New England Wind

AVANGRID RENEWABLES

Construction and Operations Plan

Lease Area OCS-A 0534

Volume III Appendices

February 2024

Submitted by
Park City Wind LLC

Submitted to
Bureau of Ocean Energy Management
45600 Woodland Rd
Sterling, VA 20166

Prepared by
Epsilon Associates, Inc.

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Submitted to:
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The Proponent has also identified two variations of the Phase 2 Offshore Export Cable Corridor (OECC)— the Western Muskeget Variant and the South Coast Variant—in the event that technical, logistical, grid interconnection, or other unforeseen issues arise during the engineering and permitting processes that preclude one or more Phase 2 offshore export cables from being installed within all or a portion of the OECC (see Section 4.1.3 of COP Volume I). This Appendix considers the potential impacts associated with the Western Muskeget Variant; an assessment of the South Coast Variant in federal waters is provided separately in the COP Addendum.

New England Wind

Essential Fish Habitat Assessment

Prepared for:

Park City Wind LLC

Prepared by:

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August 2023

APPENDIX III-F ESSENTIAL FISH HABITAT ASSESSMENT

1.0 Introduction

The Magnuson-Stevens Fishery Conservation and Management Act mandates that federal agencies conduct an Essential Fish Habitat (EFH) consultation for any activity that may adversely affect EFH for federally managed fish species. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Included in 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act, the primary goal of EFH designation is to identify and protect important fish habitat from certain fishing practices and coastal and marine development.

EFH is designated by National Oceanic and Atmospheric Administration's (NOAA) Fisheries (or National Marine Fisheries Service [NMFS]) and Regional Fishery Management Councils. EFH is typically assigned by egg, larvae, juvenile, and adult life stages and designated as waters or as substrates. In 50 CFR § 600.10, NOAA Fisheries defines waters and substrate as:

- Waters—Aquatic areas and their associated physical, chemical, and biological properties that are used by fish and, where appropriate, may include aquatic areas historically used by fish.

- Substrate—Sediments, hard bottoms, structures underlying the waters, and associated biological communities.

Additionally, the Regional Fishery Management Councils identify Habitat Areas of Particular Concern (HAPCs) within their Fishery Management Plans (FMPs). HAPCs are discrete subsets of EFH that serve important ecological functions or are especially vulnerable to degradation.

2.0 Description of New England Wind

New England Wind is the proposal to develop offshore renewable wind energy facilities in Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0534 along with associated offshore and onshore cabling, onshore substations, and onshore operations and maintenance (O&M) facilities. New England Wind will be developed in two Phases with a maximum of 130 wind turbine generator (WTG) and electrical service platform (ESP) positions. Five offshore export cables will transmit electricity generated by the WTGs to onshore transmission systems in the Town of Barnstable, Massachusetts (see Figure 2.0-1). Park City Wind LLC, a wholly owned subsidiary of Avangrid Renewables, LLC, is the Proponent and will be responsible for the construction, operation, and decommissioning of New England Wind.

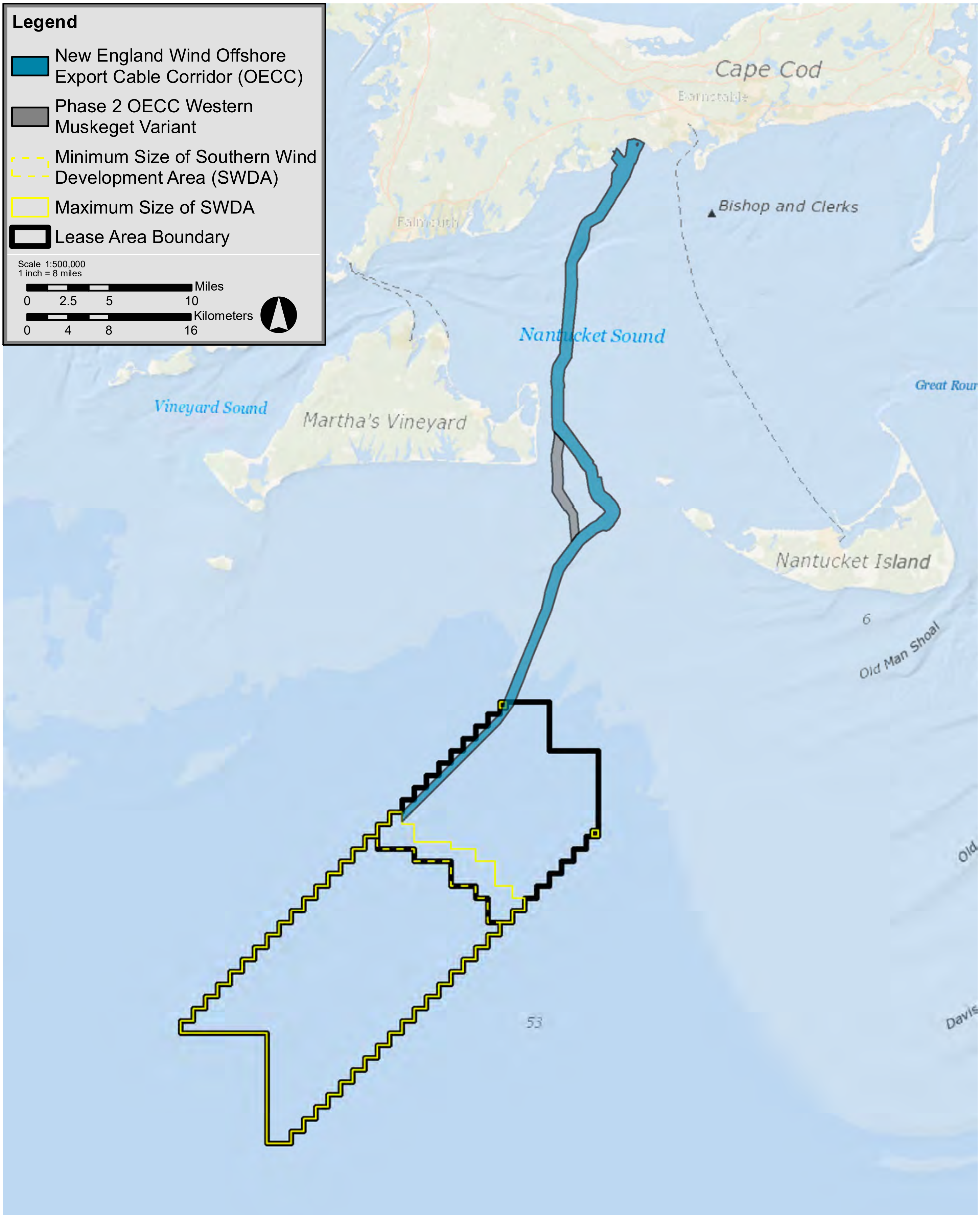

Figure 2.0-1

Overview of the Offshore Development Area of New England Wind

New England Wind's offshore renewable wind energy facilities are located immediately southwest of Vineyard Wind 1, which is located in Lease Area OCS-A 0501. New England Wind's will occupy all of Lease Area OCS-A 0534 and potentially a portion of Lease Area OCS-A 0501 in the event that Vineyard Wind 1 does not develop "spare" or extra positions included in Lease Area OCS-A 0501 and Vineyard Wind 1 assigns those positions to Lease Area OCS-A 0534. For the purposes of the COP, the Southern Wind Development Area (SWDA) is defined as all of Lease Area OCS-A 0534 and the southwest portion of Lease Area OCS-A 0501, as shown in Figure 2.0-1.

