Beacon Wind Foundation Testing

Essential Fish Habitat Assessment with NOAA Trust Resources

December 2023

For the National Marine Fisheries Service

U.S. Department of the Interior

Bureau of Ocean Energy Management
Office of Renewable Energy Programs

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Abbreviations

APM	Applicant Proposed Mitigation
ASFMC	Atlantic States Marine Fisheries Commission
Beacon Wind	Beacon Wind, LLC
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
CMECS	Coastal and Marine Ecological Classification Standard
COP	Construction and Operations Plan
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EPM	Environmental Protection Measures
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
HAPC	Habitat Areas of Particular Concern
HRG	high-resolution geophysical
Lease Area	Lease Area OCS-A 0520
MAFMC	Mid-Atlantic Fishery Management Council
MA WEA	Massachusetts Wind Energy Area
MBES	multibeam echo sounder
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NMFS	National Marine Fisheries Service
OCS	Outer Continental Shelf
ROV	remotely operated vehicle
SAP	Site Assessment Plan
SAV	submerged aquatic vegetation
sf	sub-female
SMAST	School for Marine Science and Technology
SPI/PV	sediment profile imaging and plan view
SPL	sound pressure level
SSS	side scan sonar
TSS	total suspended sediment
USACE	U.S. Army Corps of Engineers
YOY	young-of-year

Unit Abbreviations

°C	degrees Celsius
dB	decibels
°F	degrees Fahrenheit
ft^2	square feet
Hz	hertz
m^2	square meters
m^3	cubic meters
mg/L	milligrams per liter
mm	millimeters
ppt	parts per thousand
µm	micrometers

1. Introduction

The Energy Policy Act of 2005, Public Law No. 109-58, added Section 8(p)(1)I to the Outer Continental Shelf Lands Act, which grants the Secretary of the Interior the authority to issue leases, easements, or rights-of-way on the Outer Continental Shelf (OCS) for the purpose of renewable energy development (43 United States Code [USC] § 1337(p)(1)(C)). The Secretary delegated this authority to the former Minerals Management Service, now the Bureau of Ocean Energy Management (BOEM). On April 22, 2009, BOEM (formerly the Bureau of Ocean Energy Management, Regulation, and Enforcement) promulgated final regulations implementing this authority at 30 Code of Federal Regulations (CFR) § 585.

The Magnuson-Stevens Fishery Conservation and Management Act (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 Essential Fish Habitat (EFH) regulation at 50 CFR 600.905. BOEM will be the lead Federal agency for the consultation and will coordinate with any other Federal agencies that may be issuing permits or authorizations for this project, as necessary, for one consultation that considers the effects of all relevant Federal actions, including in offshore and inshore coastal environments [e.g., issuance of permits by the U.S. Army Corps of Engineers (USACE)]. 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). NMFS’s 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 ecosystems 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 action occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

On June 3, 2014, BOEM issued a Finding of No Significant Impact (FONSI) based on a Revised Environmental Assessment for Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts (BOEM 2014; referred to herein as the “2014 EA”). On December 8, 2020, Beacon Wind, LLC (Beacon Wind) submitted a Site Assessment Plan (SAP) in support of site assessment activities consisting of installation and operation of metocean equipment, with updated versions submitted April 27, 2021, and June 28, 2021. The 2014 EA addressed the activities included in the SAP, and the SAP was approved by BOEM on September 24, 2021. The metocean equipment was deployed in Lease Area OCS-A 0520 (Lease Area) on November 10, 2021.

On March 2, 2023, Beacon Wind submitted a SAP Amendment in support of additional site assessment activities in the Lease Area not included in the 2020 SAP, to consist of short-term deployment and subsequent removal of representative wind turbine/offshore substation foundation components (Proposed Action). The Proposed Action includes repeated tests of a single suction bucket within the Lease Area, at selected areas planned for eventual installation of wind turbines. The suction bucket would be similar to those considered within the Beacon Wind Construction and Operations Plan (COP) for the suction bucket jacket foundation, which may support wind turbines and/or offshore substations. Approval of the SAP Amendment, authorizing the Proposed Action, would enable Beacon Wind to adequately assess wind and environmental resources of the Beacon Wind Lease Area to determine if areas within the Lease Area are suitable for, and could support, commercial-scale wind energy production. The Proposed Action will be conducted to further assess the site conditions and to gather information to support the engineering design of wind turbine and offshore substation foundations that would potentially be installed within the Lease Area.

The SAP Amendment submitted by Beacon Wind was intended to add the Proposed Action to the approved activities under the previously submitted SAP, to be conducted during the site assessment term of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf and prior to BOEM approval of the COP for the Lease Area. This EFH Assessment describes the Proposed Action and presents an assessment of the potential for the Proposed Action to adversely affect EFH and managed species.

This EFH assessment provides a comprehensive description of the Proposed Action, defines the area where the Proposed Action would occur, describes EFH and EFH species potentially impacted by the Proposed Action, and provides an analysis and determination of how the Proposed Action may affect EFH and EFH species.

2. Proposed Action

The Proposed Action consists of a series of 35 deployments and removals of a single suction bucket foundation at 26 locations (Figure 2-1) to gather information to support the engineering design of wind turbine and offshore substation foundations that would potentially be installed within the Lease Area. The suction bucket will be similar to those considered within the COP (Beacon Wind 2023a) for the suction bucket jacket foundations, which may be used for some of the wind turbines and/or offshore substations if seabed geology necessitates. Suction bucket foundations are an alternative foundation design to traditional pile-driven foundations. This technology secures a steel bucket-shaped foundation by penetrating the sediment and pumping water from within the bucket to create an area of reduced pressure against the seafloor. Potential advantages of suction bucket foundations include reduced noise and depth disturbance during installation compared to pile-driven foundations.

The proposed foundation testing locations would be within the Beacon Wind Lease Area in the vicinity of wind turbine foundation positions that are currently part of the Project design for the wind farm. At each site, activities will occur within a 984- x 984- foot (300- x 300-meter) square, which is centered on the location for eventual installation of the proposed wind turbines as described in the COP (Beacon Wind 2023a). This area is conservative and would cover all foundation testing activities at each location, including the possibility of multiple tests at a single location, such that up to 35 total trials would be conducted.

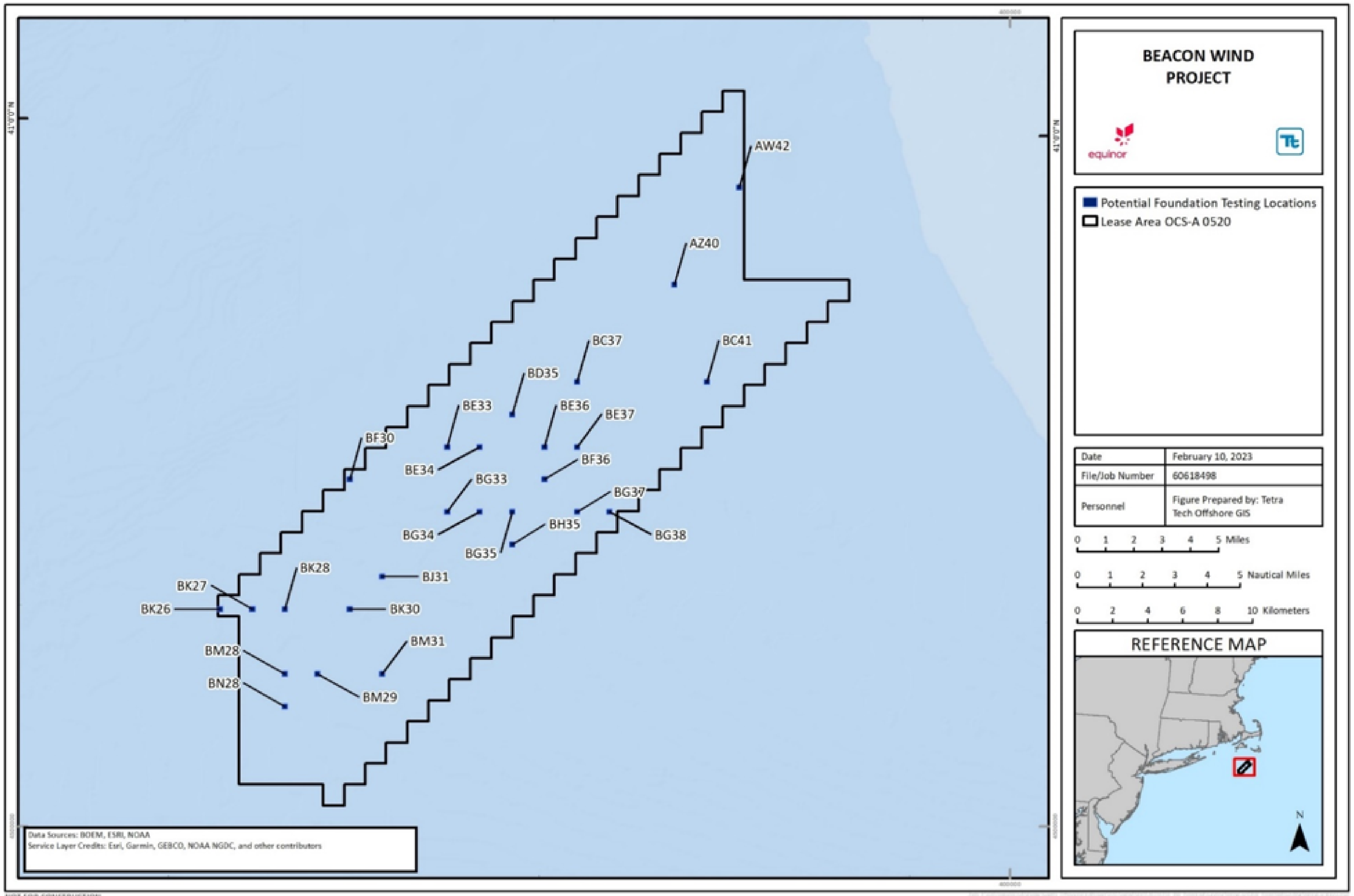

Figure 2-1. Locations for the Proposed Action

2.1. Foundation Testing

Foundation testing would be conducted at-sea over a 10- to 15-day period within the Lease Area, plus additional days for inclement weather or other potential delays. No foundation materials or other survey equipment would be detached from the vessel or remain in the water for a period exceeding the duration of the suction bucket trial at each site. The vessel would use dynamic positioning; therefore, no anchors or jack-up legs would be used. No equipment would be left in the water at the conclusion of the Proposed Action.

The suction bucket used during the Proposed Action would have a diameter of 30 to 39 feet (9 to 12 meters), a height of 36 to 39 feet (11 to 12 meters), and a weight of approximately 200 tons (181.4 mt). The suction bucket is designed to penetrate into the seafloor to a maximum depth of 33 to 39 feet (10 and 12 meters). This depth of penetration is significantly less than that assessed in the 2014 EA, which assumed that metocean tower foundations would be pile-driven up to 100 feet (30 meters) below the seafloor. The final design of the Proposed Action is currently in development. A representative photograph is shown in Figure 2-2. Note that the photographed suction bucket includes chains on the side which will not be present in the suction bucket used for the Proposed Action.

Figure 2-2. Representative Photograph of a Suction Bucket

A low-flow suction pump would be mounted to the top of the suction bucket (Figure 2-3) approximately 19 feet (6 meters) above the seabed. After the bucket has settled into the seafloor, the suction pump would slowly remove water from within the bucket to create an area of reduced pressure which would assist in completing penetration to the target depth. The suction pump would generate noise during operation, but observations conducted at other OSW facilities suggest that noise from suction pumps would attenuate to background noise levels at a relatively short distance from the pump. For instance, in noise measurements conducted during operation of underwater suction pumps at the OSW facility Borkum Riffgrund 2 in the North Sea, the average sound pressure level ($L_{eq}50$) did not differ from the background noise level (137 decibels referenced to 1 micropascal) at a distance of 2,460 feet (750 meters), and the noise of the suction pumps could not be measured beyond 1,640 feet (500 meters) from the source (Koschinski and Lüdemann 2020).

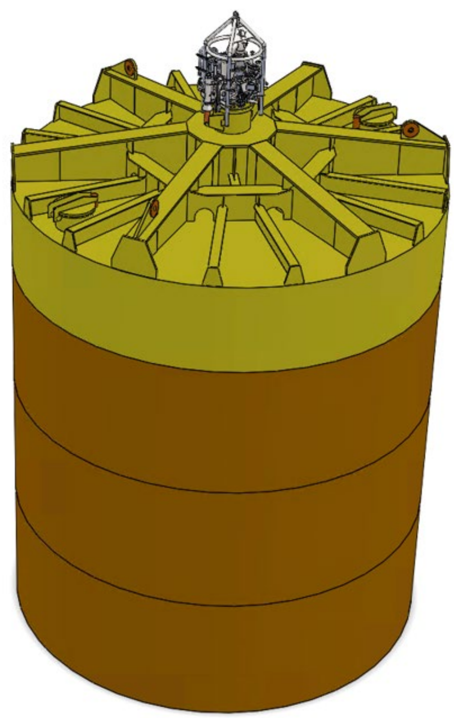

Figure 2-3. Indicative Drawing of a Suction Pump Mounted atop a Suction Bucket

The suction pump would operate at a nominal rate of 1,320 gallons per minutes (5 cubic meters [m^3] per minute), and the removed water would be released immediately outside the bucket. The volume of seawater removed would be limited to the volume inside the bucket, with a maximum of 358,504 gallons (1,357 m^3) removed per test. At the completion of each test, the pump would slowly return water to the interior of the bucket to create positive pressure inside the bucket, allowing it to be removed from the seafloor.

Measurement equipment would be deployed inside the bucket during testing to monitor the soil plug on the inside of the bucket and to gather data to assist with foundation engineering. Imaging equipment (e.g., sonar, echo sounder, sub-bottom profiler) would be mounted inside the lid of the bucket. The imaging equipment would be operated at frequencies at or above 400 kilohertz, which is inaudible to marine organisms. The imaging equipment is therefore not expected to be a source of noise disturbance for EFH species.

The Proposed Action may also use up to two remotely operated vehicles (ROVs) to assist in positioning the precise location of the bucket during deployment, as well as to observe and gather data on the process of penetration and recovery. The ROVs would be suspended in the water column and would not contact the seafloor. The ROVs would be controlled from on board the vessel and would navigate via hydraulic propellers or thrusters that do not generate significant underwater noise.

Prior to lowering the bucket to the seafloor, a reference frame (Figure 2-4) would be lowered to the seafloor to assist the vessel lowering the bucket onto the targeted location and to ensure accurate positioning of the bucket on the seafloor. The reference frame is made of steel with a maximum weight of approximately 1,100 pounds (500 kilograms). The footprint of the reference frame is approximately 11 square feet (ft^2) (1 square meter [m^2]). The reference frame would be directly lowered from the vessel onto the seafloor and would remain stationary on the seafloor for the duration of each foundation installation test, which is expected to take six to nine hours. The edge studs of the reference frame may penetrate the top 2 inches (5 centimeters) of the seabed. Upon completion of each trial, the reference frame would be raised vertically back onto the vessel.

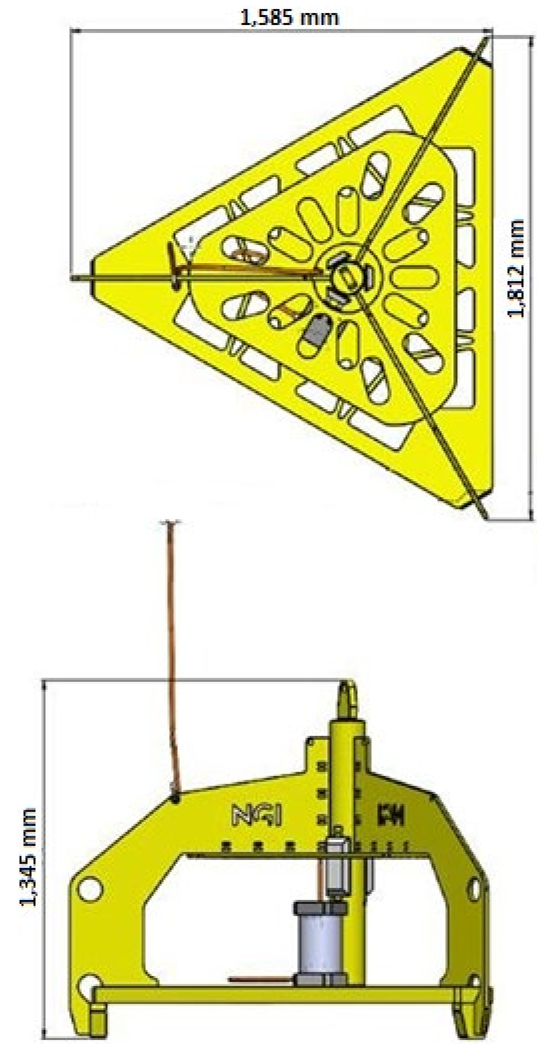

Figure 2-4. Top and Side View of a Representative Reference Frame with Dimensions Provided in Millimeters

Beacon Wind would proceed with foundation testing following BOEM approval of the Proposed Action, in February 2024 but no later than August 2024. Each foundation installation test is expected to take six to nine hours, including three to five hours for deployment (lowering and seabed penetration) and three to four hours for removal (reverse penetration, lifting, potential cleaning, and lifting onboard).

