances where technically necessary. For the OCS-DC position, the preliminary area needed to ensure sufficient maneuvering space for installation, commissioning, operation, and maintenance vessels has been identified. Within this area, boulders within 0.5 m (1.6 ft) to 2.4 m (7.9 ft) in diameter may be relocated with the boulder grab. Only the immediate areas of boulder relocation activities would result in disturbance of the seabed. Most of the boulder relocation areas would remain largely undisturbed by the boulder relocation/clearance activities.

During this period, construction and installation would continue 24 hours a day as weather and other conditions allow, to minimize the overall timeline to complete construction and installation of the project. The timing and duration of specific activities may be modified by voluntary impact avoidance measures, seasonal restrictions, and other measures used to avoid and minimize impacts on sensitive species and the environment.

Biotic subclasses in the SRWEC-OCS were soft sediment fauna and attached fauna (Figure 3-11). The hard coral *Astrangia poculata*, a sensitive taxon, was not observed. Cerianthids (burrowing anemones) were observed at two stations in sand and muddy sand habitat where the corridor shifts to the west.

The sand and muddy sand habitats in the SRWEC-OCS were characterized by CMECS subgroups medium, fine, and very fine sand and accounted for 40 of the 81 SPI/PV ground-truth sites (Figure 3-12). Sand and muddy sand (mobile) included a coarse sand in the subgroup and accounted for 29 of the survey sites. The subgroup of very fine sand was present intermittently (9 sites) along the OCS corridor, coincident with mud and sandy mud. Gravelly sand, very coarse and coarse sand subgroups occurred at a total of 3 survey sites.

The spatial distribution of seabed composition was also reflected in the biological component of the benthic environment along the SRWEC-OCS. Generally, the western portion of the SRWEC-OCS was characterized by high densities of sand dollars while the eastern portion of the SRWEC-OCS was inhabited by burrowing anemones and sea stars. Gravel was not a substantial proportion of the sediments along the SRWEC-OCS and was not greater than 5 percent cover at any station, with the exception of two stations both of which were composed of gravelly sand (CMECS Substrate Subgroup;

i.e., 5-30 percent cover of gravel), with pebble/granule being the largest gravel at these two stations. A total of 19 percent of the SPI/PV sample stations included burrowing anemones.

The SRWEC would be installed in a 30-m (98 ft) wide corridor. Boulders within 0.3 m (1 ft) to 2 m (6.6 ft) would typically be relocated just outside of the installation corridor with the boulder grab. Boulders may be relocated larger distances where technically necessary. Along the SRWEC, boulder fields were only identified in the nearshore area of the SRWEC-NYS. Boulder fields are not encountered anywhere else along the SRWEC, although individual boulders were identified in some locations. Boulders would be relocated outside of the cable corridor. Further SRWEC routing would minimize the boulder relocation/clearance requirement and installation footprint across complex habitat.

SRWEC-NYS waters were characterized by soft sediments ranging from very fine sand to medium sand (Table 3-2, Figure 3-7) with evidence of generally low organic matter content and evidence of benthic microalgae at many survey stations. Macrohabitat characteristics indicated greater bedload transport nearer to shore with more distinct ripples in the sand as well as greater suspended material which contributed to higher turbidity. This trend indicates decreasing wave action effects proceeding from shallower waters out into deeper areas.

The SRWEC-NYS area included all primary benthic habitats except glacial drift. Coarse sediment habitats were found near the point where the SRWEC-NYS portion of the Project area widens nearshore (Figure 3-10). The majority of the SRWEC-NYS was composed of sand and muddy sand habitats. Of the habitats with modifiers, sand and muddy sand was the most prevalent (67 percent), followed by coarse sediment – mobile (15 percent), and sand and muddy sand – mobile (14 percent). Coarse sediment – mobile with medium/high density boulder fields made up less than 1 percent of the SRWEC-NYS. Biotic subclasses (Figure 3-11) were dominated by soft sediment fauna. The hard coral *Astrangia poculata*, a sensitive taxon, was not observed, and ceriantheids (burrowing anemones) were observed and were prevalent in sand and muddy sand habitats just inshore of the state waters boundary.

The sand and muddy sand habitat in the SRWEC-NYS waters were characterized by CMECS subgroups fine and very fine sand. Fine sand subgroups occurred at the single sand and muddy sand with boulder field site nearer shore and the sand and muddy sand. Coarse sediment habitat was characterized by medium, fin, and very fine sand subgroup.

The landing (landfall) area for the SRWEC includes up to 6.5 ac (2.6 ha) for HDD ducts, temporary anchoring walls, and drilling rig, in addition to 2.5 ac (1 ha) for the beach stringing area and trenching to the ICW-HDD crossing. Coastal habitats in the landing area relevant to the EFH assessment include those located within state waters and inland to the mainland, inclusive of bays and back-barrier lagoons (USFWS 1997) that separate the barrier islands from the coastal mainland on the Long Island south shore. At landfall, the cables intercept coastal habitats associated with the landfall/ICW-HDD work areas on Fire Island including maritime beaches, dunes, and grasslands, although the landfall/ICW work area on the mainland is primarily developed. The onshore facilities correspond with existing developed areas including parking lots and paved roadways.

The SRWEC-NYS intercepts the soft bottom sand before it reaches shore and emerges in the paved parking area at Smith Point County Park. From there, the cable corridor follows roadways and existing infrastructure until it meets the location of the ICW-HDD.

The ICW-HDD crossing included two primary habitats sand and muddy sand and coarse sediment. Sand and muddy sand was the dominant habitat type mapped and coarse sediment habitats were found along the ICW west of the bridge, coincident with the dredged navigational channel, and was represented by coarse sediment (Table 3-2).

Benthic habitat complexity categories were complex and soft bottom (Figure 3-14). Complex categories included present/potential presence of benthic macroalgae and/or SAV. Of the habitats with modifiers, sand and muddy sand was the most prevalent habitat type mapped within the ICW-HDD crossing (74 percent), followed by sand and muddy sand with recent and/or potential SAV and/or benthic macroalgae (18 percent), and coarse sediment (7 percent). Sands were observed except in coarse sediment habitats where gravelly sand and sandy gravel was recorded. Sand and muddy sand habitats were dominated by areas of potential and occurring benthic macroalgae and SAV, primarily on the west side of the ICW bridge (Figure 3-12).

Biotic subclasses included attached and soft sediment fauna (Figure 3-15). Coarse sand habitats in the ICW-HDD channel included 3 of the 8 SPI/PV ground-truth sites and were characterized by the sandy gravel, gravelly sand CMECS subgroup (Figure 3-16). Vegetated habitats (2 sites) and sand and muddy sand (3 sites) occurred along the shore were both characterized by sand or finer CMECS subgroups.

The ICW-HDD were more than 5 percent cover of gravel and were classified with the CMECS substrate group of either gravel mixes or gravelly. The remaining ICW-HDD area were classified as sand or finer. The biotic subclass of attached fauna occurred at stations composed of gravel, and the mobile sand present at the other stations in the ICW-HDD were classified with the biotic subclass of soft sediment fauna and included habitat for sensitive life stages present bryozoa and serpulid tubes. HAPC for summer flounder includes entire aquatic area of ICW.

The use of HDD would avoid impacts to SAV habitats and macroalgal mats; however, impacts could occur in the unlikely event of an inadvertent release of drilling fluid. The potential for a significant loss of drilling fluid in this inshore environment is considered to be low. Any unanticipated discharges or releases during construction are expected to result in minimal, temporary impacts; activities are heavily regulated, and discharges and releases are considered accidental events that are unlikely to occur. Additionally, where HDD is utilized, an Inadvertent Return Plan would be prepared and implemented to minimize the potential risks associated with release of drilling fluids. See also Section 2.2.2.

5.1.2.1 Vessel Activity

Habitat Disturbance

During installation of the IAC and SRWEC, up to 33 vessels would simultaneously lay and bury the cable using a mechanical plow, aided by a pull anchor and tugboat, while one vessel would be needed when using a jet plow. Vessels involved in cable installation would include main laying vessels, burial vessels, and support vessels. Vessels may require anchoring and/or spudding to facilitate construction activities.

Maximum total IAC length would be approximately 155 mi (249 km). Maximum total offshore export cable length would be approximately 104.6 miles (168.4 km). Short-term disturbance activities to prepare the seafloor and lay the SRWEC and Landfall HDD cables may potentially impact approximately

1,270.2 acres, primarily categorized as soft bottom (93 percent), with some area categorized as complex (7 percent) and no large grain complex (0 percent). Impacts to EFH would be expected to be similar to those listed in Section 5.1.1.1.

Localized impacts on sessile and or slow-moving benthic resources would occur in these areas. Sessile demersal and benthic life stages such as eggs and larvae would be subject to mortality from these activities. In addition, sessile and slow-moving benthic invertebrates such as bivalves would also likely be subject to mortality because of these activities. Mobile benthic organisms would be temporarily displaced by the anchors. Certain construction vessels would require stabilization spuds. The spuds would cause some localized direct impacts where they meet the sediment. Vessels may also have a direct impact via organism entrainment while taking on ballast water and engine cooling. Impacts from increased vessel traffic and construction activities would be short-term and localized in nature.

As mentioned in Section 5.1.1.1, anchoring impacts to bedforms such as ripples and megaripples could occur and result in short-term, indirect disturbance/conversion impacts to EFH and EFH species within the Project area. These features provide structural complexity, shelter, and opportunities for feeding and migration in high flow environments (Gerstner 1988). They may also play a role in mediating fish-prey interactions and provide shelter from predation (Auster et al., 2003). Alterations of these bedform features could impact EFH species present in the Project area during sensitive life history stages that rely on their mediating effects. EFH species present in the Project area that may utilize megaripples and ripples, as well as medium sands, coarse sands, fine sands, and very fine sands include Atlantic cod (adults), Atlantic herring (adults), Atlantic sea scallops (larvae, juveniles, and adults), little skates (eggs, juveniles, and adults), longfin squids (eggs and adults), monkfish (juveniles and adults), ocean pout (eggs, larvae, juveniles, and adults), red hake (larvae, juveniles, and adults), winter flounder (eggs, larvae, YOY, juveniles, and adults), and winter skates (juveniles and adults). Disturbances to linear depressions would disproportionally impact adult hake, which are often found in association with these bedform features.

Anchoring could result in short- to long-term disturbance/conversion impacts to EFH that support sensitive life stages of EFH species and crush or bury benthic eggs, larvae, and juveniles with limited mobility. For example, the benthic eggs of Atlantic herring, longfin squid, and winter flounder, as well as the juvenile stages of relatively immobile species like Atlantic Sea scallops, would be particularly vulnerable to mortality from crushing and burial impacts. These species and sensitive life stages are associated with the substrates (e.g., coarse to very find sands) and utilize biogenic features (i.e., shell hash, amphipod tubes, hydroids, and moon snail eggs) as refuges, attachment surfaces, and food sources. The potential for crushing and burial impacts associated with vessel anchoring and spudding would be short-term and localized as previously described in Section 5.1.1.1. Within these areas benthic or epibenthic EFH species and/or life stages would be the primary groups affected, with secondary effects on EFH species and/or life stages that prey on benthic and epibenthic organisms. Pelagic species and/or life stages would not be at risk for lethal crushing or burial impacts but could be subject to entrainment effects. Only those life stages likely to be directly exposed to crushing and burial or associated effects on benthic prey species are addressed in this section. Crushing and burial exposure and associated effects on benthic prey organisms represent a short-term reduction in habitat suitability for EFH species.

IAC installation would occur during Q1 - Q2 of 2024; Q2 - Q4 of 2025, and offshore export cable installation would occur during Q1 of 2024 through Q2 of 2025. Vessel activities previously discussed would occur during cable installation activities. Thus, crushing, and burial effects would be limited in duration but could occur throughout the anticipated construction window. Construction and burial impacts during cable installation would be similar to those associated with WTG and OCS foundation installation discussed in Section 5.1.1.1.

Sediment Suspension

In general, vessel activities associated with cable installation would cause short-term impacts to water quality intermittently throughout Project construction. Hydrodynamic and sediment transport modeling were conducted to assess the sediment suspension and resulting deposition from proposed construction activities and are detailed in Section 5.1.1.1. Modeling demonstrated that sediments within the SRWF would return to ambient levels within 0.4 hours after the disturbance was completed. These benthic disturbances would increase turbidity and suspend sediment in the water column. Impacts to benthic habitat would occur locally and temporarily within the specified cable routes. The potential impacts to water quality, and by extension, EFH and EFH-designated species, such as resuspension of sediments, would be short-term and localized, and would be similar to those discussed in Section 5.1.1.1.

Vessel Noise

Impacts from vessel noise would be similar to those discussed in Section 5.1.1.1.

Potential Introduction of Exotic/Invasive Species Via Ballast

Impacts from potential introduction of invasive species from vessel activity would be similar to those discussed in Section 5.1.1.1.

5.1.2.2 Seabed Preparation (including UXO removal/Boulder Relocation/Dredging)

Habitat Alteration

Seabed preparation may be required prior to installation of IAC and SRWEC and could include seabed leveling and removal of surface or subsurface debris such as boulders, lost fishing gear, or lost anchors. Excavation may be required where debris is buried or partially buried. CFE and/or trailing suction hopper dredge may be used for sand wave leveling. CFE is a non-contact dredging tool which utilizes thrust to direct waterflow into sediment, creating liquefaction and subsequent dispersal. The trailing suction hopper dredge involves the use of a drag arm which is pulled along the seafloor from the dredge and hopper vessel at the surface. The drag arm fluidizes sediment at the seafloor which is then hydraulically pumped to the hopper portion of the vessel where the sediment is able to settle out of suspension. Jet trenching trials to demonstrate method performance and TSS concentrations would also be performed over approximately 1,000 feet (305 meters) of the SRWEC-NYS corridor between KP 1.88 and KP 3.5.

Short-term disturbance activities to prepare the seafloor in the lease area may potentially impact approximately 4,600.56 acres (1,861.8 hectares), primarily categorized as soft bottom 2612.8 acres (1,057.4 hectares), with some area categorized as complex 1,964.9 acres (795.2 hectares) and heterogeneous complex 22.7 acres (9.2 hectares). Construction-related disturbance, specifically boulder relocation and the installation of foundations and scour protection, would also result in long-term to permanent impacts to EFH species and habitats by modifying the structure and composition of pelagic and benthic habitat.

Boulder relocation would potentially alter the composition of both the original and relocated habitat. Over time, the relocated boulders would be recolonized, contributing to the habitat function provided by existing complex benthic habitat of relocated boulders. Long-term to permanent impacts of artificial structures associated with the Project, as well as affected species are discussed further in Section 5.1.3.1.

Benthic or epibenthic eggs that occur within the SRWF Project area could be exposed to lethal crushing, burial, or entrainment effects. This includes eggs and larvae of EFH species, and eggs and larvae that provide prey for EFH species. Pelagic eggs and larvae of Atlantic cod and the pelagic eggs of red hake, two species of federally managed fish that are currently below target population levels and that have rebuilding plans in place, would be particularly vulnerable to mortality from entrainment effects. The areas affected by seabed preparation activities described above would be rendered temporarily unsuitable for EFH species associated with complex, large-grained complex, and soft bottom benthic habitats during one or more life stages. IAC and SRWEC installation would therefore result in a short-term adverse effect on EFH lasting through surface preparation activities and installation but would be expected to recover shortly after installation.

Effects on EFH and EFH species:

- Direct
    - Short-term loss/conversion of EFH: EFH for Sessile Benthic/Epibenthic – Soft Bottom, Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex; Mobile Benthic/Epibenthic – Complex; Pelagic species groups; Prey Species – Benthic; Prey Species.
    - Permanent, localized crushing and burial of EFH species: Sessile Benthic/Epibenthic – Soft Bottom, Sessile Benthic/Epibenthic – Complex; Prey –Benthic/Epibenthic species groups.
    - Short-term avoidance of anchoring activities by EFH species: Mobile Epibenthic/Benthic – Soft Bottom; Mobile Epibenthic/Benthic – Complex; Pelagic; Prey Species – Benthic and Prey Species – Pelagic species groups.
- Indirect
    - Short-term loss of benthic prey items: Mobile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Complex.

Sediment Suspension

Seabed preparation and subsequent sediment suspension prior to installation of IAC would take place within areas that were previously disturbed during the seabed preparation activities associated with WTG and the OCS-DC foundation installations.

Although Sunrise Wind plans to avoid all pUXO/pMEC targets, encountering UXO/MEC is still a potential emergent situation. Low order (deflagration) or high order (detonation) in-situ disposal of UXO/MEC has the potential to affect benthic resources. UXO/MEC disposal has the potential to cause disturbances to the seafloor (sediment suspension and deposition) as well as noise. Impacts would be expected to be short-term and direct, with the potential to cause injury or mortality to benthic species within the direct vicinity of the disposal activities. Impacts and effects would be similar to those analyzed in Section 5.1.1.3.

Hydrodynamic and sediment transport modeling were conducted to assess the sediment suspension and resulting deposition from proposed construction activities. The hydrodynamic and sediment transport analysis characterized the hydrodynamics within the Project area, the hindcast results of the Northeast Coastal Ocean Forecast System (NECOFS) model (NERACOOS, UMass Dartmouth Massachusetts Fishery Institution, and MIT Sea Grant College), used the numerical scheme of the FV-COM (Finite-Volume Coastal Ocean Model). The NECOFS hydrodynamic model output was used as input for sediment transport modeling within the Project construction area. The sediment transport model used was the Particle Tracking Model in the Surface-Water Modeling System, was developed by the Coastal Inlets Research Program and the Dredging Operations and Environmental Research Program at the United States Army Corps of Engineers (USACE) Research and Development Center for the transport and fate of suspended sediments surrounding dredging and subsurface construction activity. Once the model was validated, a year was selected from the 39-year hindcast that was representative of average annual conditions. A ranking process resulted in the selection of 1997 as being the most representative of average annual conditions.

Surficial sediment characteristics along the SRWEC and in the SRWF were provided from grab samples collected in January 2020 in support of the Project in federal waters. A single grab sample and the USGS East Coast Sediment Texture Database was used to define the surficial seafloor sediments along the SRWEC in NYS waters and at the HDD exit pit representative location.

General findings from the sediment transport analysis indicated the suspended sediment plume from the proposed construction activities is transient and its location in relation to the sediment disturbance varies with the tidal cycles. The sediment plume is shown to be larger in areas where there are higher percentages of fine-grained surficial seafloor sediments.

- Impacts to EFH species are expected to occur and would be similar to those discussed in Section 5.1.2.3. Sand redeposition would be close in vicinity to the trench centerline, minimizing impacts to demersal fish eggs. Direct impacts to foraging habitat are expected to be localized to the width of the trench and short-term as benthic organisms would recolonize the area. Direct
    - Short-term decrease in quality of EFH due to suspended sediments and increased turbidity: EFH for Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; and Pelagic species groups.
    - Short-term, local impacts due to sedimentation: Sessile Benthic/Epibenthic – Soft Bottom; Prey Species – Benthic.
- Indirect
    - Short-term loss of foraging opportunities: Mobile Epibenthic/Benthic – Soft Bottom; and Pelagic species groups.
    - Short-term decrease in quality of EFH in areas adjacent to Project activities for: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Summer Flounder HAPC; Prey Species – Benthic.

Entrainment

Some types of seabed preparation equipment (e.g., hydraulic dredges) use water withdrawals, which can entrain planktonic larvae of benthic fauna (e.g., larval polychaetes, mollusks, crustaceans) with assumed 100-percent mortality of entrained individuals. Due to the surface-oriented intake, water withdrawal could entrain pelagic eggs and larvae, but would not affect resources on the seafloor. However, the rate of egg and larval survival to adulthood for many species is very low and the limited volume of water withdrawn (250 to 650 million gallons (946 to 2,460 million liters) for the jet plow and approximately 191 to 516 million gallons (724 to 1,953 million liters) for CFE equipment), BOEM does not expect population-level impacts on any given species.

The use of a jet plow for cable installation is expected to cause entrainment of ichthyoplankton (fish eggs and larvae), and zooplankton. An ichthyoplankton and zooplankton assessment was conducted by INSPIRE for the South Fork Wind Farm, located adjacent to the Sunrise Wind Farm Lease Area, in 2019 (INSPIRE 2019). Although the seawater is released back into the ocean during jet plow activities, it is assumed that all entrained eggs, larvae, and zooplankton would be killed. The equipment modeled in this study was assumed to have a nominal power of 1,600 kW and would circulate 1674 yd^3 (1,400 m^3) of seawater per hour. Species data were obtained from NOAA's Marine Resource Monitoring, Assessment and Prediction (MARMAP) Program and their subsequent Ecosystem Monitoring (EcoMon) plankton sampling programs. Ichthyoplankton and zooplankton densities were calculated for the region surrounding the South Fork Export Cable and South Fork Wind Farm (SFWF) regions, which overlap with the Sunrise Wind Farm and Export Cable (Figure 5-1). The selected sampling area represent portions of the Middle Atlantic Bight and southern New England sub-regions of the EcoMon sampling plan. This jet plow entrainment study used data from spring and summer months when zooplankton and ichthyoplankton densities are the greatest to provide the most conservative entrainment loss estimates. The data included 249 zooplankton tows and 186 ichthyoplankton tows within the spring/summer timeframe (April – August). The results of the study indicated that the total estimated losses of ichthyoplankton along the export cable route were approximately 0.001% of the total ichthyoplankton abundance present within the study region. The greatest losses for individual taxa for South Fork Export Cable subsections included cunner, Atlantic mackerel, and sand lance. Estimated losses of ichthyoplankton related to the SFWF IAC were estimated to be less than 0.001% of the total ichthyoplankton abundance present in the study region. The greatest losses for individual taxa for the SFWF IAC included cunner, Atlantic mackerel, and Phycid hake. While this study was conducted for the South Fork Project, it is expected that entrainment results for jet plow activities would be similar due to the close proximity of the two projects and the study area overlapping with most of the Sunrise Wind Proposed Action area.

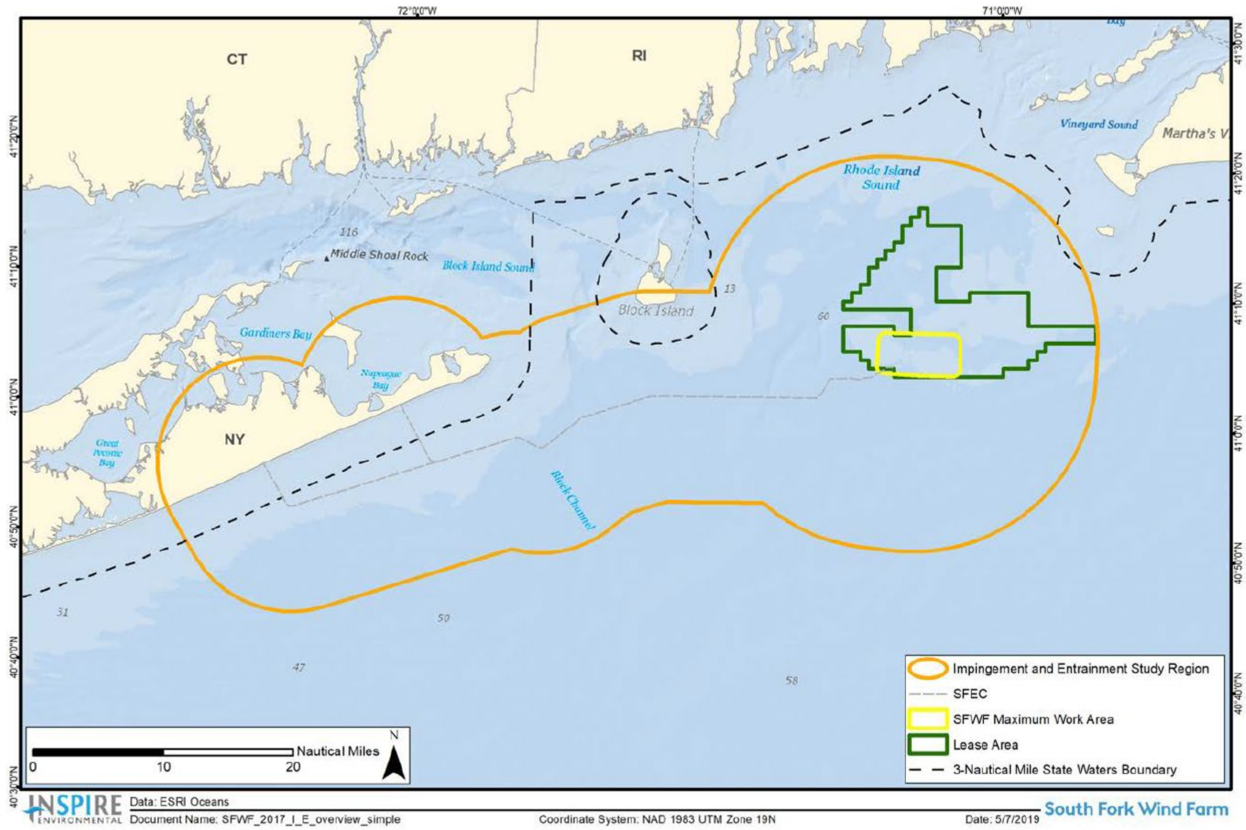


Figure 5-1 Study Region for the South Fork Jet Plow Impingement and Entrainment Study (INSPIRE 2019)

Effects on EFH and EFH species:

- Direct
  - Loss of EFH and EFH species due to water intake for eggs, larvae, and small juveniles of within the Pelagic and Prey Species – Pelagic species groups.
- Indirect
  - Loss of food sources for planktivorous species, including filter-feeding invertebrates: Sessile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Benthic/Epibenthic; Prey Species – Pelagic.

Underwater Sound

As previously discussed, underwater sound associated with construction activities from seabed preparation is expected to be short-term and localized to the area of impact. Maximum total impacts for IAC includes boulder clearance of 185 acres (74.7 ha) and sand wave clearance of 92 acres (37.3ha).

Sunrise Wind is planning to avoid all identified pUXO/pMEC targets, but they may encounter unexpected UXO/MEC on the seabed along export cable routes. While non-explosive methods may be employed to lift and move these objects, as discussed above, some may need to be removed by explosive detonation. Underwater explosions of this type generate high pressure levels that could kill, injure, or disturb fish.

Sunrise Wind conducted modeling of acoustic fields for UXO detonations and ranges to physiological injury were calculated (Hannay and Zykov 2022). Threshold levels and impacts are the same as described in Section 5.1.1.3.

Effects on EFH and EFH species:

- Direct
    - Short-term, direct effects on EFH and EFH species and life stages for all Hearing Categories, with greatest impacts to Hearing Category 3 species and life stages.
    - Short-term, direct effects on EFH of all Species Groups: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Benthic/Epibenthic; Prey Species – Pelagic.

5.1.2.3 Trenching/Cable Installation

Habitat Loss/Conversion

The installation of IAC between WTGs and substation foundations (interconnection cables) would take place within areas that were previously disturbed during the seabed preparation activities and foundation installation. The maximum total installed IAC length would be approximately 155 mi (249 km). IAC installation would be completed via mechanical dredging wherever possible with alternative methods that include surface lay, trenching, jetting, plowing and pre-plowing, vertical injection, and control flow excavation as necessary. Cable installation would require sand wave leveling, boulder relocation, cable installation, and placement of cable protection. Depending on the timing and location, these activities could result in direct and indirect short-term or long-term impacts to benthic habitat and associated EFH species and habitat features. Boulder relocation would be required along portions of the cable route prior to cable installation. Boulder relocation could alter bedforms such as ripples and megaripples, resulting in short-term, indirect disturbance/conversion impacts to EFH and EFH species within the Project area. As mentioned in Sections 5.1.1.1 and 5.1.1.6, these features provide structural complexity, shelter, and opportunities for feeding and migration in high flow environments (Gerstner 1988). Damage to habitat forming invertebrates on relocated boulders and cobbles could take several years to decades to fully recover (Auster and Langton 1999; Collie et al. 2005; Tamsett et al. 2010) and would constitute a long-term and indirect impact to EFH species present in the Project area as these features provide both refuge from predators, attachment surfaces, and foraging opportunities. For example, crabs and shrimps are a common prey items for many EFH species present in the Project area (e.g., groundfish and longfin squid). This would constitute a long-term effect on benthic habitat structure.

An estimated 2,046.8 acres (828.3 hectares) of benthic disturbance is anticipated during the IAC installation process. It is anticipated that pelagic species and motile life stages would avoid construction activities based on typical installation speeds. Impacts to EFH could occur as a result of sediment suspension, temporarily decreasing foraging success due to increased turbidity. Hydrodynamic and sediment transport modeling were conducted to assess the sediment suspension and resulting deposition from proposed construction activities and are detailed in Section 5.1.1.1. Modeling demonstrated that sediments within the SRWF would return to ambient levels within 0.4 hours after the disturbance was completed. It would be expected that normal foraging behavior would resume following completion of installation and settlement of suspended sediments. Sediment suspension impacts are discussed further below.

Offshore export cables would be placed by the same methods listed above for IAC, depending on site conditions. The installation disturbance area is 104.6 miles (168.4 km). Direct impacts to EFH due to habitat disturbance are expected within the designated 98-foot-(29.9-m)-wide cable corridor along the entire length of each corridor. An estimated 1,171 acres (473.9 ha) of short-term benthic disturbance is anticipated during the offshore export cable installation process, and approximately 25.2 acres (10.2 ha) of long-term benthic habitat disturbance is anticipated during the cable installation. Impacts are expected to be similar to those of the IAC and converter station interconnection cables.

The estuarine portion of the SRWEC-NYS would be affected by cable installation. These areas have a more diverse fish assemblage compared to the SRWF. Species that inhabit estuarine waters utilize the unique inshore habitats such as tidal wetlands, shellfish and SAV beds and shoreline structures for shelter, feeding, and spawning. During cable installation, habitat alteration would likely cause adult and juvenile fish to relocate temporarily. Summer flounder, whose HAPC exists within SAV beds in its EFH range, would be an example of a species that could be impacted by the loss of SAV habitat during construction.

At the offshore HDD exit pit, Sunrise Wind anticipated that approximately 4,900 cy (3,750 m^3) of material would be excavated from within an approximate 164-ft x 49-ft x 16-ft (50 m x 15 m x 5 m) area, as reported in the Sediment Transport Modelling Report (COP Appendix H), noting the actual volume would be less due to angled side slopes (not vertical sides). More recently, in the Environmental Monitoring and Construction Plan 2 (EM&CP 2) submitted to NYS Department of Public Service in March 2023, the HDD exit pit dimensions and methods have been refined. Appendix QQ of the EM&CP 2 indicates the HDD exit pit would be approximately 20-ft by 50-ft by 10-ft deep with 3:1 side slope and a total volume of 731 cy (559 m^3).

Excavation of the HDD exit pit would occur via divers using diver jetting (e.g., high lift portable venturi dredge system) and airlift tools (e.g., high lift gold dredge) to accommodate drilling activities and the HDD pipe string pull-in work. The discharged end would be placed approximately 10 to 20 ft (3 to 6 m) away from the excavation, and materials from the pit would be selectively relocated away from the pit. As the material is placed on the sea floor, the divers would move the discharge end to minimize build-up in one location. The divers would be deployed and recovered to the lift boat deck by a launch and recovery system (LARS). To ensure the excavated pit does not naturally backfill before drilling is completed, a trench box, approximately 20-ft by 50-ft in size (1,000 ft^2) would be placed within the excavated area. Once the drilling has been completed, the trench box would be removed and the exit pit would be naturally backfilled.

Consistent with Certificate of Environmental Compatibility and Public Need (Certificate) Conditions, Sunrise Wind would minimize the sediment removed from the offshore HDD exit to the maximum extent practicable. Excavated material would be expected to naturally backfill the exit area excavation to pre-existing elevations after completion of drilling, alleviating the need to dispose of dredged material at an offsite facility. Temporary placement of excavated HDD exit pit sediment on the seabed for a 45-day period may occur. Model simulations show this placed sediment would be subject to mobilization and resettlement during storm events (multi-day events with average winds in excess of 20 mph and gusts exceeding 35 mph). After a 45-day model simulation which included two mobilization events associated with storm activity, 89 percent of the excavated sediment would be within 38 m (125 ft) of the initial placement. All impacts from the HDD exit pit and anchoring support area would be temporary and occur entirely in soft bottom, non-complex habitats (i.e., Sand and Muddy Sand – Mobile; Table 4-1, Appendix M3 of COP). All areas where vessel pads contact the seafloor would be within the designated anchoring area (see Figure 2-6) and outside areas identified as sensitive benthic habitat and Significant Coastal Fish and Wildlife Habitats.

Anchoring of vessels within NYS waters would only occur during the scope of work associated with the following activities: 1) installation and use of Temporary Equipment to receive the transit barge during construction activities in Smith Point County Park; 2) HDD and cable pull-in for the Landfall HDD; and 3) installation of temporary wave (measurement) buoys and ADCPs. Anchoring is not planned for 1) installation of the ICW HDD; 2) installation of the SRWEC-NYS; or 3) trials of installation equipment. Areas of sensitive benthic habitat are located within the Project corridor, including hard-bottom habitat and submerged aquatic vegetation. Commercial shellfish beds, salt marsh, or corals are not present within the Project corridor.

Installation of the IAC, substation interconnection cable, and the offshore export cables could result direct impacts such as crushing and burial, of slow-moving or sessile organisms and life stages. Dredging and sidecast, and vessel anchoring could result in crushing and burial effects. Direct mortality of benthic life stages and sessile organisms could also result from fluidizing the sediments along the cable corridors during cable burial. The effects of crushing and burial impacts on EFH resulting from cable installation would vary depending on how benthic and near-bottom habitats exposed to these impacts are used by EFH-designated species. Benthic and epibenthic life stages would be the primary groups affected, with secondary effects on EFH-designated species and life stages that prey upon benthic and epibenthic organisms. Mobile organisms such as juvenile and adult finfish may be temporarily displaced by cable installation but would be able to avoid direct impacts related to these activities. Use of the jet plow would cause lethal impacts to non-motile pelagic life stages due to the surface-oriented water intake.

A number of APMs have been developed to minimize impact to EFH and EFH species during cable installation. To minimize impacts to areas sensitive and slow to recover that are utilized by EFH-designated species, onshore export cable corridors and landfall would be sited within existing rights-of-way or previously disturbed/developed lands to the extent practicable. Onshore, cable landfall and offshore facilities would be sited to avoid known locations of sensitive habitat (such as known nesting beaches) or species during sensitive periods (such as nesting season); important marine habitat such as high density, high value fishing grounds identified through a stakeholder and scientific review process and sensitive benthic habitat to the extent practicable. Efforts would be made to avoid hard-bottom habitats and seagrass communities, where practicable, and restore any damage to these communities. Areas that would require extensive seabed or onshore alterations would be avoided to the extent practicable. Onshore and offshore cables would be buried below the surface or seabed to the extent practicable. Offshore cable burial depth would be periodically inspected during project operation to ensure that adequate coverage is maintained to avoid interference with fishing gear/activity. Anchoring on sensitive habitat would be avoided and turbidity reduction measures would be implemented to minimize impacts to sensitive habitat from construction activities. BMPs would be used to minimize seabed disturbance and sediment dispersion during cable installation and construction of project facilities.

Effects on EFH and EFH species:

- Direct
    - Short-term loss/conversion of EFH: EFH for Sessile Benthic/Epibenthic – Soft Bottom, Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex; Mobile Benthic/Epibenthic – Complex; Pelagic species groups; Prey Species – Benthic; Prey Species – Pelagic, Summer Flounder HAPC; Summer Flounder HAPC.
    - Permanent, localized crushing and burial of EFH species: Sessile Benthic/Epibenthic – Soft Bottom, Sessile Benthic/Epibenthic – Complex; Prey –Benthic/Epibenthic species groups.
    - Short-term avoidance of anchoring activities by EFH species: Mobile Epibenthic/Benthic – Soft Bottom; Mobile Epibenthic/Benthic – Complex; Pelagic; Prey Species – Benthic and Prey Species – Pelagic species groups.
- Indirect
    - Short-term loss of benthic prey items: Mobile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Complex.

Sediment Suspension and Redeposition

Cable installation activities would generate localized plumes of suspended sediments within the immediate proximity of the trench excavation and reburial. Sediment-producing activities would occur intermittently during the cable installation process.

Hydrodynamic and sediment transport modeling were conducted to assess the sediment suspension and resulting deposition from proposed construction activities associated with the SRWF and SRWEC. Model scenarios were developed for each proposed construction activity. Where multiple installation methods are being considered, the model scenario assumed the method that would create the most sediment disturbance.

The SRWEC-OCS modeling detailed in Section 5.1.2.2 resulted in peak TSS concentrations reaching 261 mg/L and concentrations exceeding 100 mg/L within 89 m of the SRWEC-OCS route centerline. The maximum deposition thickness was 12.7 mm resulting in a small area (0.0015 ha) having a thickness greater than 10 mm with a maximum extent of 7.5 m from the route. While the time to return to ambient turbidity levels would vary along the SRWEC route, the time to return to ambient levels was 0.4 hours after completion.

Modeling of the IAC installation detailed in Section 5.1.2.2 had similar results to the SRWEC with peak TSS concentrations up to 305 mg/L and concentrations exceeding 100 mg/L within 120 m of the route centerline. The predicted sediment deposition was less with a maximum thickness of 5.7 mm.

For SRWEC-NYS, peak TSS concentrations reached 141 mg/L with concentrations exceeding 100 mg/L within 120 m of the SRWEC route centerline. The maximum deposition thickness was 10.1 mm resulting in a small area (0.0015 ha) having a thickness greater than 10 mm with a maximum extent of 7.5 m from the route. While the time to return to ambient turbidity levels would vary along the SRWEC-NYS route, the time to return to ambient levels was 0.3 hours after completion. Sediments in inshore Project areas are comprised of fine to medium grains. Therefore, suspension and settlement of sediments would be expected. The finer sediments in these areas would become suspended and extend above the trench and take longer to settle to the seabed than in areas of sand or coarser-grained sediments. Direct impacts would be associated with early life stages of demersal species. Immediately following installation, indirect impacts from suspended sediments could potentially cause mortality to demersal fish eggs due to burial and reduced hatching success (Berry et al. 2011). Across many different USACE dredging projects in New York Harbor, even when dredging sediments with high percentage of fine grain particles, plumes dissipated rapidly over distance of 650 feet (200 meters) in the upper water column and 2,000 feet (600 meters) in the lower water column to levels not detectable against background conditions. Active swimmers would be able to easily avoid plumes, and passive drifters would only be exposed over short distances (USACE 2015). Juvenile and adult finfish associated with benthic habitats are unlikely to be significantly affected by suspended sediment and sediment deposition at the burial depths anticipated. Spawning habitat of Atlantic cod, winter flounder, and other species may be temporarily impacted by suspended sediment and deposition, but impacts would be short-term and localized, and turbidity would be expected to dissipate rapidly due to prevailing oceanic conditions. Benthic eggs and larvae of some species could be harmed (Kjelland et al. 2015; Michel et al. 2013; Wilber and Clarke 2001). While sensitivity varies widely, the eggs and larvae of some species can be killed by as little as 0.4 inch (10 mm) of sediment deposition. The eggs of certain species, like winter flounder, are particularly sensitive and can be killed by burial depths less than 0.1 inch (3 mm) (Michel et al. 2013). While some adverse effects would undoubtedly occur, the extent of deposition and burial impacts is small relative to the amount of egg and larval settlement habitat available, and the duration of those impacts would be short-term (hours to days). Invertebrates like burrowing bivalve clams and burrow-forming amphipods are highly tolerant to burial (Gingras et al 2008; Johnson 2018). More sedentary invertebrates that cannot move within the sediment column as quickly, such as small anemones and tube-dwelling worms, could exhibit stress or mortality if completely buried or exposed to repetitive burial events (Johnson 2018).

The magnitude and duration of construction-related sediment effects must be considered in the context of the environmental baseline. The sand and mud substrates on the Mid-Atlantic OCS are continually reshaped by bottom currents and sediment delivery from upland sources (Daylander et al. 2012). The prevalence of sediment ripples and megaripples throughout the area is evidence of these dynamic conditions. This indicates that the benthic habitats and habitat forming organisms impacted by the project are regularly exposed to and therefore must be able to recover from burial by mobile sediments. Seagrasses and SAV in this environment have evolved in areas prone to periodic elevations in suspended sediment levels and have vertical structure that can accommodate levels of sediment deposition greater than those anticipated from the Proposed Action.

Adult Atlantic cod, while expected to avoid area of elevated suspended sediment concentrations and depositions of suspended sediments, could be impacted indirectly through negative effects to their prey (e.g., shellfish, herring).

Direct impacts would be associated with early life stages of demersal species. Immediately following installation, impacts from suspended sediments could potentially cause mortality to demersal fish eggs due to burial and reduced hatching success (Berry et al. 2011). Impacts to demersal life stages and sessile organisms due to burial via sediment deposition may occur but would be expected to be localized and short-term.

Effects on EFH and EFH species:

- Direct
    - Short-term decrease in quality of EFH due to suspended sediments and increased turbidity: EFH for Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; and Pelagic species groups; Summer Flounder HAPC.
    - Short-term, local impacts due to sedimentation: Sessile Benthic/Epibenthic – Soft Bottom; Prey Species – Benthic.
- Indirect
    - Short-term loss of foraging opportunities: Mobile Epibenthic/Benthic – Soft Bottom; and Pelagic species groups.
    - Short-term decrease in quality of EFH in areas adjacent to Project activities for: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Summer Flounder HAPC; Prey Species – Benthic.

Horizontal Directional Drilling

Landfall construction would occur via HDD methodology. The Landfall HDD work area would be situated onshore within the eastern side of the Smith Point County Parking Lot located north of Fire Island Beach Road at Smith Point, Long Island, New York and would occupy approximately 6.5 acres. The borehole would be approximately 44 inches in diameter and consist of three high density polyethylene (HDPE) conduits measuring approximately 3,290 ft in length (0.6 mi.). The exit pit would be located at the offshore terminal end of the HDD drill path and would be utilized during construction as an access point to the HDD borehole. The HDD exit pit would be located approximately 2,200 ft (650 m) seaward of mean high water line and approximately 3,280 ft (1,000 m) southeast of the entry pit (Figure 2-6). The location of the Landfall HDD exit pit is an area identified as Sand and Muddy Sand - Mobile (i.e., soft bottom, non-complex habitat).

At the offshore HDD exit pit, Sunrise Wind anticipated that approximately 4,900 cy (3,750 m^3) of material would be excavated from within an approximate 164-ft x 49-ft x 16-ft (50 m x 15 m x 5 m) area, as reported in the Sediment Transport Modelling Report (COP Appendix H), noting the actual volume would be less due to angled side slopes (not vertical sides). More recently, in the Environmental Monitoring and Construction Plan 2 (EM&CP 2) submitted to NYS Department of Public Service in March 2023, the HDD exit pit dimensions and methods have been refined. Appendix QQ of the EM&CP 2 indicates the HDD exit pit would be approximately 20-ft by 50-ft by 10-ft deep with 3:1 side slope and a total volume of 731 cy (559 m^3).

Excavation of the HDD exit pit would occur via divers using diver jetting (e.g., high lift portable venturi dredge system) and airlift tools (e.g., high lift gold dredge) to accommodate drilling activities and the HDD pipe string pull-in work. The discharged end would be placed approximately 10 to 20 feet (3 to 6 meters) away from the excavation, and materials from the pit would be selectively relocated away from the pit. As the material is placed on the sea floor, the divers would move the discharge end to minimize build-up in one location. The divers would be deployed and recovered to the lift boat deck by a launch and recovery system (LARS). To ensure the excavated pit does not naturally backfill before drilling is completed, a trench box, approximately 20-ft by 50-ft in size (1,000 ft^2) would be placed within the excavated area. Once the drilling has been completed, the trench box would be removed and the exit pit would be naturally backfilled.

Consistent with Certificate of Environmental Compatibility and Public Need (Certificate) Conditions, Sunrise Wind would minimize the sediment removed from the offshore HDD exit to the maximum extent practicable. Excavated material would be expected to naturally backfill the exit area excavation to pre-existing elevations after completion of drilling, alleviating the need to dispose of dredged material at an offsite facility. Temporary placement of excavated HDD exit pit sediment on the seabed for a 45-day period may occur. Model simulations show this placed sediment would be subject to mobilization and resettlement during storm events (multi-day events with average winds in excess of 20 mph and gusts exceeding 35 mph). After a 45-day model simulation which included two mobilization events associated with storm activity, 89 percent of the excavated sediment would be within 38 m (125 ft) of the initial placement. All impacts from the HDD exit pit and anchoring support area would be temporary and occur entirely in soft bottom habitats (Table 4-1, Appendix M3 of COP). All areas where vessel pads contact the seafloor would be within the designated anchoring area (see Figure 2-6) and outside areas identified as sensitive benthic habitat and Significant Coastal Fish and Wildlife Habitats.

In addition, results of geotechnical and chemical analysis of sediment cores from the HDD exit pit area indicated dredged sediments would be expected to be suitable for disturbance and natural backfill in the proposed excavation area. Therefore, offsite disposal of dredged sediments from HDD activities would not be necessary. Consistent with the Certificate, backfill would be evaluated for presence/absence of a discernable depression no later than three months following dredge completion, exclusive of the construction windows described in the Certificate Conditions. If a discernable depression was to be discovered, the depression would be backfilled in a timely manner unless, in consultation with agencies, it is determined backfill is not necessary. In addition, the Sediment Transport Modelling Report (COP Appendix H) also includes a model scenario (Scenario 3) that was developed to assess the potential mobilization and resettlement of the temporary sediment mound following excavation of the HDD exit pit. At the end of 45 days, 89 percent of the material would remain within 38 m (125 ft), 92 percent would remain within 76 m (250 ft), and 95 percent of the material would remain within 152 m (500 ft). As noted above, the volumes utilized in the Sediment Transport Modelling Report of the COP are greater than current plans for excavation quantities.

In-water seabed disturbing work (including dredging) is planned to occur beginning December 1 and ending on, but inclusive of, April 30 of the succeeding year (e.g., will not occur between May 1 to June 30 or September 1 to November 30). If backfill of the HDD exit or remedial burial/secondary cable protection installation and defect remedy would need to occur during the restricted window (May 1 to June 30 or September 1 to November 30), Sunrise Wind has developed an Atlantic Sturgeon Monitoring and Impact Minimization Plan (Appendix TT in EM&CP 2). Within four months of completion of activities, results of water quality monitoring with respect to model prediction would be reported, per the Suspended Sediment and Water Quality Monitoring Plan (Appendix SS in EM&CP 2).

Approximately 2,640 ft (0.4 mi) of the onshore transmission cable would be installed via HDD under the ICW (i.e., Narrow Bay). Two trenchless work sites would be located on both sides of the HDD and utilized for the duration of the ICW HDD work. The drill entry site would be located in the southeast corner of the Smith Point Marina parking lot. The exit site will be located on the northern side of Smith Point County Park just west of the Smith Point Bridge and William Floyd Parkway. The borehole would be approximately 36 inches in diameter and consist of six (6) HDPE conduits. The cables would be installed approximately 42 ft below the existing seabed of the waterway. The HDD crossing included 133 mapped acres, comprising the two primary habitats sand and muddy sand and coarse sediment. Sand and muddy sand was the dominant habitat type mapped and coarse sediment habitats were found along the west of the bridge, coincident with the dredged navigational channel, and was represented by coarse sediment.

The proposed Onshore Transmission Cable route may cross under SAV habitat in the ICW that is considered HAPC for summer flounder. The use of HDD would avoid impacts to tidal wetlands and SAV; however, impacts could occur in the unlikely event of an inadvertent release of drilling fluid. An inadvertent release occurs when drilling fluids (i.e., naturally occurring bentonite clay) migrate unpredictably to the surface of the seafloor through fractures, fissures, or other conduits in the underlying rock/sediments. An inadvertent release of drilling fluid along the HDD segment could cause a temporary turbidity plume, however bentonite clay particles would be expected to settle quickly due to the natural flocculation of clay particles in seawater. Although bentonite by itself is non-toxic, it is a fine particulate material that could become entrained in the water column and transported to other locations if sufficient current velocities were present, causing turbidity and sedimentation. Impacts on EFH species, if they were to occur, would be temporary and localized, and would generally be limited to individuals in the immediate vicinity of the release.

Benthic habitat complexity categories were complex and soft bottom. Complex categories included present/potential presence of benthic macroalgae and/or SAV. Of the habitats with modifiers, sand and muddy sand was the most prevalent habitat type mapped within the HDD crossing (74 percent), followed by sand and muddy sand with recent and/or potential SAV and/or benthic macroalgae (18 percent), and coarse sediment (7 percent). Sands were observed except in coarse sediment habitats where gravelly sand and sandy gravel was recorded. Sand and muddy sand habitats were dominated by areas of potential and occurring benthic macroalgae and SAV, primarily on the west side of the ICW bridge. Biotic subclasses included attached and soft sediment fauna. The non-reef-building hard coral *Astrangia poculata* and the burrowing anemone ceranthids, were not observed within the HDD area. Coarse sand habitats in the HDD channel were characterized by the sandy gravel, gravelly sand CMECS subgroup. Vegetated habitats and sand and muddy occurred along the shore were both characterized by sand or finer CMECS subgroups.