The SWDA may be approximately 411–453 square kilometers (km^2) (101,590–111,939 acres) in size depending upon the final footprint of Vineyard Wind 1. At this time, the Proponent does not intend to develop the two positions in the separate aliquots located along the northeastern boundary of Lease Area OCS-A 0501 as part of New England Wind (see Figure 2.0-1). The SWDA (excluding the two separate aliquots that are closer to shore) is just over 32 kilometers (km) (20 miles [mi]) from the southwest corner of Martha's Vineyard and approximately 38 km (24 mi) from Nantucket.[1] The WTGs and ESPs in the SWDA will be oriented in an east-west, north-south grid pattern with one nautical mile (NM) (1.85 km) spacing between positions.

Five offshore export cables—two cables for Phase 1 and three cables for Phase 2—will transmit electricity from the SWDA to shore. Unless technical, logistical, grid interconnection, or other unforeseen issues arise, all New England Wind offshore export cables will be installed within a shared Offshore Export Cable Corridor (OECC) that will travel from the northwestern corner of the SWDA along the northwestern edge of Lease Area OCS-A 0501 (through Vineyard Wind 1) and then head northward along the eastern side of Muskeget Channel towards the southern shore of Cape Cod (see Figure 2.0-1).

Based upon careful consideration of multiple technical, environmental, and commercial factors, the Proponent identified the OECC for New England Wind that is largely the same OECC included in the approved Vineyard Wind 1 COP, but it has been widened by approximately 300 m (984 ft) to the west along the entire corridor and by approximately 300 m (984 ft) to the east in portions of Muskeget Channel, for a total width of approximately 950–1,700 m (3,100–5,500 ft). The two Vineyard Wind 1 offshore export cables will also be installed within the New England Wind OECC. To avoid cable crossings, the Phase 1 cables are expected to be located to the west of the Vineyard Wind 1 cables and, subsequently, the Phase 2 cable(s) are expected to be installed to the west of the Phase 1 cables. At approximately 2-3 km (1-2 mi) from shore, the OECC diverges for each Phase to reach separate landfall sites in Barnstable. For Phase 1, the OECC includes two possible landfall sites located near one another along the same stretch of shoreline in Barnstable: Craigville Public Beach Landfall Site and Covell's Beach Landfall Site. For Phase 2, the OECC landfall sites includes one or both of the following landfall sites in the Town of Barnstable: Dowses Beach Landfall Site and Wianno Avenue Landfall Site.

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1 Within the SWDA, the closest WTG is approximately 34 km (21 mi) from Martha's Vineyard and 40 km (25 mi) from Nantucket.

While the Proponent intends to install all New England Wind offshore export cables within the OECC that travels from the SWDA northward through the eastern side of Muskeget Channel towards landfall sites in the Town of Barnstable, the Proponent is reserving the fallback option to install one or two Phase 2 cables along the western side of Muskeget Channel, referred to as the Phase 2 OECC Western Muskeget Variant[2] (see Section 4.1.3.2 of COP Volume I). However, it is highly unlikely that more than one cable could be installed within the Western Muskeget Variant due to multiple technical reasons related to challenging site conditions. These technical reasons include the highly variable bathymetry and steep slopes, the presence of Mutton Shoal directly to the east of a bathymetric depression (which severely restricts the available area for cable installation), the presence of greater areas of large sand waves compared to the OECC, the presence of navigational buoys, and the migration of Wasque Shoal (which poses a significant risk to the overall stability and capacity of any export cables installed within the Western Muskeget Variant). Throughout this section, unless the Western Muskeget Variant is specified, "the OECC" refers to the OECC that travels along the eastern side of Muskeget Channel.

Each Phase of New England Wind will be developed and permitted using a Project Design Envelope (the "Envelope"). This allows the Proponent to properly define and bracket the characteristics of each Phase for the purposes of environmental review while maintaining a reasonable degree of flexibility with respect to the selection of key components, such as the WTGs, foundations, offshore cables, and ESPs. To assess potential impacts and benefits to various resources, a "maximum design scenario," or the design scenario with the maximum impacts anticipated for that resource, is established considering the Envelope parameters for each Phase that have the potential to cause the greatest effect. For some resources, the approach overestimates potential environmental impacts as the maximum design scenario is not the scenario the Proponent is likely to employ.

3.0 Description of the Affected Environment

The Offshore Development Area is the offshore area where the Proponent's wind energy generation facilities are physically located and includes the SWDA and OECC. The SWDA is located south of Martha's Vineyard in the northern Mid-Atlantic Bight of the Northeast United States (US) Shelf Ecosystem. The OECC is the surveyed area identified for routing the offshore export cables.

Habitat along the OECC and within the SWDA was evaluated utilizing approximately 26,150 km (16,249 mi) of geophysical trackline data, 259 benthic grab samples, 379 vibracores, and 155 underwater video transects collected from 2016–2020. Within the 9.6 km^2 (2,371 acre) Western Muskeget Variant, habitat was evaluated using 785 km (488 mi) of geophysical trackline data, 11 benthic grab samples, 22 vibracores, and 6 underwater video transects collected from 2017-2018. As described in Section 5.2 of Volume II of the COP, potential sensitive habitat boundaries were classified and mapped in two ways: (1) using the Massachusetts Ocean Management Plan (MA OMP) definition of special, sensitive, and unique habitats (SSUs), and (2) using the NMFS

[2] The Western Muskeget Variant is the same exact corridor as the western Muskeget option included in the Vineyard Wind 1 COP and has already been thoroughly reviewed and approved by BOEM as part of that COP.

Recommendations for Mapping Fish Habitat (2021). NMFS (2021) requires the following habitat areas to be mapped:

- Soft Bottom habitats (i.e. mud and/or sand);
- Complex habitats (i.e. SAV, shell/shellfish, and/or hard bottom substrate);
- Heterogeneous Complex habitats (i.e. mix of soft and complex stations within a delineated area);
- Large Grained Complex habitats (e.g. large boulders); and
- Benthic Features (i.e. ripples, megaripples, and sand waves).

A comparison of the two classification systems indicates that NMFS (2021) is a much more conservative classification system. In particular, the definition of Complex in the NMFS (2021) mapping recommendations has a smaller grain size threshold (>2 mm) and lower composition threshold (>5% gravel) than what is required in the MA OMP and what was classified in previously used classification systems such as Auster (1998) and Barnhardt et al. (1998). Therefore, more ground truthing samples are now classified as Complex, resulting in increased areas of Complex or Heterogeneous Complex Habitats than had been previously mapped. Many of these samples that are now considered Complex, such as those in the Gravelly Group, have low percentages of gravel (5 to 30%) and a small grain size of Pebbles/Granules (2 to 64 mm). Areas with this low percentage of gravel and small grain size such as those outside Muskeget Channel, though classified as Complex or Heterogeneous Complex Habitats, do not have the same habitat values as areas with more and larger gravel such as those within Muskeget Channel. Because the NMFS habitat classifications are broad enough to include these varying levels of habitat values within the Complex and Heterogeneous Complex Habitat categories, habitat areas that have lower habitat value are now classified as Complex or Heterogeneous Complex Habitat.