2.2. Vessel Activity

The Proposed Action would use a single large vessel, equipped with a crane rated to a minimum of 300-ton capacity. The vessel will transit from Europe with the suction bucket, will stop at ports in Canada and/or the U.S. to mobilize crew, and will then transit to the Lease Area to conduct testing. Once the vessel arrives at each foundation testing location, it would be positioned using dynamic positioning technology, without the use of anchors or jack-up legs. Once the suction bucket deployment is complete, retrieval would be initiated. The onboard crane would lift it from the seabed to the surface. The bucket would then be lifted back on the vessel deck, followed by lifting and onboarding of the reference frame. After all equipment is onboard and secure, the vessel would transit to the next trial location and the above process would be repeated. If the weather conditions are hazardous, the bucket may be left suspended under the vessel and above the seabed as the vessel transits at low speed (1 to 2 knots) to next location to ensure safe operations. Once testing at all sites is complete, crew and materials would transit back to their respective ports and demobilize.

2.3. Site Clearance Survey

Because the foundation testing would be a temporary activity and no facilities would be installed, no decommissioning would be required. Foundation testing is not expected to result in any trash or bottom debris. However, following the completion of testing, Beacon Wind would ensure that the seafloor has been cleared of all obstructions created by the Proposed Action. This would be accomplished via photo documentation of all deployed and retrieved equipment. Additionally, to confirm that all equipment was retrieved from the site, Beacon Wind would carry out photographic bottom survey using an ROV. Beacon Wind is also evaluating the potential to use sector scanning sonar for the site clearance survey. The sonar equipment under consideration operates at frequencies of 300 kilohertz or higher, indicating that sector scanning sonar, if utilized, would not produce sound that is audible to marine organisms.

3. Existing Environment

The existing environment consists of the characteristics of the water column (e.g., depth, temperature, salinity) and the seabed (e.g., sediment composition, morphology) in the Lease Area that are relevant to defined EFH for fish and invertebrates. To characterize the distribution and relative abundance of fish and invertebrate habitat within the Lease Area, Beacon Wind performed high-resolution geophysical (HRG) and benthic surveys. For the purposes of this assessment, the results of those surveys were supplemented with data from earlier trawl surveys, and video and grab sampling conducted by others. Those earlier sampling efforts included:

- Beam trawls and grab samples collected in 2016 by BOEM for preliminary characterization of the Lease Area (Guida et al. 2017);
- Northeast Fisheries Science Center (NEFSC) seasonal trawls and beam trawls (2003-2016);
- University of Massachusetts Dartmouth – School for Marine Science and Technology (SMAST) Video Survey Samples Collected in Wind Development Area in May 2012 and September 2013 (Stokesbury, 2012, 2014);
- Other reports and publications (e.g., NAS 2018; Walsh and Guida 2017; Hare et al. 2016; Walker et al. 2016 [scallop survey]; and others);
- Analysis of USGS sediment data, grab samples with infauna, and beam trawl surveys for regional habitat mapping of the Massachusetts Wind Energy Area (MA WEA) (Guida et al. 2017); and
- FMPs (Mid-Atlantic Fishery Management Council [MAFMC] 2017; New England Fishery Management Council [NEFMC] 2017; Atlantic States Marine Fisheries Commission [ASMFC] 2015, 2018a, 2018b), and regional analyses of species assemblages (e.g., Walsh et al. 2015; Hare et al. 2016; Selden et al. 2018).

Beacon Wind conducted benthic surveys including video, grab sampling, and sediment profile imaging and plan view (SPI/PV) in Summer 2021 at 157 foundation locations in the Lease Area (Figure 3-1). An additional 218 stations along the interarray cable were sampled using SPI/PV (Figure 3-2). At each of these locations, SPI/PV imagery was reviewed in real time to identify sensitive, rare, or unexpected species (including nonindigenous species) and to note any hardbottom habitat (gravel pavements, cobbles, boulders, exposed bedrock, etc.).

3.1. Benthic Habitat

Seafloor sediments within the Lease Area are typical of the U.S. North Atlantic continental shelf, dominated by very fine sand and silt (MAFMC 2019). The Lease Area is predominately sand in the shallower, more northerly portions with an increase of the silt/clay fraction at stations in the deeper, more southerly portion. Soft-bottom substrate includes unconsolidated material ranging from gravel (> 2,000 micrometers [µm]) to sand (62.5 to 2,000 µm), silt (4 to 62.5 µm), and clay (< 4 µm) (Williams et al. 2006), as well as empty shells and shell fragments of various sizes. Benthic surveys conducted by SMAST in the Lease Area in 2012 and 2013 corroborate the soft bottom, low rugosity, and limited habitat variability within the MA WEA. The MA WEA is characterized as silts and sand with a high occurrence of faunal beds dominated by sand shrimp and sand dollars (NYSERDA 2017; Guida et al. 2017; Stokesbury, 2012 and 2014). Unconsolidated sand, clay, and silt provide a matrix in which a variety of invertebrates reside, including both infaunal (living within the sediment matrix) and epifaunal (living on or in close association with the seafloor) organisms (Ward 2017). In general, assemblages of benthic invertebrate species tend to vary with depth/distance from shore, sediment type, and organic richness.

Beacon Wind conducted site-specific geophysical, geotechnical, and benthic surveys across the Lease Area in Summer 2021. The surveys were designed to identify the dominant substrates in the Lease Area and to establish a pre-construction baseline and characterize potentially sensitive or important seafloor areas that may serve as EFH. The benthic survey methods (e.g., recommended equipment, procedures, lab analyses, etc.) were selected to meet federal guidance, including BOEM benthic survey guidance and NMFS recommendations for mapping essential fish habitat. Results of Beacon Wind's extensive surveys of the Lease Area using multibeam echo sounder, digital imagery, grab samples, and SPI/PV were used to characterize benthic habitat as predominantly homogeneous consisting of silty sand with small areas of sandy mud and a high occurrence of faunal beds dominated by tube-building fauna and amphipods The Lease Area is predominately sand in the shallower, more northerly portions with an increase of the silt/clay fraction at stations in the deeper, more southerly portion (Figure 3-3). The geophysical and geotechnical surveys confirmed that the Lease Area is predominantly flat with low rugosity and slope. The interpretation of benthic substrate indicated by backscatter was well-correlated with SPI/PV results. Grain size distribution was analyzed in sediment grab samples to ground-truth the SPI/PV results; and benthic infauna was sampled at 44 priority stations. Priority stations were identified as those having potential homogeneity and heterogeneity of seafloor conditions based on HRG survey data.

Results from the grain size analysis across the Lease Area indicated that the foundation sites mainly consisted of fine-grained particles that included very fine sand (0.125 to 0.0625 mm) and silt (0.0625 to 0.0039 mm). No boulder (256 to 4,096 mm) or cobbles (64 to 256 mm) were observed in these samples and 42 out of 157 samples included pebbles (4 to 64 mm). Fifteen samples did not contain any particles greater than 2.0 mm with the majority of these stations located in the northern portion of the Lease Area. All habitat in the Lease Area was classified by NOAA Habitat Complexity Category as soft-bottom habitat. Grain size analysis from a subset of the selected suction bucket trial locations showed that total gravel ranged from 0.0 – 2.1 percent, total sand ranged from 37.7 – 90.5 percent, and total silt and clay combined ranged from 9.4 – 62.1 percent. Average sediment TOC concentrations across the entire Lease Area ranged from 0.064 – 1.20 percent. Average sediment TOC for the selected suction bucket trial locations ranged from 0.315 – 1.170 percent.

No complex, hard-bottom habitat was observed in the 2021 survey of the Lease Area, other than areas of pebbles and muddy sandy gravel. However, artificial hard bottom in the form of shipwrecks does provide complex structure in the Lease Area. Beacon Wind has performed surveys to identify potential undiscovered wrecks and obstructions and has identified four shipwrecks within the area. These shipwrecks were avoided during the selection of the foundation testing locations.

Bedforms were observed large portions of the Lease Area during Beacon Wind's geotechnical and geophysical survey and include pitted seabed, ripples, and sorted bedforms, all of which indicate that the bottom currents are actively and episodically scouring, sorting, and redepositing the seabed sediments. Bedforms in the Lease Area evolve from classic depressions in the north to sand ripples in the west central region. Bedforms are delimited by the areas of rippled seabed and are concentrated in two areas, in the north and the west central portions of the Lease Area. Two of the foundation testing locations overlap with sand ripples in the central portion of the Lease Area (Figure 3-4).

3.2. Pelagic Habitat

The pelagic environment is particularly important for EFH species because it supports the growth of phytoplankton that sustain marine food webs, and it provides a dispersal mechanism for planktonic larvae of many managed species. Water depth influences surface and bottom temperatures, light penetration, sediment movement, and other physical and chemical habitat parameters that define EFH in the pelagic environment. Based on information from the high-resolution geophysical survey of the Lease Area, water depths in the Lease Area range from a shoal depth of 122 feet (37.2 meters) in the northwest to 206 feet (62.9 meters) in the southeast (Figure 3-5). The entire Lease Area is in the photic zone (i.e., top 600 feet [200 meters]), the top layer of the pelagic environment where sunlight supports photosynthesis (Karleskint et al. 2006). Phytoplankton are consumed by zooplankton (i.e., tiny animals such as copepods and larval forms of crustaceans, bivalves, and other invertebrates) and ichthyoplankton (fish larvae). The most numerically abundant component of the pelagic fish community in the open waters of the Lease Area is the ichthyoplankton assemblage. Buoyant eggs and larvae of most marine fishes in Southern New England can remain in the plankton for weeks to months (Walsh et al. 2015).

A number of finfish and invertebrate species with pelagic life stages occur within the Lease Area. During NEFSC seasonal trawl surveys in the MA WEA from 2003-2016, Atlantic herring, which is pelagic throughout its life, was the most numerically abundant species during the cold season (Guida et al. 2017). Other finfish and invertebrates with pelagic life stages that were collected during the NEFSC trawl surveys include species that are pelagic throughout their life (e.g., Atlantic mackerel, butterfish), species that have pelagic egg and larval stages (e.g., black sea bass, red hake, silver hake, witch flounder), and species that have pelagic juvenile and adult stages (e.g., longfin inshore squid). Other pelagic species that inhabit the Lease Area include highly migratory species (e.g., tunas, swordfish, sharks).

3.3. Benthic Epifauna and Infauna

Benthic samples were collected during two NEFSC–sponsored cruises (Guida et al. 2017) in the MA WEA in March and April in 2014, including 23 beam trawls for benthic epifauna and 30 triplicate Van Veen grabs for benthic infauna. Among the epibenthic fauna as obtained in beam trawls, there were no dominant species, but sand shrimp and sand dollars were considered the most dominant taxa. These results were anticipated as the area was documented by Guida et al. (2017) as consisting of largely sandy sediments particularly in the northern most portions of the MA WEA. The deeper, southern station locations showed a mix of sands and silts, habitat that is preferred by amphipods and polychaetes. The benthic infaunal assemblages resembled those observed and found to be common among OceanSAMP stations, described by LaFrance et al. (2010) as dominated by the amphipod *Ampelisca agassizi* and the bivalve *Nucula annulata*. This pattern suggests that, absent significant disturbance, benthic infaunal assemblages can be stable over periods of many years (LaFrance, 2010). The large number of "core" taxa in these MA WEA samples suggests that benthic assemblages from this WEA are closely related.

Benthic video and SPI/PV imagery collected during Beacon Wind's benthic survey of the Lease Area showed a biological assemblage with numerous burrows, bioturbation, polychaete/amphipod tubes, and macrobenthos. Three Coastal and Marine Ecological Classification Standard (CMECS) Components (Geoform, Biotic, and Substrate) were used to classify benthic habitats in the Lease Area. The foundation testing locations were classified into two Geoform Level 2 classes (Geologic-Flat or Biogenic-Burrows/Bioturbation), with twenty locations being classified as Geologic-Flat and six locations being classified as Biogenic-Burrows/Bioturbation (Figure 3-6). Testing locations were classified into one Biotic Subclass (Soft Sediment Fauna) and two Biotic Groups (Small Tube Building Fauna and Starfish Bed), with the majority of locations (81 percent) being classified as Small Tube Building Fauna (Figure 3-7). Testing locations were classified into three Substrate Groups (Muddy Sand, Sand, and Sandy Mud) with all but two of the 26 locations being classified as Muddy Sand (Figure 3-8). Three foundation testing locations were fully characterized during the benthic survey of the greater lease area, as summarized in Table 3-1 below. The number of taxa identified at these locations ranged from nine to forty-seven.

Arthropoda was the dominant taxon at two of these locations, and Annelida was the dominant taxon at the other location. Each of the three locations were classified as Muddy Sand.

Table 3-1. Summary of data for the three priority foundation testing locations

Lease Area Location	Number of Taxa	Dominant Taxa	Dominant Species	Successional Stage	Grain Size
BF36	47	Arthropoda (41%)	*Ampelisca vadorum*	I over III	Muddy Sand
BE37	51	Arthropoda (49%)	*Ampelisca vadorum*	I over III	Muddy Sand
BK30	9	Annelida (63%)	*Levinsenia gracilis*	I over III	Muddy Sand

The most dominant organism observed during Beacon Wind's benthic surveys were tube-dwelling amphipods, which were present at 85 percent of all stations. The dominant mobile epifauna was the sand dollar (*Echinarachnius parma*), followed by shrimp and hermit crabs. Sand dollars (*E. parma*) were observed in the northwestern portion of the Lease Area being most visually abundant at six stations. Sea stars (*Asterias* sp. and *Astropecten* sp.) were more abundant in the southern portion of the sampling area but were observed throughout the Lease Area (45 of 157 stations).

3.4. Demersal Fish and Invertebrates

The most commercially valuable demersal fish and invertebrates in the Lease Area include the Jonah crab, longfin squid, and silver hake. Other commercially valuable fish and invertebrates in the Lease Area include haddock, flounders, hakes, scup, black sea bass, bluefish, spiny dogfish, skates, groundfish species, horseshoe crab, ocean quahog, surfclam, sea scallops, lobsters, and Atlantic herring (Guida et al. 2017; Petruny-Parker et al. 2015). Although demersal fishes and invertebrates are closely associated with benthic habitats as adults, many species interact with overlying pelagic habitats through predator-prey interactions, early life stage dispersal, or seasonal migrations (Malek et al. 2014).

In anticipation of the development of offshore wind projects, experts from NOAA Fisheries and BOEM characterized fisheries resources within the MA WEA using long-term regional datasets and surveys within the WEA. The resulting habitat assessment highlighted several features of the Lease Area relevant to finfish and macroinvertebrates based upon analysis of data collected between 2003 and 2016: (1) the rarity of cod in the Lease Area; (2) the affinity of black sea bass with structures; (3) little skate, silver hake, and winter skate were dominant species in catches in both warm and cold seasons; (4) the other dominant species were seasonal migrants; (5) there has been a substantial seasonal shift in dominant species observed; (6) sea scallops and ocean quahogs were widespread and numerous; and (7) egg mops of longfin squid were not detected in the MA WEA (Guida et al. 2017).

Dominant commercially important species collected in NEFSC seasonal trawls (2003–2016) in the Lease Area were identified as Atlantic herring, little skate, silver hake, and winter skate in the cold season and butterfish, little skate, longfin squid, red hake, scup, silver hake, spiny dogfish, and winter skate in the warm season (Guida et al. 2017). Atlantic herring, butterfish, squid, and scup were seasonal migrants; the other species were year-round residents. Of the 56 taxa collected in cold-season NEFSC trawls, the little skate was dominant by percent catch by weight (greater than 40 percent) and frequency of catch (80 percent) in the cold season. Little skate was also the only species to occur consistently within the cold-season trawls in the Lease Area (Guida et al. 2017). The dominant species in the Lease Area by percentage of catch was Atlantic herring (55 percent). Warm-season NEFSC trawls in the Lease Area yielded 65 taxa (NEFSC 2021). The longfin squid was numerically dominant (approximately 35 percent of the total catch), with butterfish and scup making up the next 40 percent. Spiny dogfish were the dominant species by percent of catch by weight with 25 percent of the total species caught. For frequency of catch in the warm season, butterfish, little skate, long-finned squid, silver hake, and summer flounder had similar occurrences with 80 to 100 percent caught from each trawl (Guida et al. 2017).