Rocky habitat (9.34 acres), soft bottom sand and mud (122 acres), tidal marsh (less than 2 acres) SAV and macroalgae (24 acres), and biogenic habitats (bryozoa and serpulid tubes) were found in the area. The benthic community analysis of the sediment grabs collected five taxa accounted for just over 60 percent of the total benthic infaunal abundance (1) an oligochaete, Naididae (Family, LPIL), (2) the amphipod *Eobrolgus spinosus*, (3) the polychaete *Exogone dispar*, (4) the amphipod *Elasmopus levis*, and (5) the amphipod *Gammaropsis* (Genus, LPIL). Acoustic impacts from the installation of the casing pipes and sheet piles on EFH species are similar but less than those discussed in detail in Section 5.1.1.2.

During installation of the estuarine portion of the onshore cable, impacts to SAV would be minimized, where practicable, by the use of HDD to install the cable beneath overlying sediments and SAV without direct physical disturbance. During HDD, a sediment mix including drilling mud (i.e., bentonite) would be used. During drilling, reaming, or pulling events, some drilling mud may be released from the end of the bore hole. Therefore, HDD would have an exit pit to receive the drilling mud. Bentonite is heavier than water, so it would remain in the exit pit and then be removed through a vacuum or suction dredge. HDD conduits would be drilled for landfall and an HDD entry pit would be required . Trenchless installation (e.g., HDD) has the potential for impact in the event of inadvertent return of drilling fluids, thus causing adverse impacts to water quality through increases in turbidity, as well as hazardous chemical impacts to EFH and EFH-designated species. Best management practices, such as monitoring of the drilling mud volumes, pressures, and pump rates and returns, would be followed to determine if drill mud loss occurs in amounts that signal a possible inadvertent return. SAV habitat would be avoided wherever possible, and impacts minimized should the cable need to traverse a unique habitat (e.g., complying with seasonal work windows and other best management practices). Impacted species would likely relocate to surrounding similar habitat during and immediately following construction. Following construction, the areas of cable burial would be restored to previous elevations and natural succession would proceed, reestablishing the HAPC areas. Where HDD trenchless technology methods are used, develop, and implement an Inadvertent Return Plan that includes measures to prevent inadvertent returns of drilling fluid to the extent practicable and measures to be taken in the event of an inadvertent return.

HDD: Temporary Pile-Supported Trestle

Temporary equipment proposed for use for the HDD would be transported via a temporary trestle. Heavy construction materials are needed to energize the Project across the ICW to Smith Point County Park. Since using the Smith Point Bridge is not an option due to its current deteriorating condition, several options including a single HDD bypassing Fire Island, open cut sea-to-shore transition, dismantling of equipment, and helicopter transport were considered and deemed infeasible due to logistics, safety considerations, and the weight of the equipment needing to be transported. The only practical solution identified to move materials was a temporary pile-supported trestle (also referred to as temporary equipment). The trestle support piles would be placed in the mudline by barge-based installation equipment. It is estimated that approximately 24 driven piles would be required. The up to 24 production piles would first be driven using a vibratory hammer followed by an impact hammer. A vibratory hammer with a centrifugal force of approximately 160 tons would be used for both installation and removal of piles. An impact hammer with a rated energy of approximately 15,000 ft-lbs would be used to complete installation of the production piles. Both production and temporary piles would be removed using vibratory pile driving.

It is anticipated that installation of the pier would occur over approximately three to four weeks. Installation of up to 24 production piles could result in a total of up to 324 minutes (5 hours 24 min) of vibratory pile driving (24 x 13.5 min) and 36 minutes of impact pile driving (24 x 1.5 min). Installation and removal of up to 24 temporary piles could require up to 720 minutes (16 hours) of vibratory pile driving only (2 x 24 x 15 min). The maximum total pile driving time for installation would be 1,044 min (17 hours

24 min) of vibratory pile driving and 36 minutes of impact pile driving. Removal of the temporary pier would involve the removal of all 24 production piles using a vibratory hammer. Thus, the total duration of vibratory pile driving during pier removal could be up to 360 min (6 hours; 24 x 15 min).

An increase in underwater sound levels will occur as a result of vibratory and impact pile driving at the temporary pier location. Overall, impacts are likely to be limited to sub-lethal effects that in some cases may increase the possibility for delayed mortality (Hawkins et al. 2014). Because pile driving sources produce low frequency noise that is within the hearing range of most fish and the majority of pile installations will involve a non-impulsive (vibratory hammer) source, the potential for fish to experience TTS, masking, and behavioral impacts is higher than permanent injury or mortality. The maximum radial distance to recoverable injury thresholds is approximately 0.091 mi (146.6 m), and the maximum distance to the fish behavioral threshold is 0.55 mi (891.3 m), both of which result from installation using an impact hammer. Some fish may move away from the area before noise levels exceed the threshold for injury but given the size of the potential zones of ensonification exceeding the behavioral disturbance threshold, some behavioral disturbance of individual fish is likely (Popper et al. 2014). Monitoring and mitigation measures would be implemented to mitigate impacts to fish during piledriving activity including soft-start techniques and seasonal restrictions. Time-of-year-in-water restrictions would be employed to the extent feasible to avoid or minimize direct impacts to species of concern, such as Atlantic sturgeon and winter flounder.

The barge used for installation of the piles and trestle would require two to four temporary spuds to hold its station during installation. The spuds associated with the installation barge would have a diameter of approximately 30 inches. Once the Temporary Equipment is installed, a transit barge would require up to four spuds to hold its station during equipment transfer. The spuds associated with the transit barge would have a diameter of approximately 30 inches. For landfall HDD activities, the contractor would primarily utilize vessels that do not require the use of anchors to maintain position (e.g., dynamic positioning vessels), which would avoid impacts to existing buried resources. Sunrise Wind conducted a SAV survey in fall 2022 to confirm the presence/absence of submerged aquatic vegetation in the vicinity of the Temporary Equipment. Based on the results of that survey, while individual shoots were identified in the northeast corner of the project corridor at least 120 ft from Temporary Equipment, no indications of significant populations of eelgrass were found within the proposed site for the Temporary Equipment. Anchoring and spudding would be avoided in SAV mapped in 2018 and 2022 in the vicinity of the temporary trestle pier.

Effects on EFH and EFH species:

- Direct
  - Short-term, direct effects on EFH and EFH species and life stages for all Hearing Categories, with greatest impacts to Hearing Category 3 species and life stages.
  - Short-term, direct effects on EFH of all Species Groups: Sessile Benthic/Epibenthic – Soft Bottom; Mobile Benthic/Epibenthic – Soft Bottom; Sessile Benthic/Epibenthic – Complex Habitat; Mobile Benthic/Epibenthic – Complex Habitat; Pelagic; Prey Species – Benthic/Epibenthic; Prey Species – Pelagic.
- Indirect – no indirect impacts anticipated.

5.1.2.4 Cable Protection (Concrete Mattresses, etc.)

Cable protection could be required where burial cannot occur, sufficient depth cannot be achieved, or protection is required due to crossing other cables or pipelines. Rock placement, mattresses, frond mattresses, or rock bags may be used to protect the cable (see Section 2.2.2.4).

Approximately 15 percent of the cable route may require cable protection. Installation of cable protection would cause long-term and localized habitat conversion and short-term and localized sediment suspension which would adversely affect EFH and EFH-designated species.

Habitat Loss/Conversion

IAC and substation interconnection cable construction area potentially requiring cable protection is comprised of 367.12 acres (148.57 hectares) of soft bottom habitat, zero acres of large-grained complex habitat, and 286.17 acres (115.81 hectares) of complex habitat. Cable protection may be required for up to 15 percent of the route (up to 223.2 acres [90.3 hectares]), this number is not inclusive of the CPS stabilization the cable crossing protection for crossing of existing cables. The majority of the area that may be impacted by cable protection is classified as soft bottom habitat (56 percent). Most of the remaining area (44 percent) intersects habitats categorized as complex.

The offshore export cable construction area that could potentially require cable protection is comprised of 419.2 acres (169.6 hectares) of soft bottom habitat and 23.2 acre (9.4 hectares) of complex habitat. Impact calculation above is based on an assumed 39 ft (12 m) wide strip, inclusive of cable installation width. In general, impacts from seabed disturbance would be localized and short-term with the exception of habitat conversion and/or loss due to the installation of the WTGs and OCS-DC and associated scour protection, where required. It is anticipated that mobile life stages would move out of the area to avoid potential impacts. Demersal non-mobile life stages would be impacted due to the placement of foundations and scour protection in the immediate area of installation. Most juvenile and adult finfish would actively avoid all construction activities. However, immobile finfish life stages such as demersal eggs and larvae, and sessile organisms could experience mortality as a result of being crushed or buried by the foundations, scour protection, and vessel anchors within the SRWF footprint. EFH-designated species that would likely be impacted by crushing and burial effects of installation of scour protection are like those listed in Section 5.1.1.1.

Benthic Effects from Cable Protection

<u>Complex Benthic Habitat</u>

Placement of physical structures such as concrete mattresses, frond mattresses, rock bags, and rock placement, as protection for exposed segments would result in the intermediate to long-term modification of complex benthic habitat. A maximum potential impact of approximately 348.3 acres (140.95 hectares) of complex benthic habitat would be permanently altered by placement of protective structures.

The nearshore terminus (estuarine portion) of the cable route overlaps areas of complex habitat but would avoid the designated HAPC for summer flounder. While the project would avoid macroalgae and seagrass areas during construction, any impacts on macroalgae or aquatic vegetation would constitute an intermediate-term adverse effect on HAPC for this species. EFH for gadid juveniles and adults, demersal egg, larvae, juvenile, and adult fishes, various juvenile and adult skates and sharks, and demersal invertebrate life stages be adversely affected in the intermediate-term to long-term by alteration of natural habitat and the placement of protective structures.

Non-Complex (Soft Bottom) Benthic Habitat

The placement of concrete mattresses and other protective structures (e.g., rock bags) to exposed segments of the cable would result in long-term conversion of soft bottom habitat to complex benthic habitat.

The affected areas would be rendered unsuitable for EFH-designated species associated with non-complex benthic habitats during one or more life stages. The cable installation would therefore result in long-term adverse effects on EFH. Mattress placement in soft bottom habitat would convert benthic habitat to more complex benthic habitat and would provide similar artificial reef benefits as previously discussed.

EFH for demersal organisms and life stages would be adversely affected in the intermediate-term to long-term by alteration of natural habitat and the placement of protective structures.

Sediment Suspension

Installation of cable protection through the above-mentioned methods disturb benthic habitat. Placement of cable protection may temporarily increase suspended sediments due to resuspension of bottom sediments. These benthic disturbances would increase turbidity and suspend sediment in the water column. Impacts to benthic habitat would occur locally and temporarily within each previously discussed cable corridor. These seabed disturbances could result in short-term suspended sediment/sedimentation and direct mortality of sessile or slow-moving organisms due to burial upon sediment deposition. EFH-designated species that would likely be impacted by suspended sediment are similar to those listed in Section 5.1.1.1.

5.1.3 Operation/Presence of Structures

5.1.3.1 Artificial Substrate (WTG/OSS/Converter Station/Scour Protection)

Community Structure Changes/Invasive Species

Development of the SRWF would include installation of up to 87 WTGs, the OCS-DC and their foundations. The installation of the WTGs and OCS-DC would permanently alter benthic habitat by introducing new hard surfaces to the seabed. Additionally, these vertical structures, extending from the seabed to the water surface would alter the character of pelagic habitats used by many EFH-designated species and their prey and foraging resources. Over time, these new hard structures would become colonized by sessile organisms, creating complex habitats that effectively serve as artificial reefs within the SRWF.

Underwater Sound

The operation of the SRWF would produce underwater noise from the following sources:

- Effectively continuous, non-impulsive, low-frequency underwater noise and particle motion effects from WTG operations
- O&M vessel operations

The effects of these underwater noise sources on habitat suitability for EFH species are described by project component in the following sections.

SRWF

Offshore WTGs produce continuous, non-impulsive underwater noise during operation, mostly in lower-frequency bands below 8 kilohertz (kHz). There are several recent studies that present sound properties of similar turbines in environments comparable to that of the Proposed Action. These are presented in detail in in the Underwater Acoustic and Exposure Modeling Survey (Küsel et al. 2021). Studies indicate that operating turbines (e.g., both older-generation, geared turbine designs and quieter, modern, direct-drive systems like those proposed for the SRWF) produce underwater noise on the order of 110 to 125 dB relative to 1 µPa SPL_{RMS} at a reference distance of 50 meters, occasionally reaching as high as 128 dB relative to 1 µPa SPL_{RMS}, in the 10-Hz to 8-kHz range (Tougaard et al. 2020). When compared to injury thresholds for fish, no physiological effects on fish as a result of WTG operational noise is anticipated. In addition, WTG operational noise is not expected to exceed fish behavioral thresholds. It is important to note that, more recently, Stöber and Thomsen (2021) attempted to estimate operational noise from larger current-generation, direct-drive WTGs. They found that these designs could generate higher operational noise levels than those reported in earlier research; however, these findings have not yet been validated.

Some degree of habituation to these operational noise and particle motion effects is to be anticipated. Bejder et al. (2009) argue that habituation of organisms to ongoing low-level disturbance is not necessarily a neutral or benign process. For example, habituation to particle motion effects could make individual fish or invertebrates less aware of approaching predators, or could cause masking effects that interfere with communication, mating, or other important behaviors.

Collectively, these findings suggest that the SRWF operations could have adverse effects on habitat suitability for EFH-designated species within a certain distance of each monopile foundation. The extent of these effects is difficult to quantify as they are likely to vary depending on wind speed, water temperature, ambient noise conditions, and other factors. Applying the sensitivity thresholds detailed in Section 5.1.1.2, potential adverse effects on habitat suitability for squid and fish belonging to the hearing specialist group are estimated to extend up to 722 ft (220 m) from each foundation. This equates to adverse effects on habitat suitability over 3,835 acres (1,552 hectares) for the 39-ft (12-m) monopile.

Offshore Export Cables and Array Cables

The offshore export cable and IAC would produce no operational noise effects and would therefore have no associated effects on EFH or EFH-designated species.

Vessel Noise

Impacts on EFH from ship and aircraft noise during operation and maintenance of the SRWF are expected to be similar to those discussed for the construction phase, though much lesser in intensity and spatial extent. The underwater noise generated by vessel and aircrafts would be similar to the range of noise from existing vessel and aircraft traffic in the region and are not expected to substantially affect the existing underwater noise environment.

Short-term, localized impacts from geophysical surveys during operation and maintenance may occur from the use of multibeam echosounders, side-scan sonars, shallow penetration sub-bottom profilers, medium penetration sub-bottom profilers and marine magnetometers. The survey equipment to be employed would be equivalent to the equipment utilized during survey campaigns associated with Lease Area OCS-A 0500 conducted in 2016, 2017, 2018, 2019, and 2020 and with Lease Area OCS-A 0487 conducted in 2019 and 2020 (CSA Ocean Sciences Inc.2020).

5.1.3.2 Hydrodynamic Effects

Hydrodynamic disturbance resulting from the broad-scale development of large offshore wind farms is a topic of emerging concern because of potential indirect effects on local and regional oceanic responses (e.g., currents, temperature stratification) and related larval transport under typical seasonal conditions. The placement of monopiles and WTGs in the SRWF has the potential to influence hydrodynamic conditions at both local and broader regional scales. These effects fall into two categories, changes in wind field down current of the wind farm, affecting surface currents and wave formation, and turbulent mixing caused by the presence of the structures in the water column. The extent of these effects and resulting significance on biological processes are likely to vary considerably between different oceanographic environments (van Berkel et al. 2020).

A growing body of research has demonstrated that atmospheric effects offshore windfarms, specifically changes in the near surface wind field, could lead to observable effects on oceanographic conditions at scales ranging to tens of miles down field from windfarm sites (e.g., Christiansen et al. 2022; Raghukumar et al. 2022). Changes in the surface wind can in turn influence mixing and circulation patterns and associated biological processes (e.g., Daewel et al. in-press; Dorell et al. 2022; Floeter et al. 2022; Raghukumar et al. 2022). Monopile wakes have been observed and modeled at the kilometer scale (Cazenave et al. 2016; Vanhellemont and Ruddick 2014). Foundations disrupt current flow, creating tidal wakes and a turbulent mixing effect extending downcurrent from the structures. The presence of monopiles in the water column can introduce small-scale mixing and turbulence that can affect water column stratification under some circumstances (Carpenter et al. 2016; Floeter et al. 2017; Li et al. 2014; Schultze et al. 2020). This effect is muted in oceanographic environments that display strong seasonal stratification (Schultze et al. 2020), but the introduction of nutrients from depth into the surface mixed layer can lead to a local increase in primary production (Floeter et al. 2017). While impacts to current speed and direction decrease rapidly, there is evidence of hydrodynamic effects out to a kilometer away from a monopile including localized changes in circulation and stratification patterns, with potential implications for primary and secondary productivity and fish distribution (van Berkel et al. 2020). Changes in distribution of finfish eggs and larvae caused by hydrodynamic disturbance could potentially change estimated entrainment at the OCS-DC, however these changes should not lead to population level impacts.

The Mid-Atlantic Cold Pool is a mass of relatively cool water that forms on the Mid-Atlantic OCS in the spring and is maintained through the summer by stratification. The Cold Pool supports a diversity of marine fish and invertebrate species that are usually found farther north but thrive in the cooler waters it provides (Chen 2018; Lentz 2017). Changes in the size and seasonal duration of the cold pool over the past 5 decades are associated with shifts in the fish community composition of the Mid-Atlantic Bight (Chen 2018; Saba and Munroe 2019). Several lease areas within the area are located on the approximate northern boundary of the cold pool. The potential indirect and cumulative effects of extensive wind energy development on features like the Cold Pool is a topic of emerging interest and ongoing research (Chen et al. 2016). Changes in Cold Pool dynamics resulting from future activities, should they occur, could conceivably result in changes in habitat suitability and invertebrate community structure, but the extent and biological significance of these potential indirect and cumulative effects are unknown.

Van Berkel et al. (2020) and Shultze et al. (2020) note that environments characterized by strong seasonal stratification are likely to be less sensitive to wind field and turbulent mixing effects on oceanographic processes. The SRWF and surroundings are characterized by strong seasonal stratification in summer and fall, within increased mixing and deterioration of stratification driven by storms and changes in upwelling in late fall into winter (Chen 2018; Lentz 2017). On the Mid-Atlantic Bight, increased mixing could influence the strength and persistence of the Cold Pool, a band of cold, near-bottom water that exists at depth from the spring to fall. However, the turbulence introduced by monopile foundations is not expected to significantly affect the Cold Pool due to the strength of the stratification [temperature differences between the surface and the Cold Pool reach 10°C (Lentz 2017)]. Temperature anomalies created by mixing at each monopile would likely resolve quickly due to strong forcing towards stabilization (Schultze et al. 2020).

BOEM has conducted a modeling study to predict how planned offshore wind development in the area could affect hydrodynamic conditions northern Mid-Atlantic Bight. Johnson et al. (2021) considered a range of development scenarios, including full buildout of both WEAs with a total of 1,063 WTG and OSS foundations. They determined that all scenarios would lead to small but measurable changes in current speed, wave height, and sediment transport in the northern Mid-Atlantic Bight. The resulting changes in current speed and wave height could influence larval transport and settlement and reduce bed shear stress thereby affecting sediment transport. Particle tracking, which integrates the overall effect of objects subjected to the effects of currents, showed variations on the order of ± 10 percent between the baseline condition (no offshore wind farms) and the 12 MW full build-out scenario (1,063 WTG and OSS foundations). This is in line with the observed order of magnitude change in the depth averaged currents (Johnson et al. 2021). In addition, small changes in stratification could occur, leading to prolonged retention of cold water near the seabed within the area during spring and summer.

Johnson et al. (2021) used an agent-based model to evaluate how these environmental changes could affect planktonic larval dispersal and settlement for three EFH species, summer flounder, silver hake, and Atlantic sea scallop. They determined that offshore wind development could affect larval dispersal patterns, leading to increases in larval settlement density in some areas and decreases in others, but would be unlikely to negatively impact population productivity for these species. Johnson et al. (2021) concluded that changes in larval distribution patterns on the order of miles or tens of miles are therefore unlikely to result in biologically significant effects on larval survival and recruitment. For example, in the case of sea scallops, larval dispersal to waters southwest of Block Island is predicted to increase while dispersal to waters south of Martha’s Vineyard would decrease under all modeled scenarios (Johnson et al. 2021). These localized effects are unlikely to have a measurable population-level effect on this species because sea scallop larvae originate both local and distant spawning areas and dispersed regionally over along a southwesterly gradient (Johnson et al. 2021). These dispersal patterns are driven by regional circulation patterns, which are generally consistent but vary annually (Chen et al. 2021; McCay et al. 2011; Munroe et al. 2018; Roarty et al. 2020; Zhang et al. 2015). In this context, localized shifts in larval transport and settlement density on the scale of miles to tens of miles are unlikely to lead to the development of significant population sinks. Even where they occur, localized changes larval recruitment may not necessarily translate to negative effects on adult biomass. For example, Atlantic sea scallops are prone to overcrowding and reduced growth rates in areas with high larval recruitment (Bethoney and Stokesbury 2019), therefore changes in dispersal that reduce overcrowding could lead to increased growth and abundance in specific areas.

While findings for these species are instructive, they are not necessarily representative of potential effects on all EFH species that rely on planktonic dispersal of eggs and larvae. The BOEM modeling results determined that small but measurable changes in current speed, wave height, and sediment transport would occur across the northern Mid-Atlantic Bight. As stated, hydrodynamic effects could change how the planktonic eggs and larvae of many marine species are dispersed across the region. Changing larval dispersal pathways can disrupt connectivity between populations and the processes of larval settlement and recruitment (Sinclair 1988). Unfavorable changes can create a condition where population may be negatively affected by a prolonged reduction in larval survival (Sinclair 1988). This could result in negative impacts on species like Atlantic cod that return to the same spawning habitats year after year and rely on relatively consistent oceanographic conditions to disperse planktonic eggs to areas favorable for larval and juvenile survival (Dean et al. 2022). However, insufficient information is available to determine the source populations of cod larvae and juveniles occurring in Southern New England waters and it is uncertain if the area is fully supported by self-recruitment (NEFMC 2022). As such, hydrodynamic effects on these species could be more significant, but the available information does not suggest that such effects are likely. Cod spawning appears to occur throughout the Southern New England region (DeCelles et al., 2017; BOEM *pers. comm.* 2022), which could help buffer against any potential impacts to planktonic eggs and larval transport. While hydrodynamic effects on these species could potentially be more significant, the available information does not suggest that such effects are likely."

Affected Species

Installation of up to 87 WTGs would likely to create individual localized hydrodynamic effects that could have localized effects on food web productivity and pelagic eggs and larvae. Given their planktonic nature, altered circulation patterns could transport pelagic eggs and larvae out of suitable habitat, altering their survivability. These effects would apply to EFH-designated species that have or prey upon pelagic eggs and larvae. These localized hydrodynamic effects would persist throughout the life of the Project until monopiles are decommissioned and removed. EFH-designated species with pelagic eggs and larvae that are known to likely occur within the SRWF footprint.

Pelagic juveniles and adults with EFH-designated species utilizing water column habitat could experience localized hydrodynamic effects down current of each SRWF monopile. These effects may be limited to decreased current speeds but could also include minor changes to seasonal stratification regimes. Adults and juveniles would be expected to elicit an avoidance behavioral response away from potential unsuitable habitat due to hydrodynamic effects from monopiles. These localized effects would persist throughout the life of the project. EFH-designated species with pelagic juvenile and adult life stages that would likely to occur within the SRWF area.

5.1.4 Operation/Presence of Inter-Array and Offshore/Onshore Cables

5.1.4.1 Power Transmission (EMF, Heat)

Operation of the WTGs would not generate electro-magnetic fields (EMFs); however, once the IAC become energized, the cables would produce a magnetic field, both perpendicularly and in a lateral direction around the cables. The IAC would be AC. The electricity transmitted by the IAC would be converted from AC to DC at the OCS-DC. There would be no EMF emissions from the OCS-DC itself; however, several cables come into this structure and the cables would emit EMF when energized. The

SRWEC that would carry DC electricity from the OCS-DC to shore would be a source of a static magnetic field and a weak electric field. Therefore, the following discussion focuses on potential impacts from AC EMF emissions of the IAC and DC static magnetic and electric emissions of the SRWEC.

The IAC would be shielded and, where feasible, buried beneath the seafloor and would otherwise be protected. Shielded electrical transmission cables do not directly emit electrical fields into surrounding areas but are surrounded by magnetic fields that can cause induced electrical fields in moving water (Gill et al. 2012). The SRWEC would consist of two cables strapped together. DC cables of the SRWEC would be placed in separate conduits within the HDD bore hole, buried under the seafloor. The DC magnetic field from the SRWEC would be combined with the earth's geomagnetic field. Magnetic fields diminish rapidly with distance, so it impacts would be limited to the immediate vicinity of the cables and at the seabed surface over the buried cables. Although the SRWEC cables would not produce a DC electric field on their own, an electric field can be induced by the movement of electric charges in a static magnetic field around the cable. Exposure to EMF could be short- or long-term, depending on the mobility and behavior of the species/life stage. A modeling analysis of the magnetic fields and induced electric fields anticipated to be produced during operation of the IAC, and OCS-DC was performed by Exponent Engineering, PC (Exponent Engineering 2020a (COP Appendix J1) Sunrise Wind 2022b), along with a summary of data from field studies conducted to assess impacts of EMF on marine organisms. Though multiple cables come into the OCS-DC, the cables would be sufficiently distributed that the level of EMF emissions at this structure would be similar to the individual cables themselves. These studies constitute the best source of evidence to assess the potential impacts on finfish and invertebrate behavior or distribution in the presence of energized cables.

The available laboratory-generated research regarding the effects of 50- or 60-Hz AC power sources on fish behavior do not indicate that produced fields would have adverse effects on magnetosensitive and electrosensitive species. Controlled laboratory studies conducted with eel and salmon (Richardson et al. 1976; Armstrong et al. 2015; Orpwood et al. 2015) support the conclusion that EMF produced by 50-75 Hz AC cables do not alter the behavior of magnetosensitive fish species, indicating that high frequency EMF are not easily detected by magnetosensitive migratory fish species. Laboratory studies assessing the EMF detection abilities of elasmobranchs indicate that the EMF detection ability decreases as the source frequency increases over 20 Hz and suggest that elasmobranchs would be unlikely to easily detect electric fields produced by 50/60 Hz power sources (Andrianov et al. 1984; Kempster et al. 2013). In a laboratory study, demersal catshark were exposed to magnetic fields produced by a 50-Hz source and did not exhibit any significant behavioral changes (Orr 2016). Field studies have also concluded that energized power cables neither attract nor repel elasmobranchs (Love et al. 2016). Based on the available information, EMF produced by 50/60 Hz power sources such as the IAC is unlikely to be detected by elasmobranchs and is unlikely to cause changes in elasmobranch behavior or distribution.

Love et al. (2016) conducted a series of surveys between 2012 and 2014 to track fish populations at both energized and unenergized submarine cables off the California coast. These studies were designed to assess whether EMF produced by the energized cable had any in-situ effects on the distribution of marine species. Over three years of observations, no differences in fish communities at energized and unenergized cable sites were noted, indicating that EMF had no effect on fish distributions, although the physical structure of the unburied cables did create a "reef effect" (Love et al. 2016). Additionally, multiple fish surveys have been conducted at existing offshore windfarm sites. Results from these studies strongly indicate that operating windfarms and cables do not adversely affect the distributions of resident fish populations.

Nearly 10 years of pre- and post-operational data from the Horns Rev Offshore Wind Farm site near Denmark indicate "no general significant changes in the abundance or distribution patterns of pelagic and demersal fish" (Leonhard et al. 2011), including species similar to those expected to inhabit the SRWF. Researchers did note an increase in fish species associated with hard ground and vertical features, especially around WTG footings (Leonhard et al. 2011).

Studies of swimming activities of Atlantic haddock (*Melanogrammus aeglefinus*) larvae around magnetic field from HVDC cables have recently been published (Cresci et al. 2022). Atlantic haddock is a demersal fish that may be at risk of exposure to HVDC cables. Their larvae drift over the continental shelf and use the Earth's magnetic field for orientation during dispersal. Therefore, anthropogenic magnetic fields from HVDC cables could alter their behavior. In the laboratory. Cresci et al. (2022) tested the behavior of 92 haddock larvae using a setup designed to simulate the scenario of larvae drifting past a magnetic field in the intensity range of that produced by a DC subsea cable. Exposure to the magnetic field did not affect the spatial distribution of haddock larvae in the raceway. Larvae were categorized by differences in their exploratory behavior in the raceway. The majority (78 percent) of larvae were nonexploratory, and exposure to the artificial magnetic field reduced their median swimming speed by 60 percent and decreased their median acceleration by 38 percent. There was no effect on swimming of the smaller proportion (22 percent) of exploratory larvae. These observations support the conclusion that the swimming performance of nonexploratory haddock larvae may be temporarily reduced following exposure to magnetic field from exposed HVDC cables; long-term impacts from exposure to a magnetic field have not been investigated (Cresci et al. 2022). However, HVDC cables used in offshore wind projects are required to be buried at least 4 – 6 ft below the surface of the substrate or covered by cable protection if not buried. This would substantially reduce exposure risk of any nearby organism. Impacts would therefore be short-term and localized and would not rise to population-level impacts.

Compared to fish and elasmobranchs, relatively little is known about the response of marine invertebrates to EMF. Field surveys on the behavior of large crab species and lobster at submarine cable sites (Love et al. 2017; Hutchison et al. 2018) indicate that the Project's calculated magnetic field levels are not likely to impact the distribution and movement of large epibenthic crustaceans. Ancillary data and observations from these field studies also suggest that cephalopod behavior is similarly unaffected by the presence of 60-Hz AC cables. Based on the modeling results and existing evidence, the EMF associated with the AC cables would be below the detection capability of most invertebrate species and would be unlikely to result in measurable impacts on EFH invertebrate species. Based on the modeling results and existing evidence, EMF associated with the IAC, and OCS-DC would not be expected to adversely affect EFH habitat in the SRWF. Results of modeled static and electric magnetic fields from the DC cables of the SRWEC suggest the magnetic fields produced by the DC cables buried under the seabed would not impact finfish but may elicit changes in the behaviors of crustaceans and elasmobranchs. At peak loading, electric fields associated with DC cables would be detectable by elasmobranchs but are not expected to adversely affect species. These conclusions are consistent with the findings of a previous comprehensive review of the ecological impacts of marine renewable energy projects, where it was determined that there has been no evidence demonstrating that EMF at the levels expected from marine renewable energy projects would cause an effect (negative or positive) on any species (Copping et al. 2016). Moreover, a 2019 BOEM report that assessed the potential for AC EMF from offshore wind facilities to affect marine populations concluded that, for the southern New England area, no negative effects would be expected for populations of key commercial and recreational fish species (Snyder et al. 2019).

5.1.4.2 Cable Protection

Cable protection would have permanent effects on complex, large-grained complex, and soft bottom benthic habitats resulting from boulder relocation and placement of cable protection. Some intermediate-term effects (6 months to 1 year) on soft bottom benthic habitats may also result from jet plow installation. The placement of cable protection for exposed segments of the cables would result in the intermediate- to permanent modification of complex and large-grained complex habitats. The affected habitats would eventually be recolonized by habitat forming organisms, leading to increasing habitat complexity and improvement in habitat function over time.

Cable protection placed in complex and large-grained complex habitat would reduce the suitability of the affected habitat for an intermediate-term period lasting up to 10 years as artificial reef features mature. Placement of cable protection in soft bottom habitat would convert soft bottom habitat to complex habitat, with a similar lag period of up to 10 years before functional habitat status is achieved. The presence of cable protection would therefore result in a diminishing, intermediate-term adverse effect on EFH for species associated with complex benthic habitat lasting up to 10 years. At this point colonization of cable protection by habitat forming organisms would result in gradually improving habitat conditions for the remaining 20 to 25 years of project life. These effects would be reversed when cable protection is removed during project decommissioning.

In soft-bottomed habitats the placement of cable protection would result in the permanent conversion of those habitats to a new habitat type, effectively converting the affected areas to a new habitat type with novel hard surfaces available for colonization by habitat forming organisms. The affected areas would be rendered unsuitable for EFH species associated with soft bottom benthic habitats during one or more life stages. SRWF installation would therefore result in a permanent adverse effect on EFH lasting for at least the 35-year lifetime of the project. The concrete mattresses would likely be removed during decommissioning, restoring the affected area to soft bottom benthic habitat.

Jet plow installation of the cable may flatten depressions and small sand waves, temporarily reducing benthic habitat suitability of EFH for juvenile and adult red and silver hake within the cable plow footprint. Prey organisms that use these habitats would also be displaced, potentially affecting habitat suitability for EFH species. In contrast, trenching may leave behind short-term depressions that provide similar habitat function. The extent of these natural features is difficult to quantify, as they are continually reshaped by natural sediment transport processes. Natural recovery from anthropogenic disturbance is likely to occur within several months of the disturbance, depending on timing relative to winter storm events. Further, conversion of soft bottom benthic habitat to complex benthic habitats could attract hard-bottom associated fish and invertebrates, both native and non-native species. The introduction of artificial hard substrates can provide novel habitats that can provide opportunities for invasive species to become established (Taormina et al. 2018). However, the affected area would be small relative to all habitat zones combined and hard substrates.

5.1.4.3 Power Conversion

The SRWF includes up to 87 individual WTGs which would generate AC power that would be transmitted to the OCS-DC through up to a maximum of 155 mi (249 km) of IAC. The OCS-DC would convert the power to DC for transmission to the existing onshore electrical grid through up to 104.6 mi (168.4 km) of offshore SRWEC and up to 5.2 mi (8.4 km) of onshore SRWEC. The onshore SRWEC would terminate at the OnCS-DC where power would be converted from DC to AC and ultimately transmitted through an Onshore Interconnection Cable to an existing Long Island Power Authority (LIPA) substation located in the Town of Brookhaven, NY.

The OCS-DC would be centrally located within the Lease Area and would house AC and DC equipment rated up to ±320 kilovolts (kV). The main equipment for the OCS-DC to convert the HVAC generated by WTGs prior to onshore transmission includes medium voltage AC (66 kV) gas-insulated switchgear, one or more converter transformers, converter reactors, and SCADA and protection systems. The approximate dimensions of the main OCS-DC topside platform are 253 ft x 171 ft (77 m x 52 m). The topside platform is located approximately 78 ft (23.8 m) above the mean higher high water elevation. The total height of the OCS-DC platform and equipment, including lightning protection and ancillary structures, would extend approximately 295 ft (90 m) from the lowest astronomical tide. The OCS-DC platform would be founded on a steel jacket pile structure. The placement of gravel material would be required to the level the seafloor (pre-installation seafloor grade) where the jacket pile structure would be installed. Scour protection would be installed around the base of the jacket pile structure following installation to stabilize where the IAC and SRWEC are pulled into the foundation. The OCS-DC location was characterized as Sand and Mud.

The OCS-DC requires the withdrawal of raw seawater through a CWIS to dissipate heat produced through the AC to DC conversion and then discharge this water as thermal effluent to the marine receiving waters. The DIF for the OCS-DC is 8.1 MGD; however, the AIF would generally range from 4.0 MGD to 5.3 MGD. The OCS-DC is proposing to discharge non-contact cooling water (NCCW) and non-contact stormwater to the marine receiving water.

Entrainment/Impingement

A total of 42 individual species of fish and invertebrates identified above in Section 4 have designated EFH in the vicinity of the OCS-DC. In addition, a benthic study conducted in 2020 detected the presence of multiple epifaunal and infaunal species. The sample collected closest to the OCS-DC location included habitats likely containing soft sediment fauna such as burrowing anemones, Jonah crab, horseshoe crab (*Limulus polyphemus*), ocean quahog, sand dollar (*Echinorachnius parma*), sea scallop, surfclam, channeled whelk (*Busycotypus canaliculatus*), amphipod species, and sea star species.

The OCS-DC cooling water intake was designed to maintain a TSV less than 0.5 feet per second (ft/s) (0.1525 meter per second [m/s]) which is below the EPA threshold for new facilities and is protective against impingement of juvenile and adult fish. Thus, only species with egg or larval life stages present in the vicinity of the OCS-DC would be susceptible to entrainment. A total of 17 finfish species and whose early life stages could be near the OCS-DC during water withdrawal activity meet this criterion.

A number of mitigation measures included in the design of the OCS-DC would reduce impacts to finfish and EFH and be protective of Atlantic cod. The low screen velocity would prevent impingement of juvenile and adults. The OCS-DC would be located 5 to 10 km south of Cox Ledge while the Hydraulic Zone of Influence (HZI) of the intake does not extend more than 20 ft from the intake (draft EPA NPDES Permit No. MA0004940). Aquatic organisms including eggs and larvae of Atlantic cod would have to pass through this relatively small area in order to be exposed to the influence of the intake and to potentially become impinged or entrained.

In addition, the OCS-DC has been designed with variable frequency drive (VFD) pumps to enable the facility to limit the volume of water it withdraws to the amount actually required to meet cooling water needs. During colder winter months when Atlantic cod spawn, less cooling water would be needed. The VFD pumps would allow the OCS-DC to reduce the volume of intake flow needed so that the actual intake flow would vary between 4.0 and 5.3 MGD, as compared to the design flow of 8.1 MGD. The use of VFDs to achieve projected actual intake flows would result in an estimated 47 to 49 percent reduction in entrainment (draft EPA NPDES Permit No. MA0004940).

The proposed average monthly intake flows (4.0-5.3 MGD) are distributed over two intake pipes; the estimated actual through-screen velocity at the intake is expected to be 0.21 – 0.28 ft/s. This through-screen velocity is lower than the EPA's threshold described above, which was set at a level that allows a majority of fish to swim away and avoid becoming impinged on the trash racks or entrapped within the intake pipes.

The OCS-DC would include three openings for intake pipes located approximately 30 ft (10 m) above the pre-installation seafloor grade. The water depth of the intake pipe openings was selected to minimize the potential of biofouling and entrainment of ichthyoplankton and to take advantage of the cooler water temperatures found at depth to maximize cooling potential of water withdrawn.

Once built, the EPA will require ichthyoplankton monitoring to document entrainment. Beginning in the first year of operation, sampling will be required during one 48-h period in each quarter of the year. However, to evaluate the potential ichthyoplankton entrainment prior to operational OCS-DC withdrawals, species abundance data was obtained from the NOAA National Centers for Environmental Information (NCEI) electronic database. This database include data collected by NOAA's Marine Resource Monitoring, Assessment, and Prediction (MARMAP) program from 1977-1987 and by the Ecosystem Monitoring (EcoMon) program from 1995 through 2017 throughout the North Atlantic region.

Ichthyoplankton tows were collected using 24-inch (in) (60 centimeter [cm]) bongo plankton nets with either 0.333-millimeter (mm) or 0.505-mm mesh. A total of 31,351 ichthyoplankton tows were conducted between North Carolina and Nova Scotia throughout the 40-year survey duration and are included in the NCEI database. For this analysis, the robust data set was trimmed to include only those ichthyoplankton tows that were conducted within the general geographic region of the OCS-DC and SRWF. The boundaries of this geographic region were selected to avoid shallow shoreline areas which would be expected to contain species not present at the OCS-DC location, to extend to the edge of the continental shelf, and to encompass a large number of samples to help offset the natural variability inherent in marine systems. This truncated data set was utilized to assess entrainment susceptibility associated with operation of the OCS-DC and consists of 1,859 total ichthyoplankton tows and contains a total of 90,799 individual ichthyoplankton. The NCEI dataset does not identify eggs to species level;

therefore, the species-specific ichthyoplankton entrainment results shown below are based only on larval life stages.

Identification of fish species and life stages that would be most susceptible to entrainment from the OCS-DC were evaluated based on their abundance or their significance to commercial and recreational fisheries. The NPDES permit included annual entrainment estimates of ichthyoplankton by grouping egg and larval stages (Sunrise Wind 2022b, Appendix N2). Since the NCEI dataset does not identify eggs to species level, entrainment numbers were considered larval estimates only when calculating adult equivalent losses. This approach is conservative as more larvae survive than eggs.

To evaluate impacts of this entrainment, supplementary analyses were conducted as part of the preparation of the EFH assessment, and not included in the NPDES permit. Entrainment estimates for adult equivalent losses (AELs) were completed for eight abundant or commercially important fish species and are listed below. AELs are estimates of the number of entrained organisms removed from the population that otherwise would have survived to some future age, or age of equivalence. To estimate AELs for the OCS-DC, the annual estimates of entrained larvae and eggs (x') from Appendix N2 of Sunrise Wind (2022) were multiplied by the survival fraction at the age of equivalence i and the proportion p of returning adults that belong to life stage i (Equation (1)):

$$AELj = \sum_{J=1}^{n} Sijx^{wi} pj \qquad (1)$$

Where $AELj$ is the expected number of adult equivalents of life stage j lost due to operations; Sij is the survival fraction of organisms of starting life stage i surviving to life stage j; x' is the extrapolated number of organisms of life stage i during time t; and pj is the expected proportion of returning equivalent adults of life stage j.

Survival rates of early life stages are often expressed on a life stage-specific basis so that the fraction surviving from any life stage i to adulthood or age of equivalence j is expressed as the product of survival fractions for all life stages (k) through which a fish must pass before reaching age of equivalence j.

The parameters used to evaluate the adult equivalent entrainment, such as instantaneous natural mortality and instantaneous fishing mortality rates at varying life stages were acquired from the EPA Regional Benefits Analysis for the Final Section 316(b) Phase III existing facilities rule (EPA 2006). Age of adulthood for the eight species of interest were found in Fishes of the Gulf of Maine (Bigelow and Schroeder 2003).

Based on this analysis, forage species are expected to be those most susceptible to entrainment impacts associated with operation of the OCS-DC including Atlantic herring, red hake, Atlantic mackerel (*Scomber scombrus)*, and silver hake (*Merluccius bilinearis*). The commercially important species with eggs and larvae that could be most susceptible to operation of the OCS-DC include yellowtail flounder (*Limanda ferruginea*), summer flounder, and Atlantic butterfish (*Peprilus triacanthus*).

Atlantic cod (*Gadus morhua*) is a species of concern in this region. However, eggs and larvae of this species are not expected to be as susceptible to OCS-DC operation relative to the other species. This analysis estimates that a total of up to 34,239 Atlantic cod eggs and larvae could be entrained on an annual basis which would result in 16.5 equivalent adults. The peak spawning period for Atlantic cod occurs in December and January in this region. To put these potential entrainment rates in context, one (1) large female Atlantic cod can produce 3 to 9 million eggs annually (NOAA Fisheries 2021). The AELs for Atlantic cod are estimated to be 16.5 fish lost.

Table 5-5. Annual Entrainment Estimates of Eight Fish Species Including Egg and Larval Stages and Adult Stages

Species	Annual Entrainment Estimates		
	Larvae	Adult Equivalent Losses	Fecundity
Atlantic Cod	34,239	16.5	3,000,000 to 9,000,000
Atlantic Herring	1,015,627	573.1	12,000 to 260,000
Red Hake	279,085	1.84	No estimate
Silver Hake	47,076	5.75	343,000 to 391,000
Yellowtail Flounder	78,988	0.25	350,000 to 4,570,000
Atlantic Butterfish	318,433	38.9	No estimate
Atlantic Mackerel	2,649	0.04	285,000 to 1,980,000
Summer Flounder	69	0.01	Up to 6,000,000

As described above, entrainment estimates at the OCS-DC, Sunrise Wind used ichthyoplankton data collected by NOAA's Marine Resource Monitoring, Assessment, and Prediction (MARMAP) program and NOAA's Ecosystem Monitoring (EcoMon) program, from tows conducted in the geographic region which encompassed 1,859 individual tows. Because Sunrise Wind's entrainment estimates are based on data collected over a much larger geographic area than the area within the proposed windfarm boundary, EPA re-examined the data and calculated entrainment estimates based on larval densities in the general area of the windfarm boundary. EPA compared average larval densities from this smaller geographic area to Sunrise Wind's estimates to determine if there is likely to be any difference in average densities in the vicinity of the OCS-DC. EPA trimmed the dataset for all species collected within an area bounded by the maximum and minimum latitude and longitude positions of the wind farm. The resulting area includes 197 individual tows, or about 10 percent of the original area in Sunrise Wind's analysis.

When the analysis is repeated using the larval EcoMon and MARMAP data for all species within the general vicinity of the wind farm, the estimated number of larvae entrained per year based on projected average monthly intake flows increases from 5,632,408 larvae to 6,345,726 larvae. The estimated entrainment among the most abundant species is generally the same or higher within the windfarm area as compared to the larger geographic region that Sunrise Wind assessed, with the exception of Atlantic herring, which was substantially more abundant across the larger area than within the wind farm boundary. Densities of Atlantic cod larvae were similar within the wind farm area and the larger geographic area. It should be noted that future changes in the distribution of finfish eggs and larvae caused by hydrodynamic disturbance due to the presence of the WTGs and associated scour protection could potentially change estimated entrainment at the OCS-DC, however these changes should not lead to population level impacts.

EPA determined that the proposed use of VFDs, the proportional intake volume, and the intake location are the Best Technology Available (BTA) for minimizing entrainment by the OCS-DC's CWIS.

Thermal Plume

The location, design, and operation of the cooling water discharge (Dump Caisson) was selected to minimize degradation by minimizing the thermal plume size to the greatest extent practicable and preventing thermal plume migration to the surface waters or benthos. For optimal performance of the CWIS, the Dump Caisson needed to be sited deep enough that it would be submerged in the 100-year wave event and at a sufficient distance away from the intake pipes to avoid heated effluent being subsequently withdrawn by the SWLP.

To identify the optimal location for the Dump Caisson, the Cornell Mixing Zone Expert System (CORMIX) was used to evaluate the mixing zone associated with multiple discharge locations in the water column. The assessment considered four different seasons using a 2 degrees Fahrenheit (°F) (1 degree Celsius [°C]) temperature differential (ΔT) threshold to delineate the extent of the mixing zone. The optimal location for the Dump Caisson discharge was determined to be approximately 40 ft (12 m) below local mean sea level. At this optimized location rapid and complete mixing occurs. The thermal plume would be contained to a distance of 87 ft (27 m) from the outfall and occupy a maximum area of 731 ft^2 (66.9 m^2) in a worst-case, slack tide scenario.

Operation of the OCS-DC would not be expected to affect marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas, or coral reefs. None of these aquatic sites would be in the near proximity of the OCS-DC nor within the boundary of the Lease Area.

5.2 Project Monitoring Activities

5.2.1 Fisheries Monitoring

5.2.1.1 Trawl Survey

The trawl survey would periodically disturb soft bottom benthic habitat within a set of pre-selected tow tracks identified as suitable for this gear type. The trawl survey net would be the same design as the NorthEast Area Monitoring and Assessment Program (NEAMAP) survey net which is a 400 x 12-cm three-bridle four-seam bottom trawl, and the net is paired with Thyboron, Type IV 168 cm (66 in) trawl doors. A 2.5-cm (1-in) knotless cod end liner would be used to sample marine taxa across a broad range of size and age classes. Trawl surveys are scheduled to occur throughout the year, which would include a winter, spring, summer, and fall survey. The trawl surveys at SRWF and Revolution Wind Farm (RWF) would be executed simultaneously using the same vessel, sampling gear, and scientific crew, and catch rates at both the SRW and RWF impact areas would be compared to the same two reference areas. The RWF trawl survey was limited to the northern portion of the RWF Lease Area which encompasses an area of approximately 125 km^2. The two reference areas proposed for the trawl survey are also 125 km^2. The entire SRW Lease Area is approximately 445 km^2. In order to sample an equivalent amount of area (125 km^2) within the SRW impact site, it is proposed that the SRW trawl survey impact area be limited to the western portion of the lease site. This greatest concentration of effort by the large mesh otter trawl fleet occurred in this portion of the lease site from 2011 through 2016. Within the SRWF and the reference areas, the sampling density associated with each seasonal survey would be one station per 8.3 km^2. The order in which the reference areas and the SRWF trawl survey are conducted would be randomized prior to the start of each survey. A sample size of 15 trawl tows per area would be targeted per season in each year at the start of the survey. The proposed seasonal sampling intensity equates to an annual sampling target of 180 tows per year across the SRWF and reference areas.

The tracks surveyed during each event would be randomly selected from the available set for each site, modified as needed to avoid gear conflicts. The trawls are designed to capture a representative sample of demersal fish species present in the impact and reference areas, emphasizing EFH and other species of commercial and recreational interest. This activity would directly affect EFH species and their prey through death of most of the trawled individuals. In addition to these direct impacts, bottom-disturbing trawls can alter the composition and complexity of soft bottom benthic habitats. For example, when trawl gear contacts the seabed it can flatten sand ripples, remove epifaunal organisms and biogenic structures like worm tubes, and expose anaerobic sediments (Nilsson and Rosenberg 2003; Rosenberg et al. 2003). The selected location for the trawl survey is subjected to regular disturbance by commercial fishing activity, and that this type of disturbance has already and would continue to occur whether the Trawl Survey is implemented.

Impacts to EFH species through capture during the trawl survey would not result in population-level impacts. Trawl surveys are not likely to significantly alter the rate and extent of disturbance of soft bottom benthic habitat relative to the environmental baseline.