While both the OMP classification and the NMFS (2021) classification are presented in Section 5.2 of Volume II of the COP, the rest of this appendix focuses on the habitat classifications under NMFS (2021). As described in Section 5.2.2 of Volume II of the COP, to classify habitat boundaries according to NMFS (2021), multibeam, side scan, and backscatter data were used to define seafloor composition based on the acoustic reflectivity which is a function of the bottom texture, roughness, slope, relief, and sediment grain size. Benthic grab samples, vibracores, and video transects were sampled to ground-truth acoustic data. Both benthic grab samples and video transects were classified using the NMFS-modified Coastal and Marine Ecological Classification Standard (CMECS) system through grain-size analysis and percent cover of still images, respectively (Table 3.0-1). All ground-truthing samples (grabs, video, and vibracores) were then assigned a final classification of Soft or Complex. Some video transects were designated as Complex Mix if the transect traversed both soft and complex bottom habitats.

Delineated habitat boundaries were assigned one of four habitat categories: Complex, Heterogeneous Complex, Large Grained Complex, or Soft Bottom based on classification of ground-truthing samples within those areas. Habitat boundaries were then refined using ground truthing data; where there was no difference in sonar data over a large area or the only difference was bedform fields, ground truthing was used to refine boundaries. Sonar-delineated boundaries that bordered other boundaries of the same habitat category were kept as separate boundaries (i.e. not merged) to illustrate differences in sonar data that showed potentially different ground types (i.e. variation in quantity of type of Complex habitat). Benthic Features, including bedforms and Organic Mud were delineated using vertically exaggerated multibeam and side scan sonar data. Organic Mud, though not a Benthic Feature specified in the NMFS (2021) mapping guidelines, was a prominent feature in the southern OECC and therefore was mapped as a separate Benthic Feature. In addition, larger scale characterizations of the Massachusetts Wind Energy Area (MA WEA) from Guida et al. (2017) were used to describe the regional setting. Large scale maps of bottom habitats and benthic features located within the Offshore Development Area of New England Wind following NMFS (2021) are presented in Annex I.

Southern Wind Development Area

Seafloor conditions within the SWDA are entirely homogenous Soft Bottom habitat, consisting of CMECS substrate groups Muddy Sand, Sandy Mud, and Sand (Fine/Very Fine, Medium, and Very Coarse/Coarse), with the majority of the area being Muddy Sand (Figure 3.0-1; Table 3.0-1; Annex I). These homogenous conditions were identified by multibeam echo sounding and side scan sonar imaging techniques that have been ground-truthed via benthic grab samples, underwater video, borings, and cone penetration tests, as described above, and further verified via historic grab sample and still photo data (Guida et al. 2017; Stokesbury 2013; 2014). Ground truth data also identified dominant biotic elements, which included aggregations of burrowing anemones and patches of sulfur sponge with mobile megafauna such as hake (Gadidae), cancer crabs (*Cancer*), sea stars (Asterias), and shrimp (Decapoda) also observed throughout this area (COP Volume II Appendix II-H). Lower current velocities and finer grain sizes in the SWDA equate to bedforms with low relief and short wavelengths, mostly ripples (less than 0.5 meters [m] [1.6 feet (ft)] height) and some megaripples (0.5–0.8 m [1.6–2.6 ft] height). Large, broad, well-defined areas of rippled bedforms and ripple scour depressions (RSDs) are located on the surface of the bathymetric highs, oriented northeast-southwest in the southeastern portion of the SWDA. Smaller groupings of RSDs are found in the northern and western portion of the SWDA, which provide the only relief as compared to the relatively flat seafloor that gradually slopes offshore. These features within the SWDA provide less than one-meter (m) (3.2-foot [ft]) relief, far smaller than sand waves in some other parts of the Atlantic that can stretch hundreds of meters.

Table 3.0-1 Examples of CMECS defined substrates captured during 2020 underwater video and benthic grab sampling throughout the Offshore Development Area of New England Wind

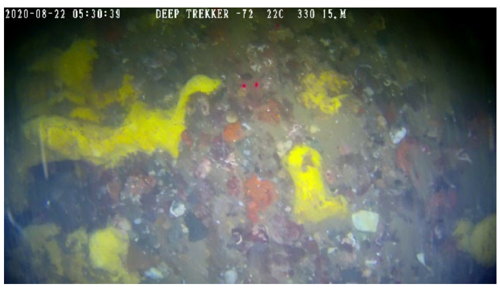
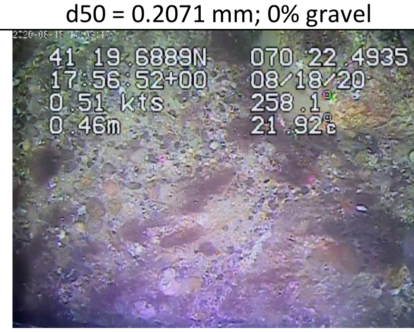
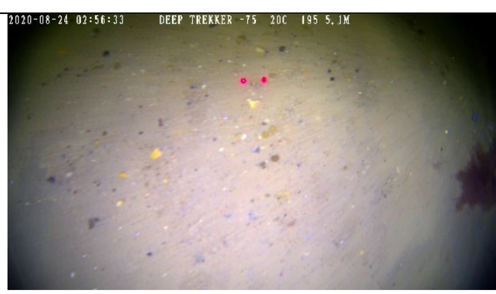
CMECS Substrate and NMFS (2021) Designation	Underwater Video	Grab Sample
Fine/Very Fine Sand; Soft Bottom	 OECC20-VT-62	 OECC20-GB-07 d50 = 0.2071 mm; 0% gravel
Gravel Pavement; Complex	 OECC20-VT-26	 OECC20-GB-30 d50 = N/A, no recovery; 74% gravel
Gravelly Mud; Complex	 OECC20-VT-28	 OECC20-GB-03 d60 = 0.0784 mm; 7% gravel
Gravelly Muddy Sand; Complex	 OECC20-VT-28	 WB19-GB-08 d50 = 0.42; 6% gravel

Table 3.0-1 Examples of CMECS defined substrates captured during 2020 underwater video and benthic grab sampling throughout the Offshore Development Area of New England Wind (Continued)