Numerous fish species were observed during Beacon Wind's benthic survey in the Lease Area. The most abundant fish in the PV imagery were right eye flounders (Pleuronectidae, 30 individuals), unidentified fish (20 individuals), and sea robins (12 individuals). Skates were observed at 30 stations. Jonah crabs were present in 27 of the 375 PV images taken throughout the Lease Area. The results observed from the Lease Area benthic habitat study are congruent with the summary of resources in the Lease Area in Guida et al. (2017) and other sources, which reported the dominance of skates, specifically little skate and winter skate.

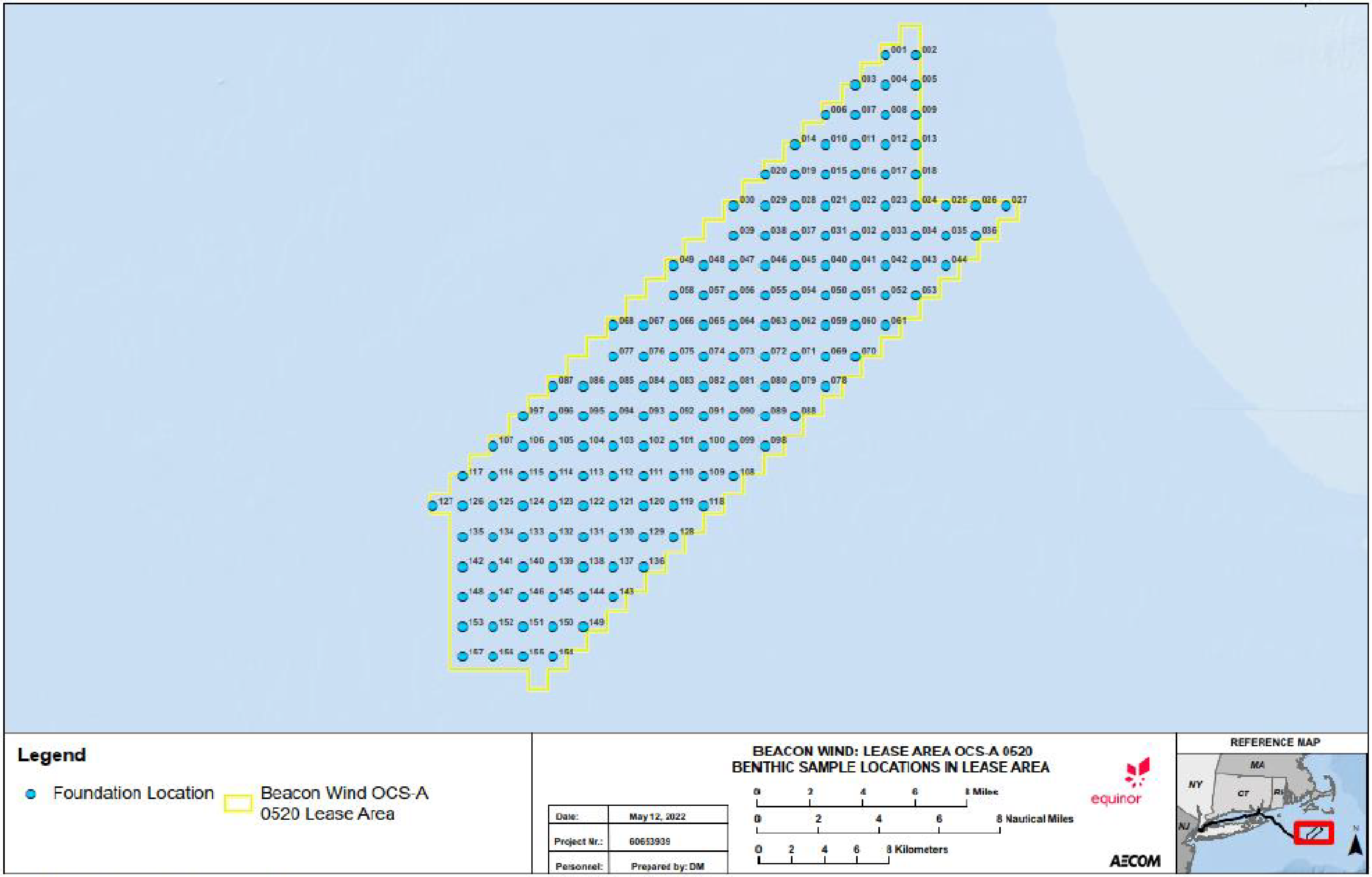

Figure 3-1. Foundation locations where SPI/PV and benthic grab samples were collected during surveys of the Lease Area in 2021

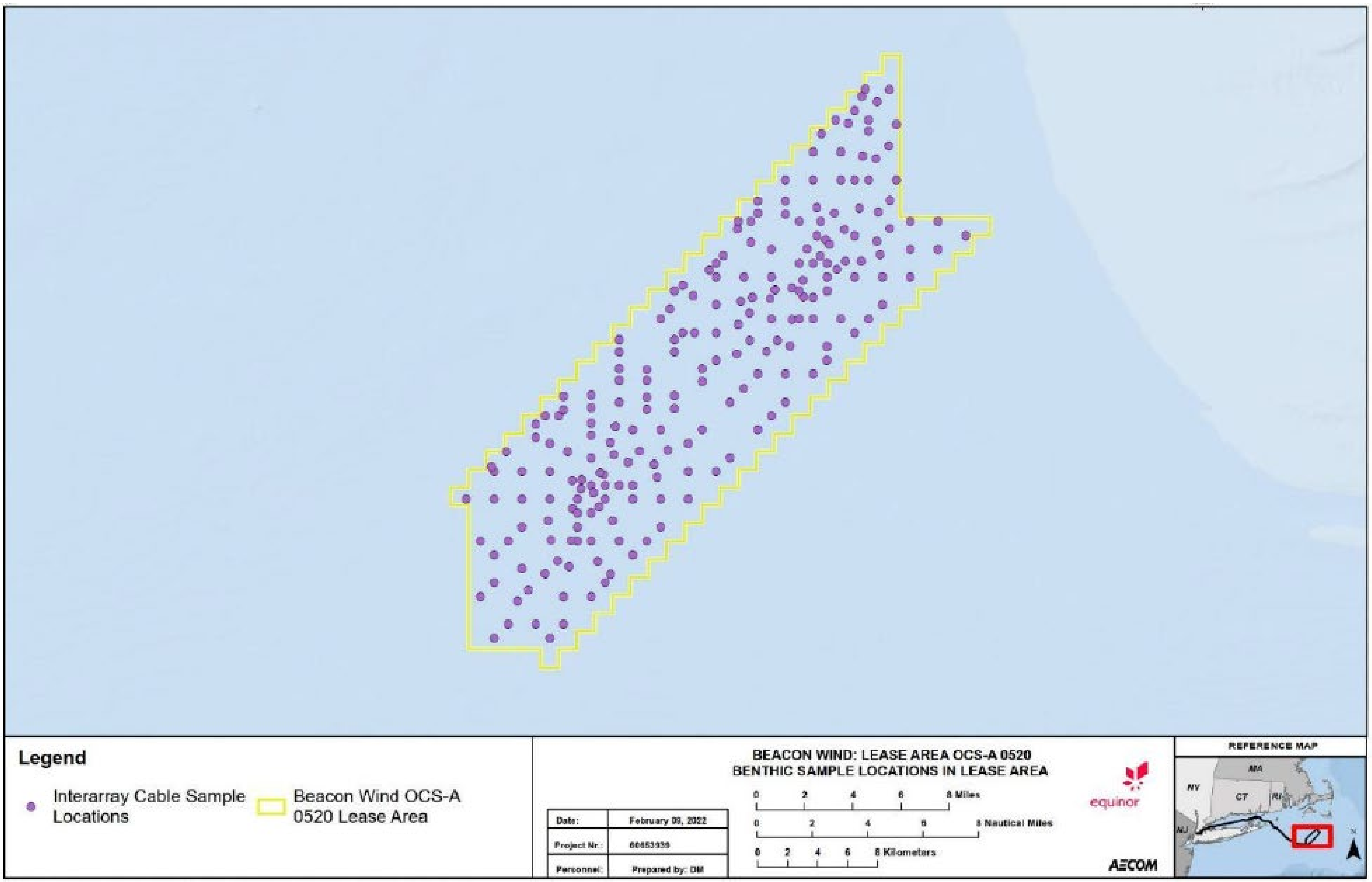

Figure 3-2. Interarray cable locations where SPI/PV samples were collected during surveys of the Lease Area in 2021

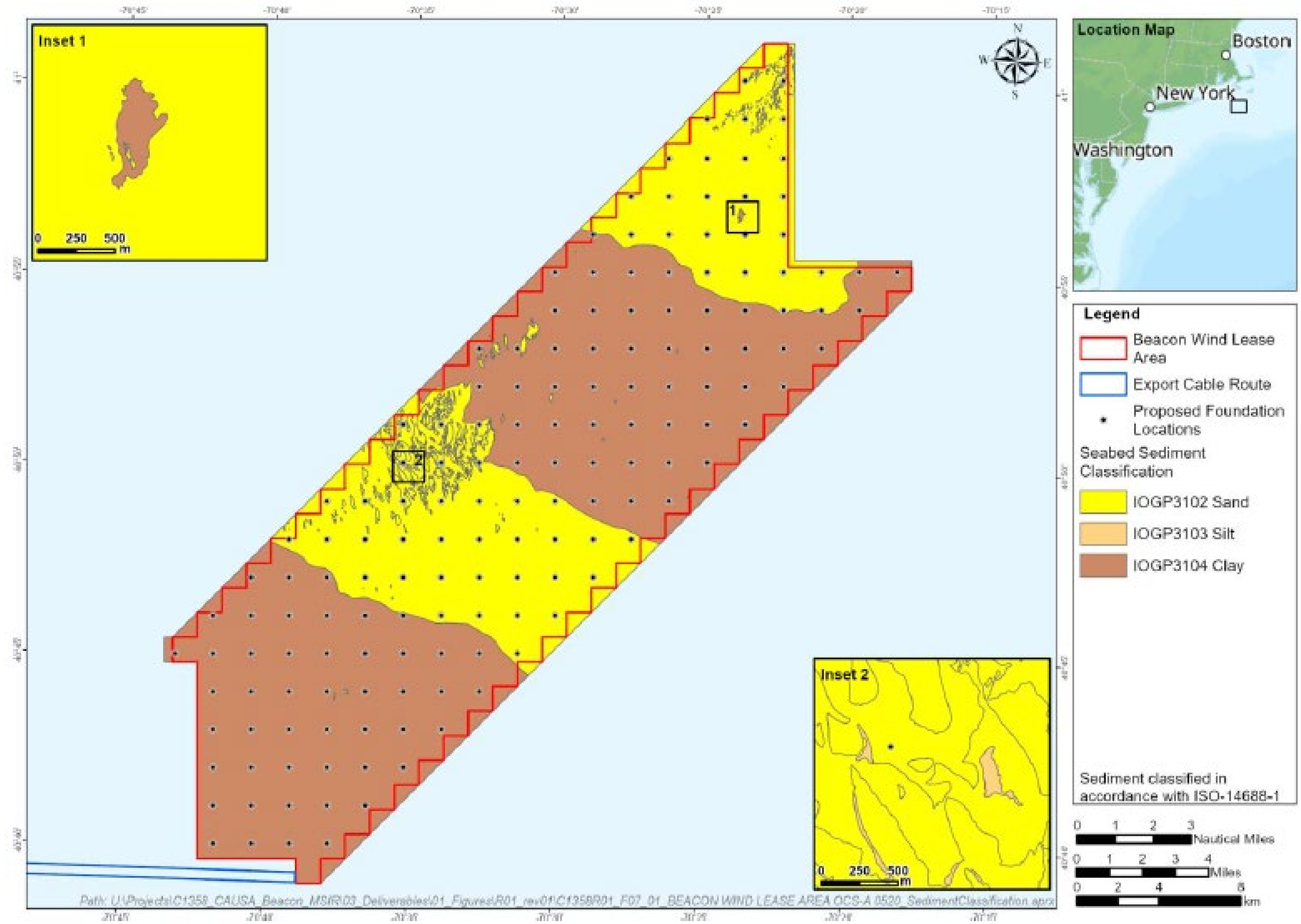

Figure 3-3. Seabed sediment types and features in the Lease Area

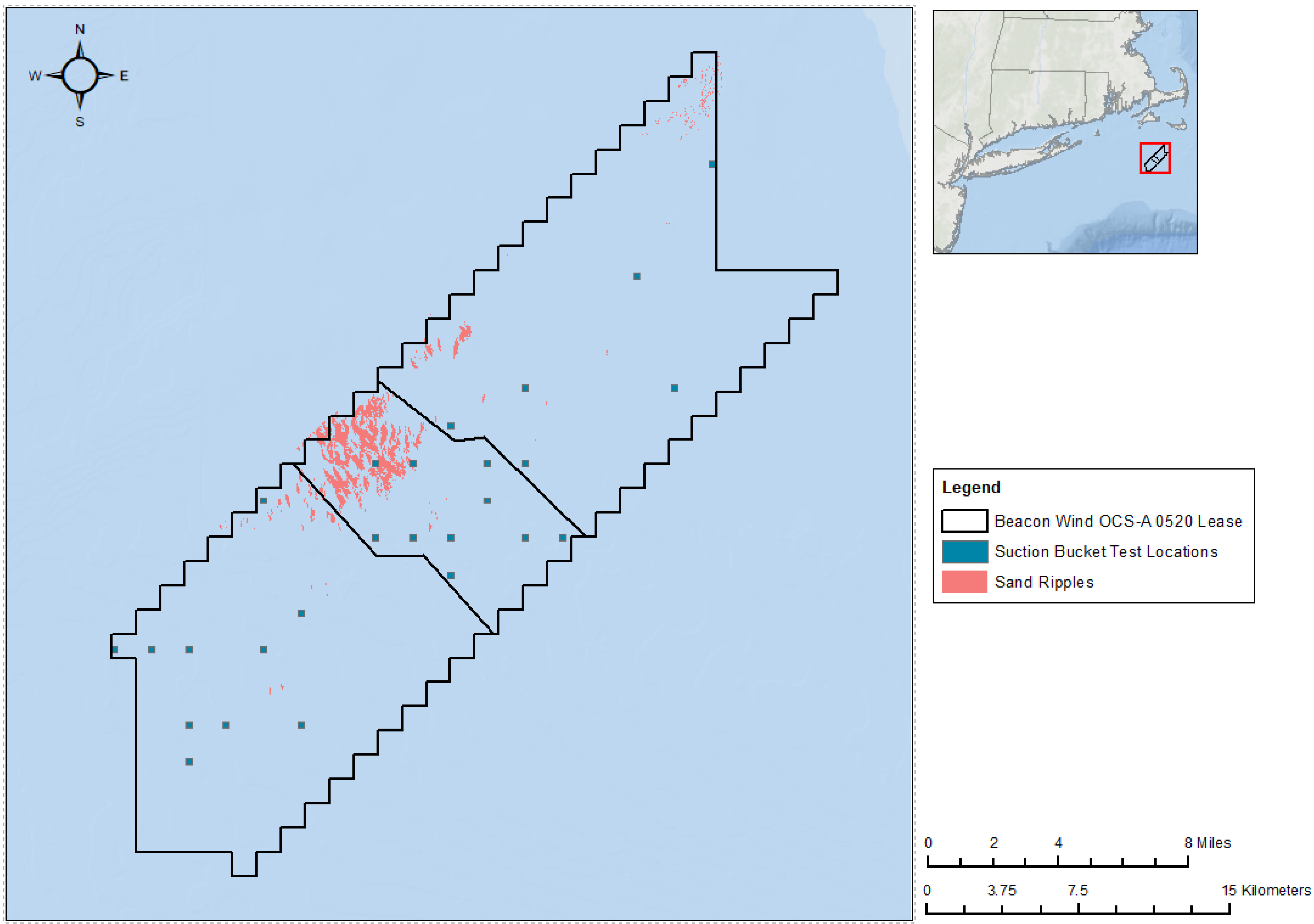

Figure 3-4. Bedform distribution in the Lease Area relative to foundation testing locations