5.2.1.2 Acoustic Telemetry HMS

HMS are currently being monitored by acoustic telemetry in the SRWF area. The Project is focusing on monitoring bluefin tuna, shortfin mako sharks, and blue sharks, shortfin mako sharks and tuna. This acoustic telemetry monitoring effort would build off these baseline studies by including five additional years of data collection, an expansion of the receiver array, and the deployment of an additional 150 acoustic transmitters for HMS.

VEMCO model VR2-AR receivers would be rigged using standard procedures outlined by VEMCO for benthic deployment. Ropeless technology (AR Buoys) were selected to minimize risks to marine mammals and other protected species. The VR2-AR receivers are equipped with acoustic release mechanisms that allow instrument retrieval without the need for surface buoys and vertical lines in the water column. The receivers would be deployed approximately two meters from the benthos, and two small floats keep the receiver oriented vertically in the water column to maximize the detection radius. Retrieval is performed with wireless communication from a VR100 aboard the vessel that triggers the release, using a push-off titanium pin and an attached floatation buoy to bring the released receiver to the surface. The receivers would be rigged inside a pop-up canister (Mooring Systems Inc) to enable to moorings to be retrieved during download trips, and to enable the moorings (75 pounds steel pyramid anchors) to be removed from the study site at the end of the monitoring.

Trips to download and maintain the acoustic receivers would be conducted in the spring and fall of each year of the Project. During each trip, receivers would be summoned, downloaded, and cleaned of any biofouling. They would be re-rigged and re-deployed at sea. Receiver deployment and maintenance would be done primarily in collaboration with a local commercial fishing vessel.

Placement of pyramid anchors would minimize benthic impacts but would result in sediment disturbance and a short-term increase in suspended sediment near the anchors and would crush any organisms and habitat underneath the anchors. The effects of the anchors on EFH species and habitats would result in slight short-term and long-term impacts to EFH and managed species.

5.2.1.3 Acoustic Telemetry - SRWEC

Evaluating the potential impacts of EMF from undersea power transmission cables has been one of the major research priorities identified by commercial and recreational fishermen during the development of fisheries monitoring guidance related to offshore wind. In this study, an acoustic telemetry receiver network would be established along the route of the SRWEC, and dedicated telemetry tagging would occur to evaluate the potential impacts associated with the operation of the SRWEC on important marine species. The species selected for telemetry monitoring are American lobsters, horseshoe crabs, winter skates, sandbar sharks, sand tiger sharks, dusky sharks, and smooth dogfish. Positional monitoring of tagged individuals would be accomplished using two arrays of acoustic receivers to evaluate both broad-scale migratory behavior as well as fine-scale movements near the SRWEC. The offshore receiver array would include three linear gates of receivers (offshore north approach, offshore south approach, and SRWEC gate). The nearshore fine-scale positional array would be used to evaluate movement around the SRWEC with high spatial resolution. Temperature (mean, minimum, maximum) would be recorded every three hours on all VR2AR-X receivers providing information to evaluate environmental drivers of the presence/absence of telemetered individuals in the study area.

The offshore receiver array would provide the ability to track movement as telemetered individuals enter the approach field, pass over the cable area, and exit the approach region. The design provides a quasi-controlled field-experiment system where the approach gates provide movement and behavior metrics independent of potential EMF impacts, while the SRWEC gate is adjacent to the cable and can capture local changes in behavior. In the offshore receiver array each linear gate would include 10 VR2AR-X acoustic release omnidirectional hydrophones (receivers) that can detect a telemetered individual from a radius of 1,640 ft to 3,280 ft (500 to 1000 m) depending on sea conditions and transmitter strength. The receivers in the three linear gates would be placed approximately 0.6 mi (1 km) apart.

The near-shore fine-scale positioning array would provide high-resolution information on the two-dimensional or three-dimensional movements (depending on the type of transmitter) of individuals in the vicinity of the SRWEC. The receivers in the nearshore fine-scale positional array are planned to be spaced approximately 1,312 ft (400 m) apart, but the exact receiver spacing would be informed by range testing performed by the VR2AR-X receivers are equipped with built-in transmitters to sync with adjacent receivers (VEMCO Positioning System), enabling the two-dimensional position of tagged individuals to be evaluated with high precision. Additionally, telemetered elasmobranchs tagged with V16TP transmitters can be positioned in three dimensions (latitude, longitude, and depth) within the fine-scale positioning array.

The VR2AR-X receivers are equipped with acoustic release mechanisms that allow instrument retrieval without the need for surface buoys and vertical lines in the water column. Ropeless technology (Acoustic Release Buoys) was selected to minimize risks to marine mammals and other protected species. The receivers would be deployed approximately 6.5 ft (2 m) from the benthos, and two small floats keep the receiver oriented vertically in the water column to maximize the detection radius. Retrieval is performed with wireless communication from a VR100 aboard the vessel that triggers the release, using a push-off titanium pin and an attached floatation buoy to bring the released receiver to the surface.

The entire receiver array would be downloaded twice per year, during which time the receivers would be cleaned of any biofouling, and the batteries would be replaced as needed. The receivers would be rigged inside a pop-up canister (Mooring Systems Inc) to enable to moorings (75 pounds pyramid anchors) to be retrieved during download trips, and to enable to moorings to be removed from the study site at the end of the monitoring.

Placement of pyramid anchors would minimize benthic impacts but would result in sediment disturbance and a short-term increase in suspended sediment near the anchors and would crush any organisms and habitat underneath the anchors. The effects of the anchors on EFH species and habitats would result in negligible short-term and long-term impacts to EFH and managed species.

5.2.1.4 Scallop Survey

Sunrise Wind would partner with researchers at Coonamessett Farm Foundation (CFF) to carry out HabCam survey for scallops and other benthic organisms within the SRWF and a nearby control area, and the survey would be executed using a Before-After-Control-Impact (BACI) design. The survey would be executed once per year, targeting sampling in summer. The target is to achieve two years of pre-construction monitoring, and the survey would continue during construction, and for at least two years after construction is completed. This survey would be carried out in collaboration with a local scallop vessel(s). The primary objective of the HabCam survey is to investigate the relative abundance of scallops and other resources in the SRWF Area ("SRW impact") and reference area ("control") over time. Using the HabCam survey equipment and protocols would ensure that the data collected as part of this fisheries monitoring plan would be compatible and standardized with fisheries-independent data that is used to inform scallop science, stock assessment, and management. The HabCam survey approach also is well-suited to sampling within the Lease Area following construction.

The towed-array vehicle is outfitted with dual cameras, which take 6 overlapping, paired images per second (518,400 paired images per day), continuously throughout its track. The system is towed 5 to 8 ft (1.5 to 2.5 m) off bottom while being towed at 4-5 knots. A survey track approximately 100-120 nm long is imaged during each 24 hours of operation while at sea. The field of view of the HabCam v3 system is around 1 m^2 yielding approximately 180,000 - 220,000 m^2 of area surveyed per 24-hour period. The vehicle is equipped with strobe lights (to reduce blur in imagery) and integrated sensors to track salinity, temperature (benthic temperature and vertical casts), depth, and altitude. This type of sensor-based data is extremely valuable, as it allows for the evaluation of fine-scale variations in bottom temperature and other factors that govern productivity.

This survey technique alone would not cause any impacts to EFH or EFH-designates species.

5.2.2 Benthic Monitoring

5.2.2.1 Benthic Monitoring – SRWF and SFWEC-OCS

Physical disturbance associated with cable and foundation installation can temporarily affect the benthic environment, removing or damaging existing fauna. Over time, the introduction of novel hard substrata (offshore wind [OSW] foundations, scour protection layers, and cable protection layers) can lead to extensive biological growth on the introduced surfaces with a complex pattern analogous to shoreline intertidal to subtidal zonation. This benthic monitoring plan is organized according to these prevailing hypotheses and describes the overall approach to tracking changes in both the novel hard bottom and soft bottom habitats associated with OSW development, specifically at the SRWF and SRWEC-OCS. A separate benthic monitoring survey for the SRWEC-NYS would be conducted within NYS waters, which is discussed in Section 5.2.1.5.

Visual monitoring survey would be conducted separately for hard bottom habitats and soft bottom habitats. Novel hard bottom habitat monitoring at turbine foundations, scour protection layers, and cable protection layers would focus on measuring changes in percent cover, species composition and volume of macrofaunal attached communities (native and non-native species groups) and physical characteristics (rugosity, boulder density). Soft bottom habitat monitoring would focus on measuring physical factors and indicators of benthic which would serve as proxies for functional changes in the community composition. It is expected that the introduction of fines and organic content sourced from the epibenthic community on the WTG foundations would support increased deposit feeding benthic invertebrate communities in the soft sediments around the structures. To accomplish the objectives of the novel hard bottom monitoring, high-resolution video imagery captured using a Remote Operated Vehicle (ROV) would be employed. Video imagery would be used to document epifaunal community characteristics on the novel hard surfaces. Monitoring at hard bottom habitats would begin after construction is complete during late summer or early fall, and sampling would be repeated annually at time intervals of 1, 2, 3, and 5 years after construction. Sampling would occur during late summer or early fall to capture peak biomass and diversity of benthic organisms.

The soft bottom monitoring would include an examination of two OSW components: WTG foundation-associated and export cable-associated soft bottom. The overall objective of the soft bottom benthic monitoring survey is to measure potential changes in the benthic function of soft bottom habitats over time, and to assess whether benthic function changes with distance from the base of the WTG foundations or SRWEC-OCS centerline. Benthic functioning of the soft bottom habitats would be captured by documenting physical parameters (grain size major mode) and biological factors (bioturbation and utilization of organic material) with a SPI/PV system. It is expected that the epibenthic community that colonizes the WTG foundations and OCS-DC jacket would 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 wind structures would likely alter the infaunal community activity, increasing sediment oxygen demand and promoting the activity of deep-burrowing infauna. Based on benthic monitoring results in other offshore wind farms, the effects of the WTG foundation on the surrounding soft sediment habitat are expected to decrease with increasing distance from the WTG. SPI/PV would be used as the monitoring approach for the soft sediment habitat 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. SPI/PV provides an integrated, multidimensional view of the benthic and geological condition of seafloor sediments and would support characterization of the function of the benthic habitat, physical changes, and recovery from physical disturbance following the construction and during operation of SRWF and SRWEC. Sampling would occur during late summer or early fall to capture peak biomass and diversity of benthic organisms in alignment with previous studies.

The video survey technique alone would not cause any impacts to EFH or EFH-designates species.

5.2.2.2 Benthic Monitoring – SRWEC-NYS

This benthic monitoring plan includes details of the pre-construction and post-construction surveying of soft sediment habitats along the SRWEC-NYS. A combination of SPI/PV imaging and sediment grab sampling would be used to monitor these benthic environments. SPI/PV is a widely accepted approach to assess the seafloor as it provides an integrated, multidimensional view of the benthic and geological condition of the seafloor sediments. SPI/PV imagery 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 allows for accurate comparisons to be made before and after 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 benthic community analysis of sediment grab samples provides quantitative descriptions of soft sediment communities including community structure, abundances of taxa, and community diversity.

The benthic community analysis approach would provide an assessment of potential changes in quantitative community diversity metrics and particular species abundances.

At least two field sampling events would occur after the proposed SRWEC-NYS has been installed. Post-construction monitoring surveys would occur between August 1st and October 31st within 24 months of the Project's commercial operational date. During the post-cable installation surveys, three stations would be sampled with SPI/PV in a transect perpendicular to the SRWEC-NYS, with one station as close as practicable to the centerline and one station approximately 100-ft on either side. These transects would repeat at 1,000-ft (305 m) intervals from the HDD exits offshore to the territorial limit of NYS waters. At each SPI/PV station a minimum of three replicate images shall be collected and analyzed. At each SPI/PV station, a conductivity, temperature, depth sensor would be used to measure the salinity and temperature through the water column to the sediment surface. Additionally, the temperature of the sediments would be measured at each SPI/PV station. The SPI/PV sampling would be supplemented with sediment grab stations located at transects every 2,000-ft (610 m) along the SRWEC-NYS centerline, with one grab sample station as close as practicable to the centerline and one grab sample station approximately 100-ft (30.5 m) on the eastern side of the cable. At each grab station three replicate grab samples would be collected, sieved onboard, and preserved.

Benthic survey activities include a combination of SPI/PV imaging and sediment grab sampling. The SPI/PV system would penetrate soft bottom habitat to collect a plan view image of the subsurface substrate composition, which could impact EFH by crushing benthic organisms, disturbing soft bottom habitat, and creating a short-term increase in suspended sediment. The sediment grab sampling would have similar impacts to EFH by crushing benthic organisms, disturbing soft bottom habitat, and creating a short-term increase in suspended sediment. The benthic surveys would not change the effects determination for EFH for any species in the EFH assessment.

5.2.3 Protected Species Mitigation and Monitoring

The Protected Species Mitigation and Monitoring Plan (PSMMP) provides protocols and requirements for mitigation and monitoring activities to minimize potential impacts on marine mammals through both visual and passive acoustic means during Project-related construction and operational activities. The PSMMP focuses on marine mammals potentially exposed to underwater sound and pressure levels and other measures intended to avoid take. The PSMMP provide Project-specific details regarding the protocols that would be implemented during vessel operations, high-resolution geophysical surveys, UXO removal, and O&M.

PAM systems are underwater acoustic recording devices deployed during Project activities to detect the presence of marine mammal vocalizations. PAM systems proposed at the Project include moored and autonomous systems. These systems could impact EFH during deployment and retrieval by crushing benthic organisms, disturbing soft bottom habitat, and creating a short-term increase in suspended sediment.

NAS include any device or suite of devices that reduces sound levels that are transmitted through the water. Sunrise proposed to deploy NAS systems that reduce the propagated sound levels. NAS systems proposed by Sunrise include a big bubble curtain, hydro-sound damper (HSD), and an AdBm, Helmholz resonator. The proposed big bubble curtain consists of a flexible tube(s) fitted with special nozzle openings and installed on the seabed around the pile. Compressed air is forced through the nozzles producing a curtain of rising, expanding bubbles. These bubbles effectively attenuate noise by scattering sound on the air bubbles, absorbing sound, or reflecting sound off the air bubbles. An HSD system consists of a fish net holding different sized elements arranged at various distances from each other that encapsulates the pile. HSD elements can be foam plastic or gas-filled balloons. Noise is reduced as it crosses the HSD due to reflection and absorption by air spaces contained in the elements. The AdBm system consists of large arrays of Helmholtz resonators, or air fill containers with an opening on one side that can be set to vibrate at specific frequencies to absorb noise, deployed as a “fence” around pile driving activities. These systems could impact EFH during deployment and retrieval by crushing benthic organisms, disturbing soft bottom habitat, and creating a short-term increase in suspended sediment.

5.3 Decommissioning

All facilities would need to be removed to a depth of 15 ft (4.6 m) below the mudline, unless otherwise authorized by BOEM (30 CFR § 585.910(a)). Care would be taken to handle waste in a hierarchy that prefers re-use or recycling, and leaves waste disposal as the last option. Absent permission from BOEM, Sunrise Wind would complete decommissioning within two years of termination of the lease.

A separate EFH consultation would be conducted for the decommissioning phase of the project. Decommissioning of the Project would include removal of all structures to a depth of 15 ft. in a general reversal of the installation activities. Similar equipment and number of vessels to those used during construction would be used to remove infrastructure. The OCS-DC would be decommissioned by dismantling and removing its topside and foundation (substructure). As with the turbine components, this operation would be a reverse installation process subject to the same constraints as the original construction phase. It is anticipated that monopole foundations would be cut below the seabed level in accordance with standard practices at the time of demolition, which may include mechanical cutting, water jet cutting, or other industry standing practices. Removal of structures during decommissioning as well as vessel anchoring could cause injury or mortality to fish and EFH-designated species. Removal of turbine foundations would mean loss of the unique hard substrate and vertical habitat that had established itself over the life of the Project.

The scour protection placed around the base of each monopile would be removed during decommissioning, according to the best practices applicable at the time of decommissioning.

Offshore cables would either be left in-situ or removed, or a combination of both, depending on the regulatory requirements at the time of decommissioning. It is anticipated that the array cables would be removed. The export cables would be left in-situ or wholly/partially removed. Any cable ends would be weighed down and buried if the cables are to be left in-situ to ensure that the ends are not exposed or have the potential to become exposed post-decommissioning. Cables may be left in-situ in certain locations, such as pipeline crossings, to avoid unnecessary risk to the integrity of the third-party cable or pipeline. The removal of cables has the potential to result in short-term localized disturbance and resuspension of benthic sediments.

These impacts to fish and EFH-designated species are anticipated to be short-term and localized due to the disturbance of a relatively small area and would not cause long-term impacts once decommissioning activities are completed. Pelagic fish species are anticipated to avoid the area during Project decommissioning activities. Benthic and pelagic finfish species are anticipated to move back into the area. However, benthic habitat that serves as forage area for bottom-dwelling species may take longer to recover to pre-impact conditions. Successional epifaunal and infaunal species are anticipated to recolonize the sediments, gradually providing the continuation of foraging habitat for fish and EFH-designated species. Fish and invertebrate communities would transition back to a sandy, soft bottom community structure, recolonizing from the surrounding sandy bottom habitat.

There would be short-term increases in sediment suspension and deposition during bottom disturbance activities. These increases in sediment suspension and deposition may cause short-term adverse impacts to mobile fish and EFH-designated species because of decrease in habitat quality for benthic species. Less mobile egg and larval life stages may experience injury or loss of individuals similar to that described for construction. Juveniles and adults are anticipated to vacate the habitat due to suspended sediment levels in the water column and avoid impact. Pelagic habitat quality and EFH is expected to quickly return to pre-disturbance levels.

Increased underwater noise during construction would primarily be associated with structure removal activities which may include mechanical cutting, water jet cutting, or other industry standard practices. The noise produced by the pile cutting activities is not expected to be impulsive and is therefore unlikely to produce noise levels with the potential for injury. The elevated noise levels could make the habitat temporarily less suitable and could cause fish and EFH-designated species to temporarily vacate the Project area during decommissioning activities. This impact is anticipated to be short-term and limited to the location of active pile removal which represents a small portion of the total available habitat. Further, short-term impacts to EFH-designated species are expected for mobile species that can detect sound associated with vessel or other decommissioning activity noises. These adverse impacts would be anticipated to be similar and short-term in nature to the current noise levels of vessels that transit the area. Direct impacts to fish and EFH-designated species may result from a degradation of habitat for species that vacate the area during increased noise levels during Project decommissioning activities. Both pelagic and demersal life stages would experience a short-term impact from vessel and other decommissioning activity noise.

5.4 Cumulative and Synergistic Effects to EFH

The primary impact of the Project would be from the installation and operation of 94 WTG turbines and foundations, which would be constructed in the mostly sandy seafloor. Installation of the turbines would produce acoustic impacts that could cause behavioral or physical effects on EFH and species with designated EFH. For species such as Atlantic cod and other gadids, alteration of the ambient noise environment by impact pile driving could interfere with communication and alter behavior in ways that could disrupt localized cod spawning aggregations These new structures could also affect the migration of species that are attracted to unique complex features. This could lead to retention of those species and could increase feeding and spawning opportunities for some species but lead to increased predation risk for other species.

It is also possible that the new structures would provide additional habitat benefit as a result of habitat conversion from non-complex habitat to complex habitat. Complex habitat and its associated fish communities is limited in the Project area, and it is possible that additional habitat would expand these fish communities. The structures would create an “artificial reef effect,” whereby more sessile and benthic organisms would likely colonize these structures over time (e.g., sponges, algae, mussels, shellfish, sea anemones). Higher densities of invertebrate colonizers would provide a food source and habitat to other invertebrates such as mobile crustaceans. With new foundations being added from additional offshore wind farms, EFH for fishes and invertebrates adapted to complex habitat would increase, but at the expense of EFH for soft bottom fishes.

To determine if activities are proposed simultaneously in the WEA potentially leading to cumulative and synergistic impacts, a schedule depicting construction activities at Sunrise Wind, Revolution Wind and South Fork was developed (Figure 5-2). The schedule compares construction schedules for the onshore facilities, export cables, offshore foundations, IAC, WTG installations and the OSS among all three wind farms. There is no overlap between the Sunrise Wind and South Fork construction schedules.

There is overlap during the construction of the onshore facilities at both Sunrise Wind and Revolution Wind however these are remote from each other and would produce no overlapping impacts (Figure 5-3). There is also overlay during the construction of the export cables between Sunrise Wind and Revolution Wind but at their closest point these cables are approximately 16 miles apart (Figure 5-4). Proposed construction of the offshore foundations, and IAC at both Projects overlap. The timing of the installation of the WTGs or OSS do not coincide between the Projects. The installation of offshore foundations and the IAC have similar timing (Figure 5-2). In some cases, this work could be as close as 2-3 mi (3.2-4.8 kilometers) apart (Figure 5-4). Results from the sound modeling show that injury from a single strike is limited to 70 m from a pile for both winter and summer seasons and injury from prolonged cumulative exposure (over 24 hours) extends as far as 9.35 km from the pile during the winter water profile. Modeling indicates that behavioral effects on fish could occur up to 7.54 km from the pile source during the winter and 5.18 km from the pile source during the summer. Within this area, it is likely that some level of behavioral reaction is expected and could include startle responses or migration out of areas exposed to underwater noise (Hastings and Popper 2005). Mitigation measures such as the use of ramp up procedures would allow mobile resources to leave the area before full-intensity pile driving begins. The Project would use bubble curtains, hydro-dampers, and AdBm, Helmholz resonators to reduce noise propagation. The Project is committed to achieving ranges associated with 10 dB of noise attenuation. Construction and installation, O&M, and decommissioning of the Project would have short-term, long- term, and permanent direct and indirect impacts on EFH in the Project area. Project activities would extend over several years, and could result in extended periods, or multiple shorter sequential periods, when activities are being conducted in the same area, leading to the potential for cumulative and synergistic impacts.

Figure 5-2 Planned Offshore Wind Installation Schedule for the Proposed Sunrise Wind Project and adjacent Revolution Wind and South Fork Projects

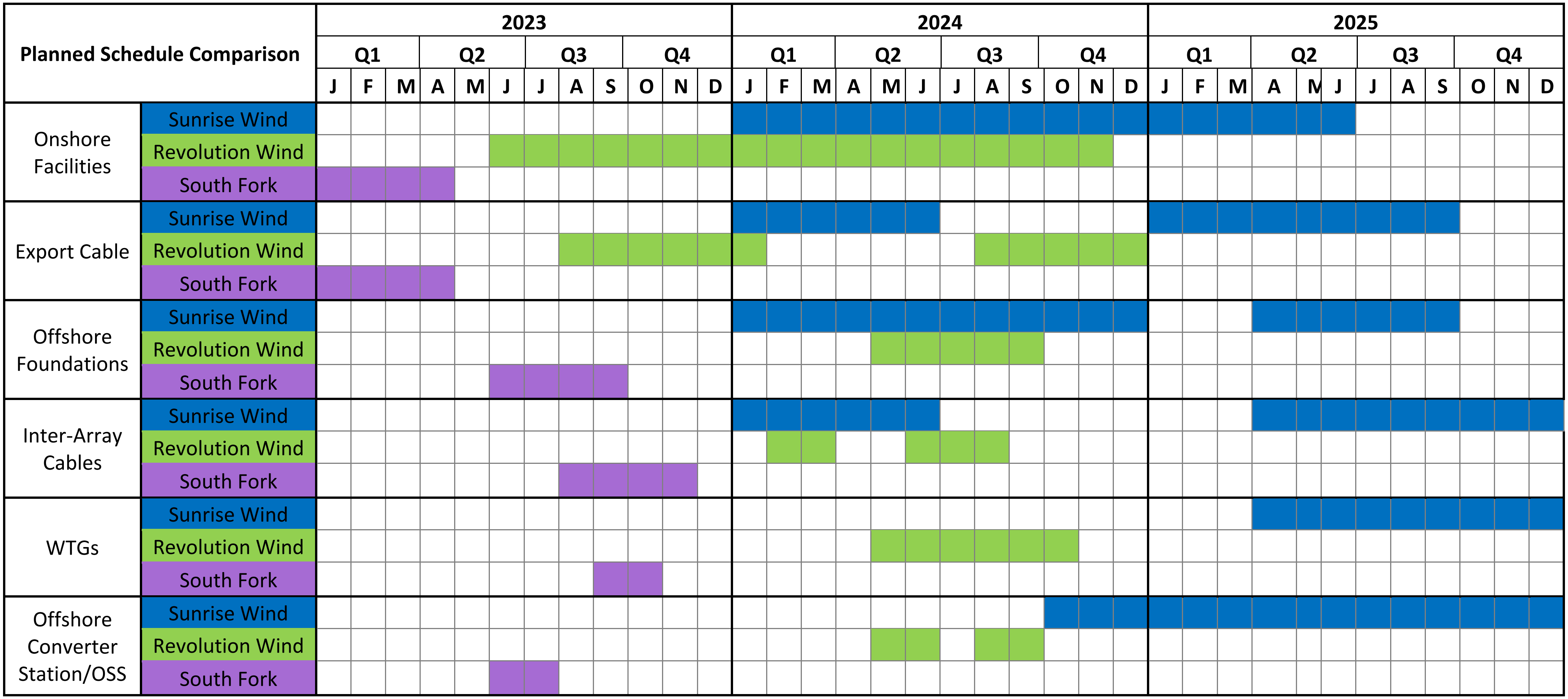


Figure 5-3 Sunrise Wind, Revolution Wind and South Fork Proposed Project Locations and Export Cables

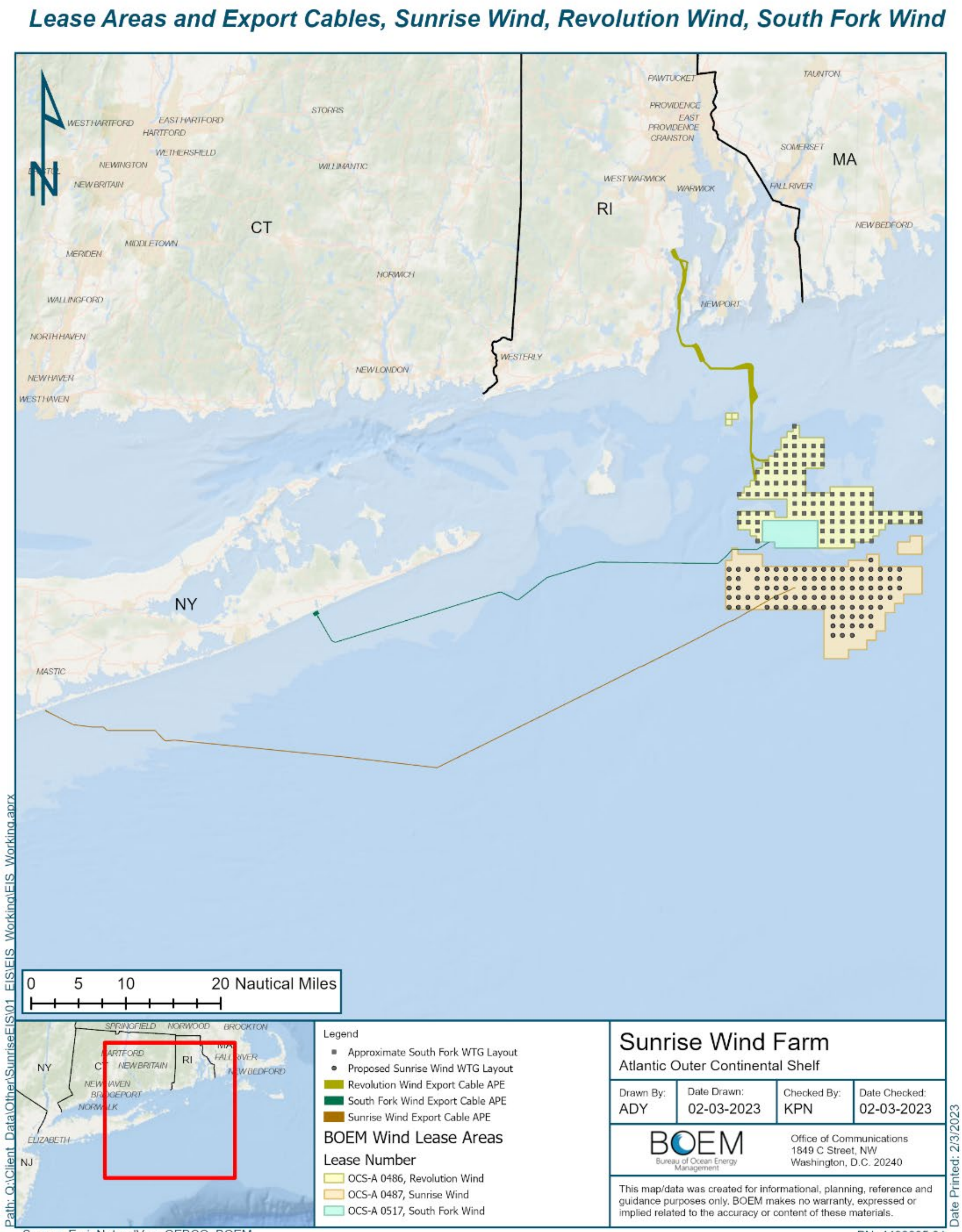
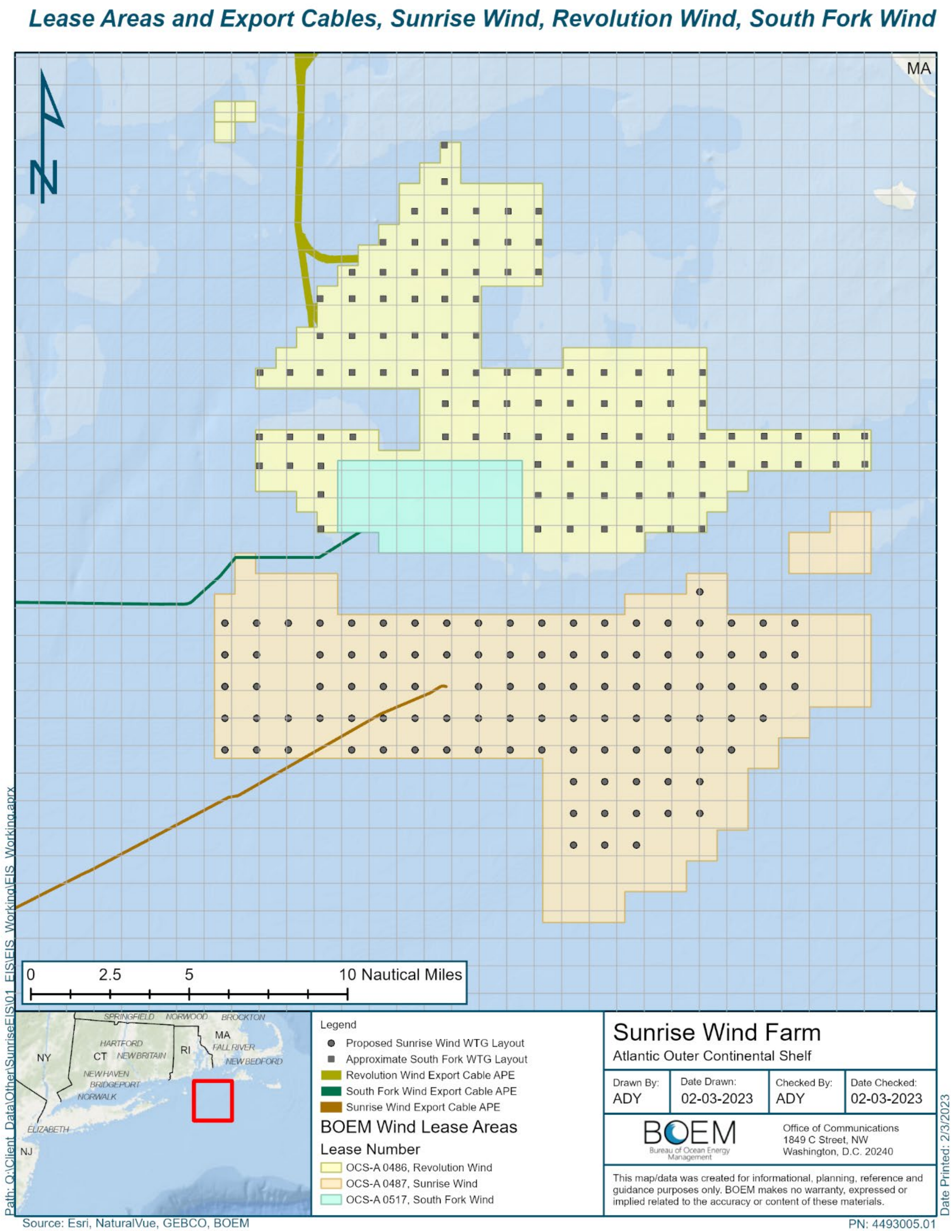


Figure 5-4 Sunrise Wind, Revolution Wind and South Fork Proposed Project Locations (grid lines equal 1 mile).



6.0 Avoidance, Minimization, and Mitigation

6.1 Avoidance and Minimization Measures

This section outlines APMs by Sunrise Wind and additional BOEM-proposed environmental protection measures (EPMs) that are intended to avoid and/or minimize potential impacts to EFH- designated species and EFH. Relevant APMs, contributions to avoiding and/or minimizing adverse effects on EFH, and supporting rationale are summarized by project component in Table 6-1. EPMs that BOEM could impose are included in Table 6-2. These measures are based on protocols and procedures that were successfully implemented for other OSW projects and align with existing BOEM-recommended best management practices (BMPs)[4]. The measures may be refined, and additional measures may be included in the final set of mitigation measures required for the Project. BOEM may choose to incorporate one or more EPMs in the record of decision and adopt those measures as conditions of COP approval.

4 Described in Attachment A of Guidelines for Information Requirements for a Renewable Energy Construction and Operations Plan (COP) (BOEM 2016).

Table 6-1. APMs for Construction and Operation of the SRWF, SRWEC-OCS, and SRWEC-NYS Project Components

APM No.	APMs to Avoid and Minimize Impacts	Project Components			Expected Effects
		SRWF	SRWEC-OCS	SRWEC-NYS	
GEN-02	To the extent feasible, the SRWEC and IAC will typically target a burial depth of 3 to 7 ft (1 to 2m). The target burial depth will be determined based on an assessment of seabed conditions, seabed mobility, the risk of interaction with external hazards such as fishing gear and vessel anchors, and a site-specific Cable Burial Risk Assessment.	X	X	X	This measure would protect the IAC and offshore export cables from damage and further help to minimize impacts to EFH.
GEN-04	A preconstruction SAV survey will be conducted prior to construction in the ICW, and the proposed temporary landing structure will be positioned to avoid and minimize impacts to sensitive habitat to the extent practicable.	X	X	X	Minimize impacts to sensitive and slow to recover habitats used by EFH-designated species.
GEN-05	To the extent feasible, installation of the IAC and SRWEC will be buried using equipment such as mechanical plow, jet plow and/or mechanical cutter. These equipment options would result in less habitat modification and impacts to surficial geology than dredging.	X	X	X	This measure will reduce habitat modification and reduce impacts to EFH
GEN-06	A plan for vessels will be developed prior to construction to identify no-anchorage areas to avoid documented sensitive resources.	X	X	X	Minimize impacts to sensitive and slow to recover habitats utilized by EFH-designated species; minimize impacts due to anchoring and construction activities.
GEN-18	DP vessels will be used for installation of the IAC and SRWEC to the extent practicable. DP vessels minimize seafloor impacts, as compared to use of a vessel relying on multi anchors.	X	X	X	Minimize impacts to sensitive and slow to recover habitats utilized by EFH-designated species
GEN-19	Sunrise Wind will require all construction and O&M vessels to comply with applicable international (IMO MARPOL), federal (USCG), and state regulations and standards for treatment and disposal of solid and liquid wastes and the prevention and control of spills and discharges generated	X	X	X	Minimizes adverse effects on EFH from impacts to water quality.

APM No.	APMs to Avoid and Minimize Impacts	Project Components			Expected Effects
		SRWF	SRWEC-OCS	SRWEC-NYS	
	during all phases of the project.				
GEN-20	A SWPPP, including erosion and sedimentation control BMPs and revegetation measures, will be implemented to minimize potential water quality impacts and limit sediment drift, transport, and deposition from construction and O&M of the Onshore Facilities.	X	X	X	Minimizes adverse effects on EFH from impacts to water quality and sedimentation.
GEN-21	Accidental spill or release of oils or other hazardous materials will be managed offshore through an ERP/OSRP and onshore through an SPCC Plan	X	X	X	Minimizes adverse effects on EFH from impacts to water quality.
GEN-22	Where HDD is utilized, an Inadvertent Return Plan will be prepared and implemented to minimize the potential risks associated with the release of drilling fluids.	X	X	X	Avoids and minimizes adverse effects on EFH from impacts to water quality.
GEN-273	The Onshore Transmission Cable will be installed via HDD under the ICW.	X	-	-	Avoids and minimizes adverse effects on EFH from impacts to water quality.
GEO-01	Avoid identified shallow hazards, to the extent feasible	X	X	X	Avoid and minimize potential direct impacts to EFH habitat and species.
GEO-03	Use of monopile and piled jacket foundations with associated scour protection will minimize impacts to surficial geology, compared to other foundation types.	X	X	X	This measure would minimize impacts on EFH and EFH species by minimizing impacts to surface geology

APM No.	APMs to Avoid and Minimize Impacts	Project Components			Expected Effects
		SRWF	SRWEC-OCS	SRWEC-NYS	
GEO-04	Dynamic positioning (DP) vessels will be used for installation of the IAC and SRWEC to the extent practicable. Use of DP vessels will minimize impacts to the seabed, compared to the use of a vessel relying on multiple anchors. The SRWEC Landfall will be installed via HDD to avoid impacts to nearshore zones and surficial geologic resources. The Onshore Transmission Cable will also be installed via HDD under the ICW to avoid impacts to coastal resources; HDD and the trenchless methods will also be used elsewhere onshore, where appropriate, to minimize impacts to surface locations and resource areas.	X	X	X	This measure would minimize impacts on EFH and EFH species from disturbance caused by anchoring; reduce impacts to water quality
WQ-01	Onshore construction activities will be conducted in compliance with the New York State Pollutant Discharge Elimination System (SPDES) General Permit for Stormwater Discharges associated with construction activities, and an approved SWPPP.	-	-	X	Avoids and minimizes adverse effects on EFH from impacts to water quality.
WQ-02	Sunrise Wind will develop a Suspended Sediment and Water Quality Monitoring Plan.	X	X	X	Avoids and minimizes adverse effects on EFH from impacts to water quality.
TCHF-01	Where appropriate, temporary erosion controls such as swales and erosion control socks will be installed and will be maintained until the site is restored and stabilized.	-	-	X	Avoids and minimizes adverse effects on EFH from impacts to water quality.
TCHF-02	The SRWEC Landfall will be installed via HDD to avoid impacts to the nearshore zones and coastal resources.	-	-	X	Avoids and minimizes adverse effects on EFH from impacts to sensitive habitats and water quality.
BENTH-01	The SRWF and SRWEC will be sited to avoid and minimize impacts to sensitive habitats (e.g., hard bottom habitats) to the extent practicable.	X	X	X	Minimize impacts to sensitive and slow to recover habitats used by EFH-designated species.

APM No.	APMs to Avoid and Minimize Impacts	Project Components			Expected Effects
		SRWF	SRWEC-OCS	SRWEC-NYS	
FISH-01	Sunrise Wind will coordinate with NYSDEC, NMFS and USACE regarding time of year restrictions for summer flounder habitat areas of particular concern (HAPC).	X	X	X	Avoid and minimize impacts to summer flounder HAPC
FISH-02	Sunrise Wind will employ time-of-year in-water restrictions to the extent feasible to avoid or minimize impacts to Atlantic sturgeon. If work is anticipated to occur outside of these time-of-year restriction periods, Sunrise Wind will work with state and federal agencies to develop construction monitoring and impact minimization plans or mitigation plans as appropriate.	-	-	X	Avoid and minimize impacts to Atlantic sturgeon
FISH-03	Sunrise Wind is committed to collaborative science with the commercial and recreational fishing industries prior to, during, and following construction. Fisheries and benthic monitoring studies (Appendices AA1 and AA2 of COP, Sunrise Wind 2022a) are being planned to assess impacts associated with the Project on economically and ecologically important fisheries resources within the SRWF, along the SRWEC, and in the ICW. These studies will be conducted in collaboration with the local fishing industry and will build upon monitoring efforts being conducted by affiliates of Sunrise Wind at other wind farms in the region.	X	X	X	Studies will help inform future activities to best reduce risks to EFH species
FISH-05	Construction and operational lighting will be limited to the minimum necessary to ensure safety and compliance with applicable regulations. Limiting lighting to that which is required for safety and compliance with applicable regulations is expected to minimize impacts on essential fish habitat.	X	X	X	Avoid and minimize impacts to EFH
MMST-08	All crew supporting the Project will undergo marine debris awareness training, and such training will include use of the data and educational resources available through the NOAA Fisheries Marine Debris Program.	X	X	X	Reduce marine debris that could impact EFH

APM No.	APMs to Avoid and Minimize Impacts	Project Components			Expected Effects
		SRWF	SRWEC-OCS	SRWEC-NYS	
MMST-09	Sunrise Wind will advise all construction and O&M vessels to comply with USCG and EPA regulations that require operators to develop waste management plans, post informational placards, manifest trash sent to shore, and use special precautions such as covering outside trash bins to prevent accidental loss of solid materials.	X	X	X	Reduce marine debris that could impact EFH
Noise attenuation systems (NAS) during impact pile driving	The Project will use NAS for all piling events. The Project is committed to achieving the modeled ranges associated with 10 dB of broadband noise attenuation of impact pile driving sounds source levels or smaller ranges, as described below in Section 6.3.2 of the ITA Application. The type and number of NAS to be used during construction have not yet been determined but will consist of a double big bubble curtain or a single bubble curtain paired with an additional sound attenuation device or a double big bubble curtain. Based on prior measurements this combination of NAS is reasonably expected to achieve greater than 10 dB broadband attenuation of impact pile driving sounds. A protected species mitigation and monitoring plan will describe mitigation measures developed in coordination with BOEM and NOAA Fisheries, and these measures will be included within the Letter of Authorization issued for the Project.	X	X	X	Avoid and minimize noise impacts to EFH species
PAM for impact pile driving	• 4-hour PAM operator rotations for 24-hour operation vessels. • Deployment of PAM systems will be outside the perimeter of the shutdown zone • There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods, piling, and post-piling monitoring periods. • Passive acoustic monitoring will include and extend beyond the largest shutdown zone for low- and mid-frequency cetaceans.	X	X	X	Also protective of EFH and EFH-designated species

APM No.	APMs to Avoid and Minimize Impacts	Project Components			Expected Effects
		SRWF	SRWEC-OCS	SRWEC-NYS	
	Mitigation zones established for all species, including North Atlantic Right Whale will be applied accordingly depending on the season in which work is performed, summer (May-November) or winter (December-April).				
Ramp-up (soft start) for impact pile driving	• Ramp-up is required prior to the initiation of HRG sources (boomers, sparkers, Chirps) • Each monopile installation will begin with a minimum of 20-minute soft-start procedure as technically feasible. • Soft-start procedure will not begin until the clearance zone has been cleared by the visual PSO or PAM operators.	X	-	-	Also protective of EFH and EFH-designated species
General UXO/MEC Disposal	For UXO/MECs that are positively identified in proximity to planned activities on the seabed, several alternative strategies will be considered prior to detonating the UXO/MEC in place. These may include relocating the activity away from the UXO/MEC (avoidance), moving the UXO/MEC away from the activity (lift and shift), cutting the UXO/MEC open to apportion large ammunition or deactivate fused munitions, using shaped charges to reduce the net explosive yield of a UXO/MEC (low-order detonation), or using shaped charges to ignite the explosive materials and allow them to burn at a slow rate rather than detonate instantaneously (deflagration). Only after these alternatives are considered would a decision to detonate the UXO/MEC in place be made. If deflagration is conducted, mitigation and a monitoring measure would be implemented as if it was a high order detonation based on UXO/MEC size. Decision on removal method will be made in consultation with a UXO/MEC specialist and in coordination with the agencies with regulatory oversite of UXO/MEC. For detonation that cannot be avoided due to safety considerations, a number of mitigation measures	X	X	-	Also protective of EFH and EFH-designated species

APM No.	APMs to Avoid and Minimize Impacts	Project Components			Expected Effects
		SRWF	SRWEC-OCS	SRWEC-NYS	
	will be employed by Sunrise Wind. No more than a single UXO/MEC will be detonated within a 24-hour period.				
Noise attenuation for UXO detonations	Sunrise Wind will use an NAS for all UXO detonation events to reduce sounds propagated into the marine environment as feasible. Sunrise Wind is committed to achieving the modeled ranges associated with 10 dB of broadband noise attenuation of UXO detonation source levels, as is described in Section 6.3.2 of the Incidental Take Authorization Application. Zones without 10 dB attenuation would be implemented if use of a big bubble curtain was not feasible due to location, depth, or safety related constraints. If a NAS system is not feasible, Sunrise Wind will implement mitigation measures for the larger unmitigated zone sizes, with deployment of vessels or use of an aerial platform adequate to cover the entire clearance zones.	X	X	-	Avoids and minimizes impacts to EFH and EFH species
UXO Time of Year/Nighttime Restrictions	No in-situ UXO/MEC detonations are planned between December and April. As part of the federal consistency review for the Project and work in Rhode Island and NYS waters, it is expected that an in-situ UXO/MEC disposal will also be subject to state specific seasonal restrictions. No UXO will be detonated during nighttime hours.	X	X	X	Avoids and minimizes impacts to EFH and EFH species.

Table 6-2. EPMs that BOEM Could Impose: General Avoidance/Minimization of Potential Impacts to EFH

<table>
<tr><th rowspan="2">EPMs to Avoid and Minimize Impacts</th><th colspan="4">Project Components</th><th rowspan="2">Expected Effects</th></tr>
<tr><th>SRWF</th><th>SRWEC -OCS</th><th>SRWE C-NYS</th><th>SRWF Onshore Cable</th></tr>
<tr><td>Marine debris awareness training - The Lessee must ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to 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 shall 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 will 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.
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, number of people trained, estimated related costs, and certifies that the training process has been followed for the previous calendar year. The Lessee would send the reports via email to BOEM (at renewable_reporting@boem.gov) and to BSEE (at marinedebris@bsee.gov).</td><td>X</td><td>X</td><td>X</td><td>X</td><td>This measured will reduce debris that may impact ESA-listed fish and EFH.</td></tr>
<tr><td>Sound field verification - BOEM, BSEE, and USACE shall ensure that if the clearance and/or shutdown zones are expanded, PSO coverage is sufficient to reliably monitor the expanded clearance and/or shutdown zones. Additional observers shall be deployed on additional platforms</td><td>X</td><td>X</td><td>X</td><td>-</td><td>This measure minimizes potential sound related impacts</td></tr>
</table>

EPMs to Avoid and Minimize Impacts	Project Components				Expected Effects
	SRWF	SRWEC-OCS	SRWEC-NYS	SRWF Onshore Cable	
for every 1,500 m that a clearance or shutdown zone is expanded beyond the distances modeled prior to verification.					on ESA-listed Fish and EFH.
Lost survey gear - If any survey gear is lost, all reasonable efforts that do not compromise human safety would be undertaken to recover the gear. All lost gear would be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) and BSEE (OSWIncidentReporting@bsee.gov) within 24 hours of the documented time of missing or lost gear. This report would include information on any markings on the gear and any efforts undertaken or planned to recover the gear.	X	X	X	-	This measure limits effects of potentially lost survey gear on ESA-listed Fish and EFH.
	X	X	X	-	
	X	X	X	-	
	X	X	X	-	

EPMs to Avoid and Minimize Impacts	Project Components				Expected Effects
	SRWF	SRWEC-OCS	SRWEC-NYS	SRWF Onshore Cable	
b.	X	X	X	_	
	X	X	X	-	.
	X	X	X	X	
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.	X	X	X	-	This plan would protect EFH.
Proposed Boulder Relocation Plan Measure - Prior to inter-array cable corridor preparation and cable installation (e.g., boulder relocation, pre-cut trenching, cable crossing installation, cable lay and burial) and foundation site preparation (e.g., scour protection installation), Sunrise Wind would provide BOEM with a boulder relocation plan for implementation. The plan would include the following: • Identification of areas of active (within last 5 years) bottom trawl fishing, areas where boulders >2 m in diameter are anticipated to occur, and areas where boulders are expected to be relocated for project purposes.	X	X	X	-	This plan would protect EFH.

EPMs to Avoid and Minimize Impacts	Project Components				Expected Effects
	SRWF	SRWEC-OCS	SRWEC-NYS	SRWF Onshore Cable	
• Methods to minimize the quantity of seafloor obstructions from relocated boulders in areas of active bottom trawl fishing, as identified in #1, as technically or economically feasible. • Identification of locations of boulders that would be moved and approximately where they would be place, method(s) for moving boulders, and measures to minimize impacts as technically and economically feasible. • Outreach conducted regarding the boulder relocation plan (e.g., notifications to mariners).					
The applicant shall develop an anchoring plan to ensure anchoring is avoided and minimized in complex habitats during construction and O&M of the project. This plan should delineate areas of complex habitat around each turbine and cable locations, and identify areas restricted from anchoring. The habitat maps and inshore maps delineating complex habitat should be provided to all cable construction and support vessels to ensure no anchoring of vessels is done within or immediately adjacent to these complex habitats. The anchoring plan should be provided to USFWS prior to BOEM approval.	X	X	X	X	Avoids and minimizes impacts to EFH and EFH species.