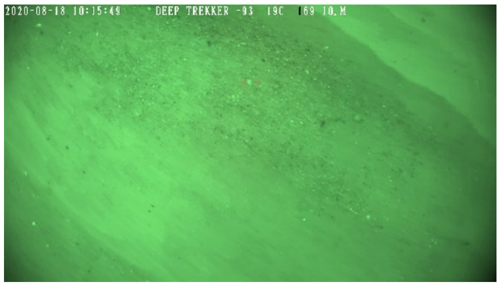
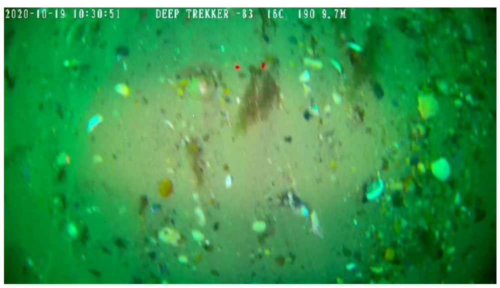
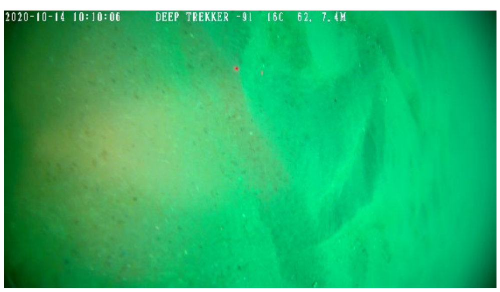
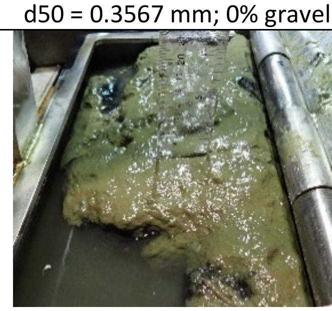
CMECS Substrate and NMFS (2021) Designation	Underwater Video	Grab Sample
Gravelly Sand; Complex	 OECC20-VT-51	 OECC20-GB-66 d50 = 1.053 mm; 9% gravel
Gravelly Sand/Shell Hash; Complex	 OECC20-VT-37	 OECC20-GB-12 d50 = 0.5444; 17% gravel
Medium Sand; Soft Bottom	 OECC20-VT-21	 OECC20-GB-73 d50 = 0.3567 mm; 0% gravel
Mud; Soft Bottom	 OECC20-VT-54	 OECC20-GB-14 d50 =N/A; 0% gravel

Table 3.0-1 Examples of CMECS defined substrates captured during 2020 underwater video and benthic grab sampling throughout the Offshore Development Area of New England Wind (Continued)

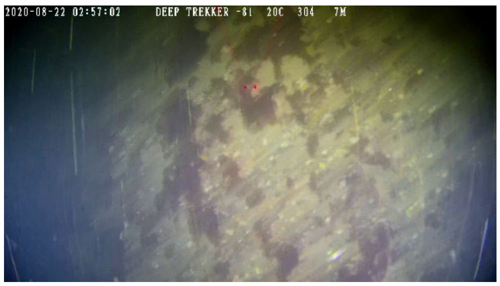
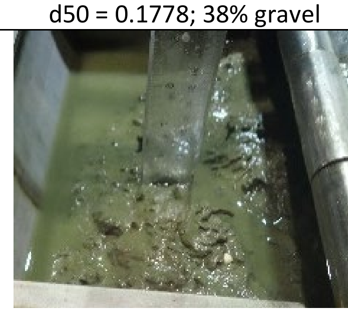
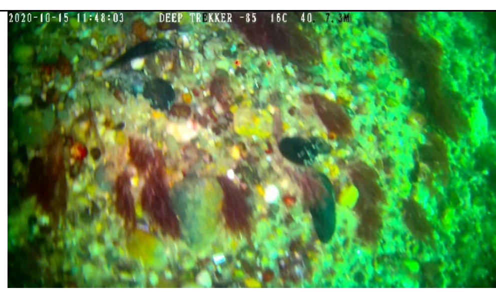
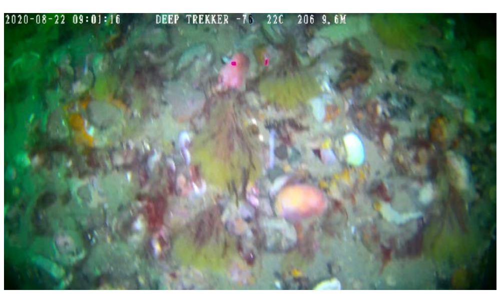
CMECS Substrate and NMFS (2021) Designation	Underwater Video	Grab Sample
Muddy Gravel/Shell Hash; Complex	 OECC20-VT-30	 OECC20-GB-02 d50 = 0.1778; 38% gravel
Muddy Sand; Soft Bottom	 SWDA20-VT-09	 SWDA20-GB-28 d50 = 0.1833 mm; 1% gravel
Muddy Sandy Gravel; Complex	 OECC20-VT-43	No data
Muddy Sandy Gravel/Shell Hash; Complex	 OECC20-VT-22	 OECC20-GB-02 d50 = 0.1778 mm; 38% gravel

Table 3.0-1 Examples of CMECS defined substrates captured during 2020 underwater video and benthic grab sampling throughout the Offshore Development Area of New England Wind (Continued)