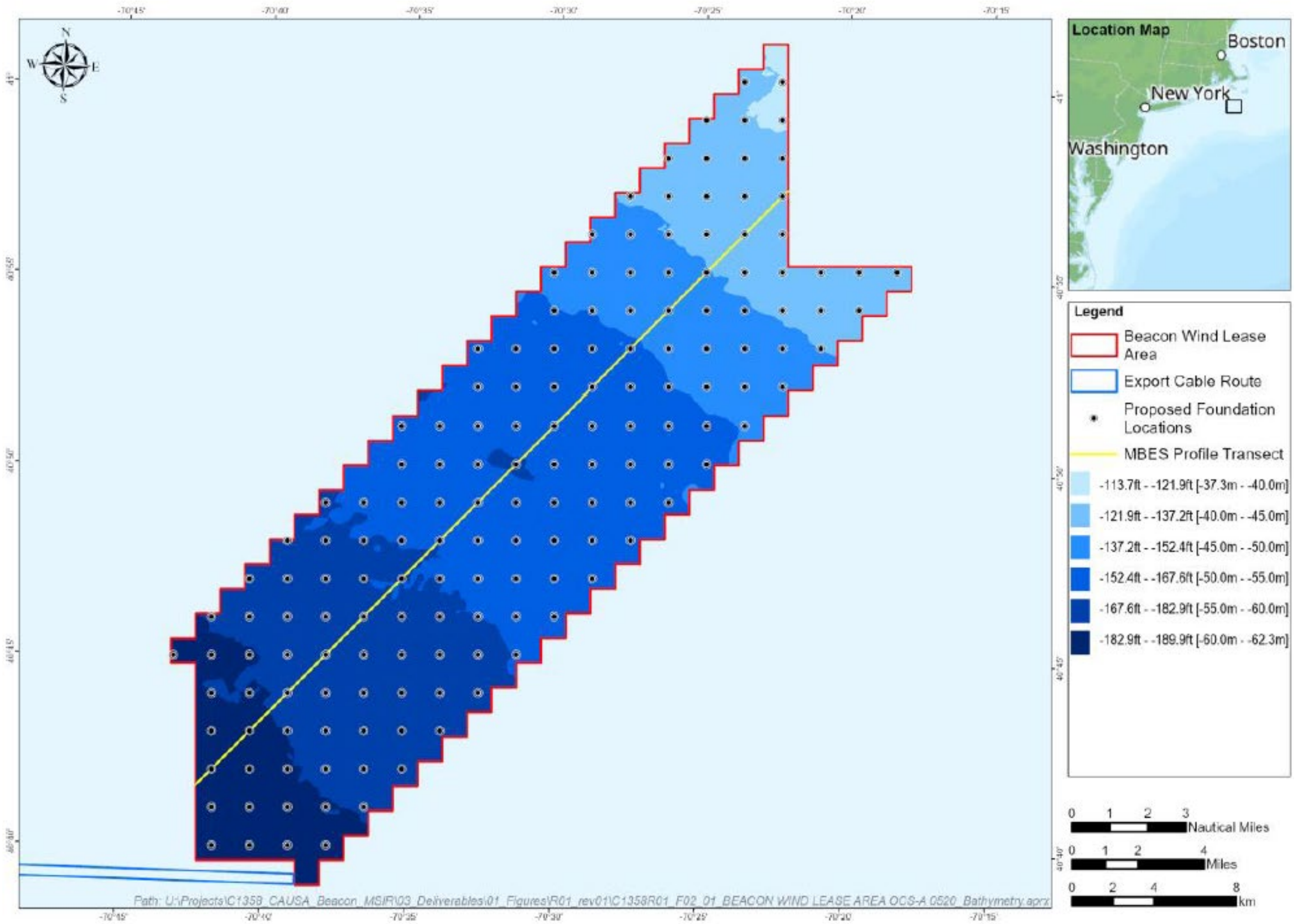

Figure 3-5. Bathymetry in the Lease Area

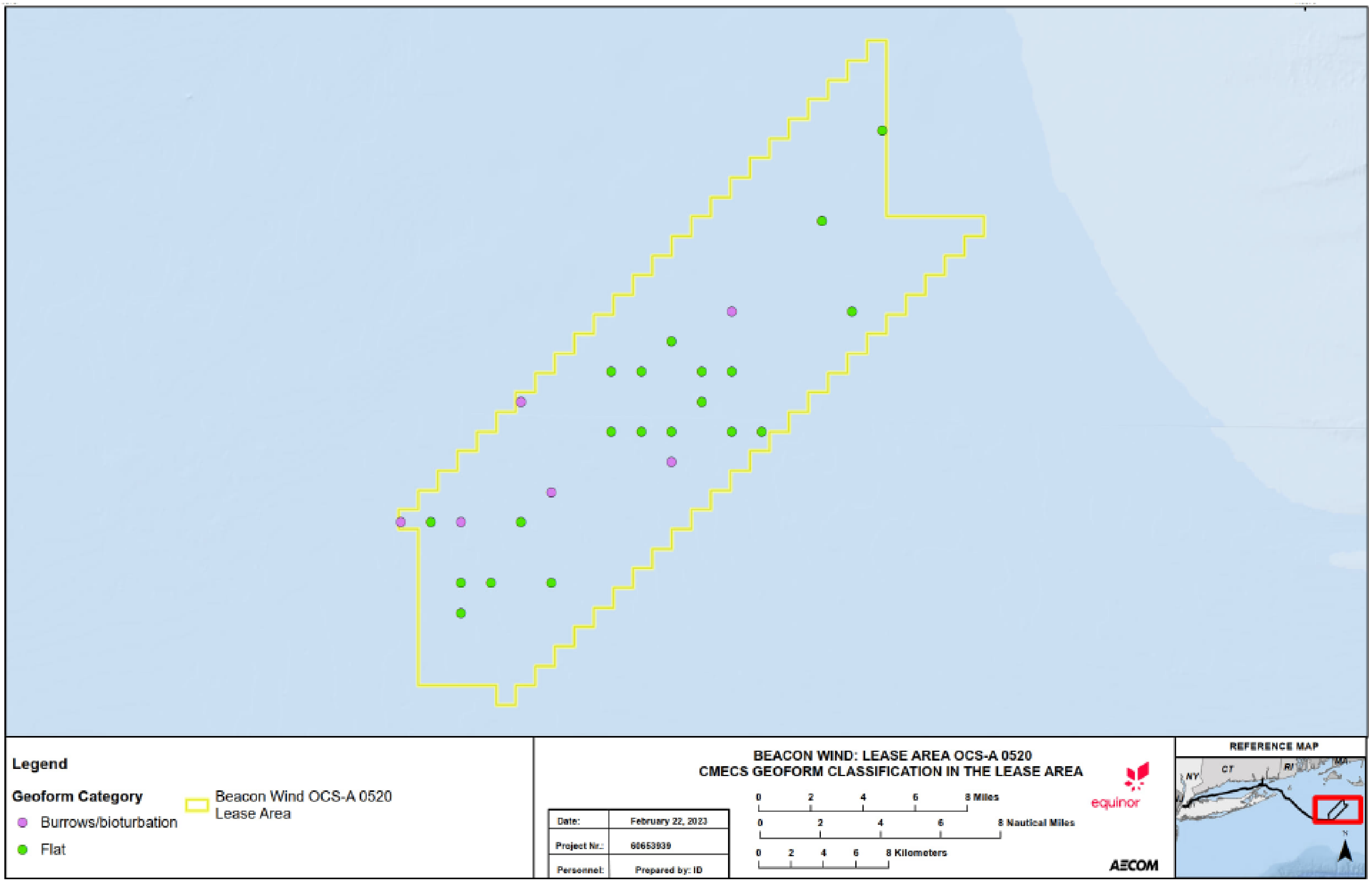

Figure 3-6. CMECS geoform classification at foundation testing locations

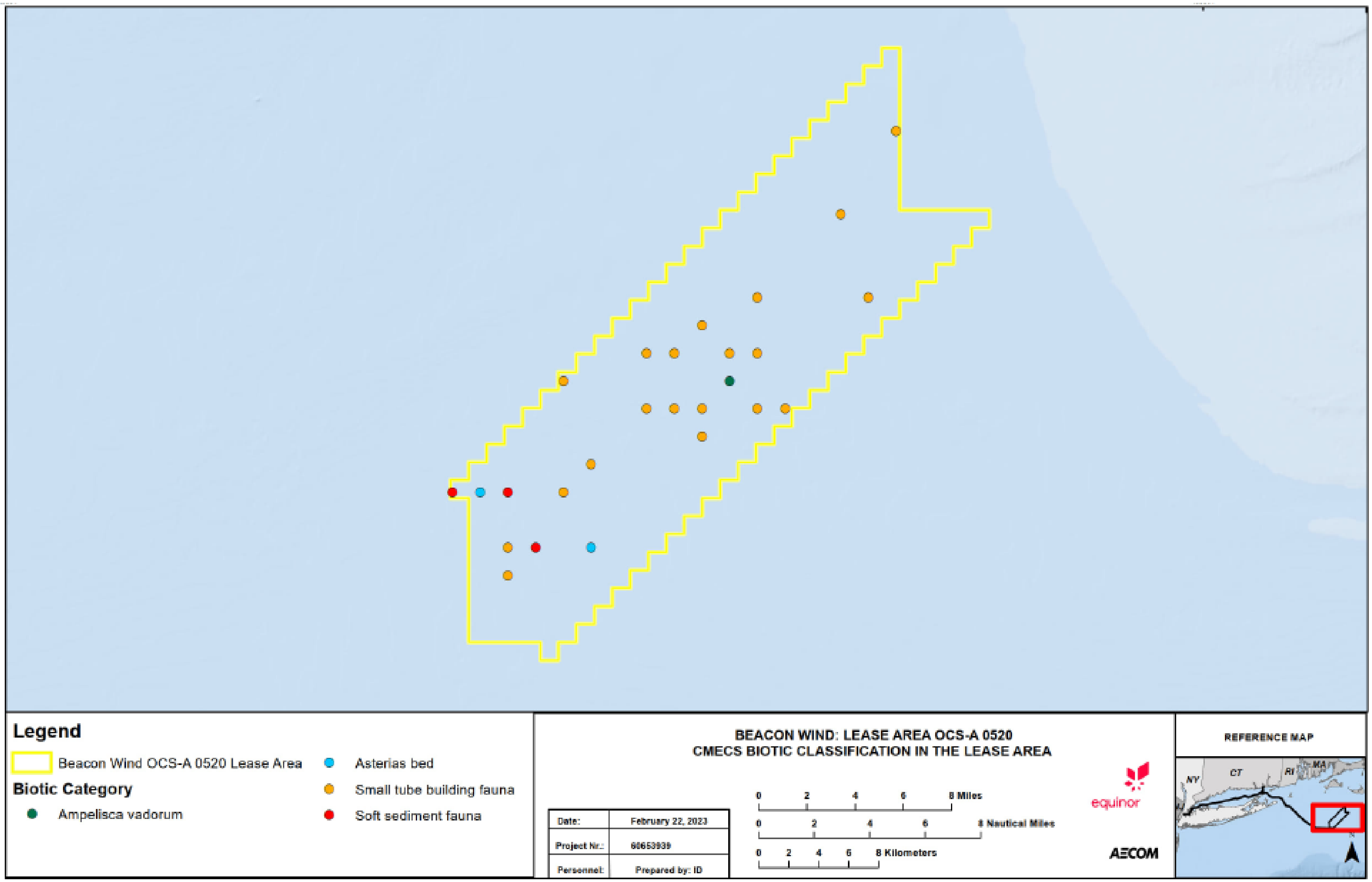

Figure 3-7. CMECS biotic classification at foundation testing locations

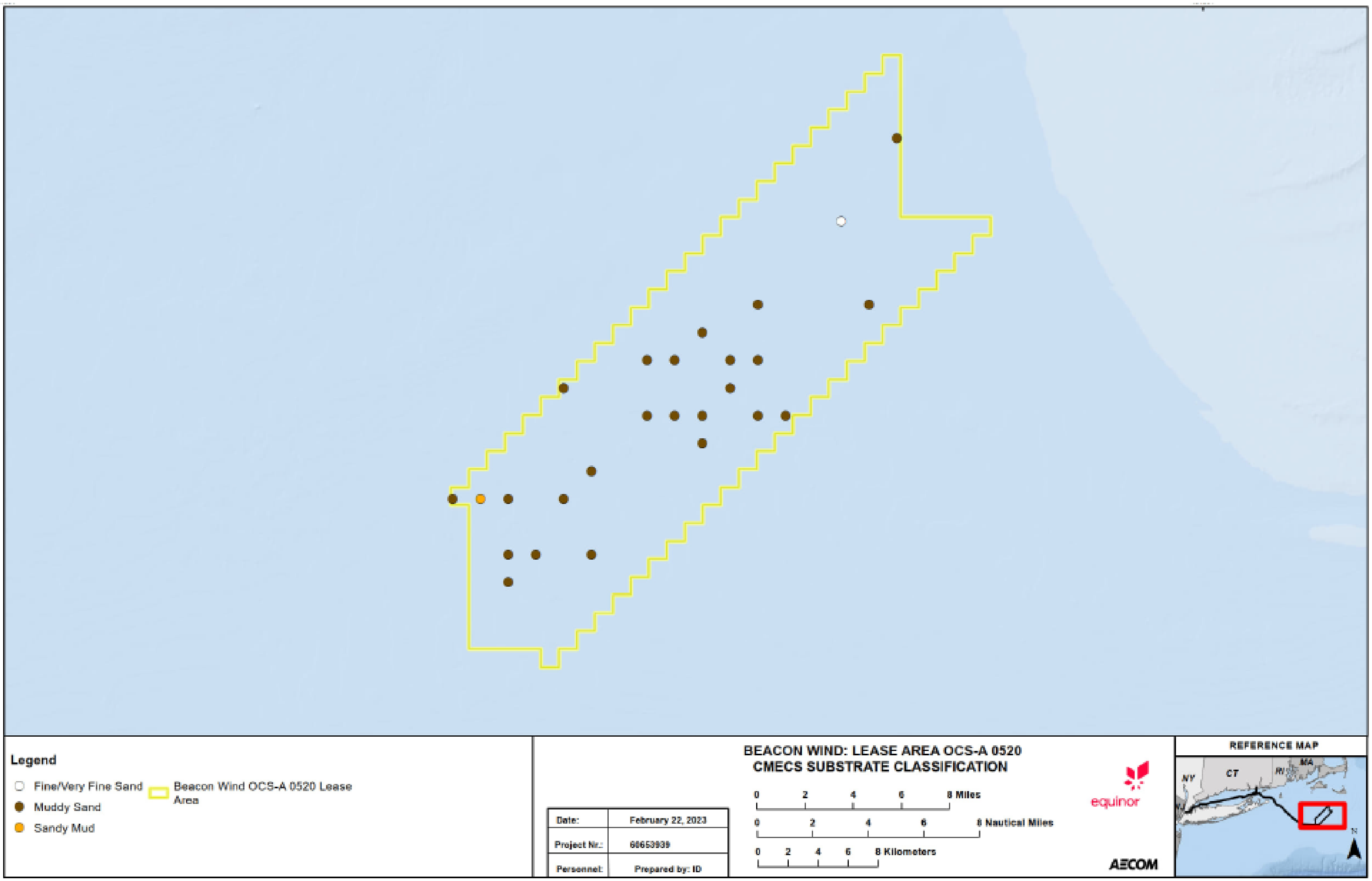

Figure 3-8. NMFS-modified CMECS classifications for the substrate components at foundation testing locations

4. Designated EFH

The Lease Area includes EFH designated by the New England Fishery Management Council (NEFMC), the Mid-Atlantic Fishery Management Council (MAFMC), and NMFS. EFH designations are made for species in association with a mapped grid of 10- by 10-minute quadrangles covering all marine habitat along the U.S. coast. The quadrangles are used by the NEFMC and the MAFMC to delineate specific areas for the purpose of EFH designations. Species and life stages with EFH in the vicinity of the Proposed Action were identified using the NMFS EFH Mapper (NMFS 2023). For the purposes of this assessment, EFH descriptions and habitat designations for all species and life stages identified using the NMFS EFH Mapper were primarily developed from NMFS EFH source documents, the Final Omnibus Essential Fish Habitat Amendment 2 (NEFMC 2017), and the Final Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species FMP (NMFS 2017).