6.2 Environmental Monitoring

During the permitting process and in consultation with the resource agencies, Sunrise Wind would develop and implement a site-specific monitoring program to ensure that environmental conditions are monitored during construction, operation, and decommissioning phases. It would be designed to ensure environmental conditions are monitored and reasonable actions are taken to avoid and/or minimize seabed disturbance and sediment dispersion, consistent with permit conditions. Avoiding and/or minimizing seabed disturbance and sediment dispersion would help minimize impacts primarily to benthic EFH habitat and benthic or epibenthic EFH species and/or life stages, with secondary effects on EFH species and/or life stages that prey on benthic and epibenthic organisms.

The Sunrise Wind Fisheries and Benthic Monitoring Plan is detailed in Appendix AA1 and AA2 of the COP (Sunrise Wind 2022b). Monitoring would be used to avoid, minimize, and/or mitigate Project effects to EFH. This Fisheries and Benthic Research Monitoring Plan 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).

6.2.1 Sunrise Wind Monitoring Plan – OCS

Monitoring would commence in 2022, and continue through 2027, encompassing all three phases of cable installation (before, during, and after installation). OCS surveys would include trawl surveys, acoustic telemetry for highly migratory species (HMS), scallop surveys, and benthic monitoring for soft- and hard bottom habitats.

6.2.1.1 Trawl Surveys

Sunrise Wind has contracted with scientists at the University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST) and the Commercial Fisheries Research Foundation (CFRF) to execute a seasonal (i.e., four sampling events per year, approximately three months apart) trawl survey using an asymmetrical BACI experimental design. The trawl survey at Sunrise Wind would be carried out synoptically with the trawl survey at the RWF Lease Area.

Using the same survey vessel and scientific crew would improve the consistency of the monitoring and data collection between the two projects/lease areas. As discussed below, the same reference areas would be used for both lease sites. The trawl survey would be conducted in collaboration with the F/V Gabrielle Elizabeth. The otter trawl fishery is active within the Sunrise Wind Lease Area, and this gear type generates the greatest revenue within the Lease Area. An otter trawl survey is an appropriate sampling gear for the Sunrise Wind Lease Area and the nearby control sites because this gear had broad selectivity and would effectively sample for multiple species, including groundfish (e.g., winter flounder, windowpane flounder, yellowtail flounder, Atlantic cod), monkfish, skates (e.g., winter and little skates), red hake, longfin squid, and others. The objectives associated with the trawl survey would be as follows:

- <u>Objective 1</u>: Evaluate changes in the relative abundance of commercially important fish and invertebrate species between SRWF and the control areas pre-construction, during construction, and post-construction.
- <u>Objective 2</u>: Assess changes in the size structure of commercially important fish and invertebrate species between SRWF and the control areas pre-construction, during construction, and post-construction.

- Objective 3: Investigate changes in the composition of fish and invertebrate species between SRWF and the control areas pre-construction, during construction, and post-construction.
- Objective 4: Evaluate changes in the diet composition of black sea bass and summer flounder between SRWF and the control areas pre-construction, during construction, and post-construction.

The use of an asymmetrical BACI sampling design would allow for quantitative comparisons of relative abundance and demographics to be made before and after construction, and between the reference areas and SRWF area. Further, the replication of sampling across both time and space increases the ability to demonstrate that a change in abundance was caused by a human activity. A sample size of 15 trawl tows per area would be targeted per season in each year at the start of the survey. This level of sampling is expected to have at least 80 percent power to detect a 33 percent temporal decrease for those species with Coefficient of Variations (CVs) ≤ 1.2, and approximately a 40 percent temporal decrease for species with CVs ≤ 2.0. Further, the use of an asymmetrical BACI design, with two rather than one reference areas, leads to gains in power for a given level of sampling intensity at the SRWF. Sample size may be refined, if necessary, in later years.

These surveys would provide information about EFH species in the Project area and potential changes to their ecosystem and population structure as a result of the project, helping to inform regulatory agencies as it relates to wind project impacts on EFH species so they can better management them. The surveys and the EFH species targeted include:

- Multi-Method Survey for Structure-Associated Fishes
- Pelagic Fish Survey
- Clam Survey

6.2.1.2 Acoustic Telemetry - HMS

This acoustic telemetry monitoring effort would build on baseline studies by including five additional years of data collection, an expansion of the receiver array, and the deployment of an additional 150 acoustic transmitters for HMS. The project would be overseen by Anderson Cabot Center for Ocean Life (ACCOL) at the New England Aquarium, with Dr. Jeff Kneebone serving as the Principal Investigator. ACCOL would partner with INSPIRE Environmental to execute the field work, data analysis, and reporting. The primary objectives associated with the acoustic telemetry monitoring would be as follows:

- Objective 1: Evaluate changes in HMS presence, residency, and movements between pre-construction, construction, and post-construction.
- Objective 2: Evaluate HMS connectivity among Orsted/Eversource lease sites.
- Objective 3: Monitor tagged HMS at spatial scales greater than the Orsted/Eversource project areas.

The current HMS receiver array (supported by other OSW developers) would be expanded from 17 to 32 receivers starting in 2022 and would achieve monitoring across the Orsted / Eversource lease sites (Sunrise Wind, Revolution Wind, and South Fork Wind) within the MA/RI WEA (Sunrise Wind 2022b). The array would be comprised of 13 VEMCO VR2-AR (acoustic release) receivers that were purchased through the INSPIRE Environmental/ACCOL MassCEC project, and 19 additional VR2-AR receivers that would be purchased by Orsted specifically for this monitoring activity. The full receiver array would be maintained year-round continuously through at least 2026. This would permit monitoring throughout the pre-construction, construction, and post-construction periods of the Sunrise Wind, Revolution Wind, and South Fork Wind projects. The receivers would also gather valuable pre-construction data at popular recreational fishing grounds within the OCS-A 0500 Lease Area. In addition, the HMS receiver array deployed during this monitoring study would continue to allow for detection of tagged cod, and all detections of tagged cod would be shared with that research team. The receivers would remain in the water year-round throughout the duration of the study to provide monitoring during the presumed cod spawning period of December through March (Cadrin et al. 2020; Dean et al. 2020).

6.2.1.3 Acoustic Telemetry - SRWEC

The Sunrise Wind Project would use one DC submarine export cable (SRWEC), within an up to 104.6-mi (168.4-km) corridor to transmit power to shore at Smith Point County Park in the Town of Brookhaven, New York. The DC magnetic field generated by the SRWEC would combine via vector addition with the Earth's geomagnetic field. In other words, the DC field from the SRWEC may affect both the magnitude and direction of the natural DC field in proximity to the cable. The cable would use materials such as grounded metallic sheaths and steel armoring, to shield the electric current from entering the marine environment (Snyder et al. 2019). However, the SRWEC would be a source of a static magnetic field that would modify the ambient static geomagnetic field. The movement of electric charges in a static magnetic field around the cable would produce a weak electric field. The strength of the magnetic field, and the induced electrical field, depend upon the amount of electrical current (Amperes) flowing through the cable.

In this study, an acoustic telemetry receiver network would be established along the route of the SRWEC, and dedicated telemetry tagging would occur to evaluate the potential impacts associated with the operation of the SRWEC on important marine species. The focal species for this study were chosen based on several factors including their known sensitivity to EMF, their ecological significance or importance to regional commercial and recreational fisheries, and their geographic overlap with the SRWEC. Monitoring efforts would focus on species associated with the benthos, given that they would experience the greatest potential impacts from EMF (Snyder et al. 2019). The species selected for telemetry monitoring are; American lobsters, horseshoe crabs, winter skates, sandbar sharks, sand tiger sharks, dusky sharks, and smooth dogfish.

The specific objectives associated with this monitoring study are as follows:

- Implant or attach acoustic transmitters on lobsters, horseshoe crabs, winter skates, smooth dogfish, sandbar sharks, dusky sharks, and sand tiger sharks.
- Deploy two arrays of acoustic receivers at the nearshore areas of the SRWEC landfall that extend outside of the existing receiver arrays deployed by Stony Brook University at Rockaway, Jones Beach, Fire Island, East Hampton, and Montauk that are is designed to capture both broad-scale migratory behavior and fine-scale behaviors.
- Evaluate effects of EMF on behavior and movement on targeted species before, during, and after construction.
- Estimate movement metrics including depth, two-dimensional position, and residency for telemetered individuals.

- Maintain the offshore and nearshore Sunrise Wind Receiver Arrays and collect data on the individuals tagged by Stony Brook University and partnering organizations along the east coast.

The study would commence in 2022, and continue through 2027, encompassing all three phases of cable installation (before, during, and after installation). The receiver array would be deployed in June or July of 2022, and dedicated tagging trips would commence shortly after the receiver array has been deployed.

6.2.1.4 Scallop Survey

Sunrise Wind would partner with researchers at CFF to carry out HabCam survey for scallops and other benthic organisms within the SRWF and a nearby control area, and the survey would be executed using a BACI design. Similar to other fisheries-independent surveys for scallops in the region, the survey would be executed once per year, targeting sampling in summer. The target is to achieve two years of pre-construction monitoring, and the survey would continue during construction, and for at least two years after construction has been completed. This survey would be carried out in collaboration with a local scallop vessel(s). The primary objective of the HabCam survey is to investigate the relative abundance of scallops and other resources in the SRWF Area (“SRW impact”) and reference area (“control”) over time. Using the HabCam survey equipment and protocols would ensure that the data collected as part of this fisheries monitoring plan would be compatible and standardized with fisheries-independent data that are used to inform scallop science, stock assessment, and management. The HabCam survey approach also is well-suited to sampling within the Lease Area following construction.

The objectives associated with the HabCam survey would be as follows:

- Objective 1: Evaluate changes in the relative abundance of scallops between SRWF and the control area pre-construction, during construction, and post-construction.
- Objective 2: Assess changes in the size structure of scallops between SRWF and the control areas pre-construction, during construction, and post-construction.
- Objective 3: Investigate changes in the composition of fish and invertebrate species (e.g., skates, flounder, hake, lobster, Jonah crab, monkfish) between SRWF and the control area pre-construction, during construction, and post-construction.

Sunrise Wind is currently working with researchers at CFF to develop the sampling protocols and statistical analyses associated with this survey, and those details would be included in a future iteration of the monitoring plan once they are available.

6.2.1.5 Benthic Monitoring – SRWF and SRWEC-OCS

Hard Bottom Habitat

Novel hard bottom habitat monitoring at WTG foundations, scour protection layers, and cable protection layers would focus on measuring changes in percent cover, species composition and volume of macrofaunal attached communities (native and non-native species groups) and physical characteristics (rugosity, boulder density). These parameters would serve as proxies for resulting changes to the complex food web. Soft bottom habitat monitoring would focus on measuring physical factors and indicators of benthic function (bioturbation and utilization of organic deposits; Simone and Grant 2020), which would serve as proxies for functional changes in the community composition. It is expected that the introduction of fines and organic content sourced from the epibenthic community on the WTG foundations would support increased deposit feeding benthic invertebrate communities in the soft sediments around the structures.

To accomplish the objectives of the novel hard bottom monitoring, high-resolution video imagery captured using a ROV would be employed. Video imagery would be used to document epifaunal community characteristics on the novel hard surfaces (WTG foundations and scour protection layers, OCS-DC jacket, cable protection layers).

An ROV video survey is planned to monitor novel hard bottom habitats (WTG foundations and scour protection layers, OCS-DC jacket, cable protection layers) within sub-areas of the SRWF. A stratified random design, with benthic habitat types as strata, would be used to select the WTG foundations and cable protection areas that would be monitored. There is only one OCS-DC jacket in the project design; it would be selected for monitoring. The same WTG foundations and the OCS-DC jacket selected for this novel hard bottom survey would be monitored as part of the soft sediment survey (see below). This would help facilitate synthesis between the degree of enrichment in the surrounding soft sediments and the epifaunal community composition and density colonizing the foundations at any given time and location.

Soft Bottom Habitat

The soft bottom monitoring would include an examination of two project components: WTG foundation-associated and export cable-associated soft bottom. The overall objective of the soft bottom benthic monitoring survey would be to measure potential changes in the benthic function of soft bottom habitats over time, and to assess whether benthic function changes with distance from the base of the WTG foundations or SRWEC-OCS centerline. A high density of fishing activity (trawling and dredging) occurs in the SRWF area. Frequent trawling and dredging activity could likely be a significant source of disturbance on the soft sediment habitats in the area. Fishing activity would be considered during survey planning and would be accounted for during data interpretation as a potential disturbance.

Benthic functioning of the soft bottom habitats would be captured by documenting physical parameters (grain size major mode) and biological factors (bioturbation and utilization of organic material) with a sediment profiling imaging/plan view (SPI/PV) system. It is expected that the epibenthic community that colonizes the WTG foundations and OCS-DC jacket would 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 foundation structures would likely alter the infaunal community activity, increasing sediment oxygen demand and promoting the activity of deep-burrowing infauna. Based on benthic monitoring results in other OSW farms, the effects of the WTG foundation on the surrounding soft sediment habitat would be expected to decrease with increasing distance from the WTG.

6.2.2 Sunrise Wind Benthic Monitoring Plan – NYS

The benthic monitoring plan for NYS waters includes details of the pre-construction and post-construction surveys of soft sediment habitats along the SRWEC-NYS (Sunrise Wind 2022b). A combination of SPI/PV imaging and sediment grab sampling would be used to monitor these benthic 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. 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 CMECS allows for accurate comparisons to be made before and after 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 benthic community analysis 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. The benthic community analysis approach would provide an assessment of potential changes in quantitative community diversity metrics and particular species abundances.

The pre-cable installation survey was conducted 12-13 August 2020 (SPI/PV collection) and 18 August 2020 (sediment grab collection), prior to commencement of cable installation activities in the area (Sunrise Wind 2022b).

At least two field sampling events would occur after the proposed SRWEC-NYS has been installed. Post-construction monitoring surveys would occur between August 1 and October 31 each year within 24 months of the Sunrise Wind Farm Project’s commercial operational date. During the post-cable installation surveys, three stations would be sampled with SPI/PV in a transect perpendicular to the SRWEC-NYS, with one station as close as practicable to the centerline and one station approximately 100 feet on either side. These transects would repeat at 1,000-ft intervals from the HDD exits offshore to the territorial limit of NYS waters.

At each SPI/PV station a minimum of three replicate images shall be collected and analyzed. At each SPI/PV station, a conductivity, temperature, depth sensor would be used to measure the salinity and temperature through the water column to the sediment surface. Additionally, the temperature of the sediments would be measured at each SPI/PV station. The SPI/PV sampling would be supplemented with sediment grab stations located at transects every 2,000 ft along the SRWEC-NYS centerline, with one grab sample station as close as practicable to the centerline and one grab sample station approximately 100 ft on the eastern side of the cable. At each grab station three replicate grab samples would be collected, sieved onboard, and preserved. One replicate grab sample from each grab station would be analyzed for benthic community analysis by standard Environmental Protection Agency approved protocols; the other two replicate grab samples would be archived and analyzed if greater precision is needed to determine if an ecological meaningful difference exists between pre-construction and post-construction communities (see below).

Benthic community data would be statistically compared across years and distance from the cable, with a specific focus on total infaunal abundances, Shannon-Weiner Index, and total number of species as response variables. SPI/PV imagery-derived metrics would be statistically compared across years and distance from the cable. The water column profile data would be used as potential explanatory variables to inform the post-construction comparison between the benthic habitat and community at stations along the centerline of the cable versus those located 100 ft from the cable centerline. Sediment temperature measurements collected during the post-construction monitoring surveys at stations along the centerline of the cable would be compared to those measurements collected 100 ft from the cable centerline, using distance from shore and depth as potential covariates.

6.3 Alternative Project Designs that Could Avoid/Minimize Impacts

This section describes changes in the extent of impacts to EFH that would result under different feasible SRWF configurations. The draft Environmental Impact Statement (EIS) carried three alternatives (one of which has sub-alternatives) forward for detailed analysis:

- Alternative A: The no action alternative
- Alternative B: The Proposed Action inclusive of the project design envelope presented in the COP (Sunrise Wind 2022b), which includes up to 94 11-MW WTGs within 102 potential positions, an OCS-DC, IAC, and the SRWEC.
- Alternative C: Also referred to as the Fisheries Habitat Impact Minimization Alternative, which is described further below.

The Proposed Action in this EFH assessment, which analyzes a maximum of up to 87 WTGs in 87 potential positions, is considered Alternative C-3a in the Sunrise Wind EIS. This Alternative was chosen for the EFH assessment due to glauconite feasibility issues with the EIS Proposed Action, which is further discussed in Section 6.3.3. On February 28, 2023, Sunrise Wind presented to BOEM their updated results from their Fall 2022 and Winter 2023 geophysical and geotechnical surveys. The results specified that the Project's Lease Area contains a large presence of glauconite sands, and Sunrise Wind indicated that 22 of the COP's original 102 potential Wind Turbine Generator (WTG) positions were no longer feasible. On March 1, 2023, Sunrise Wind submitted a revised Appendix G3[5] "S*RW01 – Feasibility Study for WTG Monopile Foundations*", which was updated to include findings following detailed investigation of glauconite-rich sediments within the site and their impact on pile design and installation.

Alternative C has been designed to avoid and minimize impacts to large-grained complex and complex benthic habitats within the Lease Area by eliminating selected WTG foundation sites, with emphasis on habitats potentially used by Atlantic cod for spawning. Under Alternative C, the construction, operation, maintenance, and eventual decommissioning within the Proposed Action area and associated IAC and export cabling would occur within the range of design parameters outlined in the COP (Sunrise Wind 2022b), subject to applicable mitigation measures. However, to reduce impacts to complex fisheries habitats that are the most vulnerable to long-term impacts as compared to the Proposed Action, certain WTG positions would be excluded from development.

[5] Please note: the document is marked as confidential as it contains sensitive cultural resource information, trade secrets, and/or privileged/confidential commercial/financial information that is exempt from disclosure under the Federal Freedom of Information Act, the New York Freedom of Information Law, the Massachusetts Public Records Law, and the Rhode Island Access to Public Records Act.

Alternative C considered and prioritized contiguous areas of complex habitat to be excluded from development to avoid and minimize impacts to complex fisheries habitats, while still meeting BOEM's purpose and need for the Project. Areas for prioritization were identified by NMFS (Figure 6-1) based upon on backscatter data, preliminary data suggesting limited Atlantic cod spawning activity in the area (Figure 4-1), assumed hard bottom complex substrate, and the presence of large boulders (see Figure 6-2). Priority Area 1 was deemed the higher priority by NMFS due to proximity to Cox Ledge, and documented cod spawning activity based upon recent acoustic and telemetry data (Figure 4-1). Cox Ledge is approximately 5 to 10 km (3.1 to 6.2 mi) north of Priority Area 1 (U.S. Geological Survey 2022). Priority Area 1 includes 16 WTG positions as well as the OCS-DC. Priority Area 2 includes 18 WTG positions and contains areas of high reflectance (indicative of hard substrates), large boulders, and is adjacent to detected cod spawning activity. Priority Area 3 includes 14 WTG positions and areas of high reflectance but fewer large boulders. Priority Area 4 includes 4 WTG positions and mid- to high-reflectance with large boulders.

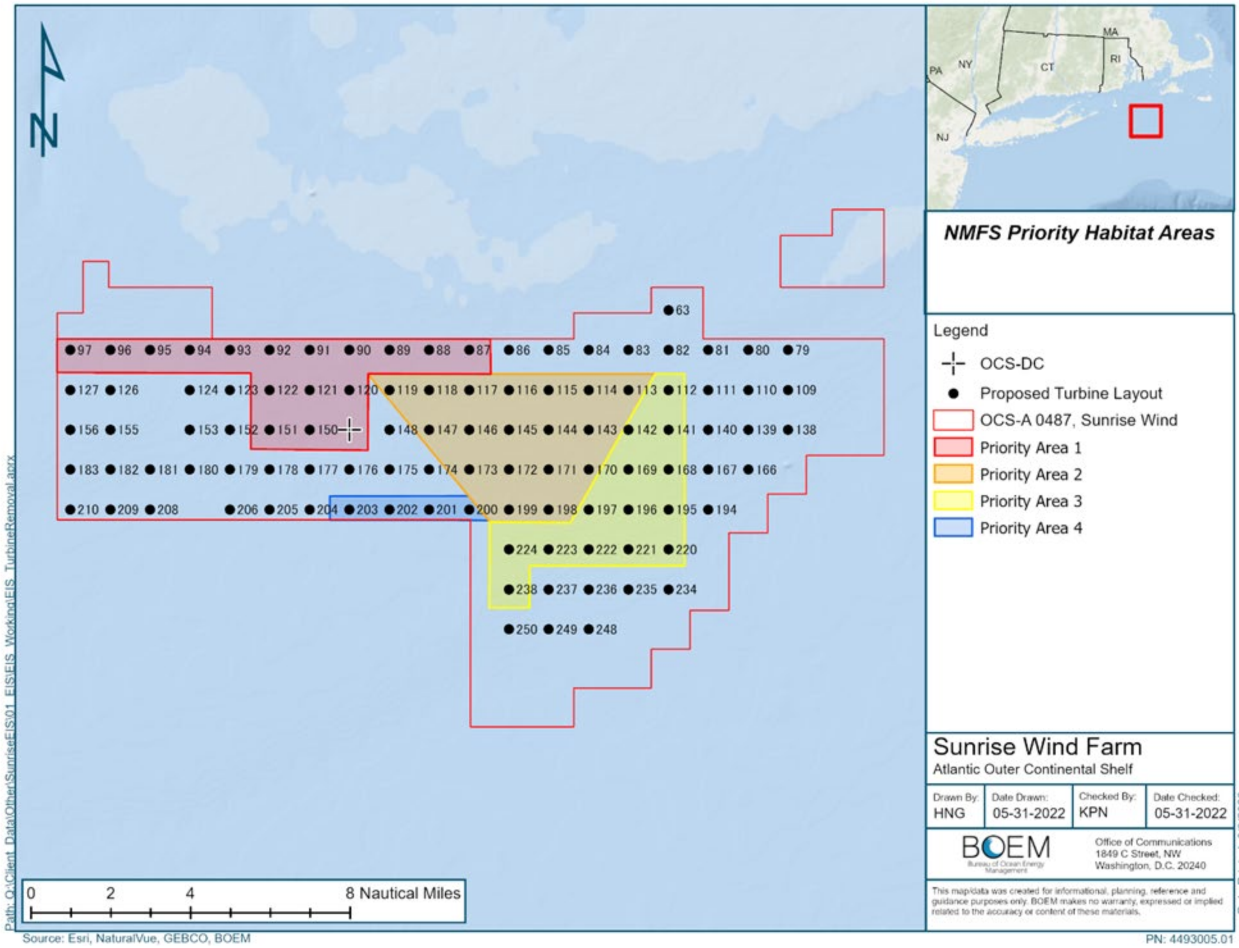


Figure 6-1. Priority Areas Identified by NMFS for WTG Exclusion

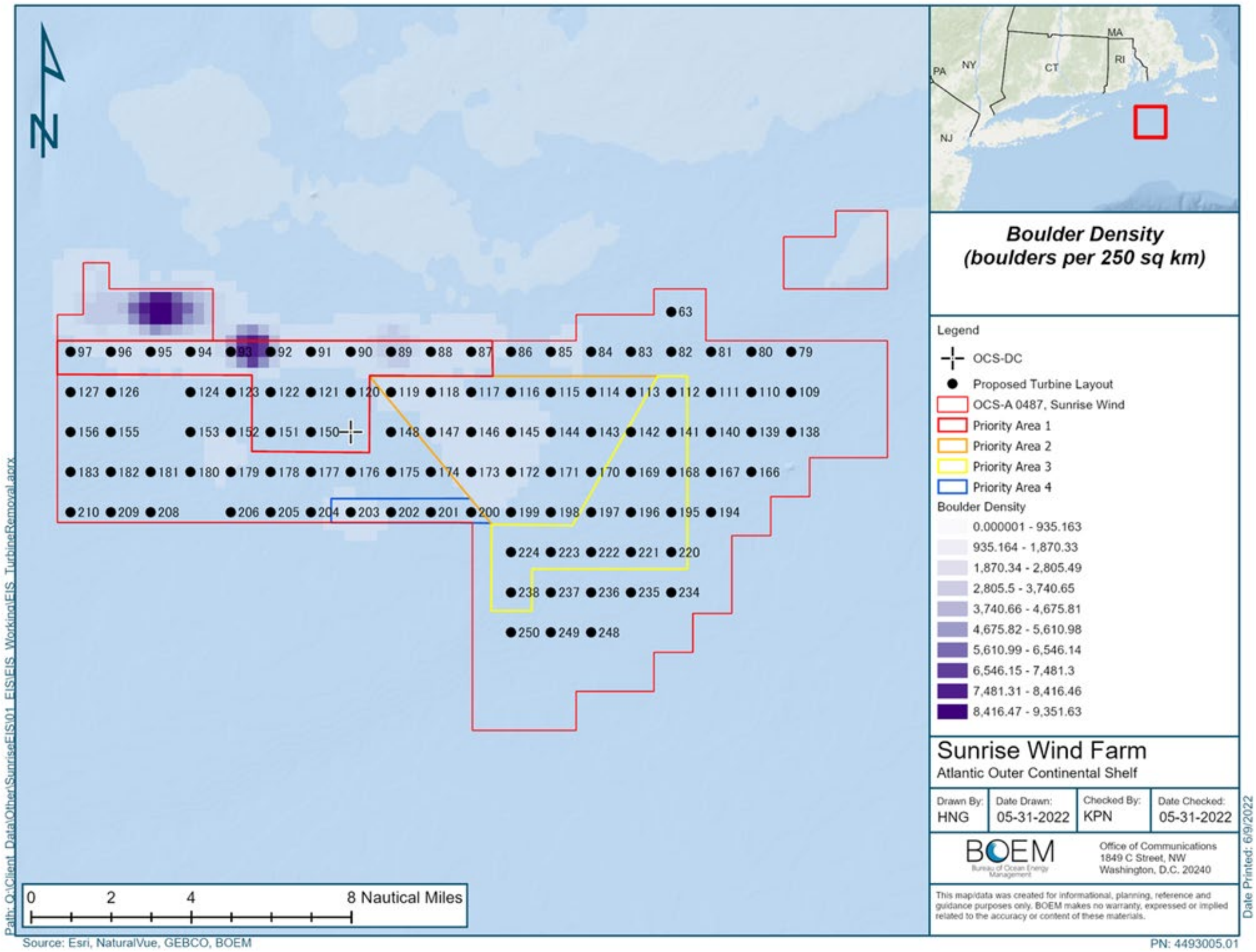


Figure 6-2. Boulder Density within the Priority Areas in the Sunrise Wind Lease Area

6.3.1 Presence of Glauconite Sands

Since publication of the draft EIS, Sunrise Wind and BOEM have further assessed evidence relating to glauconite sands that are present in the Lease Area and potential constraints that glauconite sands present for installation of WTG foundations due to resistance to pile driving.

Geotechnical site investigations and laboratory studies have shown that the geotechnical properties of glauconite make it an extremely difficult material to build upon, specifically for the installation of fixed-bottom foundations that support OSW turbine towers. The primary concern is that the crushability of glauconite may result in very high driving resistance or high friction for pile driving during monopile installation as well as reducing pile capacity with depth, which pose a significant risk to project development. Glauconite is crushable due to its low particle strength and turns into a clay-like substance under stress. Therefore, the pressure from driving a monopile into the seabed crushes the glauconite sands, which form a clay-like barrier that is not penetrable. As a result, typical hammering methods would not allow the pile to be installed to the needed penetration depth. Due to the minerals’ brittle nature, pile driving in locations that contain concentrations of glauconite is difficult (BOEM 2023).

Sunrise Wind performed additional site investigations and studies to quantify the extent of glauconite deposits across the Lease Area as well as their potential impact on pile drivability (see COP Appendix G3). The pile drivability analyses determined that of the 102 potential positions considered for the development under Alternative B (Proposed Action), 22 contain glauconite-rich sediments within the top 50 m below the seabed such that pile refusal would prevent successful foundation installation. In addition, six of the 12 positions along the eastern portion of the Lease Area identified in the draft EIS Alternative C-2 for the relocation of WTG positions from NMFS priority areas are assumed to have sufficient quantities of glauconite sand present such that refusal could occur.

One additional position, #154, has been re-evaluated since release of the draft EIS as communication with the owner of the existing subsea cable (CB-1) that traverses the Lease Area and micrositing analysis revealed installation is likely feasible as this position is not located in the area identified as containing glauconite sand. Position #125 and #207 were unable to be micro sited at an appropriate distance from the CB-1 cable, and therefore, are not considered for development.

BOEM independently reviewed Sunrise Wind's analysis related to the presence of glauconite and pile drivability in the Lease Area and based on the number of WTG positions identified to have higher risk of pile refusal, determined that draft EIS Alternatives C-1 and C-2 would not allow for installation of the minimum number of WTGs that would be necessary to meet Sunrise Wind's offshore renewable energy credits. As such, a new sub-alternative, C-3, has been developed in consideration of the presence of glauconite sands in the Lease Area.

6.3.2 Alternative C-1: Reduced Layout from Priority Areas via Exclusion of up to 8 WTG Positions

Under Alternative C-1, the same number of WTG locations (94 WTGs) as under the Proposed Action may be approved by BOEM; however, 8 WTG potential sites from Priority Area 1 along the northwestern boundary of the Lease Area would be excluded from consideration for development. To identify which 8 positions to remove, BOEM relied on the locations and densities of boulders, which can be considered a critical element of potential sensitive habitat (Gardline 2021). Gardline (2021) identified boulders as objects that 1) returned a strong backscatter signal indicative of hard substrates; 2) were observed to have a distinct shadow or measurable height; and (3) had diameters greater than 0.5 m. The density of boulders (number of boulders/250 km^2) on the seafloor surrounding each WTG position was calculated using the ESRI ArcGIS Pro Spatial Analyst Density function (Table 6-3; Figure 6-3). Then, boulder densities within NMFS's Priority Area 1 were ranked and the eight contiguous WTG positions with the highest boulder densities within Priority Area 1 were identified for exclusion in Alternative C (Figure 6-1).

Boulder densities were highest in WTG position 87 to 94, with the exception of WTG position 91, and were identified for exclusion from development (Figure 6-2). WTG position 91 has slightly lower boulder density (15.6/250 km^2) when compared to WTG position 96 (16.0/250 km^2); however, WTG position 91 was chosen for exclusion to provide contiguous fisheries habitat without disturbance. While low densities of boulders occur within Priority Areas 2 and 4, Priority Area 1 was deemed the higher priority by NMFS due to close proximity to Cox Ledge, and documented cod spawning activity based upon recent acoustic and telemetry data.

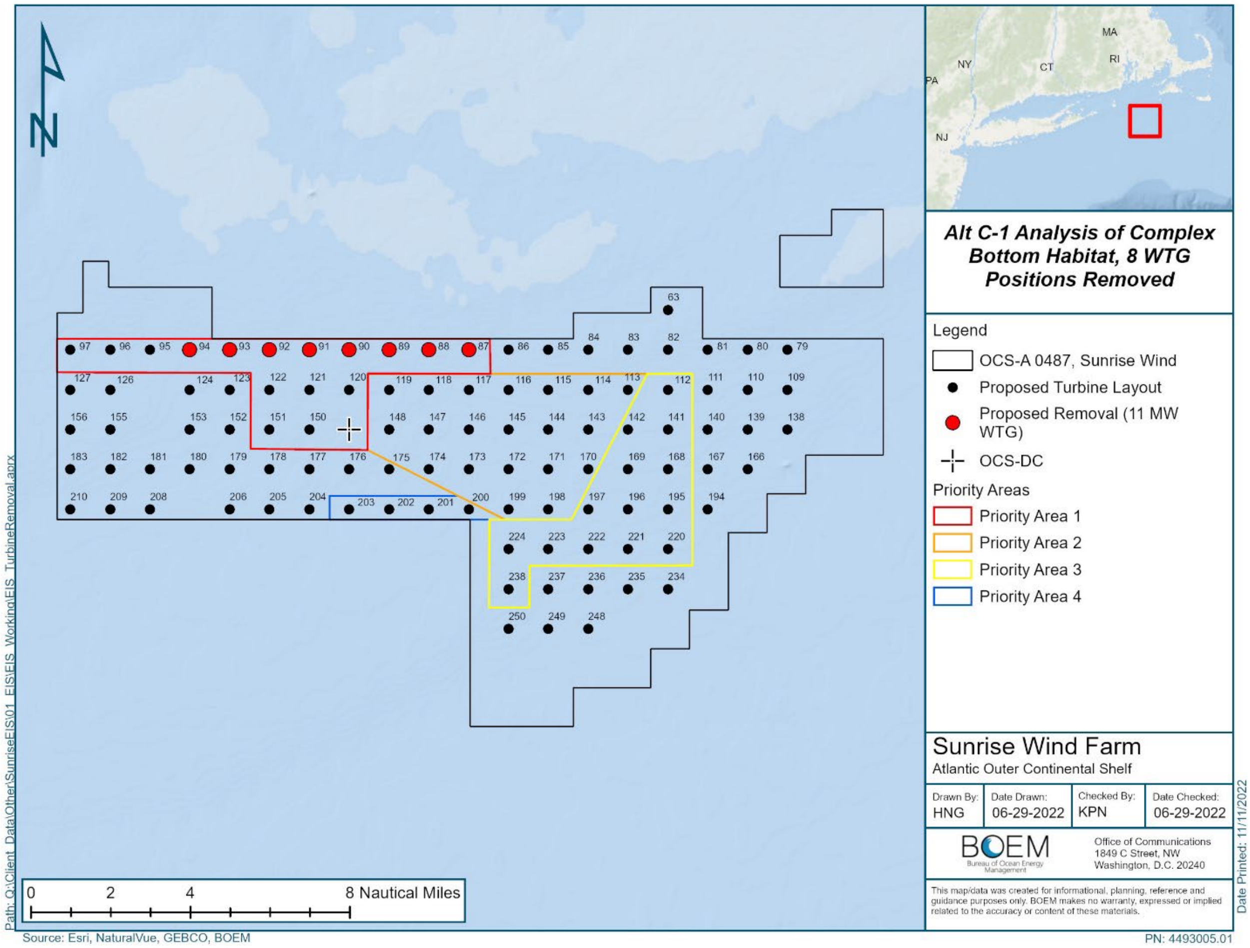


Figure 6-3. WTG positions identified for removal under Alternative C-1

6.3.3 Alternative C-2: Reduced Layout from Priority Areas via Exclusion of up to 8 WTG Positions and Relocation of 12 WTG Positions to the Eastern Side of the Lease Area

Under the Fisheries Habitat Impact Minimization Alternative C-2, the construction, O&M, and eventual decommissioning of the 11-MW WTGs and an OCS within the proposed Project area and associated IAC and export cables would occur within the range of design parameters outlined in the COP, subject to applicable mitigation measures. However, to further reduce impacts to complex fisheries habitats that are the most vulnerable to long-term impacts as compared to the Proposed Action, certain WTG positions would be excluded from development. Under this alternative, the same number of installed WTGs as described for the Proposed Action may be approved by BOEM.

In Alternative C-1, 8 WTG position were identified for removal within this area. For Alternative C-2, this analysis was expanded upon to relocate 12 WTG positions from the Priority Areas to the eastern side of the Lease Area (farther from Cox Ledge), in addition to removing the 8 WTG positions identified in Alternative C-1.

Alternative C-2 considers four WTG position configurations (C-2a, C-2b, C-2c, and C-2d) to address NMFS priority areas, provide continuous habitat, and avoid boulder fields. All eight positions identified in Alternative C-1 would remain excluded for development in all alternate configurations. An additional 12 WTG positions were selected for relocation based on a similar analysis that was performed for Alternative C-1.

Alternative C-2a

Alternative C-2a prioritized excluding 8 WTG positions (same as Alternative C-1) and relocating 3 WTG positions along the northern section of Priority Area 1 to maintain continuous habitat, and then excluding the remaining 9 WTG positions from areas with the highest boulder densities in Priority Area 2 (Figure 6-4). Boulder density at the WTG positions identified for removal/relocation ranged from 0 boulders/250 km^2 (WTG 97) to 4,665.5 boulders/250 km^2 (WTG 92) (Table 6-3).

Alternative C-2b

In Alternative C-2b, WTG positions were excluded within Priority Area 1 if boulders were present, then Priority Areas were disregarded and WTG positions with the highest densities of boulders were excluded. This resulted in 8 WTG positions excluded and 2 WTG positions relocated from Priority Area 1, 8 WTG positions relocated from Priority Area 2, and then the 1 WTG position was relocated from Priority Area 4. Additionally, 1 WTG position was relocated that was not located in a Priority Area (Figure 6-5). This alternative does not maintain contiguous habitat but identifies the highest densities of boulders. WTG positions #85 and #203 are isolated from other removal locations. WTG #203 is within Priority Area 4 and has a boulder density of 12.4 boulders/250 km^2; WTG #85 is not located within a Priority Area and has a boulder density of 15 boulders/250 km^2.

Alternative C-2c

Alternative C-2c excluded/relocated all 16 WTG positions from Priority Area 1 and then relocated an additional 4 WTG positions with the highest boulder densities in Priority Area 2 (Figure 6-6). This alternative provides continuous habitat with the exception of WTG #172 (479 boulders/250km^2) and WTG #173 (204.6 boulders/250km^2) which are located near the southern portion of Priority Area 2.

Alternative C-2d

Alternative C-2d identified the WTG positions with the highest boulder density within Priority Area 1 and excluded/relocated them. Once all WTG positions with boulders in Priority Area 1 were identified for removal/relocation, the analysis moved to Priority Area 2. The remaining 9 WTG positions that had the highest boulder densities were identified for removal (Figure 6-7). This alternative provides contiguous habitat but excludes WTG #97 in the northwestern corner of the Lease Area and Priority Area 1. This alternative provided results similar to Alternative C-2a, the only difference in results was excluding WTG #97 from relocation. WTG #97 is located in mobile coarse sediment with ripples and complex habitat (Table 6-3).

Table 6-3. Boulder Densities Surrounding WTG Positions in Priority Area 1

WTG Position No.	Boulder Density (#/250 km^2)	Exclude Position?	Benthic Habitat	Bedforms	Habitat Type
87	321.8	Yes	Coarse Sediment – Mobile	Ripples	Complex
88	261.9	Yes	Coarse Sediment – Mobile	Ripples, Trawl marks	Complex
89	2450.8	Yes	Glacial Drift	Ripples	Large-Grained Complex
90	166.4	Yes	Coarse Sediment – Mobile	Ripples, Trawl marks	Complex
91	15.6	Yes	Coarse Sediment – Mobile	Ripples, Trawl marks	Complex
92	4665.5	Yes	Coarse Sediment – Mobile	Ripples, Trawl marks	Complex
93	4398.4	Yes	Coarse Sediment – Mobile	Ripples	Complex
94	243.5	Yes	Sand and Muddy Sand	Linear Depressions, Ripples, Trawl marks	Soft Bottom
95	38.8	No	Sand and Muddy Sand	Linear Depressions, Ripples, Trawl marks	Soft Bottom
96	16.0	No	Coarse Sediment – Mobile	Ripples	Complex
97	0	No	Coarse Sediment – Mobile	Ripples	Complex
120	0	No	Sand and Muddy Sand	Ripples	Soft Bottom
121	0	No	Sand and Muddy Sand	Linear Depressions, Ripples	Soft Bottom
122	0	No	Coarse Sediment – Mobile	Ripples	Complex
150	0	No	Sand and Muddy Sand	Linear Depressions, Ripples, Trawl marks	Soft Bottom
151	0	No	Sand and Muddy Sand	Linear Depressions, Ripples, Trawl marks	Soft Bottom

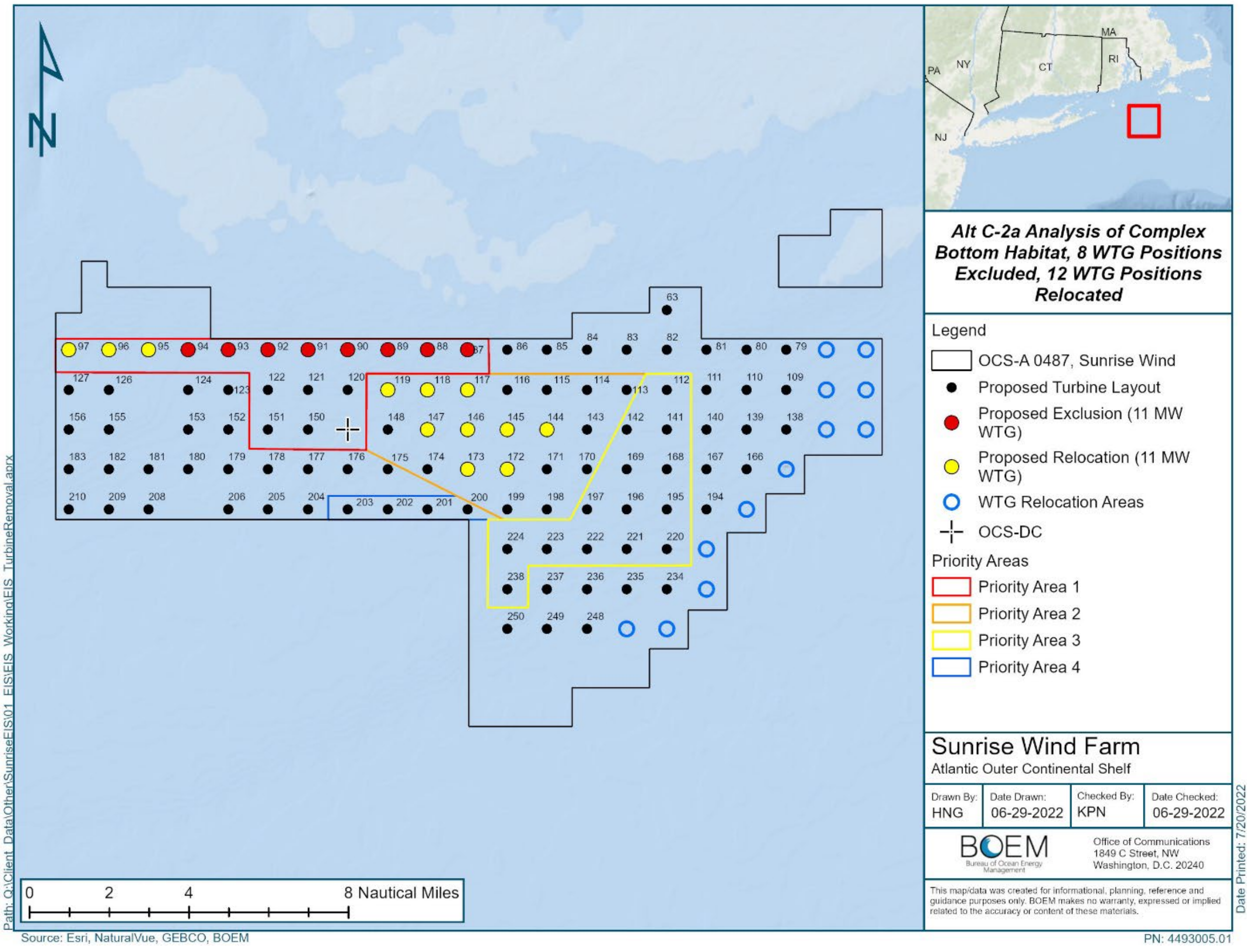


Figure 6-4. Alternative C-2a WTG Position Exclusion and Relocation Analysis

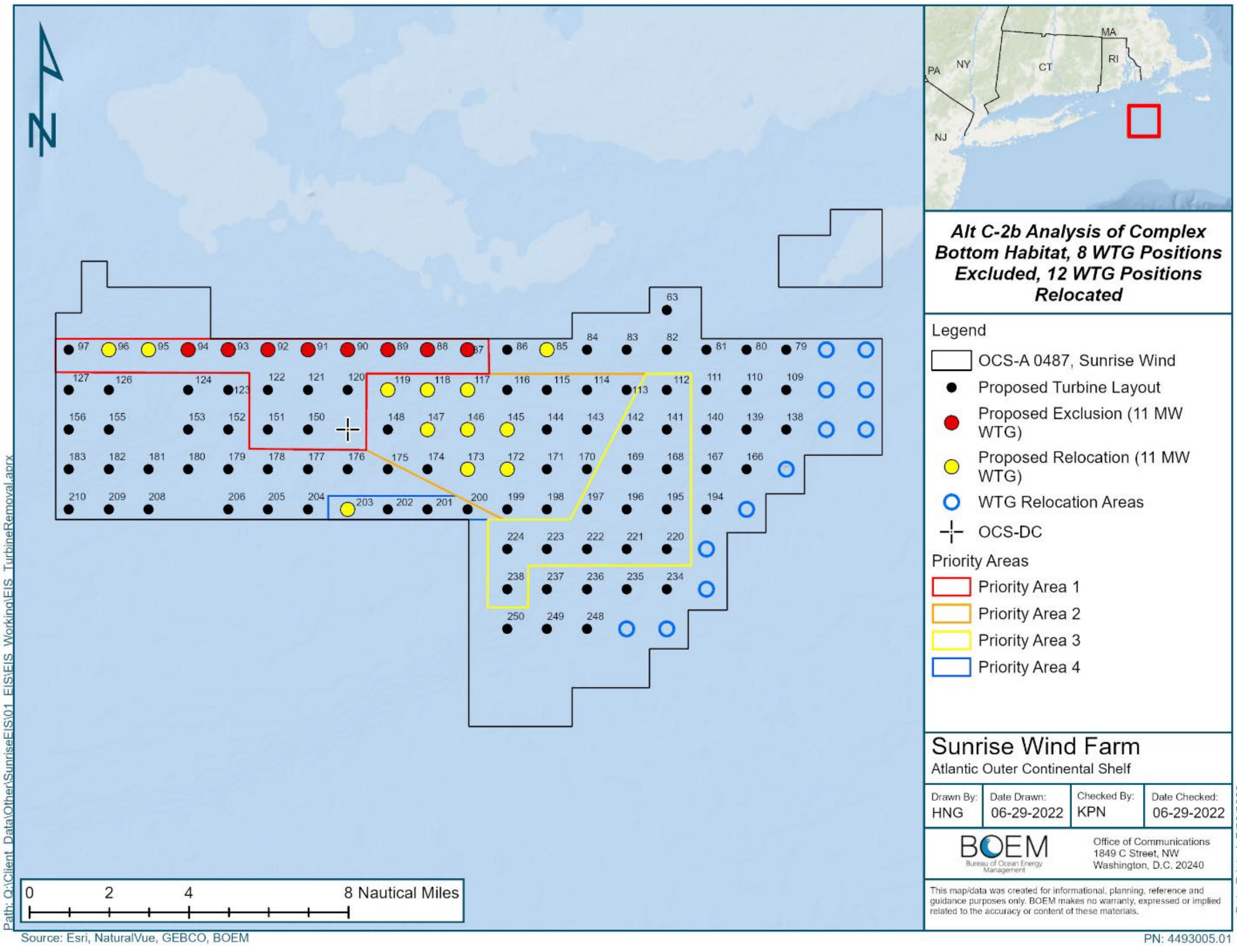


Figure 6-5. Alternative C-2b WTG Position Exclusion and Relocation Analysis

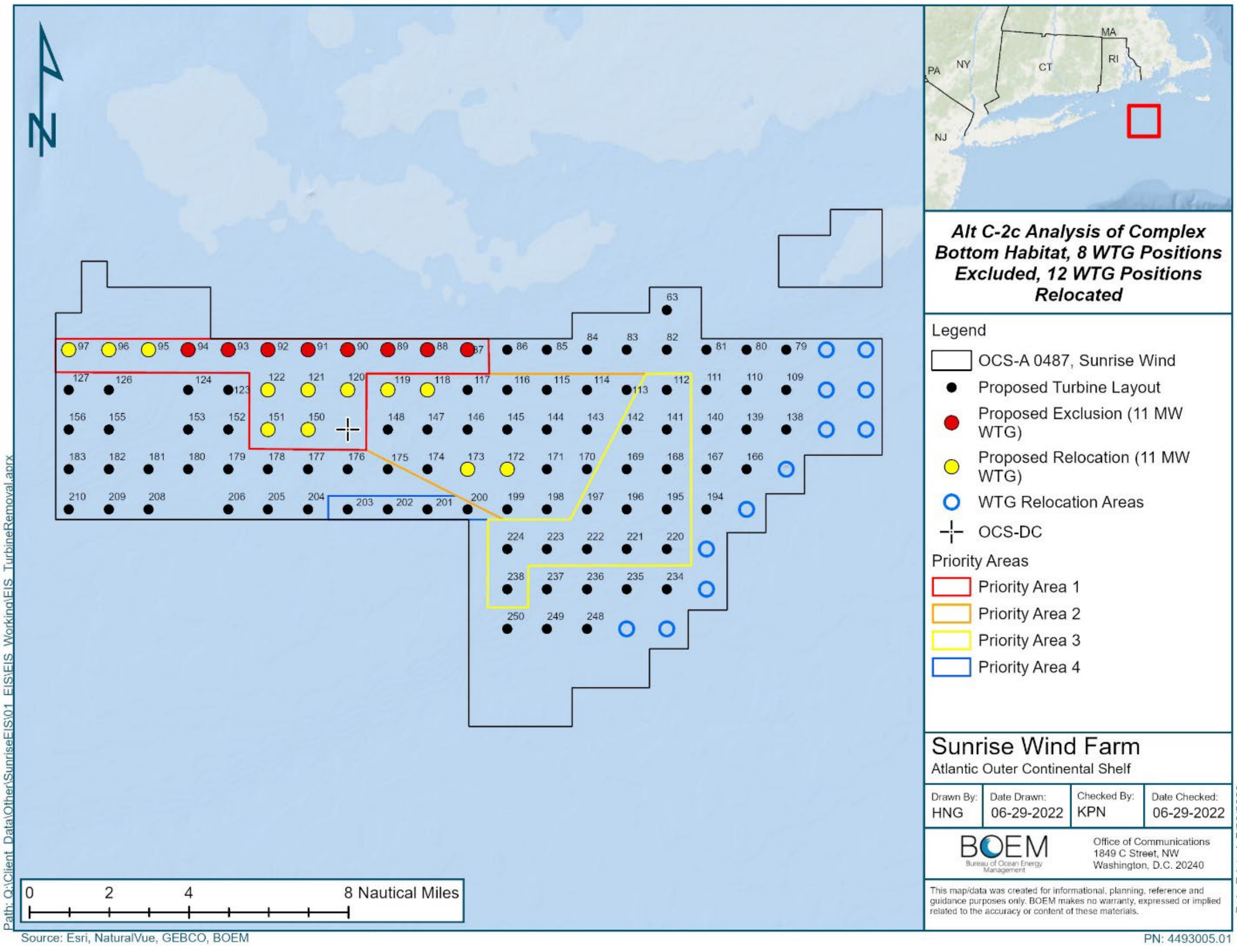


Figure 6-6. Alternative C-2c WTG Position Exclusion and Relocation Analysis

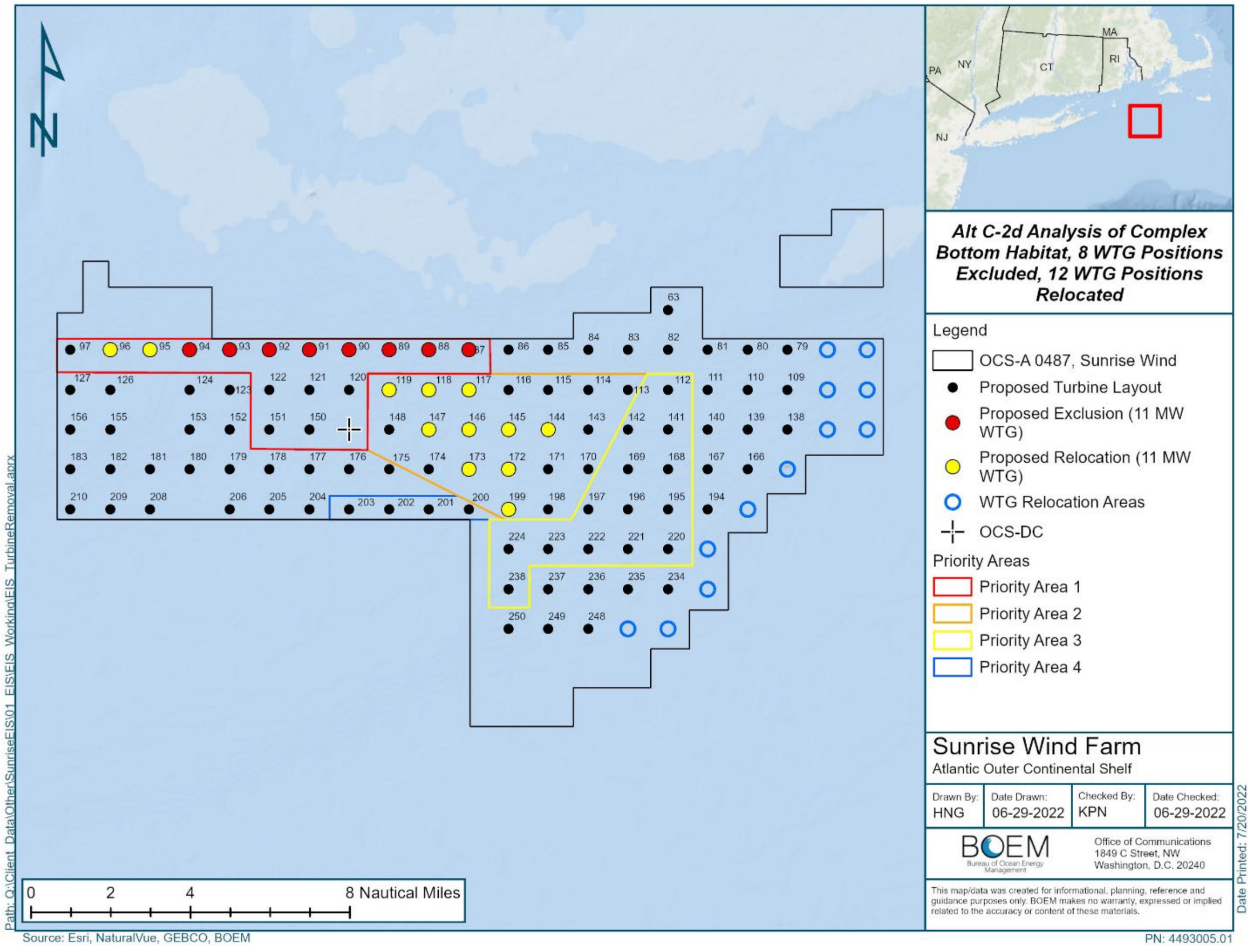


Figure 6-7. Alternative C-2d WTG Position Exclusion and Relocation Analysis

6.3.4 Alternative C-3: Revised Layout Considering Feasibility due to Glauconite Sands

Alternative C-3 was developed to address concerns regarding pile refusal due to glauconite sands in the southeastern portion of the Lease Area while still minimizing impacts to benthic and fisheries resources. Alternative C-3a, C-3b, and C-3c consider different WTG configurations to best reduce impacts while still meeting the NYSERDA offshore renewable energy credits.