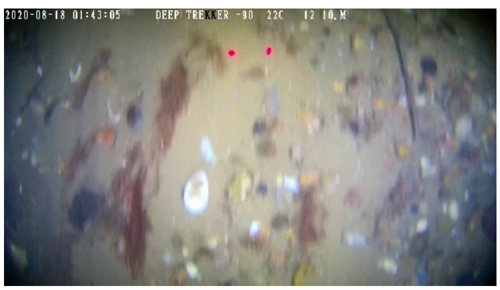
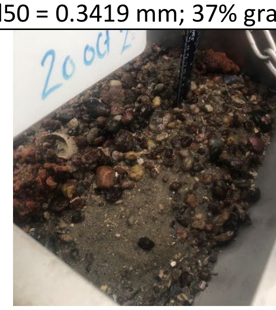
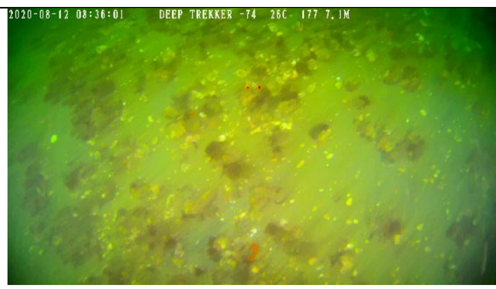
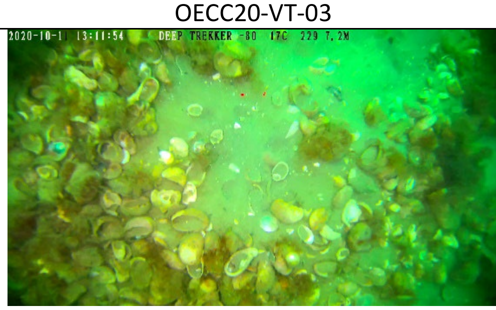
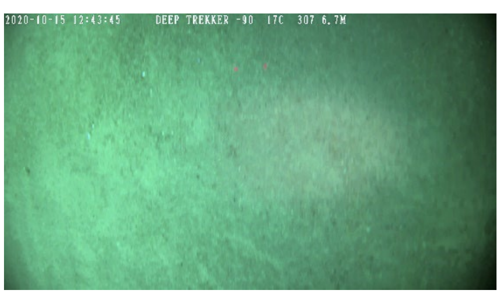
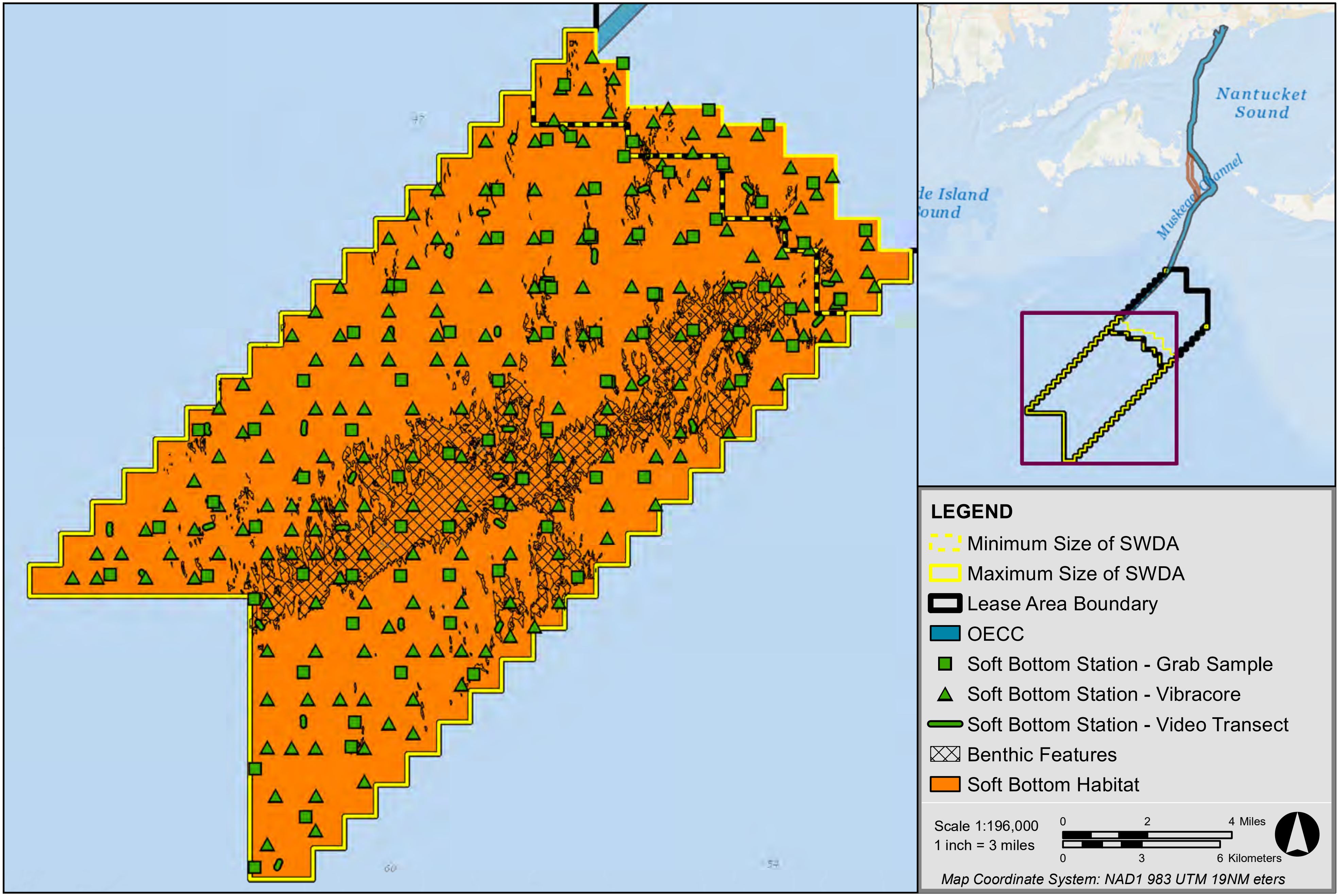
CMECS Substrate and NMFS (2021) Designation	Underwater Video	Grab Sample
Pebble/Granule; Complex	 OECC-VT-30	 OECC20-GB-29 d50 = N/A, no recovery
Sandy Gravel; Complex	 OECC20-VT-35	 OECC20-GB-43 d50 = 0.3419 mm; 37% gravel
Sandy Gravel/Shell Hash; Complex	 OECC20-VT-38	 OECC20-GB-45 d50 = 7.7342 mm; 69% gravel

Table 3.0-1 Examples of CMECS defined substrates captured during 2020 underwater video and benthic grab sampling throughout the Offshore Development Area of New England Wind (Continued)

CMECS Substrate and NMFS (2021) Designation	Underwater Video	Grab Sample
Sandy Mud; Soft Bottom	 SWDA20-VT-12	 SWDA20-GB-40 d50 = N/A; 1% gravel
Shell Hash/Muddy Sand; Complex	 OECC20-VT-03	 WB19-GB-09 d50 = 0.11; 4% gravel
Shell Rubble; Complex	 OECC20-VT-02	No data
Very Coarse/Coarse Sand; Soft Bottom	 OECC20-VT48	 OECC20-GB-63 d50 = 0.6387 mm; 0% gravel



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

New England Wind

Figure 3.0-1

Habitat Types, Benthic Features, and Ground Truth Sample Locations in the Southern Wind Development Area (SWDA) Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021).

No state-managed artificial reefs have been documented within the SWDA. There are five reported shipwrecks in the SWDA and geophysical field programs identified three potential shipwrecks within the SWDA. Other types of potentially sensitive or unique benthic habitat types, such as live bottom, are not present based on the Shallow Hazards Assessment discussed in Section 3 of COP Volume II. Pelagic habitats within and near the SWDA vary seasonally and interannually. Water depths in the SWDA (excluding the two separate aliquots) generally range from approximately 43–62 m (141–203 ft). Water temperature in this region, which is a major catalyst for faunal movements and distributions, follows a seasonal structure with increased surface temperatures starting in April and into August, vertical turnover in September or October (during which bottom temperatures are at their highest), large temperature drops throughout the water column through January, and stable temperatures < 5 °C (41 °F) in February and March (Guida et al. 2017).