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

Table 4-1. **EFH-designated fish and invertebrate species within the Lease Area.**

EFH Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Gadids					
Atlantic cod *Gadus morhua*	●	●	●	●	**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 certain bays and estuaries. **Juveniles:** Intertidal and sub-tidal 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. 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. **Adults**: Sub-tidal 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 certain 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.
Haddock *Melanogrammus aeglefinus*	--	●	●	●	**Larvae:** Pelagic habitats in coastal and offshore waters in the Gulf of Maine, the Mid-Atlantic, and on Georges Bank. **Juveniles**: Sub-tidal 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. **Adults:** Sub-tidal 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.

EFH Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Pollock *Pollachius virens*	●	●	●	--	**Eggs**: Pelagic inshore and offshore habitats in the Gulf of Maine, on Georges Bank, and in southern New England, including certain bays and estuaries. **Larvae:** Pelagic inshore and offshore habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, including certain bays and estuaries. **Juveniles:** 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 several 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.
Offshore hake *Merluccius albidus*	--	●	--	--	**Larvae:** Pelagic habitats along the outer continental shelf and slope between 60 and 1500 meters.
Red hake *Urophycis chuss*	●	●	●	●	**Eggs and Larvae:** Pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic, and in certain bays and estuaries. **Juveniles:** Intertidal and sub-tidal benthic habitats throughout the region on mud and sand substrates, to a maximum depth of 80 meters, including certain bays and estuaries. Bottom habitats providing shelter are essential for juvenile red hake, including: mud substrates with biogenic depressions, substrates providing biogenic complexity (e.g., eelgrass, macroalgae, shells, anemone and polychaete tubes), and artificial reefs. Newly settled juveniles occur in depressions on the open seabed. Older juveniles are commonly associated with shelter or structure and often inside live bivalves. **Adults:** Benthic habitats in the Gulf of Maine and the outer continental shelf and slope in depths of 50 – 750 meters and as shallow as 20 meters in several inshore estuaries and embayments as far south as Chesapeake Bay. Shell beds, soft sediments (mud and sand), and artificial reefs provide essential habitats for adult red hake. They are usually found in depressions in softer sediments or in shell beds and not on open sandy bottom.

EFH Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Silver hake *Merluccius bilinearis*	●	●	●	●	**Eggs and Larvae:** Pelagic habitats from the Gulf of Maine to Cape May, New Jersey, including Cape Cod and Massachusetts Bays. **Juveniles:** Pelagic and benthic habitats in the Gulf of Maine, including certain 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. **Adults:** Pelagic and benthic habitats at depths greater than 35 meters in the Gulf of Maine and certain 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.
White hake *Urophycis tenuis*	●	--	●	--	**Eggs:** Pelagic habitats in the Gulf of Maine, including Massachusetts and Cape Cod bays, and the outer continental shelf and slope. **Juveniles:** Intertidal and sub-tidal estuarine and marine habitats in the Gulf of Maine, on Georges Bank, and in southern New England, to a maximum depth of 300 meters. Pelagic phase juveniles remain in the water column for about two months. In nearshore waters, essential fish habitat for benthic phase juveniles occurs on fine-grained, sandy substrates in eelgrass, macroalgae, and un-vegetated habitats. In the Mid-Atlantic, most juveniles settle to the bottom on the continental shelf, but some enter estuaries, especially those in southern New England. Older young-of-the-year juveniles occupy the same habitat types as the recently-settled juveniles but move into deeper water (>50 meters).

EFH Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Flatfish					
American plaice *Hippoglossoides platessoides*	●	●	--	--	**Eggs:** Pelagic habitats in the Gulf of Maine and on Georges Bank, including the high salinity zones of the bays and estuaries. **Larvae:** Pelagic habitats in the Gulf of Maine, on Georges Bank, and in southern New England, including the high salinity zones of the bays and estuaries.
Summer flounder *Paralichthys dentatus*	●	●	●	●	**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]). 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 abundance is highest at depths of 30 to 360 feet. **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). Inshore, EFH is all estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database, in the "mixing" (defined in ELMR as 0.5 to 25.0 parts per thousand [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 feet. 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. **Juveniles:** North of Cape Hatteras, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ). Inshore, EFH is all 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. **Adults:** 1) North of Cape Hatteras, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ). 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 zones. Generally, summer flounder inhabit shallow coastal and estuarine waters ranging in depths from 1 to 82 feet, with an extensive range of salinities, during warmer months and move offshore on the outer continental shelf at depths of 500 feet in colder months.

EFH Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Winter flounder *Pseudopleuronectes americanus*	--	●	●	●	**Larvae:** Estuarine, coastal, and continental shelf water column habitats from the shoreline to a maximum depth of 70 meters from the Gulf of Maine to Absecon Inlet, and including Georges Bank, including mixed and high salinity zones in certain bays and estuaries. 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 age. **Juveniles:** Estuarine, coastal, and continental shelf benthic habitats from the Gulf of Maine to Absecon Inlet, and including Georges Bank, and in mixed and high salinity zones in certain bays and estuaries. Essential fish habitat for juvenile winter flounder extends from the intertidal zone to a maximum depth of 60 meters and occurs on a variety of bottom types, such as mud, sand, rocky substrates with attached macroalgae, tidal wetlands, and eelgrass. Young-of-the-year juveniles are found inshore on muddy and sandy sediments in and adjacent to eelgrass and macroalgae, in bottom debris, and in marsh creeks. They settle to the bottom in soft-sediment depositional areas where currents concentrate late-stage larvae and disperse into coarser-grained substrates as they age. **Adults:** Estuarine, coastal, and continental shelf benthic habitats extending from the intertidal zone to a maximum depth of 70 meters from the Gulf of Maine to Absecon Inlet, and including Georges Bank, and in mixed and high salinity zones in certain bays and estuaries. Essential fish habitat for adult winter flounder occurs on muddy and sandy substrates, and on hard bottom on offshore banks. In inshore spawning areas, essential fish habitat includes a variety of substrates where eggs are deposited on the bottom.
Windowpane flounder *Scophthalmus aquosus*	●	●	●	●	**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. **Juveniles:** Intertidal and sub-tidal 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 bays and estuaries. Essential fish habitat for juveniles occurs on mud and sand substrates and extends from the intertidal zone to a depth of 60 meters. **Adults:** Intertidal and sub-tidal 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 bays and estuaries. Essential fish habitat for adults occurs on mud and sand substrates and extends from the intertidal zone to a depth of 70 meters.
Witch flounder *Glyptocephalus cynoglossus*	●	●	--	●	**Eggs and Larvae**: Pelagic habitats on the continental shelf throughout the Northeast region. **Adults:** Sub-tidal 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.

EFH Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Yellowtail flounder *Limanda ferruginea*	●	●	●	●	**Eggs:** Coastal and continental shelf pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region as far south as the upper Delmarva peninsula, including high salinity zones of certain bays and estuaries. **Larvae:** Coastal marine and continental shelf pelagic habitats in the Gulf of Maine, and from Georges Bank to Cape Hatteras, including high salinity zones of bays and estuaries. **Juveniles:** Sub-tidal 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 certain 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. **Adults:** Sub-tidal 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 certain bays and estuaries. 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.
Other Finfish					
Atlantic butterfish *Peprilus triacanthus*	●	●	●	●	**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. **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. **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. **Adults:** EFH is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico 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.

EFH Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Atlantic mackerel *Scomber scombrus*	●	●	●	●	**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. **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. **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. **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.
Atlantic sea herring *Clupea harengus*	●	●	●	●	**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. **Larvae:** Inshore and offshore pelagic habitats in the Gulf of Maine, on Georges Bank, and in the upper Mid-Atlantic Bight, and in certain bays and estuaries. 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. **Juveniles:** Intertidal and sub-tidal pelagic habitats to 300 meters throughout the region, including certain 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. **Adults:** Sub-tidal pelagic habitats with maximum depths of 300 meters throughout the region, including certain bays and estuaries. Adults make extensive seasonal migrations between summer and fall spawning grounds on Georges Bank and the Gulf of Maine and overwintering areas in southern New England and the Mid-Atlantic region. They seldom migrate beyond a depth of about 100 meters and – unless they are preparing to spawn – usually remain near the surface. They generally avoid water temperatures above 10°C and low salinities. Spawning takes place on the bottom, generally in depths of 5 – 90 meters on a variety of substrates (see eggs).

EFH Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Black sea bass *Centropristis striata*	--	--	●	--	**Juveniles:** Offshore, EFH is the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. 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 occur in estuaries in summer and spring. Generally, juveniles occur in waters warmer than 43°F with salinities greater than 18 ppt and coastal areas between Virginia and Massachusetts. Juveniles 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.
Bluefish *Pomatomus saltatrix*	--	●	●	●	**Larvae:** North of Cape Hatteras, pelagic waters over the continental shelf, most commonly above 49 feet (15 meters), from Montauk Point south to Cape Hatteras. Bluefish larvae are not generally collected inshore, so there is no EFH designation inshore for larvae. Generally, bluefish larvae are collected April through September in temperatures greater than 64 °F (18°C) in normal shelf salinities (> 30 ppt). **Juveniles:** 1) North of Cape Hatteras, pelagic waters found over the continental shelf from Nantucket Island south to Cape Hatteras and 2) all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida. Generally, juvenile bluefish occur in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from May through October, and South Atlantic estuaries March through December, within the "mixing" and "seawater" zones. Distribution of juveniles by temperature, salinity, and depth over the continental shelf is undescribed. **Adults:** 1) North of Cape Hatteras, over the continental shelf (from the coast out to the limits of the EEZ), from Cape Cod Bay south to Cape Hatteras and 2) all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida. Adult bluefish are found in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from April through October, and in South Atlantic estuaries from May through January in the "mixing" and "seawater" zones. Bluefish adults are highly migratory and distribution varies seasonally according to the size of the individuals comprising the schools. Bluefish are generally found in normal shelf salinities (> 25 ppt).

EFH Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Monkfish *Lophius americanus*	●	●	●	●	**Eggs and 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. **Juveniles:** Sub-tidal 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. **Adults:** Sub-tidal 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. 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.
Ocean pout *Macrozoarces americanus*	●	--	●	●	**Eggs**: Hard-bottom habitats in the Gulf of Maine, Georges Bank, and in the Mid-Atlantic Bight, as well as the high-salinity zones in certain estuaries. Eggs are laid in gelatinous masses, generally in sheltered nests, holes, or rocky crevices. Essential fish habitat for ocean pout eggs occurs in depths less than 100 meters on rocky bottom habitats. **Juveniles:** Intertidal and sub-tidal benthic habitats in the Gulf of Maine and on the continental shelf north of Cape May, New Jersey, on the southern portion of Georges Bank, and in the high salinity zones of bays and estuaries north of Cape Cod, extending to a maximum depth of 120 meters. Essential fish habitat for juvenile ocean pout occurs on a wide variety of substrates, including shells, rocks, algae, soft sediments, sand, and gravel. **Adults**: Sub-tidal benthic habitats between 20 and 140 meters in the Gulf of Maine, on Georges Bank, in coastal and continental shelf waters north of Cape May, New Jersey, and in the high salinity zones of bays and estuaries north of Cape Cod. Essential fish habitat for adult ocean pout includes mud and sand, particularly in association with structure forming habitat types (i.e., shells, gravel, or boulders). In softer sediments, they burrow tail first and leave a depression on the sediment surface. Ocean pout congregate in rocky areas prior to spawning and frequently occupy nesting holes under rocks or in crevices in depths less than 100 meters.

EFH Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Scup *Stenotomus chrysops*	--	--	●	●	**Juveniles:** 1) 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. 2) 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. 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. **Adults:** 1) 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. 2) 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.
Highly Migratory Species					
Albacore tuna *Thunnus alalunga*	--	--	●	●	**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. **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.
Bluefin tuna *Thunnus thynnus*	--	--	●	●	**Juveniles:** Coastal and pelagic habitats of the Mid-Atlantic Bight and the Gulf of Maine, between southern Maine and Cape Lookout, 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 meters deep). EFH in other locations associated with temperatures ranging from 4 to 26 °C, often in depths of less than 20 meters (but can be found in waters that are 40-100 meters in depth in winter). **Adults:** EFH is 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 Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Skipjack tuna *Katsuwonus pelamis*	--	--	●	●	**Juveniles:** Offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank (off Massachusetts); 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. In all areas juveniles are found if waters greater than 20 meters. **Adults:** Coastal and offshore habitats between Massachusetts and Cape Lookout, North Carolina and localized areas in the Atlantic off South Carolina and Georgia, and the northern east coast of Florida. EFH in the Atlantic Ocean also located on the Blake Plateau and in the Florida Straits through the Florida Keys.
Yellowfin tuna *Thunnus albacares*	--	--	●	●	**Juveniles**: Offshore pelagic habitats are seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank and Cape Cod, Massachusetts, and offshore and coastal habitats from Cape Cod to the mid-east coast of Florida and the Blake Plateau. Juveniles are locally distributed in the Florida Straits and off the southwestern edge of the West Florida Shelf. Yellowfin tuna juveniles are also found in the central Gulf of Mexico from the Florida Panhandle to southern Texas. Localized EFH is southeast of Puerto Rico. **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 Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Invertebrates					
Atlantic sea scallop *Placopecten magellanicus*	●	●	●	●	**Eggs:** Benthic habitats in inshore areas and on the continental shelf, near adult scallops. Eggs are heavier than seawater and remain on the seafloor. **Larvae:** Benthic and water column habitats in inshore and offshore areas throughout the region. Any hard surface can provide an essential habitat for settling pelagic larvae ("spat"), including shells, pebbles, and gravel. They also attach to macroalgae and other benthic organisms such as hydroids. Spat attached to sedentary branching organisms or any hard surface have greater survival rates. **Juveniles:** Benthic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic, in depths of 18 to 110 meters. Juveniles leave the original substrate on which they settle and attach themselves by byssal threads to shells, gravel, and small rocks, preferring gravel. As they grow older, they lose their byssal attachment. Juvenile scallops are relatively active and swim to escape predation. While swimming, they can be carried long distances by currents. Bottom currents stronger than 10 centimeters/second retard feeding and growth. In laboratory studies, maximum survival of juvenile scallops occurred between 1.2 and 15°C and above salinities of 25 ppt. On Georges Bank, age-1 juveniles are less dispersed than older juveniles and adults and are mainly associated with gravel-pebble deposits. Essential habitats for older juvenile scallops are the same as for the adults (gravel and sand). **Adults:** Benthic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic. Essential habitats for 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 and whether oceanographic features keep larval stages near the spawning population. Bottom currents stronger than 25 centimeters/second inhibit feeding. Growth of adult scallops is optimal between 10 and 15°C and they prefer full strength seawater.
Ocean quahog *Arctica islandica*	--	--	●	●	**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. 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.

EFH Species	Life Stage				EFH Description
	Eggs	Larvae	Juvenile	Adult	
Longfin inshore squid *Doryteuthis pealeii*	●	--	●	●	**Eggs:** Inshore and offshore bottom habitats from Georges Bank 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. Eggs have also been collected in bottom trawls in deeper water at various places on the continental shelf. Egg masses are demersal and anchored to the substrates on which they are laid. Substrates include a variety of hard bottom types (e.g., shells, boulders), submerged aquatic vegetation, sand, and mud. **Juveniles: P**elagic 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. Pre-recruits are generally found over bottom depths of 6-160 meters, bottom water temperatures of 8.5-24.5°C, and salinities of 28.5-36.5 ppt. Pre-recruits migrate offshore in the fall where they overwinter in deeper waters along the edge of the shelf. Small individuals feed on planktonic organisms while larger individuals feed on crustaceans and fish. **Adults:** Pelagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, inshore waters of the Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, Raritan Bay, and Delaware Bay. Recruits are generally found over bottom depths of 6-200 meters, bottom water temperatures of 8.5-14°C, and salinities of 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. 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.