WTGs were objectively ranked within NMFS Priority Area 1 using a multi-criteria decision algorithm (MCDA). The MCDA ranked alternatives according to a number of decision criteria that included minimizing the standard deviation of backscatter observations within the micrositing buffer and minimizing boulder density. The algorithm selected was The Technique for Order Preference by Similarity of Ideal Solution (TOPSIS) for its simplicity, ability to compare criteria with incongruous units (i.e., boulder locations), and a flexibility that allows for tradeoffs. TOPSIS ranks alternatives based on their geometric distance from an ideal solution (i.e., how close the alternative is to the perfect solution). Prior to computing distances, utility scores for each objective are normalized along the same 0 – 1 scale. This way the method can incorporate objective scores with different units (i.e., backscatter and densities). Another advantage of TOPSIS is that not all criteria have to be maximized. Geometric distance is the square root of the difference squared; therefore, our preference can be in either direction (positive or negative). TOPSIS allows tradeoffs between criteria, where a poor result in one criterion can be negated by a good result in another.

Observations of the criteria are provided in Table 6-4. Boulder density varied within the Project area (Figure 6-2), with densities highest adjacent to Cox Ledge. WTGs that showed higher standard deviations (SD) in backscatter data within the micrositing area consist of more complex habitat. Table 6-4 also contains the TOPSIS results for ranking of WTGs to be removed, where the distance metric represents the distance to the best solution. WTG #92 ranked highest for removal/exclusion, while removal/exclusion of WTG #120 would be least beneficial for minimizing habitat impacts. Using the TOPSIS analysis and cod data from 2018, 2019, 2021 and 2022 (Figure 6-8), WTGs were selected for removal under Alternatives C-3b and C-3c.

Table 6-4 TOPSIS Analysis for WTGs in Priority Area 1 and Ranking Results

Turbine	Backscatter SD	Boulder (#/km^2)	Distance to Best	Rank
92	1	0.919786	1.385563583	1
89	0.13604	1	1.065851623	2
93	0.156502	0.680459	0.914855718	3
150	0.627394	0	0.792082229	4
87	0.474531	0.014656	0.69941879	5
96	0.356503	7.33E-07	0.597079553	6
151	0.26316	0	0.512991154	7
121	0.252013	0	0.502009243	8
95	0.207951	1.07E-05	0.456027853	9
94	0.178996	0.001464	0.424805938	10
122	0.162894	0	0.403601759	11
97	0.153288	0	0.391519511	12
90	0.102467	0.000931	0.321555827	13
88	0.083364	0.001067	0.290569492	14
91	0.006314	2.53E-05	0.079621089	15
120	0	0	0	16

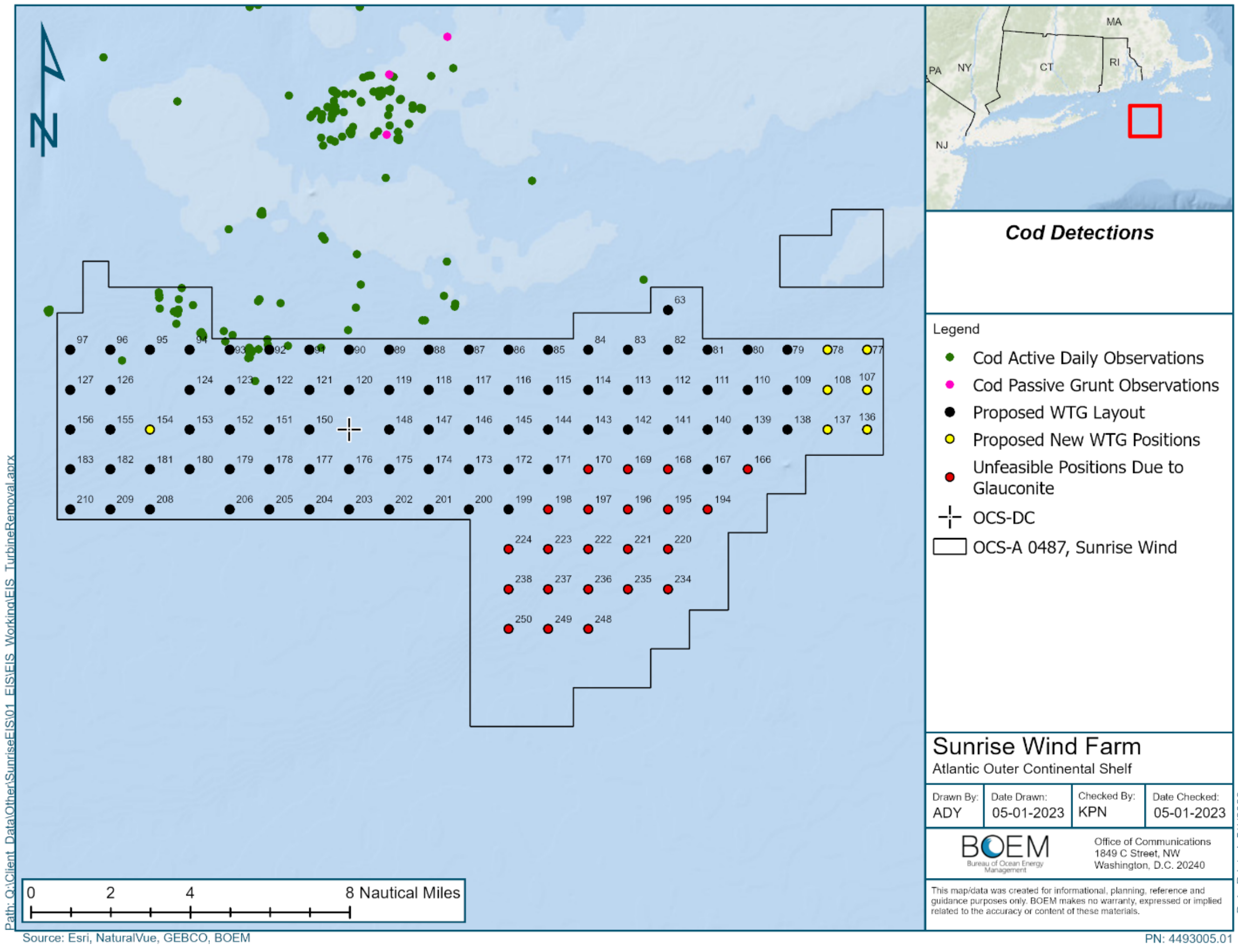


Figure 6-8 Cod Detections near the Sunrise Wind Farm with Proposed WTG Layout in Alternative C-3

6.3.4.1 Alternative C-3a

Alternative C-3a is considered the Proposed Action within this EFH assessment. Alternative C-3a has up to 87 11-MW WTGs would be installed in the 87 potential positions still deemed feasible after consideration of glauconite sands (Figure 6-9). The southeastern portion of the Lease Area would not be developed due to presence of glauconite sands which may result in pile refusal. This alternative considers development of the northeastern portion of the Lease Area and WTG #154, which is not considered in the Proposed Action of the DEIS and FEIS. The construction and installation, O&M, and eventual decommissioning of a wind energy facility would occur within the design parameters outlined in the Sunrise Wind Farm COP (Sunrise Wind 2022b) subject to applicable mitigation measures. The proposed IAC layout is shown in Figure 6-10.

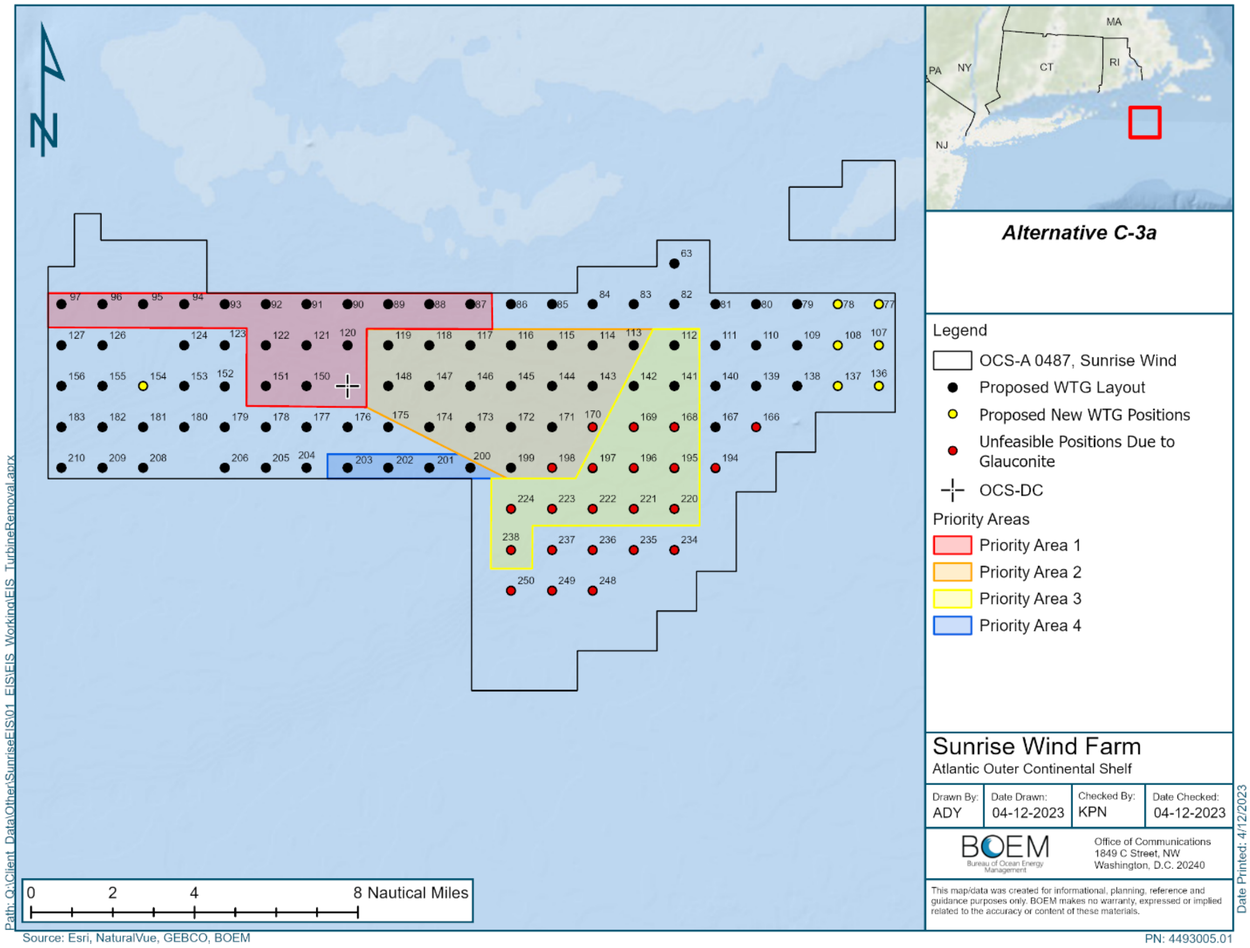


Figure 6-9 Alternative C-3a WTG Layout with Priority Areas

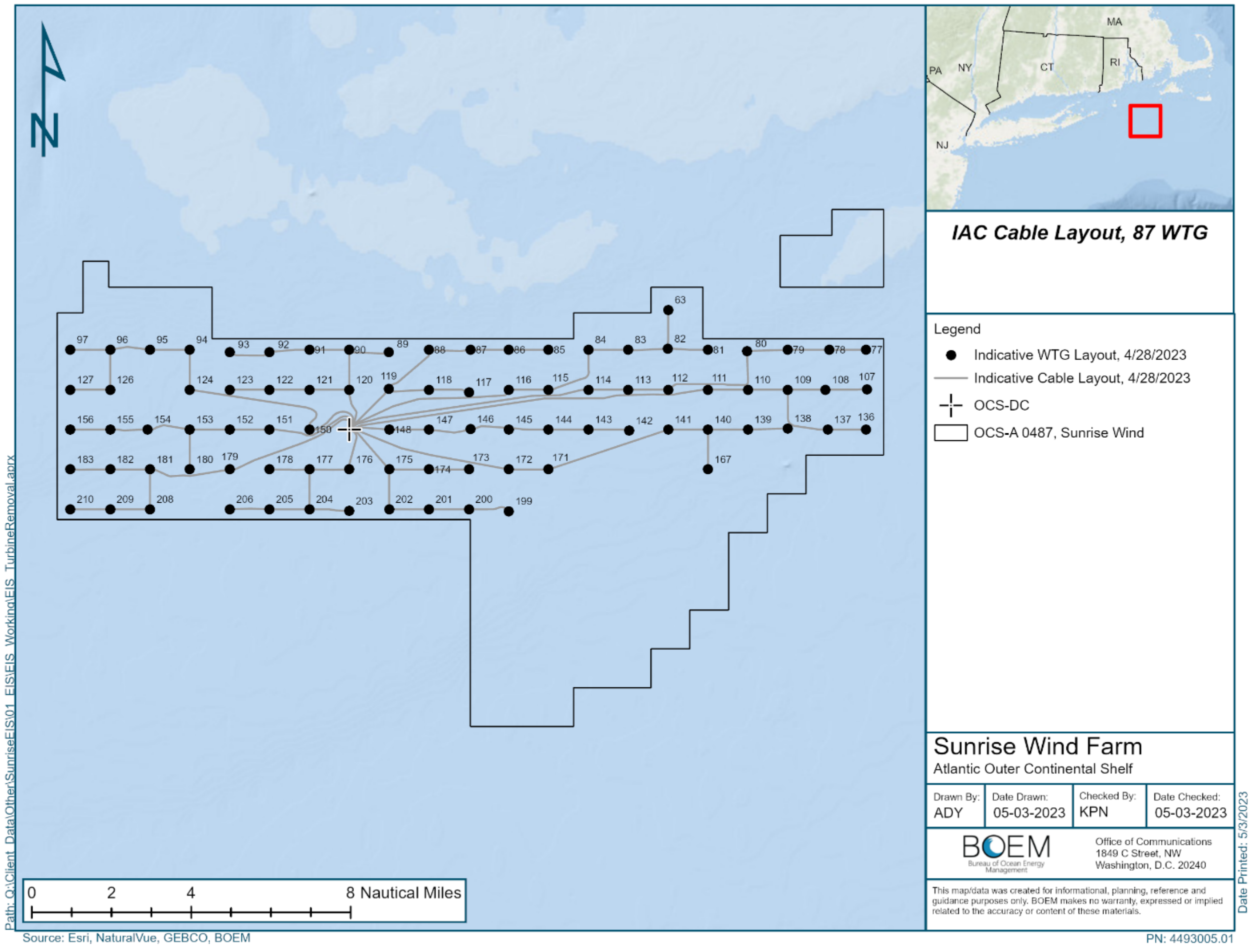


Figure 6-10 Alternative C-3a IAC Layout

6.3.4.2 Alternative C-3b

Under Alternative C-3b, up to 84 WTGs would be installed in the 87 potential positions still deemed feasible after consideration of glauconite sands. The southeastern portion of the Lease Area would not be developed due to presence of glauconite sands which may result in pile refusal. This alternative considers development of the northeastern portion of the Lease Area and WTG #154, which is not considered in the Proposed Action of the DEIS and FEIS. The construction and installation, O&M, and eventual decommissioning of a wind energy facility would occur within the design parameters outlined in the Sunrise Wind Farm COP (Sunrise Wind 2022b) subject to applicable mitigation measures. Under Alternative C-3b, WTGs #92, #93, and #94 are excluded from development (Figure 6-11). These WTGs were excluded due to proximity to cod detections and benthic habitat. The proposed IAC layout is shown in Figure 6-12.

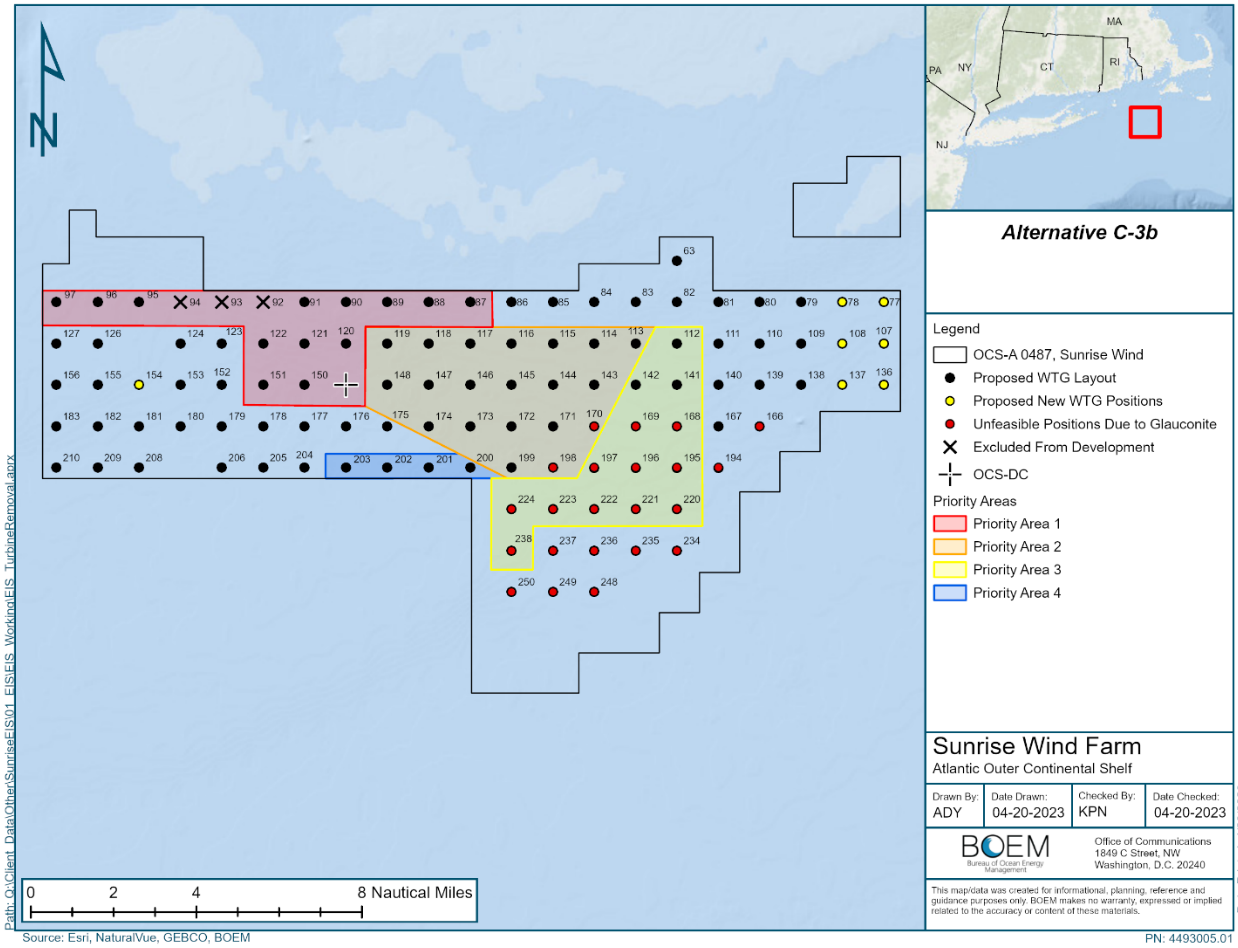


Figure 6-11 Alternative C-3b WTG layout with Priority Areas

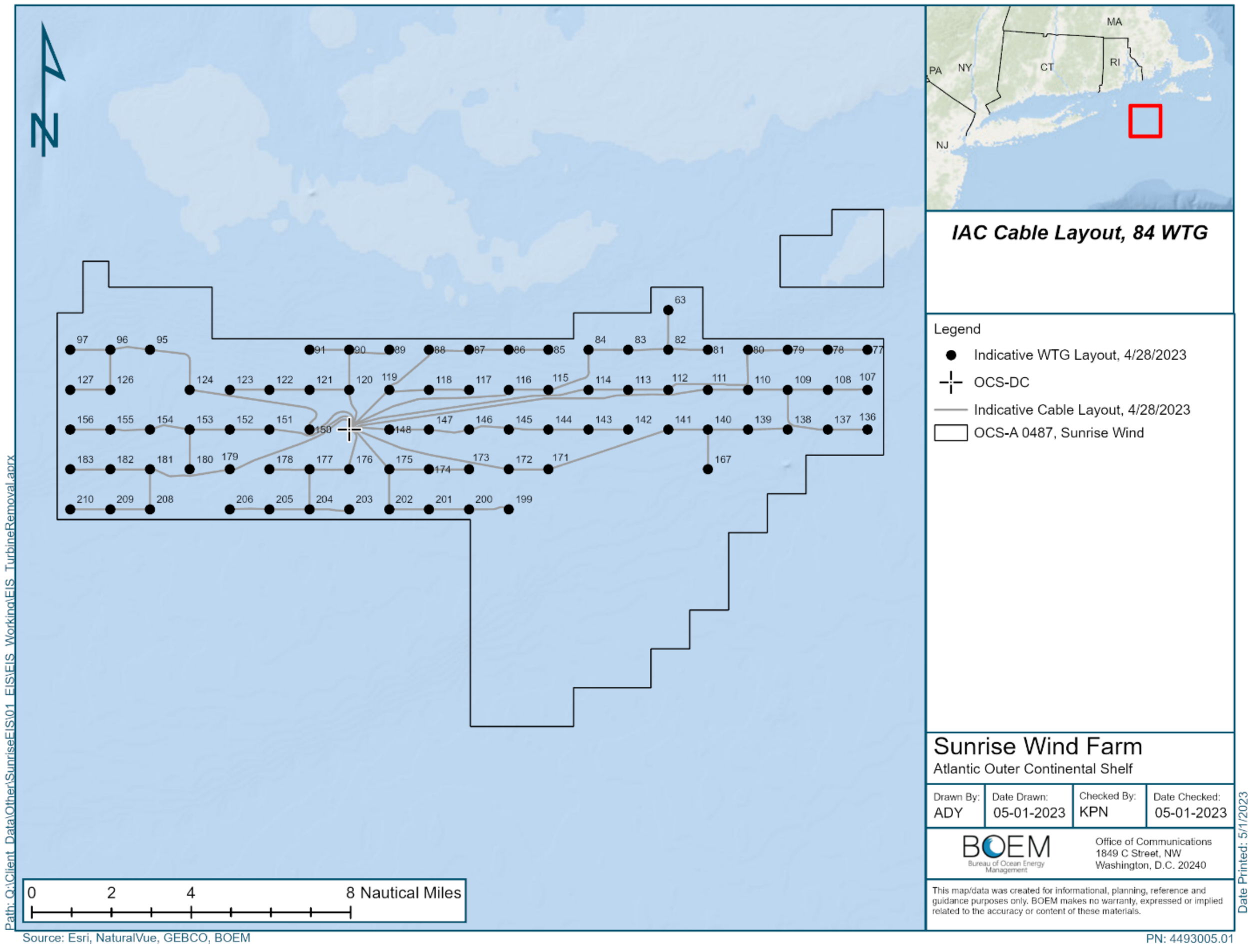


Figure 6-12 Alternative C-3b IAC Layout

6.3.4.3 Alternative C-3c

Under Alternative C-3c, up to 80 WTGs would be installed in the 87 potential positions still deemed feasible after consideration of glauconite sands. The southeastern portion of the Lease Area would not be developed due to presence of glauconite sands which may result in pile refusal. This alternative considers development of the northeastern portion of the Lease Area and WTG #154, which is not considered in the Proposed Action of the DEIS and FEIS. The construction and installation, O&M, and eventual decommissioning of a wind energy facility would occur within the design parameters outlined in the Sunrise Wind Farm COP (Sunrise Wind 2022b) subject to applicable mitigation measures. Under Alternative C-3c, WTGs #91-95, #122 and #121 are excluded from development (Figure 6-13). These WTGs were excluded due to proximity to cod detections and benthic habitat. The proposed IAC layout is shown in Figure 6-14.

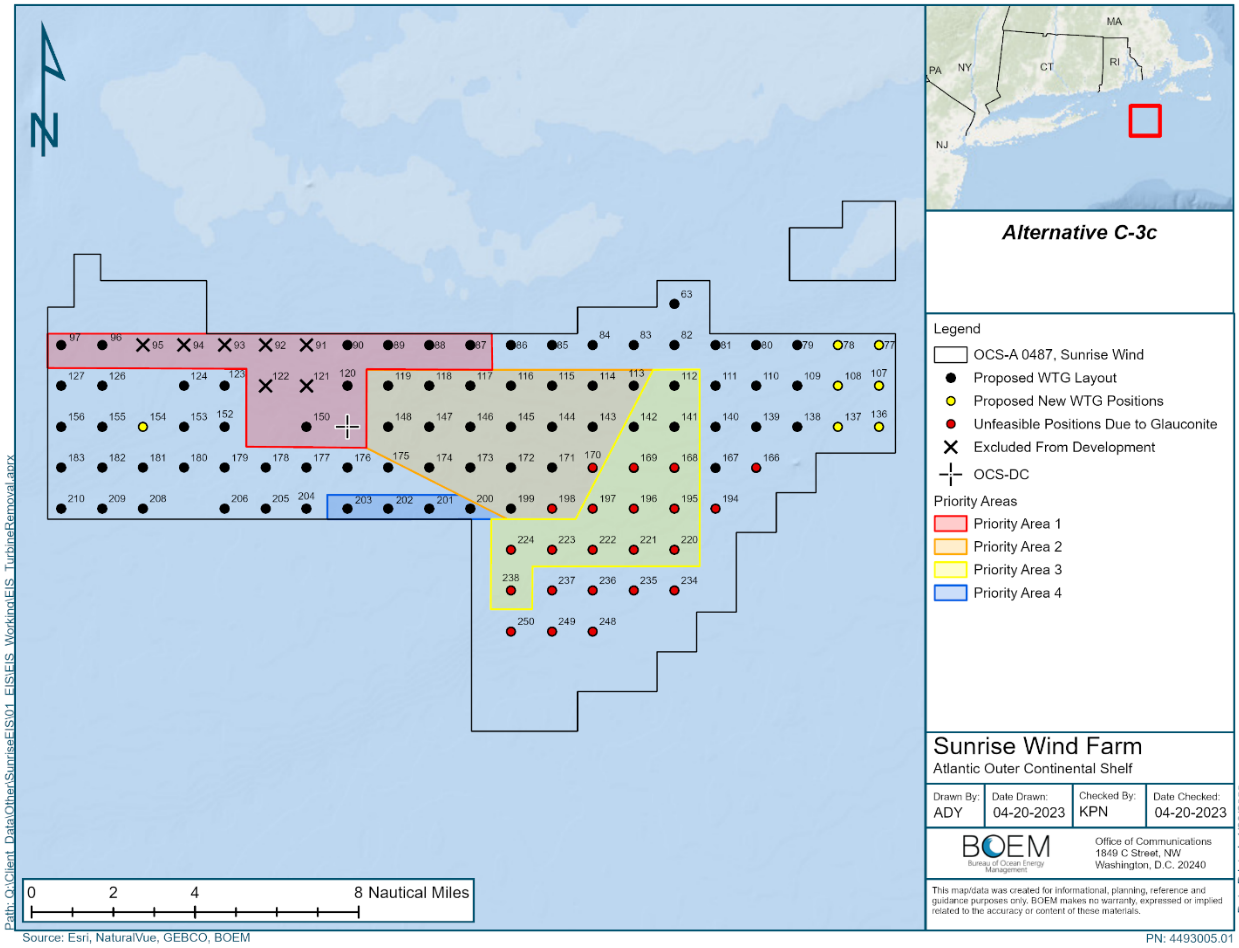


Figure 6-13 Alternative C-3c Layout with Priority Areas

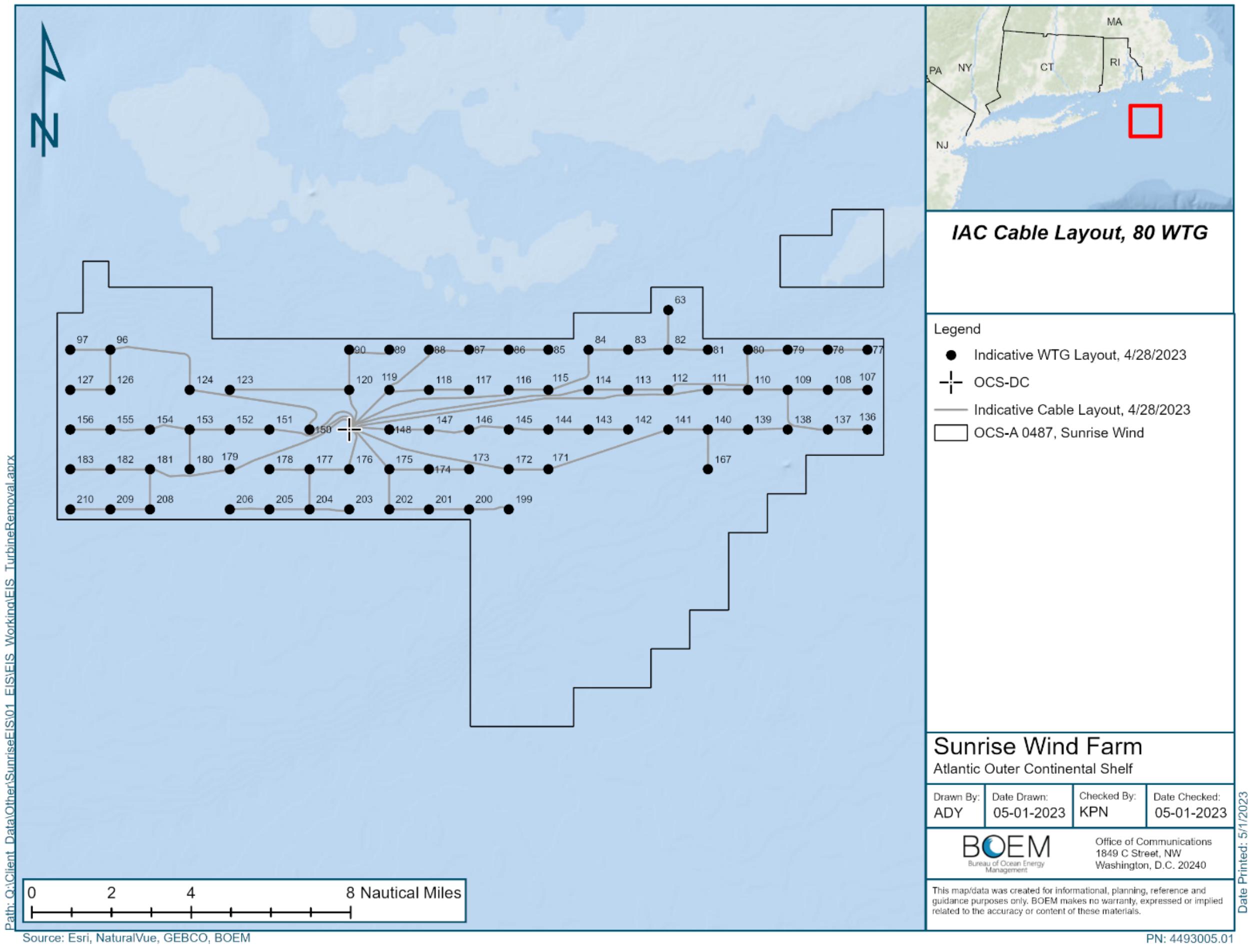


Figure 6-14 Alternative C-3c IAC Layout

6.3.5 Comparison of Impacts and Potential Minimization of Impacts for Alternatives

Temporary and permanent impacts anticipated for Alternatives B and C for the mapped habitat types occurring in the proposed Project area, as well as for NOAA Complex Categories, are provided in Appendix B. Table 6-5 summarizes permanent and temporary impacts by NOAA Complex Category for the Proposed Action (Alternative B) and the variations of the Fisheries Habitat Impact Minimization Alternative (Alternative C). Table 6-6 summarizes permanent and temporary impacts by NOAA Complex Category for the Proposed Action Export cables in the OCS and NYS.

The three action alternatives differ primarily in the locations of the WTGs with respect to complex habitat that supports EFH species and proximity to detections of cod. The focus of the fisheries habitat minimization alternative as compared to the Proposed Action (Alternative B) is on reducing temporary and permanent disturbance in the Priority Areas by removing WTG positions from the areas near Cox Ledge with complex habitat features and shifting WTGs from the northwestern side of the Lease Area where complex habitat is more common to the eastern side, which is farther from Cox Ledge. Because the actual locations for the 94 WTGs under the Proposed Action among the 102 possible positions are not final at this time, we can provide a preliminary comparison of the potential mitigating effects of Alternative C, which would reduce the overall impacts to EFH species and the habitats they depend on.

Table 6-5 Maximum Potential Impacts to Benthic Habitats by NOAA Complexity Category from Proposed Project WTGs, OSC-DC, and IAC Alternative Layouts

Impact Durations	Unit of Measure	NOAA Complexity Category			
		Large-Grained Complex	Complex	Soft Bottom	Total
Alternative B, Proposed Action					
Total Permanent Impacts	Acres	0.11	338.17	530.60	868.87
	%	0%	39%	61%	100%
Total Temporary Impacts	Acres	22.83	2,174.64	3,185.14	5,382.61
	%	0%	40%	59%	100%
Alternative C-1, Fisheries Habitat Impact Minimization, Exclusion of 8 WTGs from Priority Area 1					
Total Permanent Impacts	Acres	-	312.03	516.48	828.51
	%	0%	38%	62%	100%
Total Temporary Impacts	Acres	-	1,960.54	3,067.33	5,027.86
	%	0%	39%	61%	100%
Alternative C-2a, Fisheries Habitat Impact Minimization, Exclusion of 8 WTGs from Priority Area 1, Relocate 12 to Eastern Side of Lease Area					
Total Permanent Impacts	Acres	-	341.60	532.20	873.80
	%	0%	39%	61%	100%
Total Temporary Impacts	Acres	-	2,037.52	3,100.49	5,138.02
	%	0%	40%	60%	100%
Alternative C-2b, Fisheries Habitat Impact Minimization, Exclusion of 8 WTGs from Priority Area 1, Relocate 12 to Eastern Side of Lease Area					
Total Permanent Impacts	Acres	-	354.37	539.49	893.86
	%	0%	40%	60%	100%

Impact Durations	Unit of Measure	NOAA Complexity Category			
		Large-Grained Complex	Complex	Soft Bottom	Total
Total Temporary Impacts	Acres	-	2,106.83	3,081.26	5,188.10
	%	0%	41%	59%	100%
Alternative C-2c, Fisheries Habitat Impact Minimization, Exclusion of 8 WTGs from Priority Area 1, Relocate 12 to Eastern Side of Lease Area					
Total Permanent Impacts	Acres	-	337.07	520.33	857.40
	%	0%	39%	61%	100%
Total Temporary Impacts	Acres	-	2,083.85	3,012.70	5,096.55
	%	0%	41%	59%	100%
Alternative C-2d, Fisheries Habitat Impact Minimization, Exclusion of 8 WTGs from Priority Area 1, Relocate 12 to Eastern Side of Lease Area					
Total Permanent Impacts	Acres	-	347.77	536.57	884.34
	%	0%	39%	61%	100%
Total Temporary Impacts	Acres	-	2,072.66	3,091.70	5,164.36
	%	0%	40%	60%	100%
Alternative C-3a, Revised Layout Considering Feasibility due to Glauconite Sands with 87 WTG positions					
Total Permanent Impacts	Acres	.11	320.63	424.35	745.09
	%	.01%	43%	57%	100%
Total Temporary Impacts	Acres	22.77	1,964.99	2,612.80	4,600.56
	%	.5%	43%	57%	100%
Alternative C-3b, Revised Layout Considering Feasibility due to Glauconite Sands with 84 WTG positions					
Total Permanent Impacts	Acres	0.11	312.20	418.14	730.45
	%	0.02%	43%	57%	100%
Total Temporary Impacts	Acres	14.73	1,908.52	2,547.33	4,470.58
	%	0.3%	43%	57%	100%

Impact Durations	Unit of Measure	NOAA Complexity Category			
		Large-Grained Complex	Complex	Soft Bottom	Total
Alternative C-3c, Revised Layout Considering Feasibility due to Glauconite Sands with 80 WTG positions					
Total Permanent Impacts	**Acres**	**0.11**	**305.05**	**416.49**	**721.65**
	%	**0.02%**	**42%**	**58%**	**100%**
Total Temporary Impacts	**Acres**	**14.73**	**1,830.64**	**2,478.71**	**4,324.08**
	%	**0.3%**	**42%**	**57%**	**100%**

Table 6-6 Maximum Potential Impacts to Benthic Habitats by NOAA Complexity Category from Proposed Project Export Cable

Sunrise Offshore Wind Farm Proposed Project Design		Unit of Measure	NOAA Complexity Category			
			Large-Grained Complex	Complex	Soft Bottom	Total
SRWEC --OCS	**Cable Protection** (up to 12-m wide, applied here to entire length of cable)	**Acres**	0	23.2	419.2	**442.4**
		%	0%	5.2%	94.8%	**100%**
	Seafloor Preparation (30-m corridor, entire length of cable)	**Acres**	0	58.5	1,047.6	**100%**
		%	0%	5.3%	94.7%	**100%**
SRWEC -NYS	**Cable Protection** (up to 12-m wide, applied here to entire length of cable)	**Acres**	0	6.4	20.1	**26.4**
		%	0%	24.0%	76.0%	**100%**
	Seafloor Preparation (30-m corridor, entire length of cable)	**Acres**	0	15.5	49.9	**65.4**
		%	0%	23.7%	76.3%	**100%**

7.0 NOAA Trust Resources

NOAA Trust Resources are living marine resources that include commercial and recreational fishery resources (marine fish and shellfish and their habitats); anadromous species (fish, such as salmon and striped bass, that spawn in freshwater and then migrate to the sea); endangered and threatened marine species and their habitats; marine mammals, turtles, and their habitats; marshes, mangroves, seagrass beds, coral reefs, and other coastal habitats; and resources associated with National Marine Sanctuaries and National Estuarine Research Reserves.

7.1 NOAA Trust Resource Species

Sixteen species of NOAA Trust Resources have been identified within the general vicinity of the Project. Table 7-1 discusses species and life stage within the Project area, as well as the impact determination for each NOAA Trust Resource species.

The following NOAA Trust Resource species or species groups may utilize habitat within the Project area:

- River herring (alewife [*Alosa pseudoharengus*], and blueback herring [*Alosa aestivalis*])
- American eel (*Anguilla rostrata*)
- American shad (*Alosa sapidissima*)
- Striped bass (*Morone saxatilis*)
- Blackfish/tautog (*Tautoga onitis*)
- Weakfish (*Cynoscion regalis*)
- Forage species (Atlantic menhaden [*Brevoortia tyrannus*], bay anchovy [*Anchoa mitchilli*], and sand eel/sand lance [*Ammodytes americanus*])
- Blue crab (*Callinectes sapidus*)
- Horseshoe crab (*Limulus polyphemus*)
- Bivalves (Blue mussel [*Mytilus edulis*], Eastern oyster [*Crassostrea virginica*], quahog [*Mercenaria mercenaria*], and soft- shell clams [*Mya Arenaria*])
- Spot (*Leiostomus xanthurus*)
- Atlantic croaker (*Micropogonias undulatus*)
- Spotted hake (*Urophycis regia*)
- Smallmouth flounder (*Microstomus kitt*)
- Longfin and Shortfin squid (*Doryteuthis pealeii and Illex illecebrosus*)
- Northern kingfish (*Menticirrhus saxatilis*)
- Sea robins (*Triglidae spp.*)

Table 7-1. Trust Resources Determination by Species or Species Group

Species	Life Stage within Project Area	Impact Determination	Rationale for Determination
River herring (alewife, blueback herring)	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	Short-term disturbance effects would occur with only a small area (tens of acres) would be affected at any given time. Benthic community structure would recovery rapidly, within a few months of the activity. Benthic habitat would be displaced or altered over the long-term by placement of the monopile foundations and cable and foundation scour protection (boulders, concrete pillows). Once scour protection is colonized it would provide habitat features for species associated with hard substrates. Short-term noise disturbance from pile driving associated with monopile installation would reduce habitat suitability for these species. Habitat conditions would be unaffected after construction is complete. Operational noise effects are below established behavioral and injury effects thresholds for fish. Collectively, areas affected by short-term construction-related impacts would rapidly return to baseline conditions after the project is completed. Long-term and permanent habitat alterations and operational effects on habitat would be small because: • impacts are limited in intensity and extent, • species occurrence is limited, and • long-term impacts may produce new suitable habitats.
American eel	Larvae, Juvenile, Adult	Limited short-term, long-term, and permanent impacts	
Striped bass	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	
Blackfish/tautog	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	
Weakfish	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	
Spot	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	

Species	Life Stage within Project Area	Impact Determination	Rationale for Determination
Atlantic croaker	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	
Spotted hake	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	
Smallmouth flounder	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	
Longfin and Shortfin squid	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	
Northern kingfish	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	
Sea robin	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	
Forage species (Atlantic menhaden, bay anchovy, sand eel)	All	Limited short-term, long-term, and permanent impacts	

Species	Life Stage within Project Area	Impact Determination	Rationale for Determination
American shad	Juvenile, Adult	Limited short-term, long-term, and permanent impacts	Short-term noise disturbance from pile driving associated with monopile installation monopile installation would reduce habitat suitability for this species as its hearing is connected to its swim bladder. Habitat conditions would be unaffected after construction is complete. Operational noise effects are below established behavioral and injury effects thresholds for fish. As an anadromous species, juveniles have the potential to occur within nearshore waters near the export cable. Individuals could be displaced for the short-term during construction activities, but long-term impacts are not expected.
Blue crab	All	Short-term, long-term, and permanent impacts	Both of these species are known to occur within the Project area. Adults may use the habitat for spawning. Dredging impacts could include increased local TSS, loss of larvae due to suction dredging, or short-term displacement of individuals. However, these impacts are either short-term, or limited in spatial extent.
Horseshoe crab	All	Short-term, long-term, and permanent impacts	
Bivalves (blue mussel, eastern oyster, ocean quahog, soft-shell clam)	All	Short-term, long-term, and permanent impacts	Short-term disturbance effects would occur over benthic habitat. However only a small area (tens of acres) would be affected at any given time. Benthic community structure would recovery rapidly, within a few months of the activity. Benthic habitat would be displaced or altered over the long-term by placement of the monopile foundations and cable and foundation scour protection (boulders, concrete pillows). Project impacts have been sited to avoid and minimize overlap of long-term effects with known shellfish habitats in designated EFH. The benthic community structure would adapt and recover rapidly, within a few months of the activity.

8.0 Conclusions/Determination(s)

A total of 42 species of finfish, elasmobranchs, and invertebrates with designated EFH occur in the Project area. The Proposed Action, described in Section 2, includes construction, operation and maintenance, and decommissioning of the Project components. Project decommissioning would occur at the end of the 35-year planned lifetime of the Project and would be subject to separate EFH consultation at that time. EFH-designated species are discussed in Section 4.

Impact analyses of project activities on EFH are analyzed in Section 5. Impacts associated with construction activities, such as pile driving and jet plowing, are likely to be greater than those associated with operation and maintenance. EFH-designated species with one or more demersal life stage are more likely to be subjected to long-term or permanent adverse impacts than species with only pelagic life stages, primarily due to the installation of the turbine foundations and scour and cable protection measures, and the permanent alteration and conversion of benthic habitat.