Offshore Export Cable Corridor

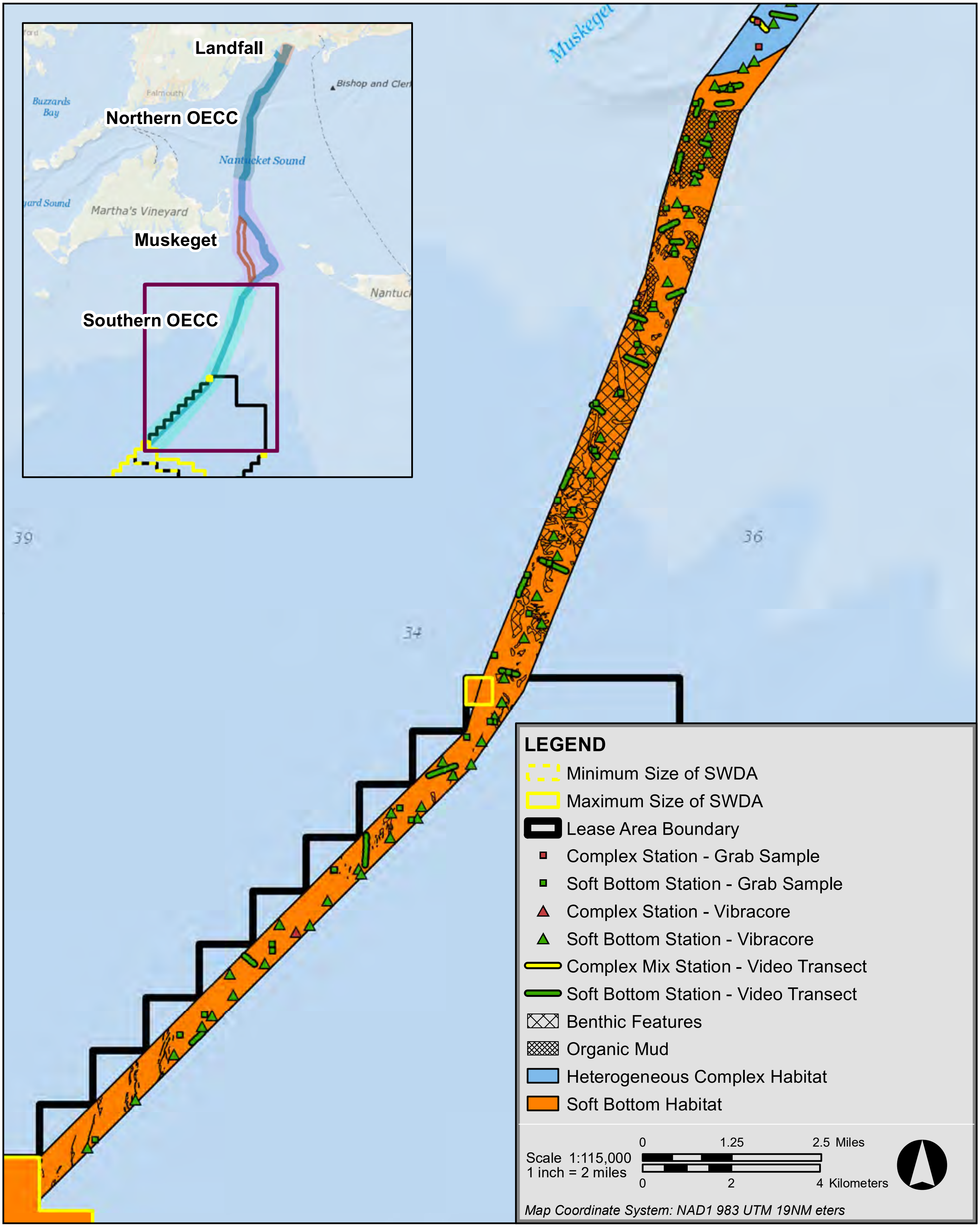
As described in COP Volume II, Soft Bottom habitats are the most common along the OECC and make up approximately 61% of the entire corridor (Table 3.0-2). Large stretches of Soft Bottom habitat were found in the northern and southern portions of the OECC (Figure 3.0-2 & Figure 3.0-4; Annex I). These areas typically contain a sandy surficial layer that is either highly mobile and comprised of migrating bedforms or flat and stable, mostly void of active sediment transport features. Within the southern portion of the OECC, dense aggregations of sand dollars and burrowing anemones were frequently observed via ground truthing data in the Soft Bottom habitat (COP Volume II Appendix II-H).

Complex Habitat, defined as hard bottom substrates, hard bottom with epifauna or macroalgae cover, and vegetated habitats (NMFS 2021), was identified along approximately 9% of the OECC, primarily in smaller patches in Muskeget Channel and near the Phase 2 landfall sites (Figure 3.0-3 & Figure 3.0-4; Annex I). Ground truthing revealed most of the Complex habitat in Muskeget Channel to be Sandy Gravel, Gravelly Sand, or Shell Hash/Rubble (Table 3.0-1). Although rare, several locations within Muskeget Channel contained coarse deposits and hard bottom (Pebble/Granule Gravel and Gravel Pavement) with sulfur sponge (*Cliona celata*) and other encrusting organism communities (COP Volume II Appendix II-H). Near the Phase 2 landfall sites, ground-truthing showed Gravelly Sand and Gravelly Muddy Sand were predominant.

Heterogeneous Complex habitat includes areas in which ground truthing revealed mixed patches of both Complex and Soft Bottom habitat (NMFS 2021). This type of habitat was found in roughly 30% of the OECC, scattered throughout the middle and northern portion of the corridor. These habitats included areas of shell aggregate, specifically common Atlantic slipper shell (*Credula fornicate*) hash, but mostly included areas with small grained coarse material and/or low percentages of gravel. In addition, one area of Heterogeneous Complex habitat was mapped in the southern portion of the OECC, which was due to grab samples categorized as Gravelly Sand, though the percentage of gravel was very low and the grain size was very small within these samples. Large Grained Complex habitat, or areas with rock outcrops or large boulders, was the rarest type of habitat identified along the OECC, only mapped at Spindle Rock and near Collier Ledge. Ground truthing visual data found that macroalgae was common along the OECC and was observed in each habitat type regularly (COP Volume II Appendix II-H).

When considering only the Western Muskeget Variant itself (i.e., the segment through the western portion of Muskeget Channel), the benthic habitat types are Heterogeneous Complex and Complex. Substrate samples from 2017 and 2018 collected in Heterogeneous Complex area consisted of Gravelly Sand, Sandy Gravel, or Medium Sand and substrate from samples collected in Complex Habitat included Gravelly Sand, Sandy Gravel, and Gravel Pavement. In several locations within the Complex Habitat, sulfur sponge and macroalgae were associated with larger grained hard bottom substrates such as Gravel Pavement. The eight samples collected from the Western Muskeget Variant in 2017 and 2018 were characterized by the dominance of polychaete worms and extreme patchiness between samples. Benthic Features ranged from ripples to sand waves and were usually a range of sizes within a given geographical area. Benthic Features within the central portion of the corridor include complex ripples to sand waves in the channel with sand waves 3–8 m (9.8–26.2 ft) high and wavelengths ~75 m (~246 ft), and bedforms up to 1.0 m (3.3 ft) high with wavelengths 30–60 m (98–197 ft). To the south, Benthic Features include megaripples/sand waves up to 5 m (16.4 ft) in height and a larger bedform 0.8–5 m (2.6–16.4 ft) high with wavelengths 45–250 m (148–820 ft).