Notes:
• = present
-- = not present
EEZ = Exclusive Economic Zone
EFH = Essential Fish Habitat
m = meters
OCS = Outer Continental Shelf
ppt = parts per thousand
SAV = submerged aquatic vegetation

Table 4-2. EFH-designated elasmobranchs within the Lease Area

EFH Species	Life Stage			EFH Description
	Neonate	Juvenile	Adult	
Skates				
Barndoor skate *Dipturus laevis*	--	●	●	**Juveniles and Adults:** Benthic habitats on the continental shelf, primarily on Georges Bank and in southern New England, in depths of 40 – 400 meters, and on the continental slope to a maximum depth of 750 meters. Essential fish habitat for juvenile and adult barndoor skates occurs on mud, sand, and gravel substrates. Both life stages are usually found on the continental shelf in depths less than 160 meters, but the adults also occupy benthic habitats between 300 and 400 meters on the outer shelf.
Little skate *Leucoraja erinacea*	--	●	●	**Juveniles:** Intertidal and sub-tidal 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, and including high salinity zones in certain bays and estuaries. Essential fish habitat for juvenile little skates occurs on sand and gravel substrates, but they are also found on mud. **Adults**: Intertidal and sub-tidal 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 certain bays and estuaries. Essential fish habitat for adult little skates occurs on sand and gravel substrates, but they are also found on mud.
Winter skate *Leucoraja ocellata*	--	●	●	**Juveniles and Adults**: Benthic habitats with mud and sand substrates on the outer continental shelf in depths of 80 – 400 meters from approximately 40˚N latitude to Cape Hatteras, North Carolina.
Sharks				
Basking shark *Cetorhinus maximus*	●	●	●	**Neonate, Juveniles, and Adults:** At this time, 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. Atlantic east coast from the Gulf of Maine to the northern Outer Banks of North Carolina, and from mid-South Carolina to coastal areas of northeast Florida. Aggregations of basking sharks were observed from the south and southeast of Long Island, east of Cape Cod, and along the coast of Maine, in the Gulf of Maine and near the Great South Channel, approximately 95 km southeast of Cape Cod, Massachusetts as well as approximately 75 km south of Martha's Vineyard and 90 km south of Moriche's Inlet, Long Island. These aggregations tend to be associated with persistent thermal fronts within areas of high prey density.
Blue shark *Prionace glauca*	●	●	●	**Neonate:** In the Atlantic in areas offshore of Cape Cod through New Jersey, seaward of the 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. **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 off Florida.

EFH Species	Life Stage			EFH Description
	Neonate	Juvenile	Adult	
Common thresher *Alopias vulpinus*	●	●	●	**Neonates, Juveniles, and Adults**: Insufficient data are available to differentiate EFH between the juvenile and adult size classes; therefore, EFH is the same for those life stages. EFH is 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 of 18.2-20.9°C and at depths of 4.6-13.7 meters.
Dusky shark *Carcharhinus obscurus*	●	●	●	**Neonate:** 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 meters. Seaward extent of EFH for this life stage in the Atlantic is 60 meters in depth. **Juveniles and 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.
Porbeagle shark *Lamna nasus*	●	●	●	**Neonate, Juveniles, and Adults:** 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.
Sandbar shark *Carcharhinus plumbeus*	--	--	●	**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.
Shortfin mako shark *Isurus oxyrinchus*	●	●	●	**General habitat description**: The shortfin mako shark is a pelagic, oceanic species that inhabits warm and warm-temperate waters throughout all oceans. **Neonates, Juveniles, and Adults**: Pelagic waters in the Atlantic from southern New England through Cape Lookout, and specific areas off Maine, South Carolina, and Florida.

EFH Species	Life Stage			EFH Description
	Neonate	Juvenile	Adult	
Tiger shark *Galeocerdo cuvieri*	--	●	●	**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.
White shark *Carcharadon carcharias*	●	●	●	**Neonate:** EFH includes inshore waters out to 105 kilometers from Cape Cod, Massachusetts, to an area offshore of Ocean City, New Jersey. **Juveniles and adults:** Known EFH includes inshore waters to habitats 105 kilometers from shore, in water temperatures ranging from 9 to 28 °C, but more commonly found in water temperatures from 14 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.
Spiny dogfish *Squalus acanthias*	--	sf	f/m	**Female Sub-Adults:** Pelagic and epibenthic habitats throughout the region. Sub-adult females occur over a wide depth range in full salinity seawater (32-35 ppt) where bottom temperatures range from 7-15°C. Sub-adult females 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. **Female Adults:** Pelagic and epibenthic habitats throughout the region. Adult females occur over a wide depth range in full salinity seawater (32-35 ppt) where bottom temperatures range from 7-15°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. **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.
Smoothhound shark complex *Mustelus spp.*	●	●	●	**Neonate, Juvenile, and Adult:** Available information is insufficient for the identification of EFH for this life stage, therefore, all life stages are combined in the EFH designation. EFH identified in the Atlantic is exclusively for smooth dogfish. 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.

Notes:

• = present
-- = not present
sf = sub-females
f = female
m = male
YOY = young-of-year

EEZ = Exclusive Economic Zone
EFH = Essential Fish Habitat
OCS = Outer Continental Shelf
ppt = parts per thousand

4.1. Vulnerable Species, Life Stages, and Habitat

Many mobile species are less susceptible to potential project impacts because they can leave or avoid areas of impacts. However, certain EFH species are more susceptible because they are immobile or have limited mobility. Certain habitats are also considered sensitive. The following list summarizes vulnerable species and habitat:

- Sessile or slow-moving benthic/epibenthic invertebrates (e.g., bivalve juveniles and adults, squid egg mops)
- Skate egg cases
- Ocean pout eggs and larvae

4.2. Habitat Areas of Particular Concern

In order to conserve fish habitat in geographical locations particularly critical to the survival of a species, NMFS and the Fisheries Management Councils have designated some locations to be Habitat Areas of Particular Concern (HAPC). According to the NMFS EFH Mapper, no HAPCs have been designated within the Lease Area (NMFS 2023).

4.3. Prey Species

Prey species are those consumed by fish and invertebrates with designated EFH and are thus considered in some cases to be a component of EFH. Prey species that inhabit the Lease Area include epibenthic and infaunal fishes and invertebrates, which provide important trophic linkages to upper trophic levels. Among the taxa that provide prey for EFH-designated species are oligochaetes, polychaetes, flatworms, and nematodes, burrowing amphipods, mysids, copepods, crabs, sand dollars, starfish, sea urchins, bivalves, snails, and burrowing anemones. Impacts to prey species may cause indirect impacts to EFH, and species and life stages with designated EFH, because of lost foraging opportunities or reduced foraging efficiency resulting from adverse impacts to this vital component of the habitat.

4.4. Species Groups

Species groups, defined as groups of EFH species and/or life history stages that predominantly share the same habitat type, are used throughout this assessment. Benthic/epibenthic species groups are sorted into two NMFS habitat classification groups (soft bottom or complex) based on the benthic habitat with which the species is typically associated, with the potential for any species occur in heterogenous complex habitat. Prey species are included as species groups because they are consumed by managed fish and invertebrate species and thus are therefore a component of EFH. A list of the species groups used in this assessment is provided below.

Sessile Benthic/Epibenthic – Soft Bottom

- Atlantic sea scallop (eggs, adults)
- Longfin inshore squid (eggs)
- Ocean quahog (juveniles, adults)
- Winter flounder (larvae)

Mobile Benthic/Epibenthic – Soft Bottom

- Barndoor skates (juveniles, adults)
- Monkfish (juveniles, adults)
- Ocean pout (juveniles, adults)
- Red hake (juveniles, adults)
- Scup (juveniles, adults)
- Sharks (neonates)
- Little skate (juveniles, adults)
- Silver hake (juveniles, adults)
- Summer flounder (juveniles, adults)
- White hake (juveniles)
- Windowpane flounder (juveniles, adults)
- Winter flounder (juveniles, adults)
- Witch flounder (adults)
- Winter skate (juveniles, adults)

Sessile Benthic/Epibenthic – Complex Habitat

- Atlantic sea scallop (eggs, larvae, juveniles, adults)
- Longfin inshore squid (eggs)
- Ocean pout (eggs)

Mobile Benthic/Epibenthic – Complex Habitat

- Atlantic cod (juveniles, adults)
- Atlantic sea herring (eggs)
- Barndoor skates (juveniles, adults)
- Black sea bass (juveniles)
- Haddock (juveniles, adults)
- Little skate (juveniles, adults)
- Monkfish (juveniles, adults)
- Ocean pout (juveniles, adults)
- Pollock (juveniles)
- Red hake (juveniles, adults)
- Scup (juveniles, adults)
- Sharks (neonates)
- Silver hake (juveniles, adults)
- Summer flounder (juveniles, adults)
- White hake (juveniles)
- Winter flounder (juveniles, adults)

Pelagic

- Atlantic butterfish (eggs, larvae, juveniles, adults)
- Atlantic cod (eggs, larvae)
- Atlantic herring (larvae, juveniles, adults)
- Atlantic mackerel (eggs, larvae, juveniles, adults)
- Bluefish (larvae, juveniles, adults)
- Flatfish (eggs, larvae)
- Haddock (larvae)
- Highly Migratory Species (juveniles, adults)
- Longfin inshore squid (juveniles, adults)
- Monkfish (eggs, larvae)
- Offshore hake (larvae)
- Pollock (eggs, larvae,)
- Red hake (eggs, larvae)
- Silver hake (eggs, larvae)
- Sharks (juveniles, adults)
- White hake (eggs, juveniles)

Prey Species – Benthic/Epibenthic

- Annelid worms
- Crustaceans (e.g., amphipods, shrimps, crabs)

5. Adverse Effects

This section provides an analysis of the potential effects of the Proposed Action on designated EFH for managed species and life stages that have documented to occur within the Lease Area, as defined in Section 2.1. As stated, potential impacts on EFH are defined by the geographic extent of measurable effects from foundation testing. Potential impacts on EFH are evaluated in this section by 1) determining if designated EFH occurs in the Lease Area, and 2) determining if impact mechanisms are likely to impair the suitability of the affected habitat for the species and life stage being evaluated. Adverse effects on EFH may include direct or indirect physical, chemical, or biological alterations of waters or substrates used by EFH species during their life cycle, impacts to pelagic and benthic prey organisms and their habitats, and other ecosystem components. Adverse effects may be short-term (less than 2 years) or permanent, site-specific, or habitat-wide, and can result from the individual, cumulative, or synergistic consequences of actions (50 CFR § 600.910). If a project activity is likely to result in a short-term or long-term impairment of designated EFH for a managed species and life stage, this would constitute an adverse effect on EFH.

The Proposed Action would generate short-term to permanent, direct and indirect effects on EFH associated with foundation testing and vessel traffic. Effects would include disturbance of benthic habitat leading to potential crushing and burial, sediment resuspension and deposition, entrainment of ichthyoplankton during use of the suction pump, vessel noise, and potential introduction of non-native species. These effects would occur intermittently and at varying locations within the Lease Area over the testing period. Therefore, the suitability of EFH for managed species may be reduced depending on the nature, duration, and magnitude of each effect. Impacts of the Proposed Action on EFH and EFH species are discussed below.

5.1. Habitat Disturbance

Potential impacts resulting from foundation testing include disturbance of the seabed from placement of the reference frame lowered from the vessel and contact and penetration of the suction bucket during installation and removal. Disturbance of benthic sediments and habitats directly within the footprint of the suction bucket and reference frame would result in a reduction of habitat suitability for benthic infauna and epifauna. Disturbance may also result in localized mortality of benthic and demersal fish and invertebrates within the footprint of the frame and suction bucket; surrounding seafloor habitat would be undisturbed.

Non-complex soft-bottom habitat, including small sand waves, ripples, and depressions in the seabed, comprises the entire 128,881 acres of the Lease Area and provides EFH for eighteen species (e.g., hakes, flounders). Deployment of the suction bucket would remove these habitat features if they occur within the footprint of the suction bucket. Tidal and wind-forced bottom currents are expected to reform most sand ripples and waves within days to weeks following disturbance. Although some sand ripples and waves may not immediately recover to the same height and width as pre-disturbance, the habitat function is expected to fully recover post-disturbance. Foundation testing would be limited to soft-bottom habitat, thereby avoiding impacts on complex habitat that would require longer to recover. Impacts of foundation testing on EFH and EFH species are expected to be localized and short term, dissipating over time as local oceanographic processes restore the altered seabed profile.

Sessile infaunal and epifaunal organisms (e.g., eggs, larvae, bivalves) within the suction bucket footprint are expected to experience direct, permanent (lethal), localized impacts as contact with the suction bucket or pressure from embedding would cause crushing or other fatal injuries. Benthic and demersal fish and invertebrates inhabiting the foundation testing locations could also potentially become crushed under the suction bucket or reference frame or become trapped inside the bucket once it reaches the seafloor, which could result in mortality. However, mobile fish and invertebrates are generally expected to leave the area as the suction bucket approaches the seafloor at a controlled rate of less than 13 inches (30 centimeters) per second, such that direct contact or trapping of those mobile fauna is unlikely. Mortality of organisms within the footprint of the suction bucket would result in a loss in foraging opportunity for benthic and epibenthic EFH species, but the overall impact on the forage base would be negligible given the small size of the impacted area and the ubiquity of similar soft-bottom habitat in the area.

Adverse impacts of foundation testing activities on EFH and EFH species are generally expected to occur within the footprint of the suction bucket, which will directly affect 0.028 acres (114 m^2) of soft-bottom habitat per test and up to 0.986 acres (3,990 m^2) collectively during the Proposed Action. This total area of impact constitutes a small portion of the surrounding soft-bottom habitat, which is homogenous throughout the Lease Area, except for the area of sand ripple habitat along the west-central side of the Lease Area. Habitat disturbance associated with the Proposed Action is expected to have a short-term, localized, adverse effect on EFH.

Direct Effects on EFH and EFH species

- Short-term, localized loss/conversion of EFH:
    - Sessile Benthic/Epibenthic – Soft Bottom
    - Mobile Benthic/Epibenthic – Soft Bottom
    - Prey Species – Benthic/Epibenthic
- Permanent, localized mortality of EFH species from crushing and burial:
    - Sessile Benthic/Epibenthic – Soft Bottom
    - Prey Species – Benthic/Epibenthic
- Short-term, localized avoidance of foundation testing activities by EFH species:
    - Mobile Epibenthic/Benthic – Soft Bottom
    - Prey Species – Benthic/Epibenthic

Indirect Effects on EFH and EFH species

- Short-term, localized loss of benthic prey items:
    - Sessile Benthic/Epibenthic – Soft Bottom

5.2. Sediment Suspension/Redeposition

Deployment of the suction bucket during foundation testing would result in sediment suspension, a concomitant increase in turbidity in the water column, and sedimentation as a result of redeposition. Because the suction bucket will be lowered to the seabed in a controlled manner and at less than 13 inches [30 centimeters] per second, sediment plumes resulting from contact with the seafloor are expected to occur in the immediate area of the suction bucket and at minimal heights from the seabed. Suctioning to embed the suction bucket into the substrate is not expected to cause increased turbidity or other measurable impacts to water quality outside of the perimeter of the bucket. Further, removal of the foundation by reversing pumps to flow into the suction bucket is not expected to have measurable impact on water quality until the bucket is pulled from the seafloor, as any potential disturbed sediment will be contained within the suction bucket. Upon lifting of the suction bucket, any residual disturbed sediments may cause increased turbidity directly below the suction bucket, and some disturbed sediment could be carried by currents at the seafloor. Sediment disturbance is not expected to cause cumulative or long-lasting impacts on water quality.

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 resulting from a decrease in habitat quality for benthic species and life stages, with small sessile or slow-moving benthic EFH species and life stages experiencing greater impacts from deposition than larger, mobile species or life stages that are able to avoid areas of reduced water quality.

Egg and larval life stages are sensitive to suspended sediment and can experience sublethal or lethal effects from as little as 0.4 inches (10 mm) of sediment deposition (Kjelland et al. 2015; Michel et al. 2013; Wilber and Clarke 2001). Egg and larval stages of certain fish species (e.g., winter flounder) are particularly sensitive to sediment deposition and can experience mortality at burial depths less than 0.1 inch (3 mm) (Michel et al. 2013). Further, sediment deposition depths between 0.4 and 1.2 inches (10 and 30 mm) could result in sublethal to lethal effects on benthic life stages of sessile bivalves. Benthic habitats exposed to measurable burial depths during foundation testing would be rendered temporarily unsuitable for EFH species with sessile, benthic or epibenthic eggs and larvae in the Lease Area. Deployment of the suction bucket during foundation testing would generate measurable sediment deposition levels only in the immediate area of seabed contact and only until suspended sediment has redeposited on the seafloor, such that impacts of sediment deposition on EFH and EFH species would be short-term and localized.