Project construction would result in short-term adverse effects on the environment that could affect habitat suitability for EFH and EFH-designated species. Short-term adverse effects include construction-related underwater noise impacts; crushing and burial effects; and disturbance of bottom substrates resulting in increased turbidity and sedimentation. These effects would occur intermittently at varying locations in the Project area over the duration of Project construction but are not expected to cause permanent effects on EFH quality. Depending on the nature, extent, and severity of each effect, this may temporarily reduce the suitability as EFH for multiple life stages of Atlantic cod and longfin squid. However, APMs such as sound attenuation and soft start procedures could minimize such acoustic impacts. Additional APMs are described in Table 6-1. The implementation of APMs (Table 6-1) would likely result in the avoidance and minimization of some of the intermediate to long-term (permanent) project impacts to EFH described above.

The operation and maintenance of the Project would result in intermediate to long-term adverse effects on EFH for some life stages of EFH-designated species (Section 5.2). Long-term adverse effects are those that would last over the approximately 35-year lifespan of the Project. These impacts include alteration of the water column and benthic habitats, operational noise, EMF and heat effects, hydrodynamic effects, and food web effects. Monopile foundations, scour protection, cable protection, and operational maintenance and improvements would alter the habitat. Benthic habitat within the entire Lease Area includes 24,913 acres of complex, and 35,283 acres of non-complex benthic habitat (*see* Table 3-2). WTG and OCS foundations would displace 1.94 acres (0.79 hectares) of complex habitat, 0 acres of large-grained complex habitat, and 2.07 acres (0.84 hectares) of soft bottom habitat. An additional estimated 32.94 acres (13.33 hectares) of complex habitat, 0.11 acres (0.04 hectares) of large-grained complex habitat, and 55.8 acres (22.58 hectares) of soft bottom habitat would be modified by placement of scour protection around the WTG and OCS foundations. The potential increase in abundance of epibenthic and demersal fishes resulting from the reef effect may offset some impacts to EFH of those species over the life of the wind farm, although it may take a decade or more for the reef effect to fully develop. The implementation of APMs (Table 6-1) would likely result in the avoidance and minimization of some of the intermediate to long-term (permanent) project impacts to EFH described above.

The Project would also affect habitats for NOAA Trust Resources known or likely to occur in the Project area (Section 7).

9.0 References

Able KW and Fahay MP. 1998. The First Year in the Life of Estuarine Fishes in the Middle Atlantic Bight. Rutgers University Press, New Brunswick, NJ.

Able KW and Hales Jr LS. 1997. Movements of juvenile black sea bass *Centropristis striata* (Linnaeus) in a southern New Jersey estuary. *Journal of Experimental Marine Biology and Ecology* 213: 153-167.

Andersson MH, Gullstrom M, Asplund ME, and Ohman MC. 2007. “Swimming Behavior of Roach (Rutilus rutilus) and Three-spined Stickleback (Gasterosteus aculeatus) in Response to Wind Power Noise and Single-tone Frequencies.” AMBIO: A Journal of the Human Environment 36: 636-638.

Andre M, Sole M, Lenoir M, Durfort M, Quero C, Mas A, Lombarte A, van der Schaar M, Lopez-Bejar M, Morell M, Zaugg S, and Houegnigan L. 2011. Low-frequency sounds induce acoustic trauma in cephalopods. *Frontiers in Ecology and the Environment* 9(9): 489-493.

Andrianov Y, Broun GR, Il'inskii OB, and Muraveiko VM. 1984. Frequency characteristics of skate electroreceptive central neurons responding to electrical and magnetic stimulation. *Neurophysiology* 16(4): 364−369.

Armstrong JD, Hunter DC, Fryer RJ, Rycroft P, and Orpwood JE. 2015. Behavioural Responses of Atlantic Salmon to Mains Frequency Magnetic Fields. *Scottish Marine and Freshwater Science* 6:9.

Auster P. and Langton R. 1999. The effects of fishing on fish habitat. *American Fisheries Science Symposium* 22: 150-187.

Auster PJ, Lindholm J, Schaub S, Funnell G, Kaufman LS, Valentine PC. 2003. Use of sand wave habitats by silver hake. *Journal of Fish Biology* 62: 143-152.

Bachman M and Couture J. 2022. Habitat Committee report. Staff presentation to the New England Fishery Management Council. June 30, 2022. Portland, Maine.

Bay State Wind LLC. 2019. Construction and operations plan, Bay State Offshore Wind Farm. Submitted to Bureau of Ocean Energy Management. Submitted by Bay State Wind LLC. Submitted March 2019, Revised July 2019.

Bejder L, Samuels A, Whitehead H, Finn H, and Allen S. 2009. Impact assessment research: use and misuse of habituation, sensitization and tolerance in describing wildlife responses to anthropogenic stimuli. *Marine Ecology Progress Series* 395: 177–185.

Bellmann MA, May A, Wendt T, Gerlach S, Remmers P, & Brinkmann J. 2020. Underwater noise during percussive pile driving: Influencing factors on pile-driving noise and technical possibilities to comply with noise mitigation values. ERA Report: Experience report on piling-driving noise with and without technical noise mitigation measures.

Bergström L, Kautsky L, Malm T, Rosenberg R, Wahlberg M, Capetillo A, and Wilhelmsson D. 2014. Effects of offshore wind farms on marine wildlife – a generalized impact assessment. *Environmental Research Letters* 9(3):1-12.

Bergström L, Sundqvist F, and Bergström U. 2013. Effects of an offshore wind farm on temporal and spatial patterns in the demersal fish community. *Marine Ecology Progress Series* 485: 199−210.

Berry WJ, Rubinstein NI, Hinchey EH, Klein-MacPhee G, and Clarke DG. 2011. Assessment of dredging-induced sedimentation effects on Winter Flounder (*Pseudopleuronectes americanus*) hatching success: results of laboratory investigations. Proceedings of the Western Dredging Association

Technical Conference and Texas A&M Dredging Seminar, Nashville, Tennessee, June 5- 8, 2011. Retrieved from http://nerdt.org/wpcontent/uploads/2014/12/WEDA_Berry.pdf

Berthe C and Lecchini D. 2016. Influence of boat noises on escape behaviour of white-spotted eagle ray Aetobatus ocellatus at Moorea Island (French Polynesia). *Comptes rendus biologies* 339(2): 99-103.

Bethoney N and Stokesbury K. 2019. Implications of extremely high recruitment: Crowding and reduced growth within spatial closures. *Marine Ecology Progress Series* 611:157–165.

Betke K, Schultz-von Glahn M, and Matuscheck R. 2004. Underwater noise emissions from offshore wind turbines. Presented at the 2004 CFA/DAGA Conference, March 22-25, 2004 – Strasbourg France.Betke K, Schultz-von Glahn M, and Matuschek R. 2004. Underwater noise emissions from offshore wind turbines. Proceedings of the Joint Congress CFA/DAGA'04, Strasbourg, France. March 22-24, 2004. Available at http://www.conforg.fr/cfadaga2004/cdrom/data/procs/welcome.html.

Bigelow HB and Schroeder WC. 1953. Fishes of the Gulf of Maine. U.S. Fish and Wildlife Service Fishery Bulletin. 53. 577p.

Brawn VM. 1961. Sound Production by the Cod. *Behaviour* 18(4): 239-255.

Bricelj, V.M., S. MacQuarrie, R.A. Schaffner, 2001. Differential effects of *Aureococcus anophagefferens* isolates ("brown tide") in unialgal and mixed suspensions on bivalve feeding. Mar. Biol. 139: 605-615.

Briggs PT. 1979. Black sea bass in New York waters. *N.Y. Fish Game J*. 25: 45-58.

Buerkle U. 1973. Gill-net catches of cod (*Gadus morhua L.*) in relation to trawling noise. *Marine & Freshwater Behaviour & Physiology* 2(1-4): 277-281.

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

Bureau of Ocean Energy Management (BOEM). 2023. Supporting National Environmental Policy Act Determinations for Offshore Wind Energy Development Related to Glauconite Sand. US Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2023-011.

Cadrin SX, Zemeckis D, Zemeckis R, Dean MJ, and Cournane J. 2020. Chapter 7. Applied Markers. In: An Interdisciplinary Review of Atlantic Cod (*Gadus morhua*) Stock Structure in the Western North Atlantic Ocean. R.S. McBride and R.K. Smedbol, eds. NOAA Tech Memo NMFS-NE-XXX. June 2020.

California Department of Transportation. 2001. Pile Installation Demonstration Project, Fisheries Effect Assessment. PIDP EA 012081, Caltrans Contract 04A0148. San Francisco – Oakland Bay Bridge East Span Seismic Safety Project.

Cargnelli LM, Griesbach SJ, Packer DB, Berrien PL, Morse WW, and Johnson DL. 1999a. Essential Fish Habitat Source Document: Pollock, Pollachius virens, life history and habitat characteristics. NOAA Tech Memo NMFS-NE-131. 30 p.

Cargnelli LM, Griesbach SJ, Packer DB, and Weissberger E. 1999b. Essential Fish Habitat Source Document: Atlantic Surfclam, Spisula solidissima, Life History and Habitat Characteristics. NOAA Tech Memo NMFS-NE-142. 13 p.

Cargnelli LM, Griesbach SJ, Packer DB, Berrien PL, Morse WW, and Johnson DL. 1999c. Essential Fish Habitat Source Document: Witch Flounder, *Glyptocephalus cynoglossus*, Life History and Habitat Characteristics. NOAA Tech Memo NMFS-NE-139. 38 p.

Cargnelli LM, Griesbach SJ, Packer DB, and Weissberger E. 1999d. Essential Fish Habitat Source Document: Ocean Quahog, Arctica islandica, Life History and Habitat Characteristics. NOAA Tech Memo NMFS-NE-148. 12 p.

Cargnelli LM, Griesbach SJ, McBride C, Zetlin CA, and Morse WW. 1999e. Essential Fish Habitat Source Document: Longfin Inshore Squid, Loligo pealeii, Life History and Habitat Characteristics. NOAA Tech Memo NMFS-NE-146. 12 p.

Carpenter JR, Merckelbach L, Callies U, Clark S, Gaslikova L, et al. 2016. Potential Impacts of Offshore Wind Farms on North Sea Stratification. PLOS ONE 11(8): e0160830. https://doi.org/10.1371/journal.pone.0160830

Carroll AG, Przeslawski R, Duncan A, Ganning M, and Bruce B. 2016. A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. *Marine Pollution Bulletin* 114 (2017): 9-24.

Castro JI. 1983. The Sharks of North American Waters. Tex. A&M University Press, College Station.

Cazenave PW, Torres R, and Allen JI. 2016. Unstructured grid modelling of offshore wind farm impacts on seasonally stratified shelf seas. *Progress in Oceanography* 145:25–41.

Chang S, Berrien PL, Johnson DL, and Morse WW. 1999. Essential Fish Habitat Source Document: Windowpane, *Scophthalmus aquosus*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-137. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center.

Chen Z. 2018. Dynamics and spatio-temporal variability of the Mid-Atlantic Bight cold pool. Rutgers University, New Brunswick, NJ.

Christiansen N, Daewel U, Djath B, and Schrum C. 2022. Emergence of Large-Scale Hydrodynamic Structures Due to Atmospheric Offshore Wind Farm Wakes. *Frontiers in Marine Science* 9:818501.

Clucas V, Lou R, Therkildsen N, and Kovach A. 2019. Novel signals of adaptive genetic variation in northwestern Atlantic cod revealed by whole-genome sequencing. Wiley Publishing DOI: 10.1111/eva. 12861

CoastalVision and Germano & Associates. 2010. Sediment Profile & Plan View Imaging Report: Evaluation of Sediment and Benthos Characteristics along Potential Cable Routes and Turbine Locations for the Proposed Block Island Wind Farm. Report prepared for Deepwater Wind, Providence, RI.

Collette BB and Klein-MacPhee GK, Eds. 2002. Bigelow and Schroeder's Fishes of the Gulf of Maine, 3rd edition. Smithsonian Institution Press, 748 pp.

Collie J, Hermsen J, Valentine P, and Almeida F. 2005. Effects of fishing on gravel habitats: assessment and recovery of megafauna on Georges Bank. Pp. 325-343 in P.W. Barnes and J.P. Thomas (eds.) Benthic habitats and the effects of fishing. American Fisheries Science Symposium 41, Bethesda, MD.

Collie JS and King JW. 2016. Spatial and Temporal Distributions of Lobsters and Crabs in the Rhode Island Massachusetts Wind Energy Area. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Sterling, Virginia. OCS Study BOEM 2016-073.

Cook RR and Auster PJ. 2007. A bioregional classification of the continental shelf of northeastern North America for conservation analysis and planning based on representation. Marine Sanctuaries Conservation Series NMSP-07-03. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, Silver Spring, MD. 14 pp.

Copping A, Sather N, Hanna L, Whiting J, Zydlewski G, Staines G, Gill A, Hutchison I, O'Hagan A, Simas T, Bald J, Sparling C, Wood J, and Masden E. 2016. Annex IV 2016 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World.

Cotton PA, Sims DW, Fanshawe S, and Chadwick M. 2005. The effects of climate variability on zooplankton and basking shark (*Cetorhinus maximus*) relative abundance off southwest Britain. Fisheries Oceanography 14(2):151–155.

Cresci A, Durif C, Larsen T, Bielland R, Skiftesvik A, and Browman H. 2022. Magnetic fields produced by subsea high-voltage direct current cables reduce swimming activity of haddock larvae Melanogrammus aeglefinus. PNAS Nexus, 2022, 1, 1–7 https://doi.org/10.1093/pnasnexus/pgac175.

CSA Ocean Sciences Inc. 2020. Application for incidental harassment authorization for the non-lethal taking of marine mammals: site characterization surveys Lease OCS-A 0486, 0517, 0487, 0500 and Associated Export Cable Routes. Submitted to Orsted. July 2020. 89 pp.

Cushing DH. 1986. The migration of larval and juvenile fish from spawning ground to nursery ground. J. Cons. Int. Explor. Mer 43: 43-49.

Daewel U, Akhtar N, Christiansen N, and Shrum C. In-press. Offshore Wind Wakes - the underrated impact on the marine ecosystem. *Research Square* https://doi.org/10.21203/rs.3.rs-1720162/v1

Daylander P, Butman B, Sherwood C, Signell R, and Wilkin J. 2012. Characterizing wave-and current-induced bottom shear stress: U.S. middle Atlantic continental shelf. *Continental Shelf Research* 52:73–86.

De Mesel I, Kerckhof F, Norro A, Rumes B, and Degraer S. 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(1): 37-50.

Dean MJ, Hoffman WS, and Armstrong MP. 2012. Disruption of an Atlantic Cod Spawning Aggregation Resulting from the Opening of a Directed Gill-Net Fishery. *North American Journal of Fisheries Management* 32: 124-134.

Dean MJ, Hoffman WS, Zemeckis DR, and Armstrong MP. 2014. Fine-scale diel and gender-based patterns in behaviour of Atlantic cod (*Gadus morhua*) on a spawning ground in the Western Gulf of Maine. *ICES Journal of Marine Science* 71: 1474–1489.

Dean M, DeCelles G, Zemeckis D, and Ames T. 2022. *Early Life History: Spawning to Settlement*. Chapter 2 in R.S. McBride and R.K. Smedbol (eds). *An Interdisciplinary Review of Atlantic Cod (Gadus morhua) Stock Structure in the Western North Atlantic Ocean.* U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NE-XXX (in press). 251 p.

DeCelles GR, Martins D, Zemeckis DR, and Cadrin SX. 2017. Using Fishermen's Ecological Knowledge to map Atlantic cod spawning ground on Georges Bank. *ICES Journal of Marine Science* 74: 1587–1601.

Deepwater Wind South Fork, LLC. 2019. Construction and Operations Plan, 30 CFR Part 585. Submitted to Bureau of Ocean Energy Management. Submitted by Deepwater Wind South Fork, LLC. June 2018, Revised September 2018, Revision 2 Submitted May 2019.

Degraer S, Carey D A, Coolen JW, Hutchison ZL, Kerckhof F, Rumes B, and Vanaverbeke J. 2020. Offshore wind farm artificial reefs affect ecosystem structure and functioning. *Oceanography* 33(4), 48-57.

Denes SL, Weirathmueller MJ, Küsel ET, Limpert KE, and Zeddies DG. 2020. Sunrise Wind Farm Project: Underwater Noise and Exposure Modeling. Document 02109, Version 1.1. Technical report by JASCO Applied Sciences for Sunrise Wind LLC.

Department of Fisheries and Oceans (DFO). 2018. Blue shark. *Prionace glauca*. Government of Canada. Available: http://www.dfo-mpo.gc.ca/species-especes/profiles-profils/blueshark-requinbleu-eng.html. Accessed on February 8, 2019.

Dorrell R, Lloyd C, Lincoln B, Rippeth T, Taylor J, Caulfield C, Sharples J, Polton J, Scannell B, Greaves D, Hall R, and Simpson J. 2022. Anthropogenic Mixing in Seasonally Stratified Shelf Seas by Offshore Wind Farm Infrastructure. *Frontiers in Marine Science* 9:830927.

Drohan AF, Manderson JP, and Packer DB. 2007. Essential Fish Habitat Source Document: Black sea bass, *Centropristis striata*, life history.

DWW Rev I, LLC. 2020. Construction and Operations Plan, Revolution Wind Farm. Prepared by VHB, Providence, RI. Submitted to the Bureau of Ocean Energy Management, Sterling, VA. March 2020

Edinger GJ, Evans DJ, Gebauer S, Howard TG, Olivero AM. 2014. Ecological Communities of NYS Second Edition: A Revised and Expanded Edition of Carol Reschke's Ecological Communities of NYS. NY NHP, NYS Department of Environmental Conservation, Albany, NY. 173 p

Edmonds NJ, Firmin CJ, Goldsmith D, Faulkner RC, and Wood DT. 2016. A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species. Marine Pollution Bulletin. Accessed September 19, 2108. http://dx.doi.org/10.1016/j.marpolbul.2016.05.006

Ellers O. 1995. Discrimination Among Wave-Generated Sounds by a Swash-Riding Clam. The Biological Bulletin189(2): 128-137. https://doi.org/10.2307/1542463.

Environmental Protection Agency. (EPA 2006). Regional Benefits Analysis for the Final Section 316(b) Phase III Existing Facilities Rule. EPA-821-R-04-007.

Fahay MP, Berrien PL, Johnson DL, and Morse WW. 1999. Essential Fish Habitat Source Document. Bluefish, *Pomatomus saltatrix*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-144, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center.

Farr H, Ruttenberg B, Walter R, Wang Y, White C. 2021. Potential environmental effects of deepwater floating offshore wind energy facilities. *Ocean & Coastal Management* 207: 105611.

Fisheries and Oceans Canada. 2018. Recovery Strategy for Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas minor*), and Management Plan for Atlantic Wolffish (*Anarhichas lupus*) in Canada [proposed]. Fisheries and Oceans Canada, Ottawa. vii + 82 p.

Fisheries Hydroacoustic Working Group (FHWG). 2008. Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities. 12 Jun 2008 edition.

Floeter J, Pohlmann T, Harmer A, and Möllmann C. 2022. Chasing the offshore wind farm windwake-induced upwelling/downwelling dipole. *Frontiers in Marine Science* 9:884943.

Floeter J, van Beusekom JEE, Auch D, Callies U, Carpenter J, Dudeck T, Eberle S, Eckhardt A, Gloe D, Hänselmann K, Hufnagl M, Janßen S, Lenhart H, Möller KO, North RP, Pohlmann T, Riethmüller R, Schulz S, Spreizenbarth S, Temming A, Walter B, Zielinski O, and Möllmann C. 2017. Pelagic effects of offshore wind farm foundations in the stratified North Sea. *Progress in Oceanography* 156:154–173.

Gardline J. 2021. Sunrise Wind Farm individual boulders within boulder fields (2019, 2020). Geophysical 1B Survey Interpretation Report, Sunrise Wind Farm Project.

Gedamke J, Ferguson M, Harrison J, Hatch L, Henderson L, Porter MB, and Parijs SV. 2016. Predicting anthropogenic noise contributions to US waters. In The effects of noise on aquatic life II (pp. 341-347). Springer, New York, NY.

Gerstner, C.L. 1998. Use of substratum ripples for flow refuging by Atlantic cod, Gadus morhua. *Environmental Biology of Fishes* 51: 455–460 (1998). https://doi.org/10.1023/A:1007449630601

Gill AB, Bartlett M, and Thomsen F. 2012. Potential interactions between diadromous fishes of U.K. conservation importance and the electromagnetic fields and subsea noise from marine renewable energy developments. *Journal of Fish Biology* 81: 664–695.

Gill AB. 2005. Offshore renewable energy: ecological implications of generating electricity in the coastal zone. *Journal of Applied Ecology* 42(4):605-615.

Gingras, MK, Pemberton, SG, Dashtgard S, and Dafoe L. 2008. How fast do marine invertebrates burrow? *Paleogeography, Palaeoclimatology, Paleoecology* 270(3–4): 280-286.

Gobler, C.J., Young, C.S., Goleski, J., Stevens, A., Thickman, J., Wallace, R.B., Curran, P., 585 Koch, F., Kang, Y., Lusty, M.W., Hattenrath-Lehmann, T.K., Langlois, K., Collier, J.L., 586 2019. Accidental ecosystem restoration? Assessing the estuary-wide impacts of a new ocean 587 inlet created by Hurricane Sandy. Estuar. Coast. Shelf Sci. 221, 132-146. 588 https://doi.org/10.1016/j.ecss.2019.02.040.

Gotceitas V and Brown JA. 1993. Substrate selection by juvenile Atlantic cod (*Gadus morhua*): effects of predation risk. *Oecologia* 93: 31-37.

Greene JK, MG Anderson, Odell J, Steinberg N, editors. 2010. The Northwest Atlantic marine ecoregional assessment: species, habitats and ecosystems. Phase one. The Nature Conservancy, Eastern U.S. Division, Boston, MA.

Griswold CA and Prezioso J. 1981. In-situ observations on reproductive behavior of the long- finned squid, *Loligo pealei*. *Fishery Bulletin* 78: 945–947.

Grosslein MD and Azarovitz TR (eds.). 1982. Fish Distribution. Marine Ecosystems Analysis Program. MESA New York Bight Atlas Monograph 15. New York Sea Grant Institute, Albany NY.

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

Gutherz E J. 1967. Field Guide to the Flatfishes of the Family Bothidae in the Western North Atlantic. U.S. Fish and Wildlife Service Circular No 263.

Handegard NO, Buisson LD, Brehmer P, Chalmers SJ, De Robertis A, Huse G, & Godø OR. 2013. Towards an acoustic-based coupled observation and modelling system for monitoring and predicting ecosystem dynamics of the open ocean. *Fish and Fisheries* 14(4): 605-615.

Handegard NO, Michalsen K, and Tjøstheim D. 2003. Avoidance behaviour in cod (*Gadus morhua*) to a bottom-trawling vessel. *Aquatic Living Resources* 16(3): 265-270.

Hannay D and Zykov M. 2021. Underwater Acoustic Modeling of Detonations of Unexploded Ordnance (UXO) for Ørsted Wind Farm Construction, US East Coast.

Hannay D and Zykov M. 2022. Technical Memorandum: Underwater Acoustic Modeling of Detonations of Unexploded Ordnance (UXO) for Ørsted Wind Farm Construction, US East Coast. Version 4.5, May 2022.

Hardy Jr JD. 1978. Development of Fishes of the Mid-Atlantic Bight: An Atlas of Egg, Larval, and Juvenile Stages. Volume III *Aphredoderidae* through *Rachycentridae*. U.S. Fish and Wildlife Service Biological Services Program FWS/OBS-78/12. 394 pp.

Hart DR and Chute AS. 2004. Essential Fish Habitat Source Document: Sea Scallop, *Placopecten magellanicus*, Life History and Habitat Characteristics. NOAA Tech Memo NMFS-NE-189. 32 p. Accessed July 2019. https://www.nefsc.noaa.gov/publications/tm/tm189/tm189.pdf.

Hastings MC and Popper AN. 2005. Effects of sound on fish (No. CA05-0537). California Department of Transportation.

Hawkins AD and Popper AN. 2014. Assessing the impact of underwater sounds on fishes and other forms of marine life. *Acoustics Today Spring* 2014:30-41.

Hawkins AD, Hazelwood RA, Popper AN, and Macey PC. 2021. Substrate vibrations and their potential effects upon fishes and invertebrates. *The Journal of the Acoustical Society of America 149*(4): 2782-2790.

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, https://espis.boem.gov/final reports/BOEM_2020-044.pdf.

Heck KL, Able KW, Fahay MP. 1989. Fishes and decapod crustaceans of Cape Cod eelgrass meadows: Species composition, seasonal abundance patterns and comparison with unvegetated substrates. *Estuaries* 12: 59–65. https://doi.org/10.2307/1351497

Hendrickson LC and Holmes EM. 2004. Essential Fish Habitat Source Document: Northern Shortfin Squid, *Illex illecebrosus*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE 191, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center.

Hinga K. 2005. Water Quality and Ecology of Great South Bay (Fire Island National Seashore Science Synthesis Paper). Technical Report NPS/NER/NRTR—2005/019. 54 pages.

Holmes LJ, McWilliam J, Ferrari MCO, and McCormick M. 2017. Juvenile damselfish are affected but desensitize to small motorboat noise. *Journal of Experimental Marine Biology and Ecology*. Vol. 494: 63-68.

Hutchison Z, Sigray P, He H, Gill A, King J, and Gibson C. 2018. Electromagnetic Field (EMF) Impacts on Elasmobranch (shark, rays, and skates) and American Lobster Movement and Migration from Direct Current Cables. Report by University of Rhode Island, Cranfield University, and FOI (Swedish Defence Research Agency).

INSPIRE Environmental. 2019. South Fork Wind Farm Reconnaissance Atlantic Cod Spawning Survey.

INSPIRE Environmental. 2022. Benthic Resources Characterization Report – New York State Waters, Sunrise Wind Farm Project. Prepared for Stantec, Quincy, MA and Sunrise Wind LLC. Prepared by INSPIRE Environmental. August 2022.

INSPIRE Environmental. 2020. South Fork Wind Farm Observational Atlantic Cod Spawning Survey.

INSPIRE Environmental. 2023. Sunrise Wind Farm Benthic Habitat Mapping and Benthic Assessment to Support Essential Fish Habitat Consultation. Prepared for Sunrise Wind, LLC. February 3, 2023.

Johnson A. 2018. The Effects of Turbidity and Suspended Sediments on ESA-Listed Species from Projects Occurring in the Greater Atlantic Region. Greater Atlantic Region Policy Series 18-02. National Oceanic and Atmospheric Administration Fisheries, Greater Atlantic Regional Fisheries Office. Available at: https://www.greateratlantic.fisheries.noaa.gov/policyseries/index.php/GARPS/article/view/14.

Johnson T, van Berkel J, Mortensen L, Bell M, Tiong I, Hernandez B, Snyder D, Thomsen F, and Petersen O. 2021. *Hydrodynamic Modeling, Particle Tracking and Agent-Based Modeling of Larvae in the U.S. Mid-Atlantic Bight*. OCS Study BOEM 2021-049. Lakewood, Colorado: U.S. Department of the Interior, Bureau of Ocean Energy Management.

Jones IT, Peyla JF, Clark H, Song Z, Stanley JA, and Mooney TA. 2021. Changes in Feeding Behavior of Longfin Squid (*Doryteuthis pealeii*) during Laboratory Exposure to Pile Driving Noise. 2021. *Marine Environmental Research* 165 (2021): 105250.

Jones IT, Stanley JA, and Mooney TA. 2020. Impulsive pile driving noise elicits alarm responses in squid (*Doryteuthis pealeii*). *Marine Pollution Bulletin* 150:110792. doi:10.1016/j.marpolbul.2019.110792.

Kastelein RA. 2008. Effects of vibrations on the behaviour of cockles (*bivalve molluscs*). *Bioacoustics* 17(1-3): 74-75.

Kempster RM, Hart NS, and Collin SP. 2013. Survival of the stillest: predator avoidance in shark embryos. *PLoS One* 8(1):e52551.

Kenney RD, Owen RE, and Winn HE. 1985. Shark distributions off Northeast United States from marine mammal surveys. Copeia 1985:220–223.

Kerckhof F, Rumes B, and Degraer S. 2019. About “mytilisation” and “slimeification”: a decade of succession of the fouling assemblages on wind turbines off the Belgian coast. Pages 73–84 in S. Dramer, R. Brabant, B. Rumes, and L Vigin (eds.) Environmental Impacts of Offshore Wind Farms in the Belgian Part of the North Sea: Marking a Decade of Monitoring, Research, and Innovation. Tethys. Available at: https://tethys.pnnl.gov/publications/environmental-impacts-offshore-wind-farms-belgian-part-north-sea-marking-decade

Kikuchi R. 2010. Acoustic pathways for underwater noise from an offshore wind turbine under operation: Risk formulation for the sonic effects of offshore wind farms on fish in the EU region. *Marine Pollution Bulletin* 60(2): 172–177.

Kjelland M, Woodley C, Swannack T, and Smith D. 2015. A review of the potential effects of suspended sediment on fishes: potential dredging-related physiological, behavioral, and transgenerational implications. *Environmental Systems and Decisions* 35: 334–350.

Küsel ET, Weirathmueller MJ, Koessler MW, Zammit KE, Quijano JE, Kanu C, Limpert KE, Clapsaddle ME, and Zeddies DG. 2022. Sunrise Wind Farm Project: Underwater Noise and Exposure Modeling. Document 02109, Version 7.0. Technical report by JASCO Applied Sciences for Sunrise Wind LLC.

Küsel TE, Weirathmueller M, Zammit K, Dufault S, Welch S, Limpert K, Zeddies D. 2021. Underwater Acoustic and Exposure Modeling. JASCO Applied Sciences (USA) Inc.

Ladich F and Myrberg AA. 2006. Agonistic behavior and acoustic communication. *Communication in Fishes* 1(1): 121-148.

LaFrance Bartley M, King JW, Oakley BA, Caccioppoli BJ. 2022. Post-Hurricane Sandy Benthic Habitat Mapping at Fire Island National Seashore, New York, USA, Utilizing the Coastal and Marine Ecological Classification Standard (CMECS). Estuaries and Coasts 45:1070–1094. https://doi.org/10.1007/s12237-022-01047-z

Laney RW. 1997. The relationship of seagrass ecological value to species managed by the ASMFC: A summary for the ASMFC Submerged Aquatic Vegetation Subcommittee in Stephan, C.D. and T.E. Bigford, editors, Atlantic Coastal Submerged Aquatic Vegetation: a review of its ecological role, anthropogenic impacts, state regulation and value to Atlantic coastal fisheries. ASMFC Habitat Management Series No. 1. Washington, DC.

Laney RW. 1997. The relationship of submerged aquatic vegetation (SAV) ecological value to species managed by the Atlantic States Marine Fisheries Commission. *Atlantic Coastal Submerged Aquatic Vegetation: A Review of its Ecological Role*, 13.

Langan JA, McManus MC, Zemeckis DR, and Collie JS. 2020. Abundance and distribution of Atlantic cod (*Gadus morhua*) in a warming southern New England. *Fishery Bulletin* 118: 145-156.

Lascara J. 1981. Fish predator-prey interactions in areas of eelgrass (*Zostera marina*). M.S. thesis, College of William and Mary, Williamsburg, VA. 81 p.

Lentz SJ. 2017. Seasonal warming of the Middle Atlantic Bight Cold Pool. *Journal of Geophysical Research: Oceans* 122(2):941–954.

Leonhard SB, Stenberg C, and Støttrup JG, eds. 2011. Effect of the Horns Rev 1 Offshore Wind Farm on Fish Communities: Follow-up Seven Years after Construction. Danish Energy Authority.

Li X, Chi L, Chen X, Ren Y, and Lehner S. 2014. SAR observation and numerical modeling of tidal current wakes at the East China Sea offshore wind farm. *Journal of Geophysical Research: Oceans* 119(8):4958–4971.

Lindeboom HJ, Kouwenhoven HJ, Bergman MJN, Bouma S, Brasseur S, Daan R, Fijn RC, de Haan D, Dirksen S, van Hal R, Hille Ris Lambers R, ter Hofstede R, Krijgsveld KL, Leopold M, and M Scheidat. 2011. Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. *Environmental Research Letters 6*: 1–13.

Liu C. 2019. Geolocation Methods for Demersal Fish Species Using Archival Tagging Data. PhD Dissertation, University of Massachusetts, Dartmouth, MA, USA.

Loehrke JL. 2014. Movement patterns of Atlantic cod (*Gadus morhua*) spawning groups off New England. MS Thesis, University of Massachusetts, Dartmouth, MA, USA.

Lough RG. 2004. Essential fish habitat source document: Atlantic cod, *Gadus morhua*, life history and habitat characteristics. NOAA Tech Memo NMFS-NE-190.

Love MS, Nishimoto MM, Clark S, and Bull AS. 2016. Renewable Energy in situ Power Cable Observation. OCS Study 2016-008. Camarillo, CA: U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region.

Love MS, Nishimoto MM, Clark S, McCrea M and Bull AS. 2017. Assessing potential impacts of energized submarine power cables on crab harvests. *Continental Shelf Research* 151: 23-29.

MacNeil MA, Skomal GG, and Fish AT. 2005. Stable isotopes from multiple tissues reveal diet switching in sharks. Marine Ecology Progress Series, 302, 199-206. Doi 10:335/MEPS302199.

Maia A, Queiroz N, Correia JP, and Cabral H. 2007. Food habits of the shortfin mako, *Isurus oxyrinchus*, off the southwest coast of Portugal. Environmental Biology of Fish 77:157–167.

Markle DF, Scott WB, and Kohler AC. 1980. New and rare records of Canadian fishes and the influence of hydrography on resident and nonresident Scotian Shelf ichthyofauna. Can. J. Fish. Aquat. Sci. 37(1):49-65.

Mavraki N, Degraer S, Moens T, and Vanaverbeke J. 2020. Functional differences in trophic structure of offshore wind farm communities: a stable isotope study. *Marine Environmental Research*, 157, 104868.

Mavraki N, Degraer S, Vanaverbeke J, and Braeckman U. 2020. Organic matter assimilation by hard substrate fauna in an offshore wind farm area: a pulse-chase study. ICES Journal of Marine Science, 77(7-8), 2681-2693.Mazzola S. 2007. Effect of boat noise on the behaviour of bluefin tuna *Thunnus thynnus* in the Mediterranean Sea. *Marine Ecology Progress Series* 331: 243–253.

McBride RS and Smedbol RK (eds). 2022. *An Interdisciplinary Review of Atlantic Cod (Gadus morhua) Stock Structure in the Western North Atlantic Ocean.* U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NE-XXX (in press). 251 p.

McCandless CT, Conn P, Cooper P, Cortés E, Laporte SW, and Nammack M. 2014. Status Review Report: Northwest Atlantic Dusky Shark (*Carcharhinus obscurus*). Report to National Marine Fisheries Service, Office of Protected Resources. October 2014. 72 pp.

McCandless CT, Pratt Jr HL, and Kohler NE. 2002. Shark nursery grounds of the Gulf of Mexico and the East Coast waters of the United States: An overview. An internal report to NOAA's Highly Migratory Species Office. NOAA Fisheries Narragansett Lab, 28 Tarzwell Dr, Narragansett RI 02882. 287 pp.

McCay B, Brandt S, and Creed C. 2011. Human dimensions of climate change and fisheries in a coupled system: The Atlantic surfclam case. *ICES Journal of Marine Science* 68:1354–1367.

McCauley RD. 1998. Radiated underwater noise measured from the drilling rig Ocean General, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor Sea, northern Australia. Report Number C98-20. Report by Centre for Marine Science and Technology (CMST) for Shell Australia. https://cmst.curtin.edu.au/wp-content/uploads/sites/4/2016/05/1998-19.pdf.

McQueen K, Meager JJ, Nyqvist D, Skjæraasen JE, Olsen EM, Karlsen Ø, Kvadsheim PH, Handergard NO, Forland TN, and Doksæter Sivle L. 2022. “Spawning Atlantic cod (*Gadus morhua L*.) exposed to noise from seismic airguns do not abandon their spawning site.” ICES Journal of Marine Science 79(10): 2697–2708.

Michel J, Bejarano A, Peterson C, and Voss C. 2013. Review of Biological and Biophysical Impacts from Dredging and Handling of Offshore Sand. U.S. Department of the Interior, Bureau of Ocean Energy Management, Herndon, Virginia. OCS Study BOEM 2013-0119. 258 pp.

Mid-Atlantic Fishery Management Council (MAFMC). 1998a. Amendment 12 to the Atlantic Surfclam and Ocean Quahog Fishery Management Plan.

Mid-Atlantic Fishery Management Council (MAFMC). 1998b. Amendment 12 to the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan.

Mid-Atlantic Fishery Management Council (MAFMC). 2011. Amendment 11 to the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan.

Mid-Atlantic Fishery Management Council (MAFMC). 2014. Amendment 3 to the Spiny Dogfish Fishery Management Plan, Mid-Atlantic Fishery Management Plan.

Mid-Atlantic Fishery Management Council (MAFMC). 2016. Ecosystem approach to fisheries management guidance document.

Minerals Management Service (MMS). 2007. Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf, Final Environmental Impact Statement, October 2007. OCS Report MMS 2007-024.

Minerals Management Service (MMS). 2008. Cape Wind Energy Project Nantucket Sound Biological Assessment (Appendix G). In Cape Wind Energy Project Final EIS. p. 296.

Mitson RB and Knudsen HP. Causes and effects of underwater noise on fish-abundance estimation, *Aquatic Living Resources*, 2003, vol. 16 (pg. 255-263)

Munroe D, Haidvogel D, Caracappa J, Klinck J, Powell E, Hofmann E, Shank B, and Hart D. 2018. Modeling larval dispersal and connectivity for Atlantic sea scallop (*Placopecten magellanicus*) in the Middle Atlantic Bight. *Fisheries Research* 208:7–15.

Mosher JI. 1972. The responses of *Macoma balthica* (*bivalvia*) to vibrations. Journal of Molluscan Studies 40(2): 125-131. https://doi.org/10.1093/oxfordjournals.mollus.a065209.

Mueller-Blenkle C, McGregor PK, Gill AB, Andersson MH, Metcalfe J, Bendall V, Sigray P, Wood DT, and Thomsen F. 2010. Effects of Pile-driving Noise on the Behaviour of Marine Fish. COWRIE Ref: Fish 06-08, Technical Report 31st March 2010.

Myrberg AA and Lugli M. 2006. Reproductive behavior and acoustical interactions. In: Ladich F, Collin SP, Moller P, Kapoor BG (eds) Communication in Fishes. Enfield, NH: Science Publishers, pp. 147–174.

Nammack MF, Musick JA, and Colvocoresses JA. 1985. Life history of spiny dogfish off the northeastern United States. Transactions of the American Fisheries Society 114:367–376.

Natanson LJ and Gervelis BJ. 2013. The Reproductive Biology of the Common Thresher Shark in the Western North Atlantic Ocean, Transactions of the American Fisheries Society, 142:6, 1546-1562, DOI: 10.1080/00028487.2013.811099.

National Marine Fisheries Greater Atlantic Regional Fisheries Office of Habitat Conservation and Ecosystem Services Division (NOAA Habitat). 2021. Recommendations for Mapping Fish Habitat.

National Marine Fisheries Service (NMFS). 2009. Final Amendment 1 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan Essential Fish Habitat. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Public Document. Pp. 422.

National Marine Fisheries Service (NMFS). 2017. Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat. Silver Spring, Maryland: National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division.

National Marine Fisheries Service (NOAA Fisheries). 2022a. National Marine Fisheries Service (NOAA Fisheries). 2022. Ocean Quahog. Accessed October 2022. https://www.fisheries.noaa.gov/species/ocean-quahog.

National Marine Fisheries Service (NOAA Fisheries). 2022b. Atlantic Sea Scallop. Accessed October 2022. https://www.fisheries.noaa.gov/species/atlantic-sea-scallop.

National Marine Fisheries Service (NOAA Fisheries). 2022c. Atlantic Surfclam. Accessed October 2022. https://www.fisheries.noaa.gov/species/atlantic-surfclam#management

National Oceanic and Atmospheric Administration (NOAA). 2017. Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat and Environmental Assessment.

National Oceanic and Atmospheric Administration (NOAA). 2019. U.S. National Bycatch Report First Edition Update 3. [accessed: 2022 Jul 01]. Available at: https://media.fisheries.noaa.gov/dam-migration/nbr_update_3.pdf.

National Oceanic and Atmospheric Administration (NOAA). 2022. Essential Fish Habitat Mapper, New England / Mid Atlantic. May 3, 2023. https://www.habitat.noaa.gov/apps/efhmapper/.

Nedelec SL, Campbell J, Radford AN, Simpson SD, and Merchant ND. 2016. Particle motion: The missing link in underwater acoustic ecology. *Methods Ecol. Evol*. 7: 836–842.

New England Fishery Management Council (NEFMC). 2017. Omnibus Essential Fish Habitat Amendment 2. Volume 2: EFH and HAPC Alternatives and Environmental Impacts.

New England Fishery Management Council (NEFMC). 2022a. Habitat Management Considerations for the Northern Edge of Georges Bank. https://s3.us-east-1.amazonaws.com/nefmc.org/6.-220120-Northern-Edge-Habitat-Management-Considerations.pdf

New England Fishery Management Council (NEFMC). 2022b. *Southern New England Habitat Area of Particular Concern Framework, Northeast Multispecies Fishery Management Plan Framework Adjustment 64, Atlantic Sea Scallop Fishery Management Plan Framework Adjustment 35, Monkfish Fishery Management Plan Framework Adjustment 14, Northeast Skate Complex Fishery Management Plan Framework Adjustment 10, Atlantic Herring Fishery Management Plan Framework Adjustment 10. Draft.* Prepared by the New England Fishery Management Council and the National Marine Fisheries Service. June 17.

New York Department of Environmental Conservation (NYSDEC). 2008. Coastal Fish & Wildlife Habitat Assessment Form – Carmans River. Available at: https://dos.ny.gov/system/files/documents/2020/03/carmans_river.pdf. 15 p.

New York Department of State (NYDOS), GOSR, NOAA, Dewberry. 2020. 2018 Long Island South Shore Benthic Habitat 2018 (LISS_Biotic_2018_Contractor_Final). Available from http://opdgig.dos.ny.gov/#/home

New York Department of State (NYDOS). 2020a. Long Island South Shore Benthic Habitat 2002. (Biotic component). Available from http://opdgig.dos.ny.gov/#/search/SAV.

New York Department of State (NYDOS). 2020b. Long Island South Shore Benthic Habitat 2018 (LISS_Biotic_2018_Contractor_Final). Available from http://opdgig.dos.ny.gov/#/search/SAV.

New York State Energy Research & Development Authority (NYSERDA). 2017a. New York State offshore wind master plan: birds and bats study. Albany (NY): Prepared for NYSERDA by Ecology and Environment Engineering, P.C. 142 p. Report No.: NYSERDA 17-25d.

New York State Energy Research & Development Authority (NYSERDA). 2017b. New York State offshore wind master plan: cable landfall permitting study. Albany (NY): Prepared for NYSERDA by Ecology and Environment Engineering, PC. 248 p. Report No.: NYSERDA 17-25e.

New York State Energy Research and Development Authority (NYSERDA). 2017c. New York State Offshore Wind Master Plan Analysis of Multibeam Echo Sounder and Benthic Survey Data Final Report Prepared for: New York State Energy Research and Development Authority Prepared by: INSPIRE Environmental Middletown, Rhode Island, NYSERDA Report 17-25a, December 2017.

Nilsson HC and Rosenberg R. 2003. Effects on marine sedimentary habitats of experimental trawling analyzed by sediment profile imagery. Journal of Experimental Marine Biology and Ecology 285–286:453–463.NOAA. 2017. Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat and Environmental Assessment.

Normandeau Associates, Inc. 2012. Effects of noise on fish, fisheries, and invertebrates in the U.S. Atlantic and Arctic from energy industry sound-generating activities. A literature synthesis for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M11PC00031, 1-361 pp. Available at http://www.data.boem.gov/homepg/data_center/other/espis/espismaster.asp?appid=1 (accessed 14 December 2015).

Northeast Ocean Data. 2020, Maps and Data for Ocean Planning in the Northeastern United States. Commercial Fishing. Accessed October 28, 2022. https://www.northeastoceandata.org/

Ocean Wind, LLC. (Ocean Wind). 2021a. Construction and Operations Plan, Ocean Wind Offshore Wind Farm. Volumes I-III. March. Available: https://www.boem.gov/ocean-wind-construction-and-operations-plan/.

Ona E, Godø OR, Handegard NO, Hjellvik V, Patel R, Pedersen G (2007). Silent research vessels are not quiet. *Journal of the Acoustical Society of America* 121, 145–50.

Ona E. 2003. An expanded target–strength relationship for herring. *ICES Journal of Marine Science* 60(3): 493-499.

Orpwood JE, Fryer RJ, Rycroft P, and Armstrong JD. 2015. Effects of AC Magnetic Fields (MFs) on Swimming Activity in European Eels Anguilla. *Scottish Marine and Freshwater Science* 6:8.

Orr M. 2016. The potential impacts of submarine power cables on benthic elasmobranchs. Doctoral Dissertation, The University of Auckland, New Zealand.

Overholtz W. 2006. Status of fishery resources off the Northeastern US – Butterfish. Available: http://www.nefsc.noaa.gov/sos/spsyn/pp/mackerel/.

Owen RE. 1984. Distribution and Ecology of the Basking Shark *Cetorhinus maximus* (Gunnerus 1765). MSc Thesis. Kingston, RI, USA: University of Rhode Island.

Packer DB, Griesbach SJ, Berrien PL, Zetlin CA, Johnson DL, and Morse WW. 1999a. Essential Fish Habitat Source Document: Summer Flounder, *Paralichthys dentatus*, Life History and Habitat Characteristics. NOAA Tech Memo NMFS-NE-151. 98 p.

Packer DB, Cargnelli LM, Griesbach SJ, and Shumway SE. 1999b. Essential Fish Habitat Source Document: Sea Scallop, Placopecten magellanicus, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-134; 21 p.

Packer DB, Zetlin CA, and Vitaliano JJ. 2003a. Essential Fish Habitat Source Document: Little Skate, Leucoraja erinacea, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-175.

Packer DB, Zetlin CA, and Vitaliano JJ. 2003b. Essential Fish Habitat Document: Winter Skate, Leucoraja ocellata, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-179.

Payne JF, Andrews CA, Fancey LL, Cook AL, and Christian JR. 2007. Pilot Study on the Effects of Seismic Air Gun Noise on Lobster (*Homarus americanus*). Canadian Technical Report of Fisheries and Aquatic Sciences No. 2712. Fisheries and Oceans Canada, St. Johns NL Canada.

Pereira JJ, Goldberg R, Zislowski JJ, Berrien PL, Morse WW, and Johnson DL. 1999. Essential Fish Habitat Document: Winter Flounder, *Pseudopleuronectes americanus*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-138.

Personal Communication. 2023a. Mr. Michael Evans, Project Manager, Sunrise Wind. February 2023.

Personal Communication. 2023b. Mr. Michael Evans, Project Manager, Sunrise Wind. May 2023.

Plante J. 2022. Council Approves HAPC for Southern New England; Previews Northeast Regional Habitat Assessment Data Explorer. Press release. New England Fishery Management Council. July 18. Available at: https://www.nefmc.org/news. Accessed July 25, 2022.

Popper AN and Hawkins AD. 2018. The importance of particle motion to fishes and invertebrates. The Journal of the Acoustical Society of America. 143.470

Popper AN, Hastings MC. 2009. The effects of anthropogenic sources of sound on fishes. *Journal of Fish Biology,* 75, 455-489

Popper AN, Hawkins AD, Fay RR, Mann D, Bartol S, Carlson T, Coombs S, Ellison WT, Gentry R, Halvorsen MB, Løkkeborg S, Rogers P, Southall BL, Zeddies D, and Tavolga WN. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer Briefs in Oceanography, Springer International Publishing, and ASA Press, Cham, Switzerland.

Popper AN, Hawkins AD, Fay RR, Mann DA, Bartol S, Carlson TJ, ... and Tavolga WN. 2014. Sound exposure guidelines. In ASA S3/SC1. 4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI (pp. 33-51). Springer, Cham.

Popper AN, Salmon M, and Horch KW. 2001. Acoustic detection and communication by decapod crustaceans. Journal of Comparative Physiology 187:83–89.

Purser J and Radford AN. 2011. “Acoustic Noise Induces Attention Shifts and Reduces Foraging Performance in Three-Spined Sticklebacks (Gasterosteus aculeatus).” PLoS ONE 6(2): e17478. Accessed: August 11, 2022. Retrieved from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0017478

Raghukumar K, Chartrand C, Chang G, Cheung L, and Roberts J. 2022. Effect of Floating Offshore Wind Turbines on Atmospheric Circulation in California. *Frontiers in Energy Research* 10:863995.

Raoux A, Tecchio S, Pezy JP, Lassalle G, Degraer S, Wilhelmsson D, Cachera M, Ernande M, Le Guen C, Haraldsson M, and Grangeré K. 2017. Benthic and fish aggregation inside an offshore wind farm: Which effects on the trophic web functioning? *Ecological Indicators* 72:33-46.

Reubens JT, Vandendriessche S, Zenner AN, Degraer S, and Vincx M. 2013 Offshore wind farms as productive sites or ecological traps for gadoid fishes?–Impact on growth, condition index and diet composition. *Marine Environmental Research* 90: 66-74.