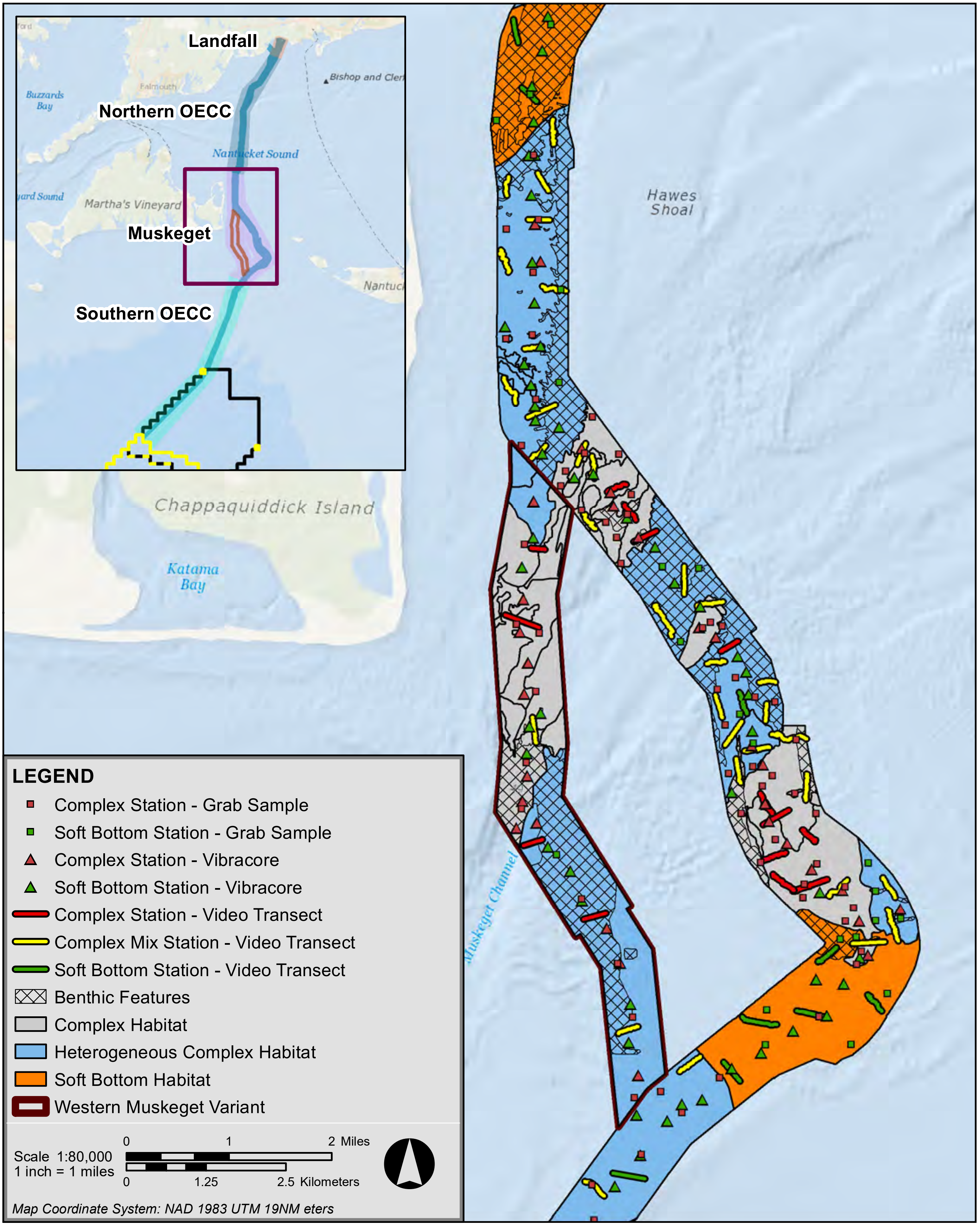
Table 3.0-2 summarizes the benthic habitat classification for the SWDA, OECC, and OECC including the Western Muskeget Variant. If the Western Muskeget Variant is used for Phase 2, there will be either (1) one export cable installed in the Western Muskeget Variant and two export cables installed in the OECC or (2) two export cables installed in the Western Muskeget Variant and one export cable installed in the OECC. Accordingly, the benthic habitat classification for the OECC including the Western Muskeget Variant includes the sum of habitat types within the OECC and the Western Muskeget Variant.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

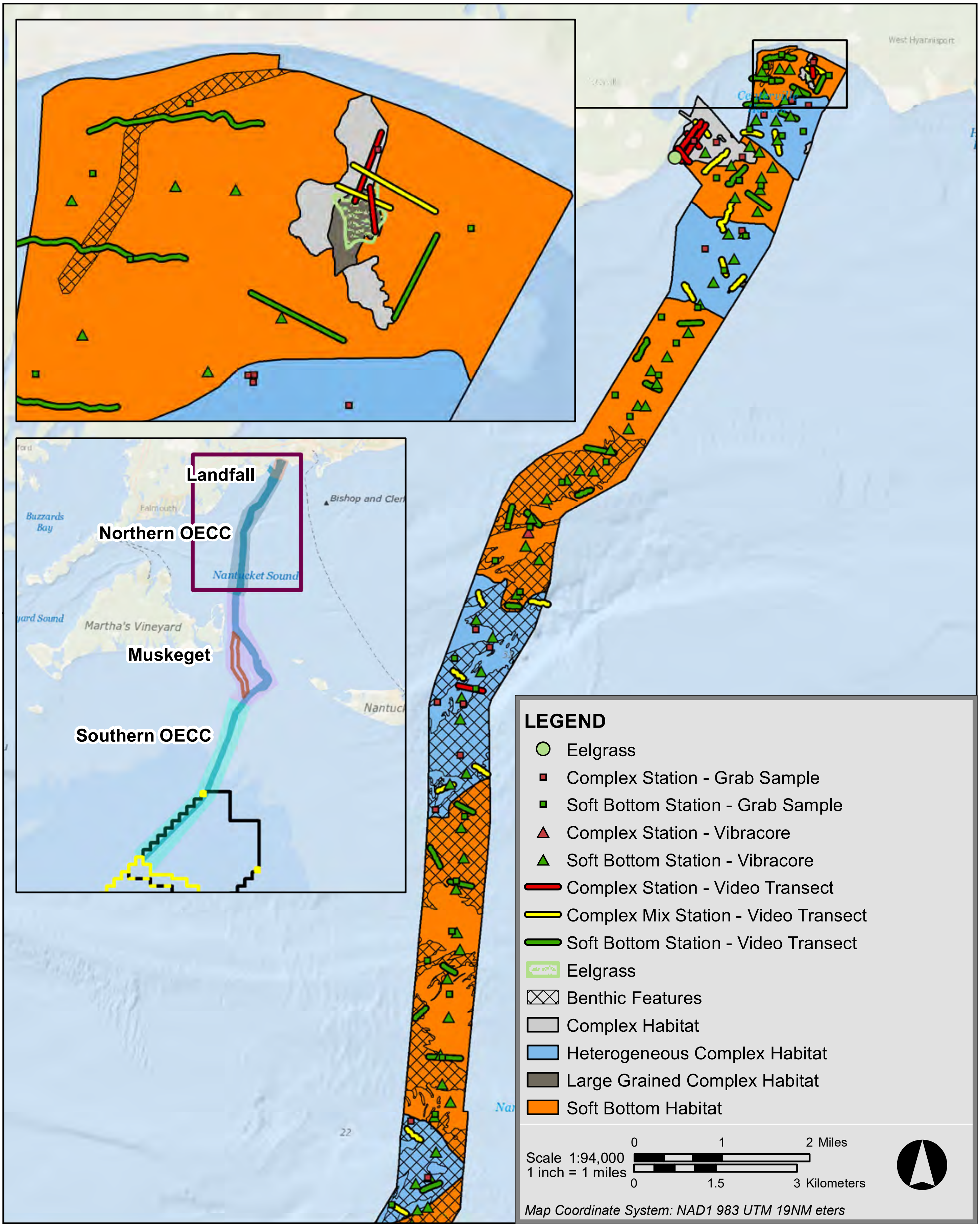
New England Wind **Figure 3.0-2**

Habitat Types, Benthic Features, and Ground Truth Sample Locations in the Southern Portion of the Offshore Export Cable Corridor (OECC) Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021).