Adult and juvenile fishes exposed to elevated suspended sediment levels may temporarily cease feeding, abandon cover, and/or experience short-term physiological stress. Short-term exposure to total suspended sediment (TSS) concentrations exceeding 1,000 milligrams per liter (mg/L) has been associated with sublethal and behavioral avoidance effects on adult marine and estuarine fishes, while concentrations of less than 500 mg/L are more commonly associated with behavioral avoidance (Michel et al. 2013; Wilber and Clarke 2001). Adult bivalves may experience sublethal effects of suspended sediments at TSS concentrations of 1,000 mg/L or higher (Wilber and Clarke 2001). Deployment of the suction bucket would generate elevated turbidity levels in the immediate area of seabed contact and for a short duration, such that impacts of suspended sediment on juvenile and adult fishes with EFH in the vicinity of the Proposed Action would be short-term and localized.

Direct Effects on EFH and EFH species

- Short-term, localized decrease in quality of EFH resulting from increased turbidity from suspended sediment:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Pelagic
- Short-term, localized impacts resulting from redeposition of suspended sediment:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Prey Species – Benthic/Epibenthic

Indirect Effects on EFH and EFH species

- Short-term, localized loss of foraging opportunities resulting from turbidity and redeposition of suspended sediment:
  - Mobile Benthic/Epibenthic – Soft Bottom

5.3. Entrainment

Benthic and pelagic eggs and larvae of EFH species inhabiting the immediate area of the suction pump may become entrained in the intake flow of the suction pump with assumed 100-percent entrainment mortality. During suction bucket penetration, all water would be withdrawn from within the 36- to 39-foot- (11- to 12-meter) tall suction bucket and would pass through the pump, assuming full penetration depth of the foundation is achieved. Consequently, both pelagic organisms and benthic epifaunal organisms within the footprint and overlying water column are expected to be susceptible to entrainment during installation of the suction bucket. During removal of the bucket, water would be withdrawn from the surrounding water column outside of the suction bucket and in proximity to the pump intake. The hydraulic zone of influence during operation of the suction pump is expected to have a radial distance of 2.5 feet and encompass an area of up to 20 square feet. Because the suction pump would be top-mounted, only pelagic organisms within the hydraulic zone of influence are expected to be susceptible to entrainment during removal of the suction bucket. Several EFH species have surface-oriented egg and larval stages (e.g., gadids, some flounders), which are not expected to be vulnerable to entrainment at the intake. During each test, the suction pump would operate for up to nine hours at a typical intake flow of approximately 1,320 gallons (5 m^3) per minute, with a maximum intake volume of 716,963 gallons (2,714 m^3) per test (including installation into the seabed and reverse suction to remove the foundation). If the maximum of 35 tests were conducted, the total intake volume would be 25.1 million gallons (94,990 m^3) over 315 hours.

An analysis of entrainment associated with foundation testing in the Lease Area was conducted in support of the Proposed Action (Beacon Wind 2023b). The analysis relied on publicly available ichthyoplankton data from the NOAA Fisheries EcoMon Survey Program, which spanned from 1977–2019. EcoMon surveys were conducted at 120 randomly selected stations and 35 fixed stations throughout the continental shelf and slope of the northeastern U.S. The surveys routinely collect phytoplankton and zooplankton, including fish larvae and eggs throughout the water column to a maximum depth of 200 meters (about 650 feet) using long, funnel-shaped nets with very fine mesh known as bongo nets. Ichthyoplankton data collected from the EcoMon surveys were queried to include larval fish densities observed at EcoMon Survey stations within a 10-nautical mile (18.5-kilometer) radius of the center of the Lease Area. Monthly mean densities of larval fish were extrapolated to the maximum volume of water withdrawn by the suction pump during a test to estimate numbers of fish entrained, by species, per test (Table 5-1).

Results of the entrainment analysis suggest that water withdrawals during foundation testing would have a minor impact on EFH species. The analysis estimated that 9,289 larval fish would be entrained per suction bucket test at peak larval abundance in August, when the greatest monthly abundances of ichthyoplankton typically occur. If the maximum of 35 foundation tests were conducted during peak abundance in August, it would result in an estimated entrainment of 325,115 larval fish. Ichthyoplankton abundances during other months between February and August are up to an order of magnitude less than that documented in August and lower entrainment would be expected during those months. Many fish species in the region exhibit broadcast spawning or other high fecundity reproductive strategies that produce thousands to millions of eggs per fish (e.g., Kelly and Stevenson 1985; Kjesbu et al. 1998; Morse 1980; Papaconstantinou and Vassilopoulou 1986; Pitt et al. 1971). Given these high fecundity rates, the suction pump entrainment mortality at the scale estimated here is not expected to result in population-level effects on EFH species. It is important to note that the entrainment analysis excluded fish eggs, such that the estimates presented are less than the potential entrainment of all life stages. However, given the high natural mortality of the egg stage for most fish species and the relatively small volume of water being withdrawn, entrainment mortality of eggs is expected to be small relative to natural egg mortality.

Entrainment mortality would remove some small organisms that are consumed by planktivorous species, potentially resulting in a loss in foraging opportunity for sessile EFH species (e.g., filter-feeding invertebrates) within the 0.028-acre (114-m^2) footprint of the suction bucket and within the 20-ft^2 hydraulic zone of influence of the pump. However, mobile and pelagic species are not expected to experience losses in foraging opportunities because they can move to feed in areas just outside the small area of the suction bucket footprint and zone of influence.

Entrainment during foundation testing is expected to result in direct, permanent (lethal), localized impacts on some EFH species.

Direct Effects on EFH and EFH species

- Permanent, localized mortality of eggs and larvae of EFH species from entrainment:
    - Sessile Benthic/Epibenthic – Soft Bottom
    - Pelagic
    - Prey Species – Benthic/Epibenthic
    - Prey Species – Pelagic

Indirect Effects on EFH and EFH species

- Short-term loss of food sources for planktivorous species, including filter-feeding invertebrates:
    - Sessile Benthic/Epibenthic – Soft Bottom

Table 5-1. Monthly larval entrainment estimates per suction bucket test

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
American plaice	0	0	5	0	11	13	0	0	0	0	0	0
Atlantic cod	56	41	64	54	7	0	0	0	0	0	16	103
Atlantic croaker	0	0	0	0	8	0	0	0	0	3	2	0
Atlantic herring	360	128	98	0	0	0	0	0	0	4	7,062	5,503
Atlantic mackerel	0	0	0	0	18	34	10	0	0	0	0	0
Atlantic menhaden	0	0	0	0	0	0	0	0	0	2	250	0
Bluefish	0	0	0	0	0	4	0	20	0	0	0	0
Bristlemouths	0	0	0	0	0	0	0	0	0	0	0	0
Butterfish	0	0	0	0	0	0	29	467	32	5	2	0
Cunner	0	0	0	0	0	0	19	15	0	0	0	0
Fourbeard rockling	0	0	0	0	6	75	39	0	0	6	2	6
Fourspot flounder	0	0	0	0	0	0	39	941	130	31	0	4
Frigate tunas	0	0	0	0	0	0	0	129	0	0	0	0
Grubby	0	0	2	0	0	0	0	0	0	0	0	0
Gulf stream flounder	0	0	0	0	0	0	9	3,957	5,163	119	3	0
Haddock	0	2	11	0	25	23	0	0	0	0	0	0
Hakes	0	0	0	0	0	8	390	3,096	2,184	690	88	0
Lanternfishes	0	0	0	0	0	0	0	0	0	0	0	0
Large-tooth flounder	0	0	0	0	0	0	0	0	60	7	1	0
Lefteye flounders	0	0	0	0	0	0	0	0	2	5	0	0
Longhorn sculpin	0	12	29	5	0	0	0	0	0	0	0	0
Madeira lantern fish	0	0	0	0	0	0	0	0	0	4	0	0
Monkfish	0	0	0	0	0	4	0	4	2	0	0	0
Offshore hake	0	0	0	0	0	0	0	0	0	11	0	0
Pollock	2	19	32	0	0	0	0	0	0	0	0	0
Rock gunnel	0	4	2	0	0	0	0	0	0	0	0	0
Rockfishes	0	0	0	0	0	0	0	0	0	0	0	0
Sand lances	670	6,430	2,447	804	3	4	0	0	0	0	0	0
Sea robins	0	0	3	0	0	0	0	23	2	0	0	0

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Silver hake	3	0	0	0	0	8	144	576	122	456	100	30
Summer flounder	0	3	2	0	0	0	0	0	711	339	318	36
Windowpane	0	0	0	0	23	72	0	53	259	50	35	0
Winter flounder	0	2	44	0	249	68	0	0	0	0	0	0
Witch flounder	0	0	0	0	25	12	10	4	0	0	0	0
Wolffishes	0	0	0	0	0	0	0	0	0	0	0	0
Yellowtail flounder	0	0	2	0	84	704	29	4	0	0	0	0
Total	**1,091**	**6,641**	**2,741**	**863**	**459**	**1,029**	**718**	**9,289**	**8,667**	**1,732**	**7,879**	**5,682**

5.4. Vessel Traffic

The Proposed Action would be conducted with a single large vessel that would use a dynamic positioning system, thereby avoiding impacts associated with anchoring (e.g., crushing, seabed disturbance, turbidity, sedimentation) (Table 6-1). The operation of this vessel would impact EFH and EFH species primarily through the underwater noise from the engines and dynamic positioning systems and the potential introduction of non-native species through the discharge of ballast water.

Vessel Noise

Vessel noise may have several effects on fish and invertebrates through changes to the ambient acoustic environment, including interfering with feeding and breeding, altering 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), masking important environmental auditory cues (Codarin et al. 2009; Radford et al. 2014), and inducing 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). 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).

Underwater sound generated by vessels has been observed to cause avoidance behavior in hearing specialist fish species (e.g., Atlantic herring [*Clupea harengus*] and Atlantic cod [*Gadus morhua*]) and is likely to cause similar behavior in other hearing specialist species (Vabø et al. 2002; Handegard et al. 2003). For example, analysis of vessel noise related to the Cape Wind Energy Project observed that underwater noise generated by construction vessels at 10 feet (3 meters) was loud enough to cause an avoidance response in fish, but not loud enough to do physical harm (MMS 2008). Vessel noise has been observed to cause avoidance behavior of herring at distances of 100 meters or greater (e.g., Mitson and Knudsen 2003; Vabø et al. 2002), suggesting that vessel noise associated with the Proposed Action may cause impacts extending to the deepest parts of the Lease Area (206 feet [63 meters]). However, pelagic species and life stages and prey species that inhabit the upper water column (e.g., Atlantic butterfish, Atlantic herring, Atlantic mackerel, bluefish, and some highly migratory pelagic species) are the most likely to be impacted by vessel noise.

Noise thresholds for adult invertebrates have not been developed because of a lack of available data. 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). However, particle motion effects dissipate rapidly and are highly localized around the noise source, suggesting that only pelagic invertebrates inhabiting waters near the surface would experience impacts from vessel-related noise.

Vessel noise associated with the Proposed Action would be intermittent and short-term and would dissipate as the vessel leaves the area.

Direct Effects on EFH and EFH species

- Short-term, localized behavioral responses to vessel noise:
  - Sessile Benthic/Epibenthic – Soft Bottom

- Mobile Benthic/Epibenthic – Soft Bottom
- Pelagic
- Prey Species – Benthic/Epibenthic
- Prey Species – Pelagic

Potential Introduction of Non-native Species

The Proposed Action would result in a small risk of invasive species being introduced through releases of ballast water and bilge water from the survey vessel into the aquatic environment. Introductions of non-native species do not always result in the establishment of viable populations of those species. Establishment of non-native introduced species depends on species characteristics that are favorable for survival, such as variability in life-history traits, high production, and wide-ranging tolerances to environmental conditions. The establishment of non-native species resulting from offshore wind activity has been documented, as the colonial tunicate, *Didemnum vexillum*, was one of the first such examples of invasive introductions from offshore wind activities (HDR 2020). However, the risk of an invasive species being introduced in the Lease Area from the Proposed Action is extremely low given than it will involve only a single trip to the area from foreign waters. 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 Vessel General Permit standards, both of which aim 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 (Table 6-1). Although the likelihood of invasive species becoming established because of project-related activities is low, the impacts of invasive species could be 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.

Direct Effects on EFH and EFH species

- Extremely low likelihood, but potentially permanent, wide-spread impacts to any or all EFH and EFH species:
  - Sessile Benthic/Epibenthic – Soft Bottom
  - Mobile Benthic/Epibenthic – Soft Bottom
  - Sessile Benthic/Epibenthic – Complex
  - Mobile Benthic/Epibenthic – Complex
  - Pelagic
  - Prey Species – Benthic/Epibenthic
  - Prey Species – Pelagic

Indirect Effects on EFH and EFH species

- Extremely 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
  - Mobile Benthic/Epibenthic – Complex
  - Pelagic

- Prey Species – Benthic/Epibenthic
- Prey Species – Pelagic

5.5. Cumulative and Synergistic Effects to EFH

Cumulative impacts are the incremental effects of the Proposed Action on the environment when added to other past, present, or reasonably foreseeable future actions taking place within the region. The spatial boundary of this cumulative impacts assessment focuses primarily on the Southern New England region where existing and planned projects/activities have the most potential for resulting in incremental impacts on resources described in this EFH Assessment. There is one existing offshore wind facility in the Southern New England region, Block Island Wind Farm, and two offshore wind projects that are under construction in the region, South Fork Wind and Vineyard Wind 1, which will likely be operating by the time the foundation tests begin in 2024. Additionally, there are two planned offshore wind projects in the Southern New England region that are scheduled to begin offshore construction in 2024, Sunrise Wind and Revolution Wind (Revolution Wind 2023, Sunrise Wind 2023). Collectively, the construction and operation of these facilities would impact EFH and EFH species primarily through seafloor disturbance during cable emplacement, pile driving noise, and habitat conversion. The cumulative and synergistic effects of each of these IPFs are discussed in the following paragraphs.

Construction of the Sunrise Wind and Revolution Wind projects would include placement of 540 miles of buried and armored cable along transmission corridors and interarray connections, disturbing 2,091 acres (8.5 km^2) of benthic habitat. Cable emplacement for each of these two projects is scheduled to begin in early 2024 and would potentially overlap the Proposed Action. Cable emplacement and would disturb, displace, and injure or kill finfish and invertebrates, release sediment into the water column, and cause habitat alterations. Mobile finfish and invertebrates are likely to move away from cable-laying equipment, but immobile or slow-moving demersal species and life stages (e.g., eggs, larvae) may be injured or killed by the equipment. Some types of equipment that are used to prepare the seabed prior to cable emplacement (e.g., hydraulic dredges) use water withdrawals, which can entrain planktonic eggs and larvae with assumed 100-percent mortality of entrained individuals. Suspended sediment and sediment deposition associated with cable emplacement may cause impacts on EFH and EFH species out to several hundred meters, including behavioral changes in fish and invertebrates and burial of sessile species and life stages. Seabed preparation prior to cable emplacement would cause short-term disturbances of soft-bottom habitat and long-term disturbances of complex habitat, which may require several years to recover.

Construction of the Sunrise Wind and Revolution Wind projects would generate pile driving noise during the installation of up to 194 WTG and 3 OSS foundations. Installation of foundations is schedule to begin in mid-2024 for each of these projects and would potentially overlap the Proposed Action. Pile driving noise generated by these projects would cause instantaneous behavioral effects and cumulative injurious effects over distances of up to several kilometers from each foundation. However, because the lease areas for these two projects are not adjacent to the Beacon Wind Lease Area, the area ensonified by pile driving noise sufficient to produce behavioral or injurious impacts is not expected to overlap any of the foundation testing locations. Pile driving noise generated by these projects would temporarily make the surrounding habitat less suitable and cause individuals to vacate the area of project activities. Pile driving is anticipated to cause adverse impacts to EFH for both pelagic and demersal life stages; however, this impact will be short-term, as EFH is expected to return to pre-pile driving conditions at the completion of foundation installation.

Planned and ongoing offshore wind activities in the Southern New England region would install or continue to operate up to 273 WTG and 6 OSS foundations, 209 acres (0.8 km^2) of foundation scour protection, and 274 acres (1.1 km^2) of cable protection. BOEM anticipates that structures would be added intermittently over a three-year period and that they would remain until decommissioning of each facility is complete. These structures would be constructed in mostly sandy seafloor and would therefore convert soft-bottom habitat to hard-bottom habitat. The installation of these structure would result in a permanent loss of EFH for epibenthic and benthic finfish and invertebrates that associate with soft-bottom habitat (e.g., clams, flounders, skates). New structures could affect migration through the area of species that prefer complex habitat by providing unique, complex features (relative to the primarily sandy seafloor). This could lead to retention of those species and possibly impact spawning opportunities. Complex habitat and its associated faunal communities are limited in the Mid-Atlantic, and it is possible that additional habitat will facilitate the expansion of these communities. The structures would create an "artificial reef effect," whereby more sessile and benthic organisms would likely colonize 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, and some finfish species. 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 species that are typically associated with soft-bottom habitat. Potential benefits of added complex habitat may be offset if the colonizable habitat provides steppingstones for non-native species. Given the duration over which the monopiles from these projects will remain in the water column (~30 years) and that non-native species have been observed to tolerate higher water temperatures than native species, the presence of these structures may interact synergistically with warming ocean temperatures to promote the establishment of invasive species.