Richardson NE, McCleave JD, and Albert EH. 1976. Effect of extremely low frequency electric and magnetic fields on locomotor activity rhythms of Atlantic salmon (*Salmo salar*) and American eels (*Anguilla rostrata*). *Environmental Pollution* 10(1): 65–76.

Roarty H, Glenn S, Brodie JF, Handel E, Nazzaro L, Smith M, Brown WS, Boicourt WC, Updyke T, and Atkinson L. 2020. Annual and seasonal surface circulation over the Mid-Atlantic Bight continental shelf derived from a decade of high frequency radar observations. *Journal of Geophysical Research: Oceans* 125(11): e2020JC016368. https://doi.org/10.1029/2020JC016368

Roberts L, Cheesman S, Breithaupt T, and Elliott M. 2015. Sensitivity of the mussel *Mytilus edulis* to substrate-borne vibration in relation to anthropogenically generated noise. *Marine Ecology Progress Series* 538: 185-195.

Roper CFE, Sweeney MJ, and Nauen CE. 1984. FAO Species Catalogue, Vol. 3 Cephalopods of the world. An annotated and illustrated catalogue of species of interest to fisheries. *FAO Fisheries Synopsis* 125 (3):1–277.

Rosenberg R, Nilsson HC, Grémare A, and Amouroux JM. 2003. Effects of demersal trawling on marine sedimentary habitats analysed by sediment profile imagery. Journal of Experimental Marine Biology and Ecology 285: 465-477.

Rowe S and Hutchings JA. 2006. Sound production by Atlantic cod during spawning. *Transactions of the American Fisheries Society* 135: 529–538.

Ruggerone GT, Goodman SE, and Miner R. 2008. Behavioral Response and Survival of Juvenile Coho Salmon to Pile Driving Sounds. Natural Resources Consultants, Inc. for Port of Washington

Rutecki D, Dellapenna T, Nestler E, Scharf F, Rooker J, Glass C, Pembroke A. 2014. Understanding the habitat value and function of shoals and shoal complexes to fish and fisheries on the Atlantic and Gulf of Mexico outer continental shelf. Literature synthesis and gap analysis. Prepared for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M12PS00009. BOEM 2015-012; 2014 2014. 176 pp.

Saba G and Munroe D. 2019. Offshore Wind and the Mid-Atlantic Cold Pool: Biology and Ecology of the Cold Pool. Rutgers University.

Sarà G, Dean JM, D'Amato D, Buscaino G, Oliveri A, Genovese S, Ferro S, Buffa G, Lo Martire M, Schultze LKP, Merckelbach LM, Horstmann J, Raasch S, and J. R. Carpenter. 2020. Increased mixing and turbulence in the wake of offshore wind farm foundations. *Journal of Geophysical Research*: *Oceans* 125(8)

Sarà, G, et al. 2007.Effect of boat noise on the behaviour of bluefin tuna *Thunnus thynnus* in the Mediterranean Sea. *Mar. Ecol.-Prog. Ser.* 331, 243–253

Schultze L, Merckelbach L, Horstmann J, Raasch S, and Carpenter J. 2020. Increased Mixing and Turbulence in the Wake of Offshore Wind Farm Foundations. *Journal of Geophysical Research: Oceans* 125(8): e2019JC015858.

Schulze A, Erdner DL, Grimes CJ, Holstein DM, and Miglietta MP. 2020. Artificial reefs in the Northern Gulf of Mexico: Community ecology amid the "Ocean Sprawl". *Frontiers in Marine Science*, 7, 447.

Schwarz AL and Greer GL. 1984. Responses of Pacific herring, Clupea pallasi, to some underwater sounds. *Canadian Journal of Fisheries and Aquatic Sciences* 41:1183-1192. http://dx.doi.org/10.1139/f84-140

Scott JS. 1982. Selection of bottom type by groundfishes of the Scotian Shelf. *Can. J. Fish. Aquat. Sci*. 39: 943-947.

Shepherd GR and Packer DB. 2006. Essential Fish Habitat Document: Bluefish, *Pomatomus saltatrix*, Life History and Habitat Characteristics, Second Edition. NOAA Technical Memorandum NMFS-NE-198.

Siemann L and Smolowitz R. 2017. Southern New England Juvenile Fish Habitat Research Paper. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. BOEM 2017-028. 43 pp.

Shinn, H. 2018. Northeast multispecies Fishery Management Plan resource guide: winter flounder (*Pseudopleuronectes americanus*).

Sims DW. 1999. Threshold foraging behaviour of basking sharks on zooplankton: Life on an energetic knife-edge? Proceedings of the Royal Society B 266: 1437–1443.

Sims DW and Merrett DA. 1997. Determination of zooplankton characteristics in the presence of surface feeding basking sharks *Cetorhinus maximus*. Marine Ecology Progress Series 158:297–302.

Sims DW and Quayle VA. 1998. Selective foraging behaviour of basking sharks on zooplankton in a small-scale front. Nature 393:460–464.

Sims DW, Southall EJ, Richardson AJ, Reid PC, and Metcalfe JD. 2003. Seasonal movements and behaviour of basking sharks from archival tagging: No evidence of winter hibernation. Marine Ecology Progress Series 248:187–196.

Sinclair M. 1988. Marine Populations: An Essay on Population Regulation and Speciation. University of Washington Press, Seattle, WA.

Skomal G. 2007. Shark Nursery Areas in the Coastal Waters of Massachusetts. American Fisheries Society, Symposium 50: 17-34.

Skomal GB, Wood G, and Caloyianis N. 2004. Archival tagging of a basking shark, *Cetorhinus maximus*, in the western North Atlantic. Journal of the Marine Biological Association of the U.K. 84:795–799.

Skomal GB, Zeeman SI, Chisholm JH, Summers EL, Walsh HJ, McMahon KW, and Thorrold SR. 2009. Transequatorial migrations by basking sharks in the Western Atlantic Ocean. Current Biology 19(12):1019-1022.

Slavik K, Lemmen C, Zhang W, Kerimoglu O, Klingbeil K, and Wirtz KW. 2018. The large-scale impact of offshore wind farm structures on pelagic primary productivity in the southern North Sea. Hydrobiologia, 845(1), 35-53.

Smith WG, Sibunka JD, and Wells A. 1975. Seasonal distributions of larval flatfishes (*Pleuronectiformes*) on the continental shelf between Cape Cod, Massachusetts, and Cape Lookout, North Carolina, 1965-66. NOAA Tech. Rep. NMFS SSRF-691. 66 p.

Snyder DB, Bailey WH, Palmquist K, Cotts BRT, and Olsen KR. 2019. Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance in Southern New England. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Sterling, VA. OCS Study BOEM 2019-049.

Soria M, Fre´on P, and Chabanet P. 2007. Schooling properties of an obligate and a facultative fish species. *Journal of Fish Biology* 71: 1257–1269.

Soria M, Fréon P, and Gerlotto F. 1996. Analysis of vessel influence on spatial behaviour of fish schools using a multibeam sonar and consequences for biomass estimates by echo-sounder. *ICES Journal of Marine Science*, 53(2), 453-458.

Southall EJ, Sims DW, Metcalfe JD, Doyle JI, Fanshawe S, Lacey C, Shrimpton J, Solandt JL, and Speedie CD. 2005. Spatial distribution patterns of basking sharks on the European shelf: Preliminary comparison of satellite-tag geolocation, survey and public sightings data. Journal of the Marine Biological Association of the U.K. 85:1083–1088.

Steimle FW, Morse WW, and Johnson DL. 1999a. Essential Fish Habitat Document: Goosefish*, Lophius americanus*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-129.

Steimle FW, Zetlin CA, Berrien PL, Johnson DL, and Chang S. 1999b. Essential Fish Habitat Document: Scup, *Stenotomus chrysops*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-149.

Stöber U and Thomsen F. 2021. How could operational underwater sound from future offshore wind turbines impact marine life? *The Journal of the Acoustical Society of America* 149(3): 1791-1795.

Stokesbury KDE. 2012. Report: SMAST video survey of Western portion of the offshore Windfarm area, School for Marine Science and Technology, Dartmouth.

Stokesbury KDE. 2014. Final Report: SMAST video survey of Western portion of the offshore Windfarm area, School for Marine Science and Technology, Dartmouth.

Stone SL, Lowery TA, Field JD, Williams CD, Nelson DM, Jury SH, Monaco ME, and Andreasen L. 1994. Distribution and Abundance of Fishes and Invertebrates in Mid-Atlantic Estuaries. ELMR Report No. 12. NOAA/NOS SEA Division, Silver Spring, MD. 280 p.

Subcommittees AR, Lukens RR, and Selberg C. 2004. Guidelines for marine artificial reef materials. Atlantic and Gulf States Marine Fisheries Commissions, 1-4.

Sunrise Wind 2022a. Appendix M3 Benthic Habitat Mapping Report. submitted to Bureau of Ocean Energy Management. August 2022. 997 p.

Sunrise Wind. 2022b. Construction & Operations Plan. Sunrise Wind Farm Project. Prepared for Sunrise Wind LLC by Stantec Consulting Services Inc. Submitted to Bureau of Ocean Energy Management. August 2022. 997 p.

Sunrise Wind. 2022c. Sunrise Wind Offshore Wind Farm Unexploded Ordnance (UXO) and Munitions and Explosives of Concern (MEC) Investigation Survey Report.

Sunrise Wind. 2023a. Boulder Relocation Plan. Sunrise Wind Farm Project. Prepared for Sunrise Wind LLC by Orsted & Eversource. Submitted to Bureau of Ocean Energy Management. February 2023. 115 p.

Sunrise Wind. 2023b. Environmental Construction and Management Plan 2. Appendix NN. HDD Work Plan.

Tallack S. 2009. Proceedings from a workshop to identify future research priorities for cod tagging in the Gulf of Maine. Northeast Fisheries Science Center Reference Document 09-09.

Tallack SML, McKenzie J, Parsons B, Seit AC, Kopf RK, Mesa M, Phelps Q. 2011. Stock identification applications of conventional tagging data for Atlantic cod in the Gulf of Maine Proceedings from the 2nd International Symposium on Advances in Fish Tagging and Marking Techniques, 2011 American Fisheries Society Symposium, 76 (pg. 1-15) 560 pp.

Tamsett A, Heinonen K, Auster P, and Linholm J. 2010. Dynamics of hard substratum communities inside and outside of a fisheries habitat closed area in Stellwagen Bank National Marine Sanctuary (Gulf of Maine, NW Atlantic). Marine Sanctuaries Conservation Series ONMS-10-05. U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, MD.

Taormina B, Bald J, Want A, Thouzeau G, Lejart M, Desroy N, and Carlier A. 2018. A review of potential impacts of submarine power cables on the marine environment: Knowledge gaps, recommendations and future directions. *Renewable and Sustainable Energy Reviews* 96: 380-391.

Thayer GW, Kenworthy WJ, Fonseca MS. 1984. Ecology of eelgrass meadows of the Atlantic Coast: a community profile. Virginia University, Charlottesville (VA): U.S. Fish and Wildlife Service, National Marine Fisheries Service, Beaufort, NC. Beaufort Lab. Department of Environmental Sciences.

Thomsen F, Lüdemann K, Kafemann R, and Piper W. 2006. Effects of offshore wind farm noise on marine mammals and fish, biota. Hamburg, Germany on behalf of COWRIE Ltd.

Thomsen F, Lüdemann K, Kafemann R, and Piper W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg, Germany on behalf of COWRIE Ltd, 62, 1-62

Tougaard J, Hermannsen L, and Madsen PT. 2020. How loud is the underwater noise from operating offshore wind turbines? *The Journal of the Acoustical Society of America* 148(5): 2885-2893.

TRC. 2021. NPDES Permit, Sunrise Wind Offshore Converter Station. Prepared for Sunrise Wind. 142 pages.

U.S. Army Corps of Engineers (USACE). 2015. New York and New Jersey Harbor Deepening Project; Dredge Plume Dynamics in New York/New Jersey Harbor - Summary of Suspended Sediment Plume Surveys Performed During Harbor Deepening. April 2015.

U.S. Department of the Interior, Minerals Management Service (MMS). 2007. Programmatic Environmental Impact Statement for Alternative Energy Development and Production and

Alternate Use of Facilities on the Outer Continental Shelf, Final Environmental Impact Statement, October 2007. OCS Report MMS 2007-024.

U.S. Fish and Wildlife Service (USFWS). 1991. Northeast Coastal Areas Study: Significant Coastal Habitats of Southern New England and Portions of Long Island, New York. August 1991.

U.S. Fish and Wildlife Service (USFWS). 1997. Significant Habitats and Habitat Complexes of the NY Bight Watershed. Southern New England - NY Bight Coastal Ecosystems Program. Charlestown, Rhode Island: Accessed April 9, 2020. Available at: https://nctc.fws.gov/pubs5/begin.htm.

van Berkel J, Burchard H, Christensen A, Mortensen L, Petersen O, and Thomsen F. 2020. The effects of offshore wind farms on hydrodynamics and implications for fishes. *Oceanography* 33(4):108–117.

Vabø R, Olsen K, and Huse I. 2002. The effect of vessel avoidance of wintering Norwegian spring spawning herring. *Fisheries Research* 58: 59–77.

Vanhellemont Q and Ruddick K. 2014. Turbid wakes associated with offshore wind turbines observed with Landsat 8. *Remote Sensing of Environment* 145:105–115.

Weilgart LI. The Impact of Ocean Noise Pollution on Fish and Invertebrates. Report for OceanCare, Switzerland. 2018 May 1.

Wilber D, and Clarke D. 2001. Biological Effects of Suspended Sediments: A Review of Suspended Sediment Impacts on Fish and Shellfish with Relation to Dredging Activities in Estuaries. *North American Journal of Fisheries Management* 21: 855-875.

Wilhelmsson D, Malm T, and Öhman MC. 2006. The influence of offshore wind power on demersal fish. *ICES Journal of Marine Science* 65(5):775-784.

Wilk SJ. 1982. Bluefish *Pomatomus saltatrix*. Pp 86-89 in: Grosslein MD and Azarovitz TR (eds.). Fish Distribution. Marine Ecosystems Analysis Program. MESA New York Bight Atlas Monograph 15. New York Sea Grant Institute, Albany NY.

Wise JP. 1963. Cod groups in the New England area. *Fishery Bulletin* 63: 189-203.

Witt MJ, Hardy T, Johnson L, McClellan CM, and others. 2012. Basking sharks in the northeast Atlantic: spatio-temporal trends from sightings in UK waters. Marine Ecology Progress Series 459:121-134. Available: https://doi.org/10.3354/meps09737.

Wysocki LE, Davidson III JW, Smith ME, Frankel AS, Ellison WT, Mazik PM, Popper AN, and Bebak J. 2007. “Effects of aquaculture production noise on hearing, growth, and disease resistance of rainbow trout *Oncorhynchus mykiss*.” Aquaculture 272: 687-697.

Wysocki LE, Dittami JP, and Ladich F. 2006. Ship noise and cortisol secretion in European freshwater fishes. *Biological Conservation* 128(4): 501-508.

Zemeckis DR, Dean MJ, DeAngelis AI, Van Parijs SM, Hoffman WS, Baumgartner MF, Hatch LT, Cadrin SX, McGuire CH. 2019. Identifying the distribution of Atlantic cod spawning using multiple fixed and glider-mounted acoustic technologies. ICES Journal of Marine Science 76(6): 1610–1625.

Zhang X, Haidvogel D, Monroe D, Powell E, Klinck J, Mann R, and Castruccio F. 2015. Modeling larval connectivity of the Atlantic surfclams within the Middle Atlantic Bight: Model development, larval dispersal and metapopulation connectivity. *Estuarine, Coastal and Shelf Science* 153:38–53.

10.0 Appendices

10.1 List of Supporting Documents

The following documents and information support this EFH assessment:

- Sunrise Wind Construction and Operations Plan, April 2022
    - https://www.boem.gov/renewable-energy/state-activities/sunrise-wind-activities
- The following documents are available in the Sunrise Wind PDEIS Cooperating Agency Review Folder on the third-party contractor's SharePoint site:
    - Acoustic Report: Underwater Noise and Exposure Modeling (COP Appendix I)
    - Benthic Monitoring Plan, New York State (COP Appendix AA2)
    - Benthic Resources Characterization Report – Federal Waters (COP Appendix M1)
    - Benthic Resources Characterization Report – New York State Waters (COP Appendix M2)
    - Benthic Habitat Mapping Report (COP Appendix M3)
    - EMF: Offshore EMF Assessment (COP Appendix J1)
    - Fisheries and Benthic Monitoring Plan (COP Appendix AA1)
    - NPDES Permit Application, December 2021
    - Ichthyoplankton Entrainment Assessment (COP Appendix N2)
    - Protected Species Mitigation and Monitoring Plan, draft May 2022
    - UXO Acoustic Modeling Report (COP Appendix P4)
    - UXO/MEC Investigation Survey Report: Supporting Documentation to ALARP Phase 4/5
    - Boulder Relocation Plan (Sunrise Wind 2023a)
- Access to the Sunrise Wind Popup Mapper was provided to NMFS on November 5, 2021. Please contact BOEM if new credentials are needed.
- Sunrise Wind Farm Benthic Habitat Mapping and Benthic Assessment to Support Essential Fish Habitat Consultation, February 3, 2023, prepared by INSPIRE Environmental.

10.2 Benthic Habitat Mapping Methods

Benthic habitat mapping for Sunrise Wind was conducted by INSPIRE Environmental. The following information is from their benthic habitat report, COP Appendix M3, Sunrise Wind (2022). All tables, figures, and citations in the methodology below can be found in COP Appendix M3.

10.2.1 Input Data and Approach

Multiple sources of geophysical and ground-truth data were used as input for mapping benthic habitats within the study area. Brief summaries of these data sources and details pertinent to their use in the habitat mapping process are described here. Full details of geophysical and ground-truth data collection, processing, and analysis are provided in the Marine Site Investigation Report (Sunrise Wind 2022b) and benthic assessment reports (INSPIRE 2023) appended to the Sunrise Wind COP (Sunrise Wind 2022b).

10.2.2 Input Data

10.2.2.1 Geophysical Data

To support Sunrise Wind site investigations, Fugro USA Marine, Inc. (Fugro) conducted high-resolution MBES and SSS surveys within the study area in 2019, 2020, and 2021 (Sunrise Wind 2022b). An additional geophysical survey was conducted by Gardline in 2019 in the southeast portion of the SRWF. Geophysical data collected during surveys completed by Bay State Wind, LLC were also utilized to support and align interpretations where these data overlap with the SRWF (Sunrise Wind 2022b). MBES and SSS are collected using different instruments deployed from the same survey vessel (Figure 2-1). The MBES is mounted to the vessel and provides the highest degree of positional accuracy; the MBES can be optimized for either bathymetric or backscatter data, but not for both. The geophysical surveys conducted for offshore wind development are designed to support engineering and construction design and, therefore, the MBES was optimized for bathymetric data, and backscatter data were collected as an ancillary data product.

Bathymetric data were derived from the MBES and processed to a resolution of 50 cm (Sunrise Wind 2022b). Bathymetric data provide information on depth and seafloor topography (Figures 2-2 and 2-3). Bathymetric data were used to create a model of seafloor slope for the study area with a cell size of 3 m (Figures 2-4 and 2-5).

Backscatter data were derived from the MBES and processed to a resolution of 25 cm (Sunrise Wind 2022b). Backscatter data are based on the strength of the acoustic return to the instrument and provide information on seafloor sediment composition and texture. Backscatter data are best interpreted in concert with hill-shaded bathymetry (Figures 2-6 and 2-7). Backscatter returns are relative (see below) and referred to in terms of low, medium, and high reflectance rather than absolute decibel values. Nominally, softer, fine-grained sediments absorb more of the acoustic signal and a weaker signal is returned to the MBES. Although backscatter data provide valuable information about sediment grain size, decibel values reflect not only sediment grain size, but also compaction, water content, and texture (Lurton and Lamarche 2015). For example, sand that is hard-packed and sand that has prominent ripples may have higher acoustic returns than sediments of similar grain size that do not exhibit compaction or ripples.

Backscatter decibel values are also influenced by water temperature, salinity, sensor settings, seafloor rugosity, and MBES operating frequency, among other factors (Lurton and Lamarche 2015; Brown et al. 2019). Differences in backscatter decibel values can also occur when data have been collected over a very large survey area under dynamic conditions, with different instruments, and in different years. This scenario is common and does not nullify the data; methods to optimize processing (as appropriate to the sensors) and to display the data optimal for interpretation are well developed (Lurton and Lamarche

2015; Schimel et al. 2018). Backscatter data products vary based on processing (Lucieer et al. 2017) and data display procedures. Mapping of seafloor composition and habitats, while greatly aided by backscatter data, should not rely solely on these data (see Table 1 in Brown et al. 2011). The manner in which the suite of data were used for habitat delineations is described further in Section 2.2.

SSS data were generated from a towed instrument (Figure 2-1) and, thus, have a lower positional accuracy than MBES data. However, because the SSS towfish is closer to the seafloor with a lower angle of incidence, the resolution, signal to noise ratio, and intensity contrast of SSS images are higher than those of MBES backscatter images (Lurton and Jackson 2008). The processed SSS images provide the highest resolution data on sediment textures and objects on the seafloor (boulders, debris) (Figure 2-8). Thermoclines and haline variations affect the acoustic signal and result in data artifacts, presenting as sinuous rippling of alternating low and high returns that cannot be removed from the data; these artifacts are visible when viewed at very close range. SSS data were processed to a resolution of 10 cm; this resolution permits detection of medium to large boulders but does not permit the reliable detection of individual cobbles (6.4 cm to 25.6 cm). Although individual small boulders and cobbles cannot be detected in 10-cm resolution SSS, SSS textures and patterns can indicate the presence or absence of higher densities of these features.

Individual boulders greater than or equal to 50 cm (0.5 m) in diameter were identified from the MBES and SSS data using manual detection methods to generate a “boulder pick” data set to accompany the boulder field dataset (Figure 2-9). Boulder fields were generated using heatmaps in Global Mapper and were reviewed manually to finalize the boulder field polygons. Boulder fields represent aggregations of boulders where they were present in low (20 – 99 per 10,000 m2), medium (100 – 199 per 10,000 m2), or high (>199 per 10,000 m2) densities (Sunrise Wind 2022b). These density values were set by the Sunrise Wind Site Investigations team and are consistent with values used for the nearby Revolution Wind project. Boulder fields are defined as a geoform by the federal Coastal and Ecological Marine Classification Standard (CMECS; FGDC 2012), however no density values are provided in CMECS. In addition to individual boulders, other solitary objects (known as “contacts” in geophysical survey terminology), such as various types of debris were identified in this manner. A combination of backscatter over hill-shaded bathymetry and SSS data was used to detect large- and small-scale bedforms, such as megaripples and ripples (sensu BOEM 2020a) (Figure 2-10).

10.2.2.2 Ground-Truth Data

Sediment profile and plan view images (SPI/PV; Figure 2-11) were collected in triplicate at 244 stations within the SRWF in April and May 2020 (Figure 2-12), at 76 stations along the SRWEC-OCS in April and May 2020, and at 35 stations along the SRWEC-NYS in August 2020 (Figure 2-13). In addition, PV were collected at 8 stations within the vicinity of the ICW HDD in September 2020 (Figure 2-14). In addition, a total of 3,447 m across 22 transects were sampled with towed video within the ICW HDD area to identify the presence of SAV and benthic macroalgae (Figure 2-14). A follow-on survey was conducted in August 2020 at the SRWF to further delineate areas of complex hard bottom habitat and areas of high backscatter returns identified by NOAA Habitat as of additional interest. During this survey, a towed video system was used to sample ~8,700 m across 17 transects in four areas of interest (Figure 2-15). An additional area of interest was sampled using a “Pogo” PV approach when sea states precluded video sampling; 87 PV images were captured along 1,080 m (Figure 2-15). This approach mimics a continuous transect by deploying the PV system in quick succession along a transect. Summarized data results are presented in Attachments A (SPI/PV), B (Pogo PV), C (Offshore Video), and D (SAV).

SPI/PV images were used to ground-truth sediment types, bedform dynamics, presence of sensitive habitats and taxa, and to characterize benthic biological communities. SPI/PV images were analyzed for a suite of variables (Table 2-1) and were classified using CMECS Substrate and Biotic components (Tables 2-2, 2-3, 2-4, and 2-5). CMECS Substrate Subgroup was particularly useful as ground-truth data for purposes of delineating seafloor sediments and benthic habitats (Figure 2-16). CMECS biotic subclasses, listing of common taxa present at higher densities (e.g., cerianthids, sand dollars), and notations of sessile and mobile epifauna present (Figure 2-17) were used to provide detail about the biological communities observed within each mapped habitat type. All ICW video footage was analyzed post-collection with a focus on the detection of SAV, and, if detected, the spatial extent of the SAV patch or bed was determined. Additional parameters were analyzed where SAV was present including SAV bed extent, in accordance with federal agency protocols (Colarusso and Verkade 2016). The video analyst also documented the presence of macroalgal beds, with qualitative notes on the density of the macroalgae observed. Detailed descriptions of each SPI/PV variable analyzed and full data analysis results for the SPI/PV and ICW HDD PV and video survey can be found in the COP Benthic Assessment Appendices (INSPIRE 2023).

For the Sunrise Wind Project, a macrohabitat variable was generated from several SPI and PV variables to create a single variable to serve as a construct to describe repeatable physical-biological associations (Figures 2-18 and 2-19; INSPIRE 2023). Using the methodology detailed in Figure 2-18 ensured that the presence of any gravel was detected; the “Max Gravel Size” variable is the maximum gravel size detected across all three analyzed replicate images at each station. Given the spatial scale of the SPI/PV data, benthic habitat types derived from replicate SPI/PV images are considered macrohabitats (sensu Greene et al. 2007). Each PV replicate image is between 0.2 and 0.5 m2 and the replicate images were collected within approximately 10 m of each other at each station. Thus, this design can provide insight into the degree of patchiness of habitat features, such as boulders and cobbles, within this spatial context. This sampling approach cannot capture larger habitat features such as sand waves or smaller habitat features such as cracks and crevices on a boulder. Recognizing scale is a critical component to habitat descriptions and delineations, the habitat types derived from the SPI/PV approach are most accurately described as macrohabitats, which is defined by Greene et al. 2007 as encompassing a scale of one to 10 meters. The macrohabitat type derived from SPI/PV at each station cannot be extrapolated beyond the scale of the station; however, this variable served as a key variable for ground-truthing benthic habitat types and informing full characterization of each mapped habitat polygon.

Videos collected within the SRWF were analyzed using Behavioral Observation Research Interactive Software (BORIS), an event logging software. Scaling lasers spaced at 10 cm were used in video collection and permitted feature identification and sizing. Videos were reviewed and analyzed by a single trained analyst, then reviewed for quality assurance by senior staff. Adjustments (e.g., pause, viewing speed) were made during analysis to optimize identification of seafloor features and increase reviewer efficiency. Features were logged to an interactive timeline to aid quality assurance checks. Video imagery was examined along the length of the entire transect for a single variable used to capture sediment composition and bedforms, terms from the CMECS substrate component and SPI/PV macrohabitat variable were used (gravels, sandy gravel, gravelly sand, sand with ripples, sand and mud). With the video at standard height off the seafloor, it is possible to distinguish the smallest gravel size (granule) from sand. In addition, point locations where boulders were observed were marked in BORIS as single point events and were mapped as such. Visual determination of boulders was possible as the minimum size of a boulder (256 cm) is approximately 2.5 times greater than the spacing of the scaling lasers. When the seafloor was not visible due to changes in the camera position or turbidity in the water column, an “Off Bottom” value was entered into the data record.

10.2.3 Habitat Mapping Approach

Geophysical and ground-truth data were reviewed in an iterative process to delineate benthic habitats. MBES data, viewed as backscatter draped over a hill-shaded bathymetric relief model, was used at a “zoomed out” scale (~1:10,000) to identify large-scale facies – areas of sedimentary characteristics (reflectance, bedform, slope) distinct from those adjacent (Figure 2-20). These initial delineations were further refined at “zoomed in” scales (~1:2,000 or finer) using the MBES data in combination with SSS, boulder picks, and ground-truth data (Figure 2-20). Delineations must be of a size appropriate both to the resolution of the data and to the subject of interpretation. The resolution of the geophysical data, delineation size, and the CMECS substrate component agency recommendations (NOAA Habitat 2021).

10.2.3.1 Geological Seabed Characterization

Sunrise Wind developed information on the geological seabed to characterize the geological provenance and stratigraphic conditions of the seafloor inclusive of surface and subsurface features (Sunrise Wind 2022b). Methods used to collect this information included MBES bathymetry and backscatter, SSS, sub-bottom profile, magnetometer, and seismic profile data. For the purposes of defining geological seabed types present at the sediment surface, the Folk classification (Folk 1954) was used, which aligns with CMECS Substrate classifications (Figure 2-21). Seabed types present within the study area based solely on this scheme are mud and sandy mud, sand and muddy sand, coarse sediment, and mixed sediment. In addition, areas of the seabed of unconsolidated or consolidated stratified glacial deposits were mapped as glacial drift.

10.2.3.2 Delineation of Benthic Habitat Types

Geological characterizations of seabed conditions are not strictly equivalent to benthic habitats as experienced by benthic biological communities and demersal fish. To map these habitats for the purposes of assessing the potential impacts of the Project on these biotic communities, INSPIRE Environmental refined the seabed interpretations to more fully characterize and map benthic habitats within the study area. Multibeam 50-cm resolution bathymetry, 25-cm resolution backscatter, and 10-cm SSS data were examined along with boulder fields and picks, and ground-truth SPI/PV and video data (Figures 2-22 and 2-23) to delineate new habitat polygons and to refine the seabed classifications for the purposes of evaluating benthic habitats (Figure 2-24).

Specifically, modifiers were used to provide additional descriptive information about the benthic habitats found within the study area; CMECS modifiers and Geoform or Substrate terms were used to the extent practicable. These modifiers include features of the seafloor that are relevant to the biota that utilize these habitats and describe the value of the habitats for these biota beyond what is provided in the geological seabed mapping. Modifiers are related to features that describe the mobility, stability, and complexity of the benthic habitats mapped. Where bedforms, such as megaripples and ripples, indicating frequent physical disturbance of the seafloor was observed across the majority of a habitat polygon, the "Mobile" modifier was used (Figure 2-25). Boulder fields mapped by Sunrise Wind Site Investigations were used to refine habitat boundaries and were applied as modifiers (Figure 2-26), except where they overlapped with glacial drift habitats, as this habitat type is always characterized by medium and high densities of boulders. SAV provides unique habitats for certain species of benthic invertebrates and demersal fish; modifiers were applied for both recent and historical (modifier of "potential") areas of SAV in the ICW HDD area.

All habitats and their distributions within the study area are described in more detail in Section 3.0. For the purposes of aiding interpretation and presentation of data in ground-truth tables, individual benthic habitat types with modifiers have been grouped and color-coded to consolidate types of related habitats that are present in very small areas (Table 2-6). In addition to the primary habitat data on types and modifiers, the geospatial data contain separate attributes to record several other features of each habitat polygon: type of bedforms observed, area, presence of scattered boulders and debris, and refinements of Coarse Sediment habitats. In addition to the natural bedforms defined in the BOEM Geophysical Survey Guidelines (2020a): megaripples = 5 - 60 m wavelength and 0.5 - 1.5 m height; ripples = <5 m wavelength and <0.5 m height; other bedforms such as linear depressions and trawl marks were noted where present. The presence of isolated boulders and debris identified by Sunrise Wind Site Investigations in the geophysical analysis (boulder picks and debris contacts) were noted as "scattered boulders and debris" in the habitat data. Additionally, further characterizations of coarse sediment habitat polygons were recorded as "coarse sediment refinements" to provide additional detail on the nature of coarse sediment (e.g., gravelly sand or sandy gravel) where it could be reliably determined from ground-truth and geophysical data. These refinements were only applied to polygons in which ground-truth SPI/PV stations and/or video transects were located.

10.2.3.3 Benthic Habitat to EFH Crosswalk

EFH is implemented through the Magnuson-Stevens Fishery Conservation and Management Act. In the Mid-Atlantic and northeastern United States, the New England and Mid-Atlantic Fishery Management Councils (Councils) work with NOAA Fisheries to identify and describe EFH in published fisheries management plans. To evaluate the potential impacts to EFH for individual species/life stages resulting from activities that directly impact benthic habitats, it is important to identify which benthic habitat types fit the descriptions of habitat use for each EFH species/life stage. Therefore, a crosswalk between benthic habitat types and EFH was conducted. For the purposes of this analysis, a crosswalk is defined as the process of reviewing species with mapped EFH in the study area and comparing their habitat preferences with the mapped benthic habitat types described in Sections 3.1 and 3.2 to identify where EFH for those species are likely to be found. Primary benthic habitat types were used for the crosswalk with additional columns for boulders and SAV (Attachment E); habitats with modifiers were not used for the crosswalk because the level of detail supporting EFH designations is rarely available at a level that matches the detail provided by modifiers. The crosswalk includes all four components of the study area: the SRWF, the SRWEC-OCS, the SRWEC-NYS, and the ICW HDD.

EFH maps, data, and text descriptions were downloaded from the NOAA Habitat Conservation EFH Mapper, an online mapping application (NOAA Fisheries 2021a). Additional EFH source information was gathered from the NEFSC's series of "EFH source documents" that contain a compilation of available information on the distribution, abundance, and habitat requirements for each species managed by the Councils (NOAA Fisheries 2021b). EFH is defined by temperature, salinity, pH, physical structure, biotic structure, depth, and currents. While all these habitat variables are important to consider in the greater context of fisheries management, the focus for this report was to create a crosswalk among individual species EFH and mapped benthic habitats. The crosswalk focused on the mapped variables of physical structure, biotic structure, and depth. In addition, only demersal species and life stages were cross-walked for this report.

EFH data for all Council-managed species were queried using Geographic Information System software to determine where each species' EFH overlaps with the study area. Available EFH source information was then reviewed to determine habitat requirements for each demersal species/life stage. These requirements were then cross-walked to each of the study area habitats based on detailed characterizations and spatial distributions (See Sections 3.1 and 3.2) to determine if the substrate, biotic structure, and depth requirements for each species/ life stage were likely to be found within a given mapped benthic habitat type.

10.2.3.4 Calculating Potential Project Impacts to Benthic Habitats

NOAA Habitat recently provided updated habitat mapping recommendations (March 2021), which request that the maximum potential acres that may be impacted by the Project be inventoried in terms of the NOAA Habitat Complexity Categories outlined in these recommendations. These habitat complexity categories were defined by NOAA Habitat for the purposes of EFH consultation. The NOAA Habitat Complexity Categories include soft bottom, complex, heterogeneous complex, and large-grained complex (large boulders). For purposes of the EFH consultation, NOAA has defined complex habitats as SAV and sediments with >5% cover of gravel of any size (CMECS substrate class rock, CMECS substrate groups of gravelly, gravel mixes, and gravels, as well as shell substrate CMECS classifications). Heterogenous complex is used for habitats with a combination of soft bottom and complex features. To provide an impact assessment of the study area in terms of NOAA Habitat Complexity Categories, the benthic habitats delineated by Sunrise Wind and detailed here have been cross-walked to the NOAA Habitat Complexity Categories. This crosswalk was used to calculate acres of each habitat category that may be impacted by Project activities.

Project activities with the potential to impact the seafloor during construction include installation of foundations for up to 102 WTGs and 1 OCS-DC, connected by a network of up to 155 mi (249 km) of IACs, and one DC submarine export cable bundle comprised of two cables located within an up to 106 mi (170 km)-long corridor. During Operations & Maintenance, disturbance to the seafloor could result from the presence of infrastructure and temporarily anchored maintenance vessels. Over the life of the Project, the placement of foundations and scour protection would alter the seabed and associated habitat by replacing the existing seabed and habitat with hard structures that create a reefing effect, which results in colonization by assemblages of both sessile and mobile animals. Decommissioning activities would have similar impacts to the seafloor as construction.

10.3 Maps of Sand Wave Clearance Areas Along the SRWEC Corridor

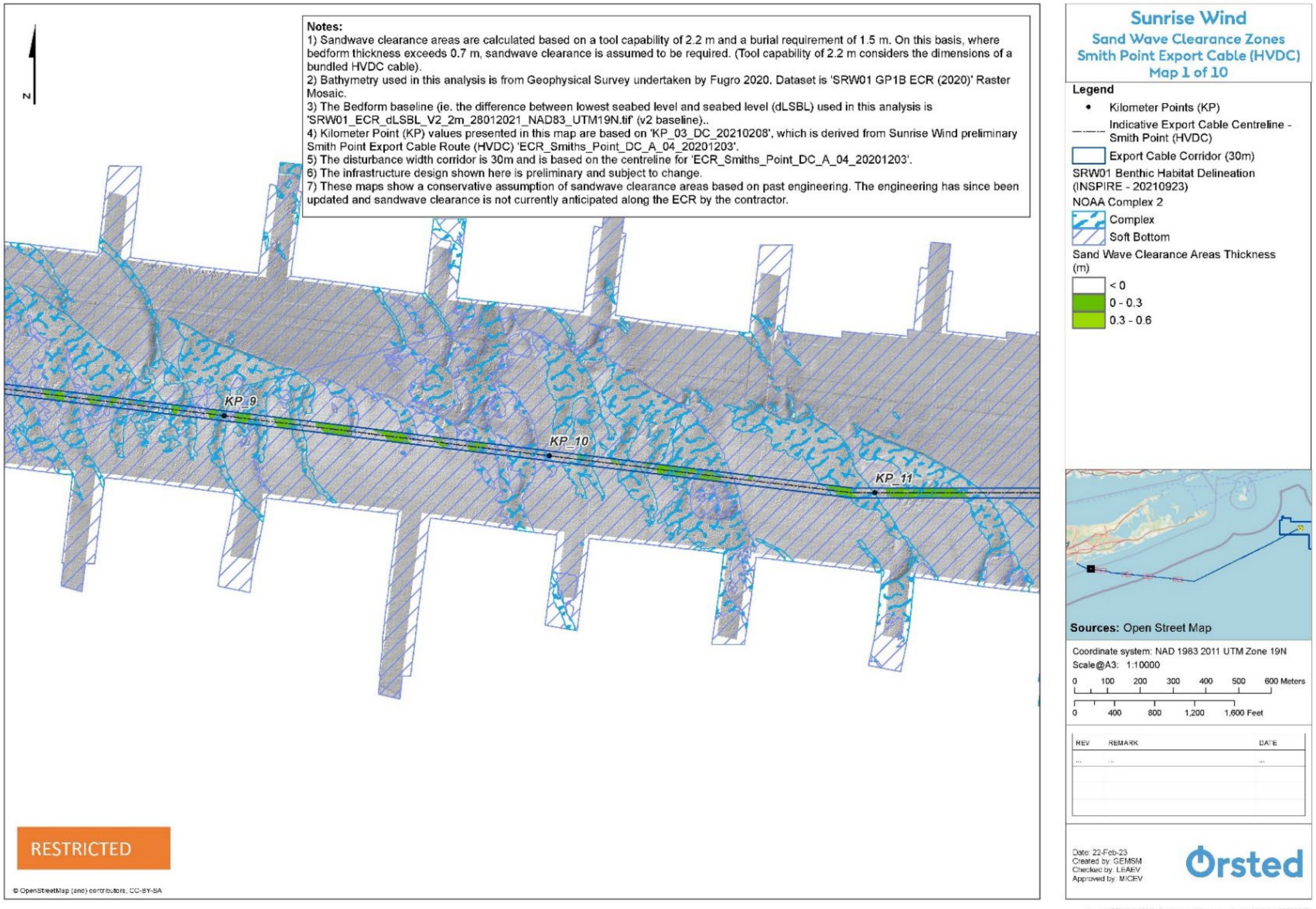


Figure 10-1. Clearance Area along the SRWEC Corridor KP9 to KP11

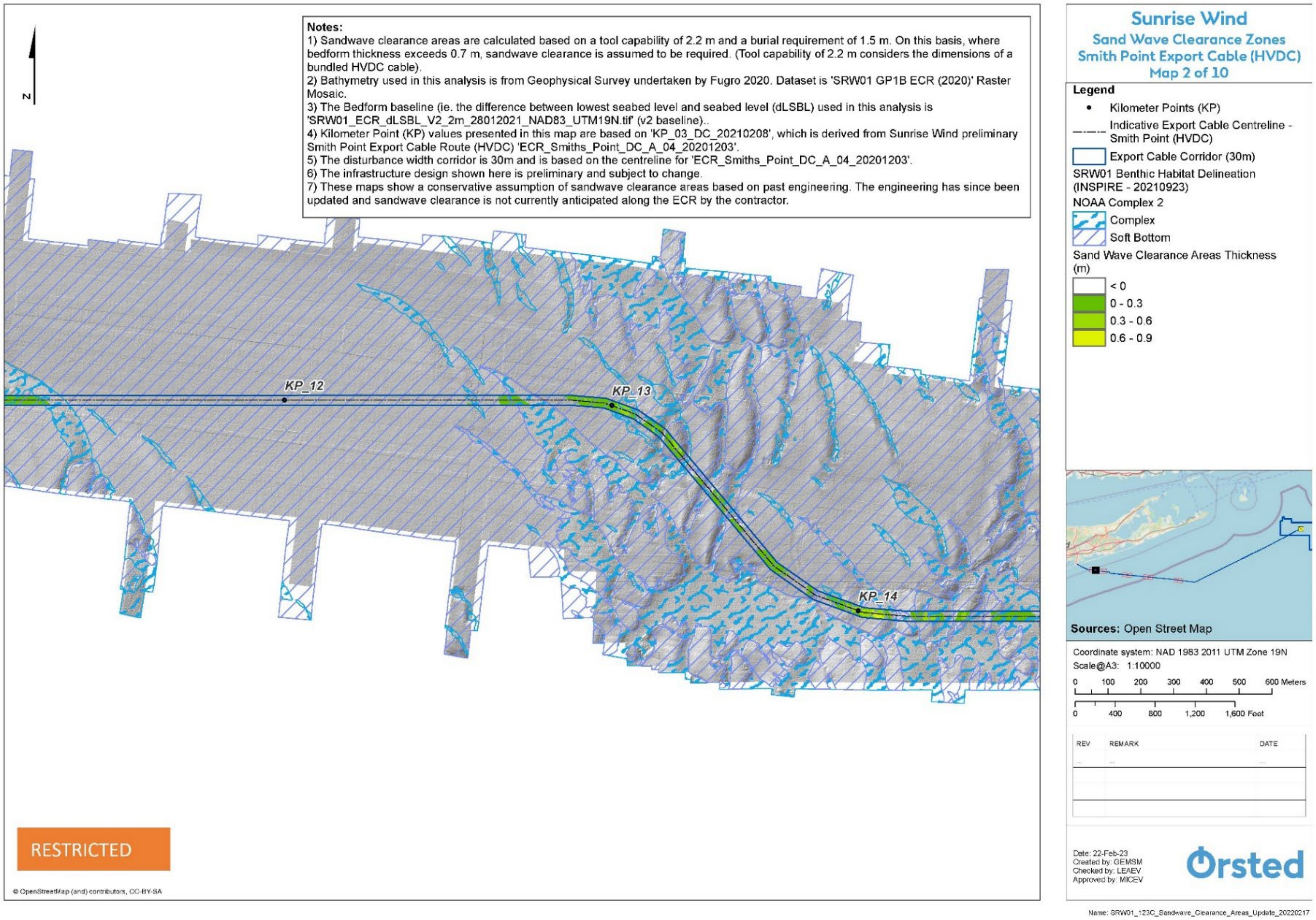


Figure 10-2. Clearance Area along the SRWEC Corridor KP12 to KP14

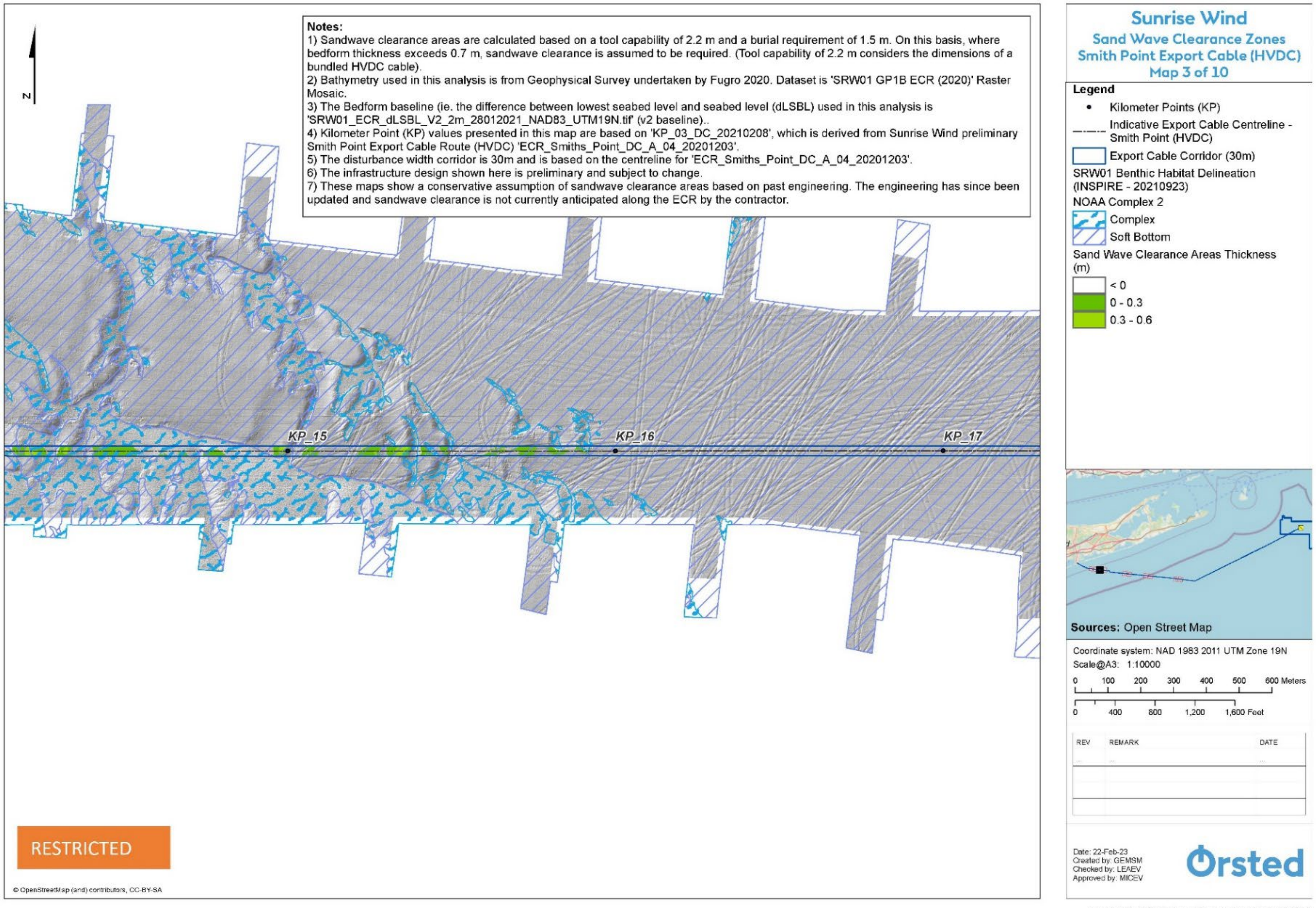


Figure 10-3. Clearance Area along the SRWEC Corridor KP15 to KP17

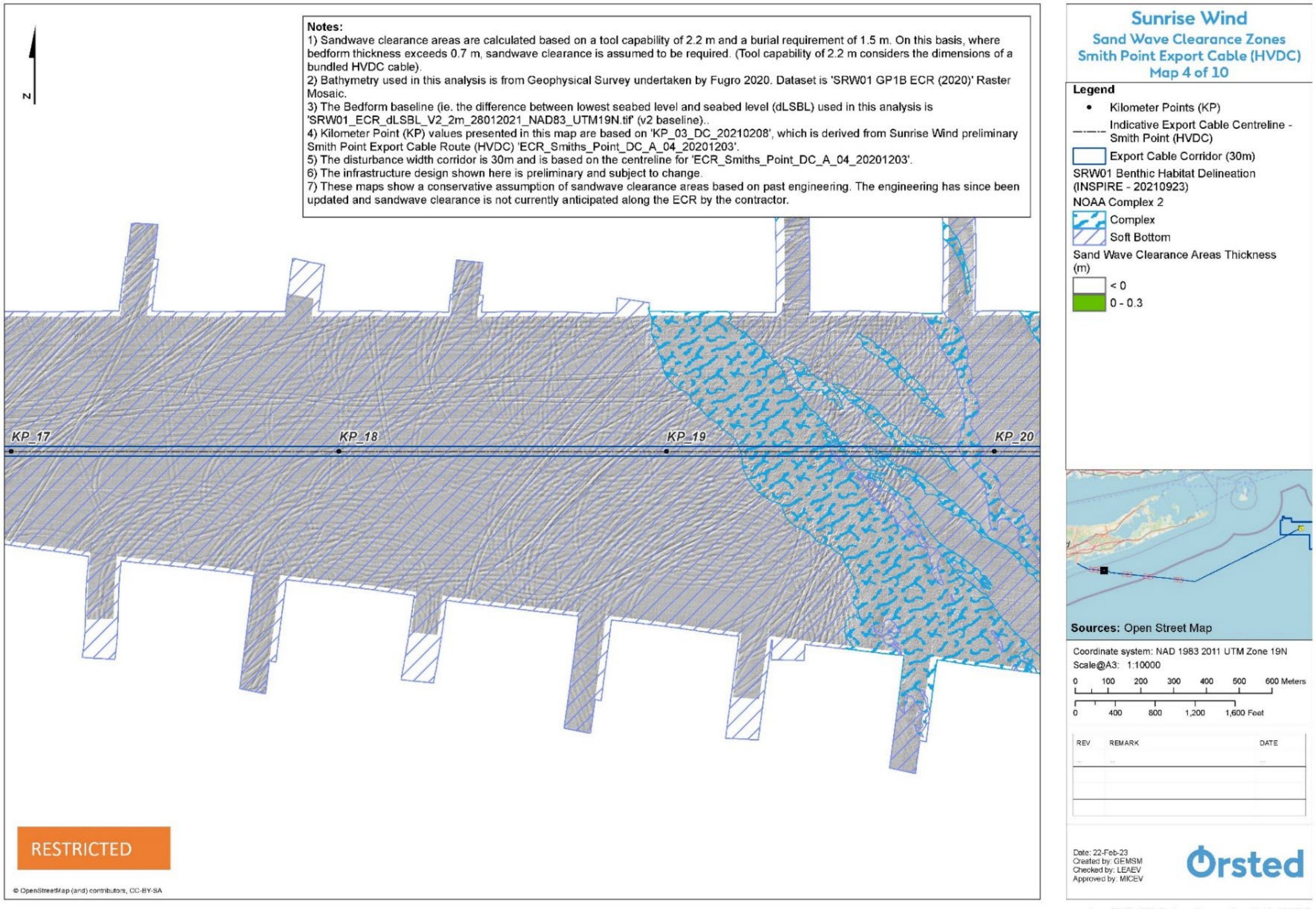


Figure 10-4. Clearance Area along the SRWEC Corridor KP17 to KP20

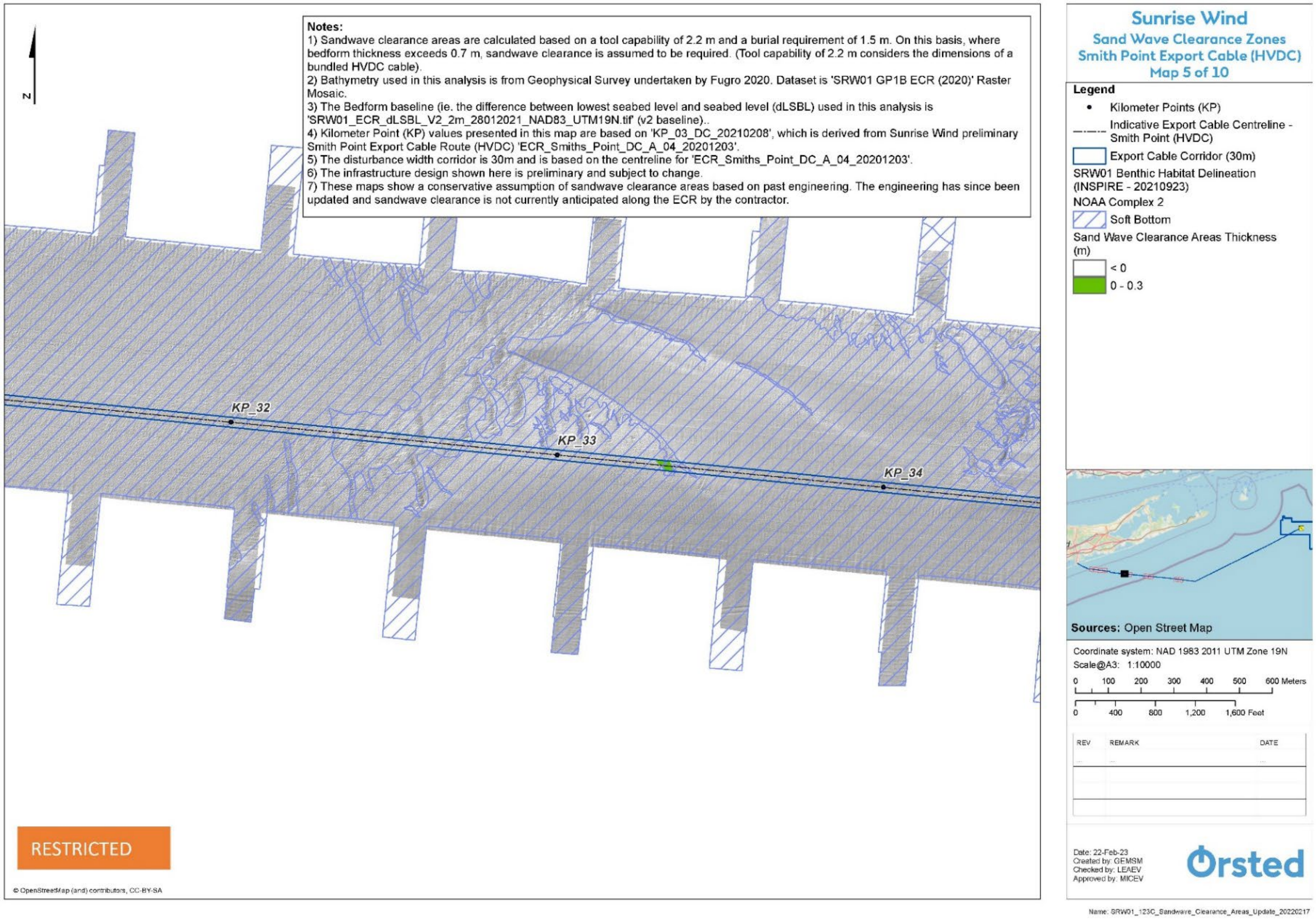


Figure 10-5. Clearance Area along the SRWEC Corridor KP32 to KP34

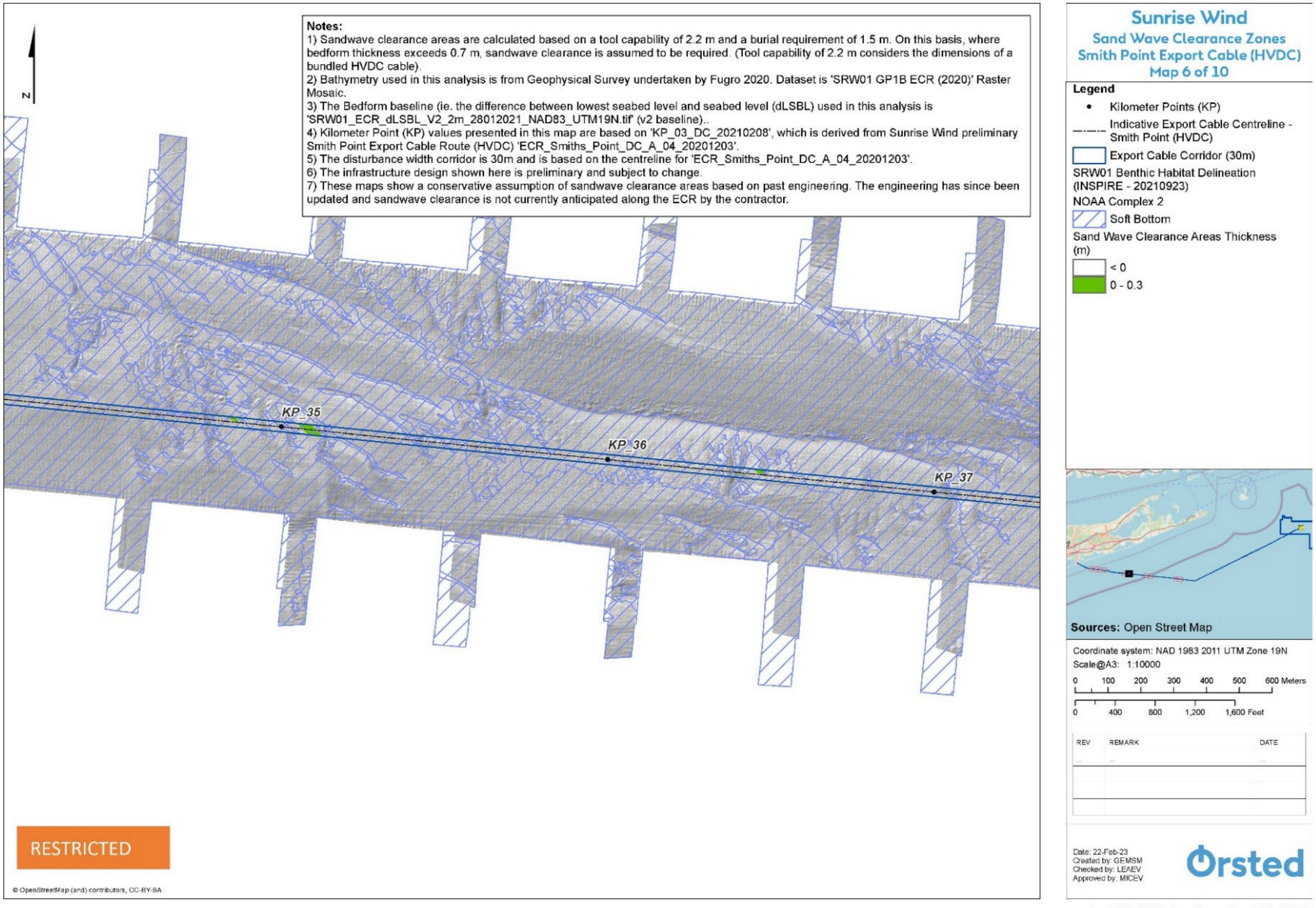


Figure 10-6. Clearance Area along the SRWEC Corridor KP35 to KP37

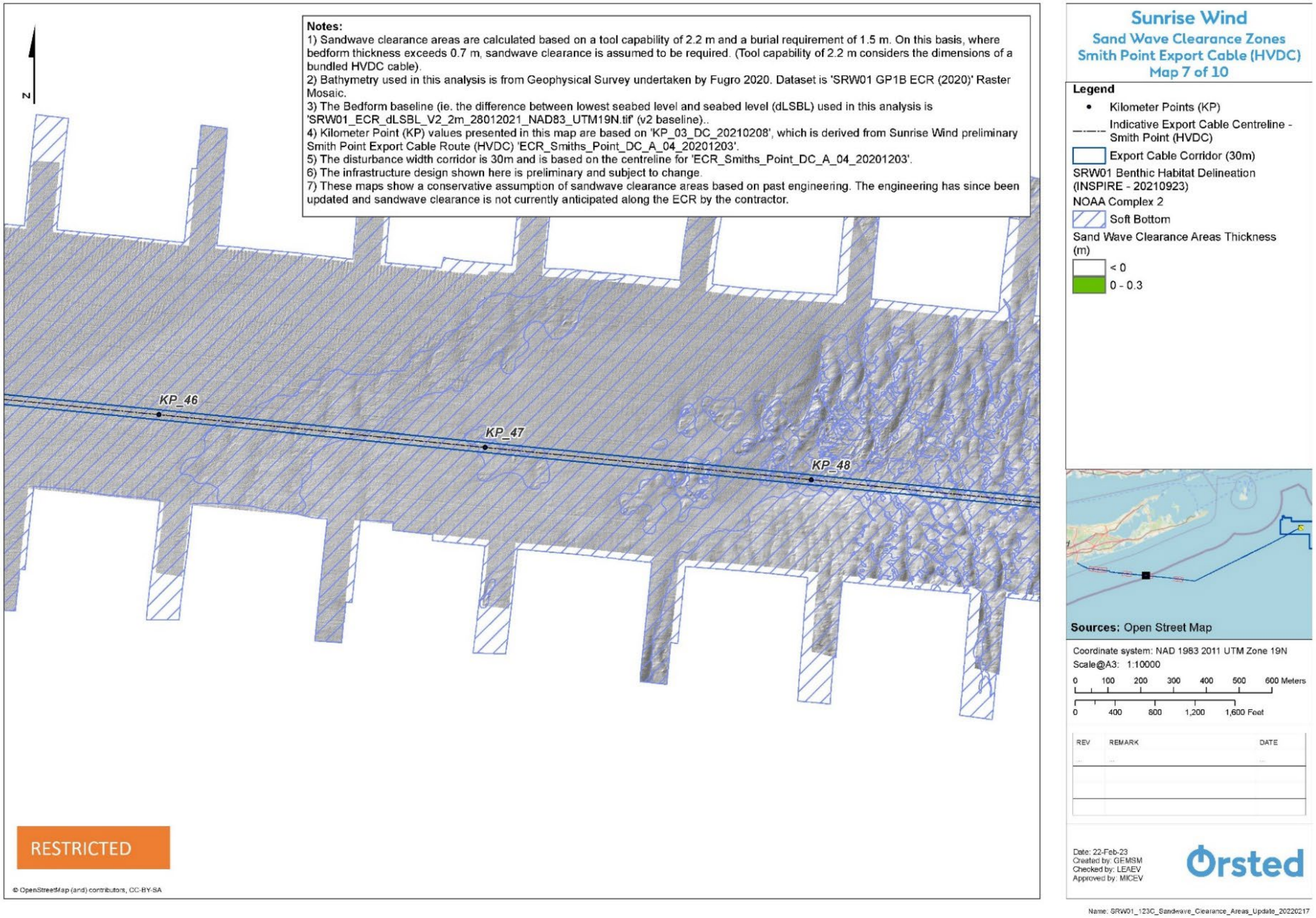


Figure 10-7. Clearance Area along the SRWEC Corridor KP46 to KP48

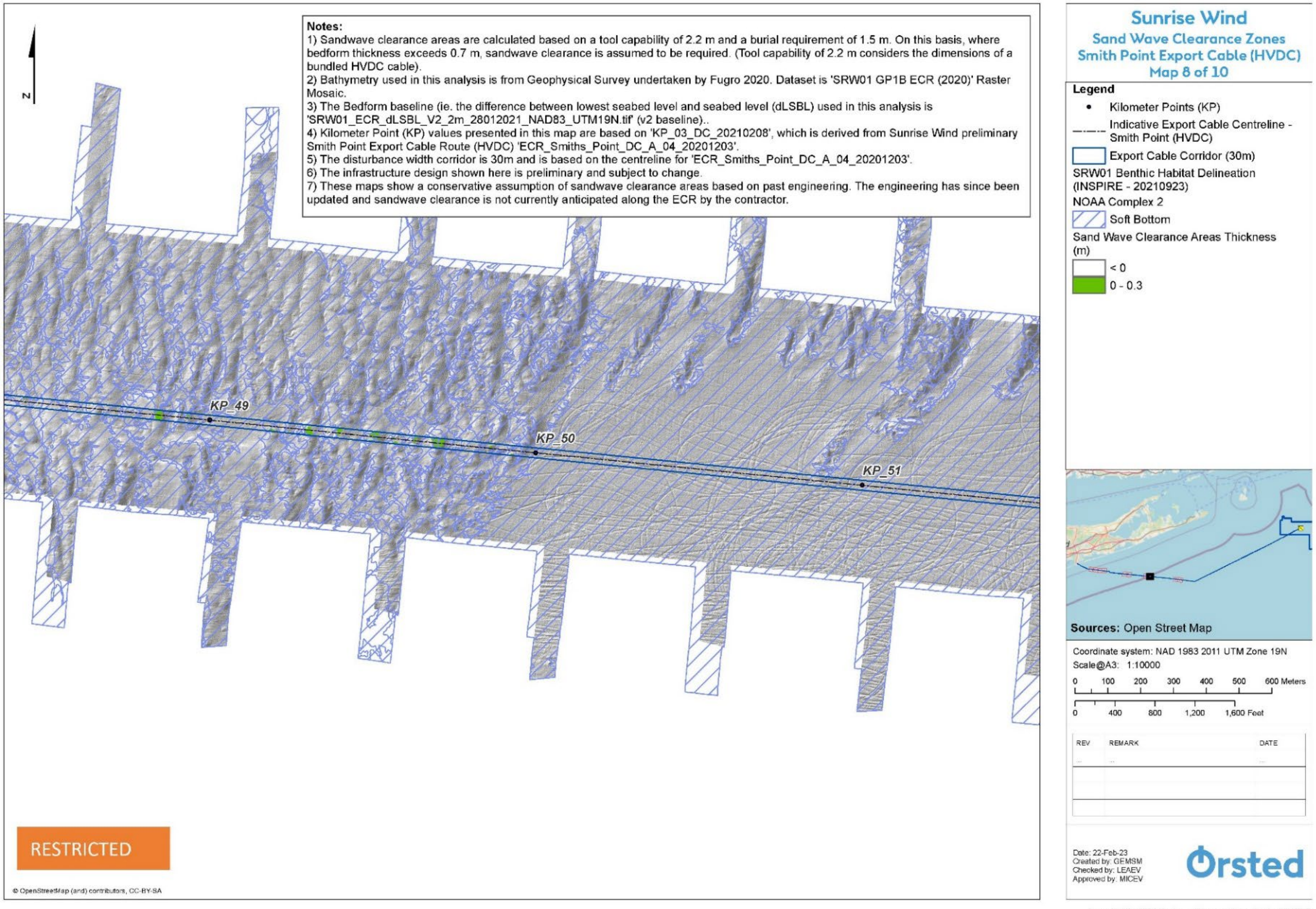


Figure 10-8. Clearance Area along the SRWEC Corridor KP49 to KP51

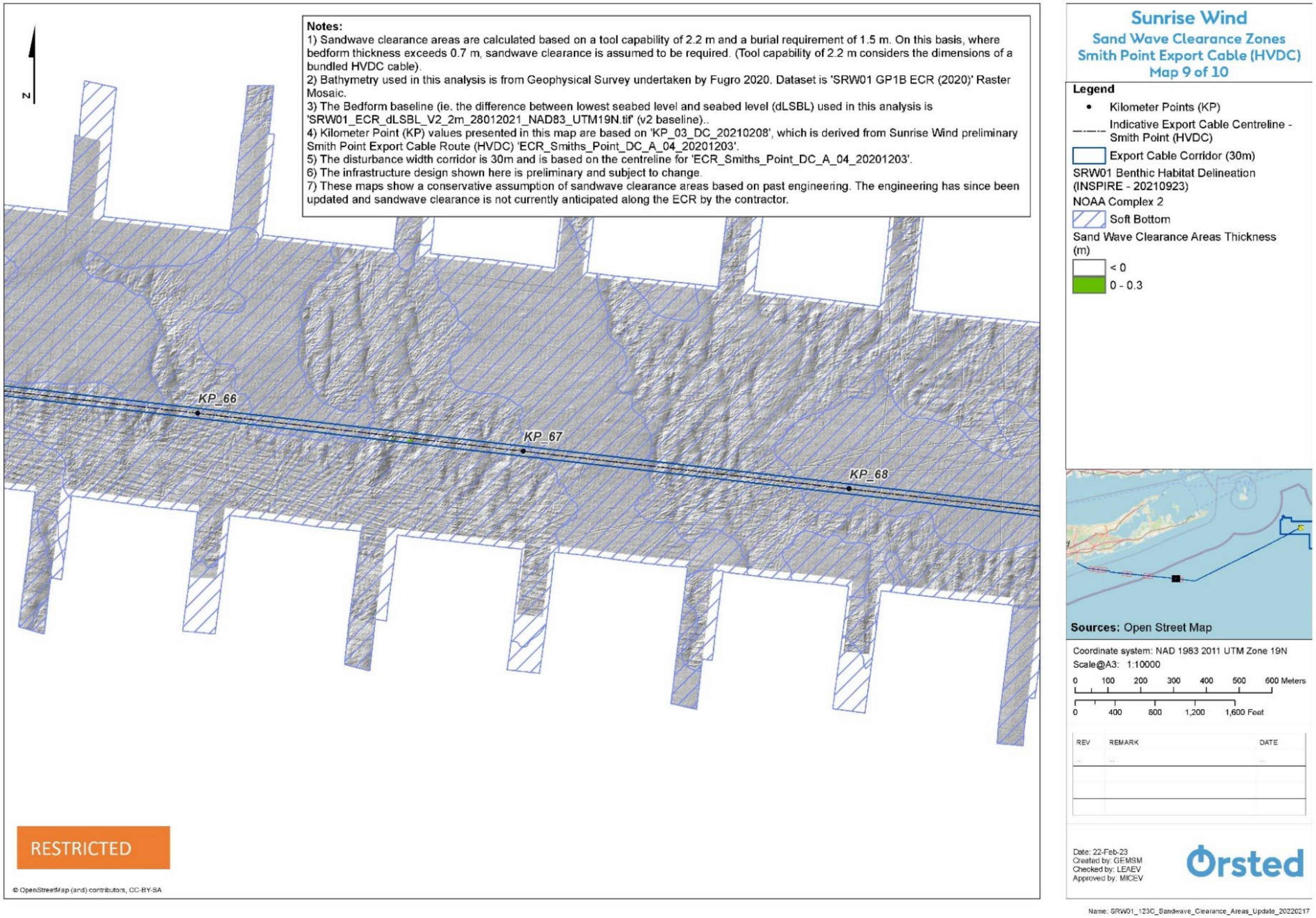


Figure 10-9. Clearance Area along the SRWEC Corridor KP66 to KP68

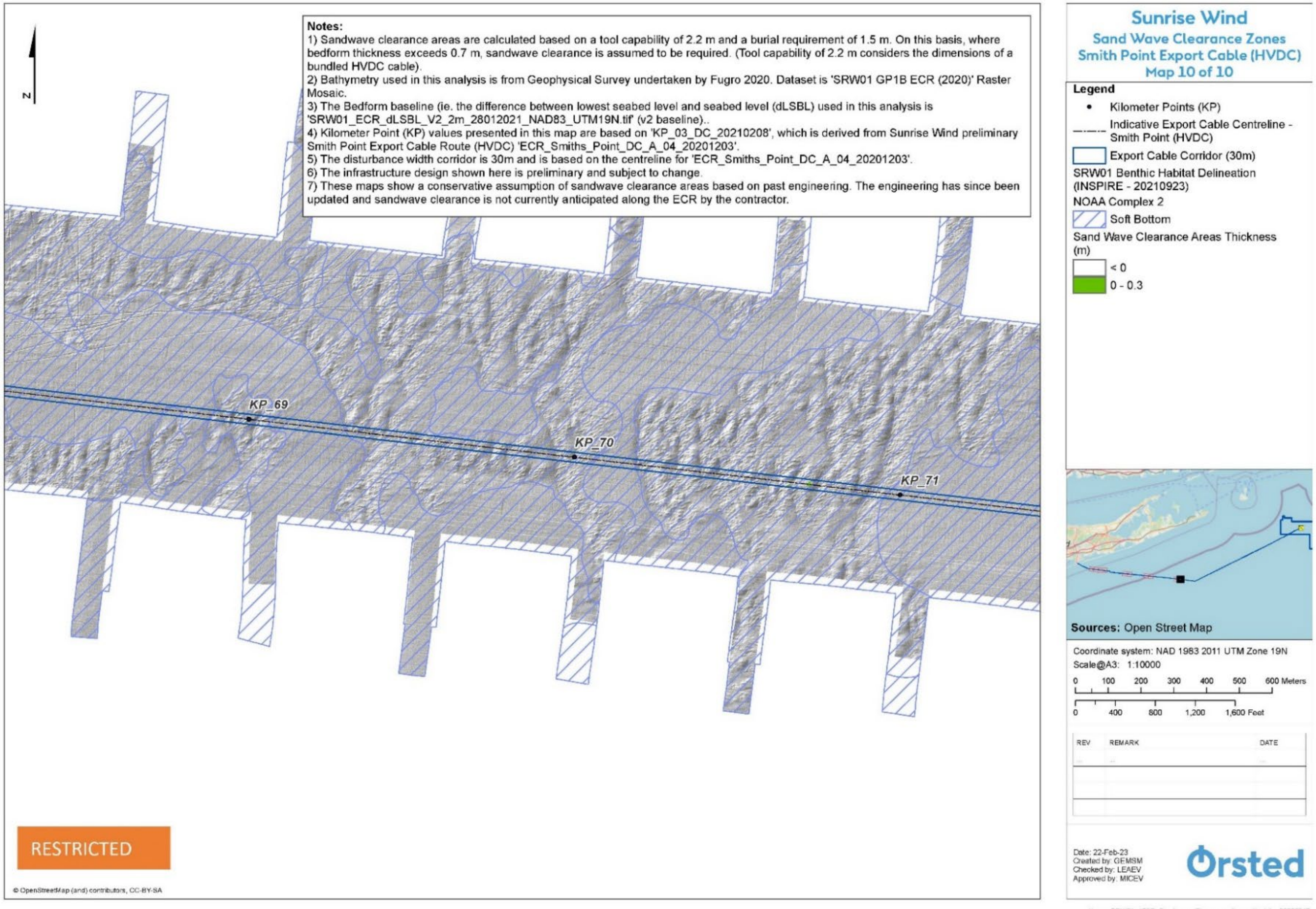


Figure 10-10. Clearance Area along the SRWEC Corridor KP69 to KP71

11.0 Appendix A

Table A- 1. Summary of Impacts of EFH Species with Benthic Life Stages within the Project Area

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Adverse Impact
American Plaice	Juvenile	Benthic habitat with soft substrates.	SRWEC-OCS	Short-term direct
Atlantic Cod	Egg	Pelagic habitats and high-salinity zones of bays and estuaries	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Larvae	Pelagic habitats and high-salinity zones of bays and estuaries	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Juvenile	Demersal and structure oriented (cobble to fine substrates).	SRWF, SRWEC-OCS	Short-term direct
	Adult	Structurally complex hard bottom composed of gravel, cobble, and boulder substrates with and without epifauna and macroalgae	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
Atlantic Wolfish	Egg	Subtidal benthic habitats.	SRWF	Short-term direct
	Larvae	Pelagic and subtidal benthic habitats.	SRWF	Short-term direct
	Juvenile	Subtidal benthic habitats of mixed substrate.	SRWF	Short-term direct

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Adverse Impact
	Adult	Subtidal benthic habitats of mixed substrate.	SRWF	Short-term direct
Atlantic Sea Scallop	Egg	Sand and gravel substrate in inshore areas and on the continental shelf	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct Long-term indirect
	Larvae	Benthic and water column in inshore and offshore areas	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct Long-term indirect
	Juvenile	Benthic habitat with firm sand, gravel, shell, or rock	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct Long-term indirect
	Adult	Benthic habitat with firm sand, gravel, shell, or rock	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct Long-term indirect
Barndoor Skate	Adult	Benthic habitats of a variety of substrates.	SRWF, SRWEC-OCS	Short-term direct
	Juvenile	Benthic habitats of a variety of substrates.	SRWF, SRWEC-OCS	Short-term direct
Black Sea Bass	Juvenile	Demersal waters over the continental shelf, inland bays, and estuaries	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short- term, long- term, permanent direct
	Adult	Demersal waters over the continental shelf, inland bays, and estuaries	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short- term, long- term, permanent direct
Haddock	Larvae	Pelagic habitats in coastal and offshore waters.	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Juvenile	Subtidal benthic habitats with firm sand.	SRWF, SRWEC-OCS	Short-term direct

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Adverse Impact
	Adult	Subtidal benthic habitats with firm sand.	SRWEC-OCS	Short-term direct
Monkfish	Egg	Surface waters	SRWF, SRWEC-OCS	Short-term direct
	Larvae	Initially pelagic and transition to benthic habitat	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Juvenile	Subtidal benthic habitat on hard sand, pebbles, gravel, broken shell, soft mud, and rocky substrate	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Adult	Benthic habitat on hard sand, pebbles, gravel, broken shell, soft mud, and rocky substrate	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
Ocean Quahog	Juvenile	Offshore sandy substrates	SRWF, SRWEC-OCS	Short-term direct Long-term indirect
	Adult	Pelagic habitats on continental shelf	SRWF, SRWEC-OCS	Short-term direct
Offshore Hake	Larvae	Offshore habitats on the continental shelf.	SRWEC-OCS	Short-term direct
Red Hake	Egg	Pelagic habitats on the continental shelf	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Larvae	Free floating at surface with debris, sargassum, and jellyfish	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Juvenile	Depression in substrate on fine, silty sand; eelgrass, deep areas offshore in sea scallops	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Adverse Impact
Scup	Juvenile	Demersal waters over the continental shelf and inshore estuaries; found in mud, sand, mussel beds	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct Long-term indirect
	Adult	Soft, sandy substrate on or near structures such as rocky ledges, wrecks, artificial reefs, and mussel beds	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct
Spiny Dogfish	Juvenile	Pelagic habitats on continental shelf	SRWEC-OCS	Short-term direct
	Adult	Pelagic habitats on continental shelf	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct
Summer Flounder	Egg	Pelagic habitats on continental shelf	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Larvae	Buried in inshore coastal and marine sandy bottom substrate	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Juvenile	Estuaries, soft bottom habitat such as mudflats, seagrass beds, marsh creeks, open bays	SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct
	Adult	Demersal waters over the continental shelf and sandy or muddy bottoms of inshore estuaries	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct Long-term indirect
Atlantic Surfclam	Juvenile	Medium sands, fine and silty-fine sands	SRWEC-OCS	Short-term direct Long-term indirect

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Adverse Impact
	Adult	Medium sands, fine and silty-fine sands	WFA, IECRC, and OECRC	Short-term direct Long-term indirect
Silver Hake	Egg	Pelagic habitat on the continental shelf	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Larvae	Pelagic habitat on the continental shelf	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Juvenile	Benthic habitat of all substrate types	SRWF, SRWEC-OCS,	Short-term direct
	Adult	Silt-sand substrate, sandwave crests, shell, and biogenic depressions	SRWEC-OCS	Short-term direct
White Hake	Juvenile	Pelagic and benthic habitat in coastal bays, estuaries and continental shelf.	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Adult	Fine-grained, muddy substates and mixed soft and rocky habitat	WFA, IECRC, and OECRC	Short-term direct
Windowpane Flounder	Egg	Pelagic habitat on the continental shelf, coastal bays, and estuaries	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct
	Larvae	Pelagic habitat on the continental shelf, coastal bays, and estuaries	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct
	Juvenile	Mud and sandy substrates in intertidal and sub- tidal habitat	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct Long-term indirect

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Adverse Impact
	Adult	Mud and sandy substrates in intertidal and subtidal habitat	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct Long-term indirect
Winter Flounder	Egg	Sand, muddy sand, mud, macroalgae, gravel bottom substrates	SRWEC-NYS, Onshore Cable	Short-term direct Long-term indirect
	Larvae	Pelagic habitat on the continental shelf, estuarine, and coastal areas	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct
	Juvenile	Mud, sand, rocky substrates, tidal wetlands, eelgrass habitat	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct Long-term indirect
	Adult	Mud and sandy substrates; hard-bottom	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct Long-term indirect
Witch Flounder	Egg	Pelagic habitat on the continental shelf	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Larvae	Pelagic habitat on the continental shelf	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Juvenile	Subtidal benthic habitat on the outer continental shelf and slope, with mud and muddy sand substrates	SRWEC-OCS	Short-term direct
	Adult	Subtidal benthic habitat on the outer continental shelf	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Adverse Impact
		and slope, with mud and muddy sand substrates		
Yellowtail Flounder	Egg	Coastal and continental shelf in water column	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Larvae	Coastal and continental shelf in water column	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Juvenile	Sandy substrates	SRWF, SRWEC-OCS	Short-term direct
	Adult	Sand, sand with mud, shell hash, gravel, and rocks	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
Little Skate	Juvenile	Sand and gravel substrates, but also on mud	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct
	Adult	Sand and gravel substrates, but also on mud	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct
Winter Skate	Juvenile	Sand and gravel substrates, but also on mud	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct
	Adult	Sand and gravel substrates, but also on mud	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct

Source: NOAA Habitat 2021

SRWF = Sunrise Wind Farm , SRWEC-OCS = Sunrise Wind Export Cable – Offshore Converter Station, SRWEC-NYS = Sunrise Wind Export Cable – New York State, Onshore Cable = Onshore Cable

Table A- 2. Summary of Impacts of EFH Species with Pelagic Life

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Impact
Albacore Tuna	Juvenile and Adult	Inshore and pelagic surface waters. Offshore and coastal pelagic habitat	SRWF, SRWEC-OCS, SRWEC-NYS	No short or long-term direct or indirect
Atlantic Butterfish	Egg	Pelagic habitats in inshore estuaries and embayment and over bottom depths of 1,500 feet (457 meters) or less	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Larvae	Pelagic habitats in depths between 101.7 and 1,148.2 feet (31 and 350 meters)	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
	Juvenile	Surface waters associated with flotsam and large jellyfish	SRWF, SRWEC-OCS	No short or long-term direct or indirect
	Adult	Bottom depths between 32.8 and 820 feet (10 and 250 meters)	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct
Atlantic Herring	Egg	Inshore and offshore benthic habitats	SRWF	Short-term direct Long-term indirect
	Larvae	Water column within inshore and estuarine waters	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct Long-term indirect
	Juvenile	Pelagic and bottom waters of inland bays	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	No short or long-term direct or indirect
	Adult	Pelagic and bottom waters of inland bays	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	No short or long-term direct or indirect
Atlantic Mackerel	Egg	Pelagic in upper water column	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct Long-term indirect

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Impact
	Larvae	Bottom waters ranging between 32.8 to 426.5 feet (10 to 130 meters)	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct Long-term indirect
	Juvenile	Bottom waters ranging from surface to 1,115 feet (340 meters)	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	No short or long-term direct or indirect
	Adult	Bottom waters ranging from surface to 1,115 feet (340 meters)	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	No short or long-term direct or indirect
Basking Shark	Neonate, Juvenile, and Adult	Coastal and oceanic deep water habitat	SRWF, SRWEC-OCS	No short or long-term direct or indirect
Blue Shark	Neonate, Juvenile, Adult	Offshore pelagic habitat	SRWF, SRWEC-OCS	No short or long-term direct or indirect
Bluefin Tuna	Juvenile	Inshore and pelagic surface waters	SRWF, SRWEC-OCS, SRWEC-NYS	No short or long-term direct or indirect
	Adult	Offshore and coastal pelagic habitat	SRWF, SRWEC-OCS	No short or long-term direct or indirect
Common Thresher Shark	Neonate, Juvenile, and Adult	Inshore, coastal, and oceanic waters	SRWF, SRWEC-OCS, SRWEC-NYS	No short or long-term direct or indirect
Yellowfin Tuna	Juvenile	Offshore, coastal, and pelagic waters	WFA and OECRC	No short or long-term direct or indirect
	Adult	Offshore, coastal, and pelagic waters	WFA and OECRC	No short or long-term direct or indirect
Bluefish	Egg	Mid-shelf waters ranging from 98.4 to 229.6 feet (30 to 70 meters)	SRWF, SRWEC-OCS	Short-term direct Long-term indirect

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Impact
	Larvae	Oceanic waters no deeper than 49.2 feet (15 meters) in water column; transported to estuarine nurseries	SRWF, SRWEC-OCS	Short-term direct Long-term indirect
	Juvenile	Pelagic nearshore areas and estuaries with sand, mud, or clay substrate	SRWEC-OCS, SRWEC-NYS, Onshore Cable	No short or long-term direct or indirect
	Adult	Oceanic, nearshore, and continental shelf waters; inland bays; not associated with specific substrate	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	No short or long-term direct or indirect
Dusky Shark	Neonate	Water column depth of 4.3 to 15.5 meters	SRWF, SRWEC-OCS, SRWEC-NYS	No short or long-term direct or indirect
	Juvenile	Coastal and pelagic waters inshore of the continental shelf break	SRWF, SRWEC-OCS, SRWEC-NYS	No short or long-term direct or indirect
	Adult	Coastal and pelagic waters inshore of the continental shelf break	SRWF, SRWEC-OCS, SRWEC-NYS	No short or long-term direct or indirect
Long Fin Squid	Egg	Inshore and offshore bottom habitats at depth in less than 50 meters	SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct Long-term indirect
	Juvenile	Bottom depths between 6 and 160 meters	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	No short or long-term direct or indirect
	Adult	Varying depths of the water column; when inshore, found at bottom depths from 6 to 200 meters	SRWF, SRWEC-OCS	No short or long-term direct or indirect

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Impact
Northern Shortfin Squid	Adult	Highly migratory pelagic species.	SRWEC-OCS	No short or long-term direct or indirect
Pollock	Egg	Pelagic inshore and offshore habitat	SRWF, SRWEC-OCS	Short-term direct Long-term indirect
	Larvae	Pelagic inshore and offshore habitat	SRWF, SRWEC-OCS, SRWEC-NYS	Short-term direct Long-term indirect
	Juvenile	Rocky bottom habitats with attached macroalgae (rockweed and kelp).	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	Short-term direct
Porbeagle Shark	Neonate, Juvenile, Adult	Offshore waters in the Mid-Atlantic Bight to George's Bank	SRWF, SRWEC-OCS	No short or long-term direct or indirect
Sand Tiger Shark	Neonate and Juvenile	Pelagic and coastal habitat	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	No short or long-term direct or indirect
Sandbar Shark	Neonate,	Pelagic and coastal habitat	SRWEC-OCS SRWEC-NYS	Short-term indirect
	Juvenile, and Adult		SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	
Shortfin Mako Shark	Neonate, Juvenile, and Adult	Pelagic wasters from Southern New England though Cape Lookout, North Carolina	SRWF, SRWEC-OCS	No short or long-term direct or indirect
Skipjack Tuna	Juvenile	Offshore and coastal pelagic habitat	SRWF, SRWEC-OCS, SRWEC-NYS	No short or long-term direct or indirect
	Adult	Pelagic habitat associated with birds, drifting objects, whales, and sharks	SRWF, SRWEC-OCS, SRWEC-NYS	No short or long-term direct or indirect

Species	Life Stage	Preferred Habitat Description	Presence in Project Area	Impact
Smooth Dogfish	Neonate, Juvenile, and Adult	Coastal shelves and inshore waters	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	No short or long-term direct or indirect
Tiger Shark	Juvenile and Adult	Offshore pelagic habitat	SRWF, SRWEC-OCS	No short or long-term direct or indirect
White Shark	Neonate	Inshore waters out to 65 miles (105 km)	SRWF, SRWEC-OCS, SRWEC-NYS, Onshore Cable	No short or long-term direct or indirect
	Juvenile	Pelagic habitat between 82 and 328 feet (25 and 100 meters)	SRWF, SRWEC-OCS, SRWEC-NYS	No short or long-term direct or indirect
	Adult	Pelagic habitat between 82 and 328 feet (25 and 100 meters)	SRWF, SRWEC-OCS, SRWEC-NYS	No short or long-term direct or indirect

Source: NOAA Habitat 2021

SRWF = Sunrise Wind Farm , SRWEC-OCS = Sunrise Wind Export Cable – Offshore Converter Station, SRWEC-NYS = Sunrise Wind Export Cable – New York State, Onshore Cable = Onshore Cable

Table A- 3. Habitat Table Group Referenced Against CMECS (Class, Subclass and Groups)

Habitat Table Group	Class	Subclass	Group(s)
Rocky (general, to include all: granule-pebble, cobble, boulder, ledge/bedrock) *Please note that CMECS Biotic Subclasses Benthic Macroalgae and Attached Fauna should be addressed in the characterization of rocky habitats.*	Substrate Class: Rock Substrate	Substrate Subclass: Bedrock	N/A
		Substrate Subclass: Megaclast	N/A
	Substrate Class: Unconsolidated Mineral Substrate - with 5 percent or greater of particles 2 mm to < 4,096 mm	Substrate Subclass: Coarse Unconsolidated Substrate	Substrate Group: Gravels
			Substrate Group: Gravel Mixes
			Substrate Group: Gravelly
Soft bottom mud (intertidal, shallow-water, and deep) *Please note that CMECS Biotic Subclasses Soft Sediment Fauna and Inferred Fauna should be addressed in the characterization of mud habitats.*	Substrate Class: Unconsolidated Mineral Substrate - with < 5% or greater of particles 2 mm to < 4,096 mm	Substrate Subclass: Fine Unconsolidated Substrate - with > 50 percent of particles < 0.625 mm	Substrate Group: Slightly Gravelly *(please note: this CMECS category label is not used in the Recommendations for Mapping Fish Habitat, but it is incorporated into the classification of the Fine Unconsolidated Substrate substrates)*
			Substrate Group: Sandy Mud
			Substrate Group: Mud
Soft bottom sand (with and without sand ripple, shoals, waves/ridges) *Please note that CMECS Biotic Subclasses Soft Sediment Fauna and Inferred Fauna should be addressed in the characterization of sand habitats.*	Substrate Class: Unconsolidated Mineral Substrate - with < 5 percent or greater of particles 2 mm to < 4,096 mm	Substrate Subclass: Fine Unconsolidated Substrate - with >/= 50 percent of particles 0.625 mm to <2 mm	Substrate Group: Slightly Gravelly *(please note: this CMECS category label is not used in the Recommendations for Mapping Fish Habitat, but it is incorporated into the classification of the Fine Unconsolidated Substrate substrates)*
			Substrate Group: Sand
			Substrate Group: Muddy Sand
Submerged Aquatic Vegetation (SAV)	Biotic Class: Aquatic Vegetation Bed	Biotic Subclass: Aquatic Vascular Vegetation	Biotic Group: Seagrass Bed
			Biotic Group: Freshwater and Brackish Tidal Aquatic Vegetation

Habitat Table Group	Class	Subclass	Group(s)
Tidal Marsh (e.g., saltmarsh and brackish marsh)	Biotic Class: Emergent Wetland	Biotic Subclass: Emergent Tidal Marsh	Biotic Group: Brackish Marsh
			Biotic Group: Freshwater Tidal Marsh
			Biotic Group: High Salt Marsh
			Biotic Group: Low and Intermediate Salt Marsh
		Biotic Subclass: Vegetated Tidal Flats	Biotic Group: Vegetated Freshwater Tidal Mudflat
			Biotic Group: Vegetated Salt Flat and Panne
	Biotic Class: Scrub-Shrub Wetland	Biotic Subclass: Tidal Scrub-Shrub Wetland	Biotic Group: Brackish Tidal Scrub-Shrub
			Biotic Group: Freshwater Tidal Scrub-Shrub
			Biotic Group: Saltwater Tidal Scrub-Shrub
			Biotic Group: Tidal Mangrove Shrubland
	Biotic Class: Forested Wetland	Biotic Subclass: Tidal Forest/Woodland	Biotic Group: Brackish Tidal Forest/Woodland
			Biotic Group: Freshwater Tidal Forest/Woodland
			Biotic Group: Saltwater Tidal Forest/Woodland
			Biotic Group: Tidal Mangrove Forest
Shellfish reefs and beds (e.g., hard clams, Atlantic surfclam, mussels, oysters)	Substrate Class: Shell Substrate	Substrate Subclass: Shell Reef Substrate	Substrate Group: Clam Reef Substrate
			Substrate Group: Crepidula Reef Substrate
			Substrate Group: Mussel Reef Substrate
			Substrate Group: Oyster Reef Substrate
		Substrate Subclass: Shell Rubble if dominated by living shells	Substrate Group: Clam Rubble
			Substrate Group: Crepidula Rubble
			Substrate Group: Mussel Rubble
			Substrate Group: Oyster Rubble
	Biotic Class: Faunal Bed	Biotic Subclass: Mollusk Reef Biota	Biotic Group: Mussel Reef
			Biotic Group: Oyster Reef
			Biotic Group: Gastropod Reef
		Biotic Subclass: Attached Fauna	Biotic Group: Attached Mussels
			Biotic Group: Attached Oysters
		Biotic Subclass: Soft Sediment Fauna	Biotic Group: Clam Bed
			Biotic Group: Mussel Bed
			Biotic Group: Oyster Bed
			Biotic Group: Scallop Bed

Habitat Table Group	Class	Subclass	Group(s)
Shell accumulations	Substrate Class: Shell Substrate	Substrate Subclass: Shell Hash	Substrate Group: Clam Hash
			Substrate Group: Crepidula Hash
			Substrate Group: Mussel Hash
			Substrate Group: Oyster Hash
		Substrate Subclass: Shell Rubble if dominated by non-living shells	Substrate Group: Clam Rubble
			Substrate Group: Crepidula Rubble
			Substrate Group: Mussel Rubble
			Substrate Group: Oyster Rubble
Other biogenic (e.g., cerianthids, corals, emergent tubes – polychaetes) *Areas with corals or dense aggregations of epifuana or emergent infauna should be identified and characterized.*	Biotic Class: Reef Biota	Biotic Subclass: Deepwater/Coldwater Coral Reef Biota	Biotic Group: Deepwater/Coldwater Stony Coral Reef
			Biotic Group: Deepwater/Coldwater Stylasterid Coral Reef
			Biotic Group: Colonized Deepwater/Coldwater Reef
		Biotic Subclass: Shallow/Mesophotic Coral Reef Biota	Biotic Group: Branching Coral Reef
			Biotic Group: Columnar Coral Reef
			Biotic Group: Encrusting Coral Reef
			Biotic Group: Foliose Coral Reef
			Biotic Group: Massive Coral Reef
			Biotic Group: Plate Coral Reef
			Biotic Group: Table Coral Reef
			Biotic Group: Turbinate Coral Reef
			Biotic Group: Mixed Shallow/Mesophotic Coral Reef
			Biotic Group: Colonized Shallow/Mesophotic Reef
	Biotic Class: Faunal Bed	Biotic Subclass: Glass Sponge Reef Biota	Biotic Group: Glass Sponge Reef
		Biotic Subclass: Mollusk Reef Biota	Biotic Group: Gastropod Reef
		Biotic Subclass: Worm Reef Biota	Biotic Group: Sabellariid Reef
			Biotic Group: Serpulid Reef
		Biotic Subclass: Attached Fauna	Biotic Group: Attached Corals
		Biotic Subclass: Soft Sediment Fauna	Biotic Group: Diverse Soft Sediment Epifauna
			Biotic Group: Larger Tube-Building Fauna
			Biotic Group: Small Tube-Building Fauna

Habitat Table Group	Class	Subclass	Group(s)
			Biotic Group: Burrowing Anemones
			Biotic Group: Brachiopod Bed
			Biotic Group: Soft Sediment Bryozoans
			Biotic Group: Hydroid Bed
			Biotic Group: Pennatulid Bed
			Biotic Group: Sponge Bed
			Biotic Group: Tunicate Bed
Pelagic (offshore and estuarine)			
Habitat for sensitive life stages (i.e., demersal eggs, spawning activity-discrete areas)	**Not defined by CMECS but by managed spp. that occur in the Project area**		
Habitat Areas of Particular Concern (HAPCs)	**Not defined by CMECS but by managed spp. that occur in the Project area**		

Please note the following substrate classes and groups should not be defined as substrate classes and should be addressed as biotic components under appropriate habitat type (see Tables A2 and A3 below):

- Substrate Class: Algal substrate,
- Substrate Class: coral substrate
- Substrate Subclass: shell sand
  - Substrate Subgroup: coquina hash
- Substrate Class: Worm Substrate
  - Substrate Subclass: Sabellariid Substrate
    - Substrate group: Sabellariid Reef Substrate
    - Sabellariid Rubble,
    - Sabellariid Hash
  - Serpulid Substrate
    - Serpulid Reef Substrate
    - Serpulid Rubble
    - Serpulid Hash

Table A- 4. Table of Biotic Subclasses that Should be Addressed in the Characterization of Rocky Habitat (see note under Rocky)

Biotic Subclass	Biotic Group
Benthic Macroalgae	Calcareous Algal Bed
	Canopy-Forming Algal Bed
	Coralline/Crustose Algal Bed
	Filamentous Algal Bed
	Leathery/Leafy Algal Bed
	Mesh/Bubble Algal Bed
	Sheet Algal Bed
	Turf Algal Bed
Attached Fauna	Biotic Group: Attached Sea Urchins
	Biotic Group: Attached Tunicates
	Biotic Group: Attached Starfish
	Biotic Group: Attached Sponges
	Biotic Group: Attached Hydroids
	Biotic Group: Sessile Gastropods
	Biotic Group: Mobile Crustaceans on Hard or Mixed Substrates
	Biotic Group: Attached Crinoids
	Biotic Group: Chitons
	Biotic Group: Attached Bryozoans
	Biotic Group: Brittle Stars on Hard or Mixed Substrates
	Biotic Group: Attached Brachiopods
	Biotic Group: Attached Basket Stars
	Biotic Group: Barnacles
	Biotic Group: Attached Anemones
	Biotic Group: Vent/Seep Communities –
	Biotic Group: Attached Tube-Building Fauna
	Biotic Group: Diverse Colonizers
	Biotic Group: Wood Boring Fauna
	Biotic Group: Mineral Boring Fauna

Table A- 5. Table of Biotic Subclasses that should be Addressed in the Characterization of Mud and Sand Habitat (see notes under soft bottom mud and soft bottom sand)

Biotic Subclass	Biotic Group
Soft Sediment Fauna	Larger Deep-Burrowing Fauna
	Small Surface-Burrowing Fauna
	Tunneling Megafauna
	Oligozoic Biota
	Soft Sediment Brittle Stars
	Soft Sediment Crinoids
	Mobile Crustaceans on Soft Sediments
	Echiurid Bed
	Holothurian Bed
	Mobile Mollusks on Soft Sediments
	Sand Dollar Bed
	Starfish Bed
	Burrowing Urchins
	Sea Urchin Bed
	Egg Masses
	Fecal Mounds
	Pelletized, Fluid Surface Layer
	Tracks and Trails

12.0 Appendix B

Habitat and Complexity Impact Calculations Tables