6. Avoidance, Minimization, and Mitigation

6.1. Applicant-Proposed Mitigation Measures

This section outlines Applicant Proposed Mitigations (APMs) proposed by Beacon Wind and additional mitigation and monitoring measures that are intended to avoid and/or minimize potential impacts to EFH-designated species and EFH. Relevant APMs and mitigation measures, contributions to avoiding and/or minimizing adverse effects on EFH, and supporting rationale are summarized by project component in Table 6-1.

Table 6-1. APMs for construction and operation of the Proposed Action

Proposed APM	Expected Effects
Use dynamic positioning, thereby eliminating the use of anchors and jack-up features.	This measure would eliminate anchoring impacts on EFH and EFH species.
Adhere to existing state and federal regulations related to ballast and bilge water discharge.	This measure would reduce the likelihood of non-native species being introduced.

6.2. Environmental Protection Measures that BOEM Could Impose

The APMs described in Section 6.1 are expected to avoid or minimize impacts of the Proposed Action to EFH-designated species and EFH to the maximum extent practicable. Therefore, BOEM is not proposing additional Environmental Protection Measures for foundation testing activities.

7. NOAA Trust Resources

Twelve species of NOAA Trust Resources have been identified within the vicinity of the Lease Area. Table 7-1 summarizes these species and life stages and provides an impact determination for each.

The following NOAA Trust Resource species or species groups may occur within the Lease Area:

- Alewife (*Alosa pseudoharengus*)
- American eel (*Anguilla rostrata*)
- American lobster (*Homarus americanus*)
- Atlantic croaker (*Micropogonias undulatus*)
- Atlantic menhaden (*Brevoortia tyrannus*)
- Blueback herring (*Alosa aestivalis*)
- Horseshoe crab (*Limulus polyphemus*)
- Jonah crab (*Cancer borealis*)
- Northern sea robin (*Prionotus carolinus*)
- Spot (*Leiostomus xanthurus*)
- Spotted hake (*Urophycis regia*)
- Striped bass (*Morone saxatilis*)

Table 7-1. Determination for NOAA trust resources by species

Species	Life Stages	Impact Determination	Rationale for Determination
Alewife	Adult	Short-term and permanent, localized and widespread impacts	The Proposed Action would result in short-term, localized effects on EFH and EFH species, including crushing and burial, disturbance to soft bottom habitat, sediment suspension and deposition, entrainment, and noise. Up to 0.986 acres (3,990 m^2) of soft-bottom benthic habitat would be disturbed by suction bucket deployment. Mortality of benthic invertebrates in the footprint of the suction bucket would result in a loss in foraging opportunity for some benthic and demersal species. Benthic community structure of disturbed soft-bottom habitat would recovery rapidly, within a few months of the activity. Up to 325,115 larval fish would be entrained with assumed 100-percent mortality during water intake withdrawals by the suction pump. Additional mortality would occur for eggs and small juveniles. Non-native species may be accidentally released in the discharge of ballast water and bilge water during vessel activities, potentially resulting in permanent, widespread impacts.
American eel	Larvae, Adult		
American lobster	All		
Atlantic croaker	Egg, Larvae, Adult		
Atlantic menhaden	Egg, Larvae, Adult		
Blueback herring	Adult		
Horseshoe crab	Adult		
Jonah crab	Juvenile, Adult		
Northern sea robin	All		
Spot	Egg, Larvae, Adult		
Spotted hake	All		
Striped bass	Adult		

8. Conclusions/Determinations

The Proposed Action includes suction bucket deployment and retrieval and vessel operations for up to 15 days of foundation testing at 26 locations within the Lease Area. These activities have the potential to cause adverse effects on EFH and EFH-designated species in the Lease Area. There are 42 species of finfish, elasmobranchs, and invertebrates with designated EFH within the Lease Area. EFH-designated species with one or more demersal life stage are more likely to experience adverse effects than species with only pelagic life stages, primarily resulting from the temporary disturbance of benthic habitat during deployment of the suction bucket.

Adverse effects from the Proposed Action would occur intermittently at varying locations in the Lease Area during the 10- to 15-day foundation testing period and may include short-term (less than 2 years) effects and permanent effects on EFH and permanent (lethal) effects on individual fish and invertebrates. Short-term adverse effects on EFH would include those from disturbance of soft-bottom habitat, increased turbidity and sedimentation, and vessel noise. Permanent adverse effects on EFH are not likely to occur because of the low probability that a non-native species would be introduced in vessel ballast water and become established. Permanent adverse effects on individual fish and invertebrates include mortality from crushing or burial and from entrainment by the suction pump.

Table 8-1 details short-term and permanent adverse effects on habitat suitability by impact producing factor described in Section 5 for managed species and life stage. The Proposed Action is expected to adversely affect EFH for a species and life stage if: 1) EFH for the designated species and life stage occurs in the Lease Area, and 2) one or more of the impact-producing factors described in Section 5 has an adverse effect on the species and life stage.

Table 8-1. Summary of adverse effects of the Proposed Action on EFH for managed species and life stages

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Effects on EFH			Permanent Effects on EFH	Permanent (Lethal) Effects on Individuals	
				Habitat Disturbance	Turbidity and Sedimentation	Vessel Noise	Establishment of Non-Native Species	Crushing or Burial	Entrainment
Gadids	Atlantic cod	Eggs	Surface	--	--	No	No	--	--
		Larvae	Pelagic	--	No	No	No	--	Yes
		Juvenile	Benthic complex	--	--	Yes	No	--	--
		Adult	Benthic complex	--	--	Yes	No	--	--
	Haddock	Larvae	Pelagic	--	--	No	No	--	--
		Juvenile	Benthic complex	--	--	Yes	No	--	--
		Adult	Benthic complex	--	--	Yes	No	--	--
	Pollock	Eggs	Surface	--	--	No	No	--	--
		Larvae	Pelagic	--	No	No	No	--	Yes
		Juvenile	Benthic complex	--	--	Yes	No	--	--
	Red hake	Eggs	Surface	--	--	No	No	--	--
		Larvae	Surface	--	--	No	No	--	--
		Juvenile	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
	Silver hake	Eggs	Surface	--	--	No	No	--	--
		Larvae	Surface	--	--	No	No	--	--
		Juvenile	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
	White hake	Eggs	Surface	--	--	No	No	--	--
		Juvenile	Pelagic/benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
Flatfish	American plaice	Eggs	Pelagic	--	No	No	No	--	Yes
		Larvae	Pelagic	--	No	No	No	--	Yes
	Summer flounder	Eggs	Pelagic	--	No	No	No	--	Yes
		Larvae	Pelagic	--	No	No	No	--	Yes
		Juvenile	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Effects on EFH			Permanent Effects on EFH	Permanent (Lethal) Effects on Individuals	
				Habitat Disturbance	Turbidity and Sedimentation	Vessel Noise	Establishment of Non-Native Species	Crushing or Burial	Entrainment
Flatfish (cont.)	Windowpane flounder	Eggs	Surface	--	--	No	No	--	--
		Larvae	Pelagic	--	No	No	No	--	Yes
		Juvenile	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
	Winter flounder	Larvae	Pelagic/benthic non-complex	Yes	Yes	No	No	Yes	Yes
		Juvenile	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
	Witch flounder	Eggs	Surface	--	--	No	No	--	--
		Larvae	Surface	--	--	No	No	--	--
		Adult	Benthic non-complex	Yes	Yes	Yes	No	Yes	No
	Yellowtail flounder	Eggs	Surface	--	--	No	No	--	--
		Larvae	Surface	--	--	No	No	--	--
		Juvenile	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
Other finfish	Atlantic butterfish	Eggs	Pelagic	--	No	No	No	--	Yes
		Larvae	Pelagic	--	No	No	No	--	Yes
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Atlantic mackerel	Eggs	Pelagic	--	No	No	No	--	Yes
		Larvae	Pelagic	--	No	No	No	--	Yes
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Atlantic sea herring	Eggs	Benthic complex/non-complex	Yes	Yes	No	No	Yes	Yes
		Larvae	Pelagic	--	No	No	No	--	Yes
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Effects on EFH			Permanent Effects on EFH	Permanent (Lethal) Effects on Individuals	
				Habitat Disturbance	Turbidity and Sedimentation	Vessel Noise	Establishment of Non-Native Species	Crushing or Burial	Entrainment
Other finfish (cont.)	Black sea bass	Juvenile	Benthic complex	--	--	Yes	No	--	--
	Bluefish	Larvae	Pelagic	--	No	No	No	--	Yes
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Monkfish	Eggs	Surface	--	--	No	No	--	--
		Larvae	Pelagic	--	No	No	No	--	Yes
		Juvenile	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
	Ocean pout	Eggs	Benthic complex	--	--	No	No	--	--
		Juvenile	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
	Scup	Juvenile	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic complex/non-complex	Yes	Yes	Yes	No	Yes	No
Tunas	Albacore tuna	Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Atlantic bluefin	Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Atlantic skipjack	Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Atlantic yellowfin	Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
Sharks	Basking shark	Neonate	Pelagic	--	No	Yes	No	--	No
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Blue shark	Neonate	Pelagic	--	No	Yes	No	--	No
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Effects on EFH			Permanent Effects on EFH	Permanent (Lethal) Effects on Individuals	
				Habitat Disturbance	Turbidity and Sedimentation	Vessel Noise	Establishment of Non-Native Species	Crushing or Burial	Entrainment
Sharks (cont.)	Common thresher	Neonate	Pelagic	--	No	Yes	No	--	No
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Dusky shark	Neonate	Pelagic	--	No	Yes	No	--	No
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Porbeagle shark	Neonate	Pelagic	--	No	Yes	No	--	No
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Sandbar shark	Adult	Benthic non-complex	Yes	Yes	Yes	No	Yes	No
	Shortfin mako	Neonate	Pelagic	--	No	Yes	No	--	No
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Tiger shark	Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	White shark	Neonate	Pelagic	--	No	Yes	No	--	No
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Smooth dogfish	Neonate	Pelagic	--	No	Yes	No	--	No
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No
	Spiny dogfish	Juvenile	Pelagic/benthic non-complex	--	Yes	Yes	No	Yes	No
		Adult	Pelagic/benthic non-complex	--	Yes	Yes	No	Yes	No
Skates	Barndoor skate	Juvenile	Benthic non-complex/complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic non-complex/complex	Yes	Yes	Yes	No	Yes	No
	Little Skate	Juvenile	Benthic non-complex/complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic non-complex/complex	Yes	Yes	Yes	No	Yes	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Effects on EFH			Permanent Effects on EFH	Permanent (Lethal) Effects on Individuals	
				Habitat Disturbance	Turbidity and Sedimentation	Vessel Noise	Establishment of Non-Native Species	Crushing or Burial	Entrainment
Skates (cont.)	Winter skate	Juvenile	Benthic non-complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic non-complex	Yes	Yes	Yes	No	Yes	No
Invertebrates	Atlantic sea scallop	Eggs	Benthic non-complex/complex	Yes	Yes	No	No	Yes	Yes
		Larvae	Pelagic/benthic complex	--	No	No	No	--	Yes
		Juvenile	Benthic complex	--	--	Yes	No	--	--
		Adult	Benthic non-complex/complex	Yes	Yes	Yes	No	Yes	No
	Ocean quahog	Juvenile	Benthic non-complex	Yes	Yes	Yes	No	Yes	No
		Adult	Benthic non-complex	Yes	Yes	Yes	No	Yes	No
	Longfin squid	Eggs	Benthic non-complex/complex	Yes	Yes	No	No	Yes	Yes
		Juvenile	Pelagic	--	No	Yes	No	--	No
		Adult	Pelagic	--	No	Yes	No	--	No

Notes:
'Yes' = adverse effect on habitat suitability
'No' = insignificant effect on habitat suitability
'--' = no life stage EFH exposure to this impact mechanism

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10. Appendices

10.1. List of Supporting Documents

The following documents support this EFH assessment.

- Applicant-Prepared Supplemental Materials in Supports of a Foundation Testing Concise Environmental Assessment – Beacon Wind Massachusetts Wind Energy Lease Area OCS-A 0520, October 2023
- Beacon Wind Construction and Operations Plan, June 2023
- COP Appendix G, Marine Site Investigation Report, June 2023
- COP Appendix S, Benthic Resources Characterization Report, June 2023
- COP Appendix S, Benthic Resources Mapbooks, June 2023

10.2. Data Collection and Mapping Methodologies

Beacon Wind conducted site-specific geophysical, geotechnical, and benthic surveys across the Lease Area in Summer 2021 (see Figure 3-1, above). The surveys were designed to identify the dominant substrates in the Lease Area and to establish a pre-construction baseline and characterizes potentially sensitive or important seafloor areas that may serve as EFH. The benthic survey methods (e.g., recommended equipment, procedures, lab analyses, etc.) were selected to meet federal guidance including BOEM benthic survey guidance and NMFS recommendations for mapping essential fish habitat. A total of 157 benthic stations located at the proposed foundation location stations were sampled spanning the entire Lease Area (Table 10-1). These 157 stations were sampled with the full suite of instruments – the HD drop/two camera system, the SPI/PV system, and the Smith-McIntyre grab sampler with mounted benthic camera. An additional 218 interarray cable stations were sampled using only SPI/PV (Table 10-1). At each foundation station, samples were collected via benthic grab for benthic infauna taxonomy and biomass, particle size distribution/grain size analysis, and total organic carbon (TOC). Replicate samples were also collected at every 10th station throughout the survey for quality assurance/quality control of particle size distribution and TOC. The resulting sample density in the Lease Area was 0.7 samples per km^2.

Prior to the benthic survey, a high resolution geophysical (HRG) survey of the Lease Area was performed starting in 2020 and continued into 2021. Using those results, 218 interarray cable station locations and 44 priority foundation sample sites (of the proposed 157 foundation locations) were identified based on review of the HRG survey's side scan sonar and sub-bottom profiling data to obtain information across the Lease Area. Characteristics derived from the HRG data that were used to determine priority foundation site selection included observations of potential homogeneity and heterogeneity of seafloor conditions. The 44 priority foundation stations were identified for immediate benthic infaunal analysis, while the remaining benthic infaunal samples from foundation sites were archived for possible future analysis. Analysis of the remaining parameters (particle size distribution, TOC, SPI/PV imagery and benthic video imagery) occurred for all 157 foundation stations.

Beacon Wind contracted MMT and their subcontractors (Continental Shelf Associates, Inc., Tombo Environmental, LLC, and NewFields, Inc.) to perform site specific benthic surveys with the survey vessel M/V Deep Helder. The survey equipment and scope included the following:

- Gridded survey lines at a spacing of approximately 98 feet (ft) by 1,640 ft (30 meters [m] by 500 m);
- Depth sounding (multibeam echosounder [MBES]) to determine site bathymetry and elevations;
- Seafloor imaging (sidescan sonar survey [SSS]) for seabed sediment classification purposes, to identify natural and man-made acoustic targets on the seabed, as well as any anomalous features;
- Sediment profile images (SPI)/plan view (PV) images; and
- Sediment grab samples and drop-down video transects to support the interpretation of geophysical data to characterize surficial sediment conditions and benthic habitat, including macrofaunal analysis with samples sieved at 0.5-millimeter (mm) mesh size.

Geophysical survey data (multibeam echo sounder and side-scan sonar) were used to support the characterization of seabed conditions within the Lease Area. Sediment grab samples were analyzed for grain size distribution, total organic carbon (TOC), and benthic infauna (identified and classified according to the Coastal and Marine Ecological Classification Standard [CMECS] [FGDC 2012]). Digital imagery was reviewed to aid in identification of key habitat types, macroinvertebrates, and fish. Beacon Wind's surveys in the Lease Area are listed in Table 10-1.

Table 10-1. Beacon Wind's benthic survey in the Lease Area

Project Subarea	MBES Percent Coverage	SSS Percent Coverage	Benthic Imagery			
			Sediment Grab	Video Transect	Benthic Grab Camera	SPI/PV
Foundation Locations	100	100	157	157	157	157
Interarray Cable Locations	100	100	--	--	--	218