New England Wind **Figure 3.0-3**

Habitat Types, Benthic Features, and Ground Truth Sample Locations in the Muskeget Channel Portion of the Offshore Export Cable Corridor (OECC) Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021).



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

New England Wind **Figure 3.0-4**

Habitat Types, Benthic Features, and Ground Truth Sample Locations in the Northern Portion of the Offshore Export Cable Corridor (OECC) Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021).

Table 3.0-2 Benthic Habitat Classification in the Offshore Development Area of New England Wind

Habitat Type	Southern Wind Development Area			Offshore Export Cable Corridor[1]			Offshore Export Cable Corridor including Western Muskeget Variant[2]		
	Km^2	Acres	%	Km^2	Acres	%	Km^2	Acres	%
Complex	0	0	0	7.9	1,956	9	12.3	3,039	13
Heterogeneous Complex	0	0	0	25.0	6,171	30	30.2	7,463	32
Large Grained Complex	0	0	0	0.04	10	<0.1	0.04	10	<0.05
Soft Bottom	453	111,939	100	50.6	12,511	61	50.6	12,511	54

Notes:

1. Offshore Export Cable Corridor includes habitat types within the corridor that travels from the SWDA northward along the eastern side of Muskeget Channel toward landfall sites in the Town of Barnstable.
2. Offshore Export Cable Corridor including Western Muskeget Variant includes habitat types within both the corridor that that travels along the eastern side of Muskeget Channel and the variant that travels along the western side of Muskeget Channel.

In general, the larger bedforms are found in waters where tidal currents force large volumes of water to enter and exit constricted pathways along the OECC. Ripples, megaripples, and sand waves (all categorized as Benthic Features here) along the OECC are typically < 3 m (9.8 ft) high with a maximum height of 9–9.5 m (29.5–31.2 ft) for a single sand wave located along the eastern Muskeget Channel stretch of the OECC (KP 33.87–33.97). Ripple scour depressions were a common Benthic Feature in the southern portion of the OECC. In addition, patches of organic mud were identified in the southern OECC, and although not a Benthic Feature specified in the NMFS (2021) mapping guidelines, were a prominent feature in the data. This area is composed of very soft sediment, with the grabs being categorized as Muddy Sand and Sandy Mud that appears as textured relief in the sonar data.

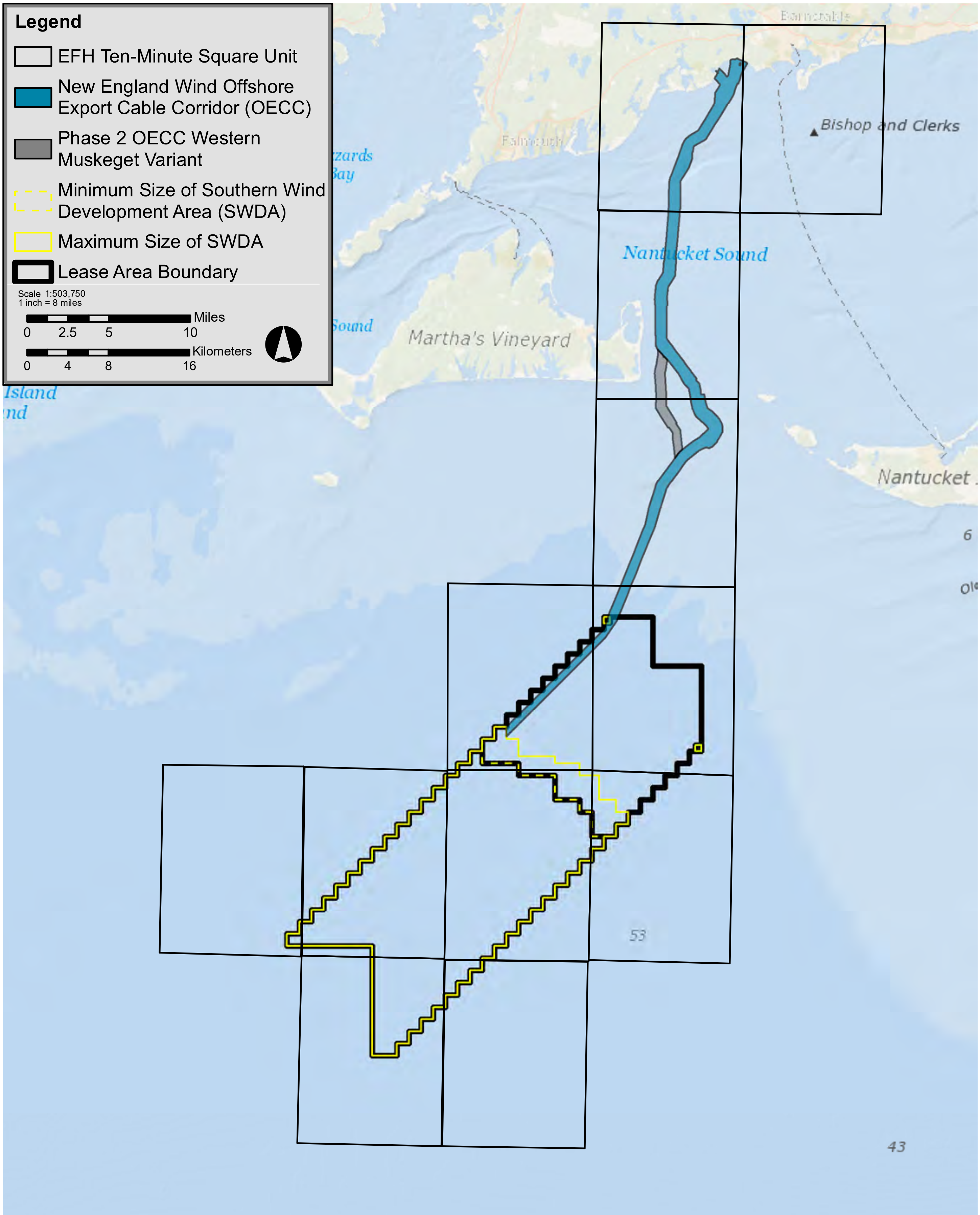
There are no artificial reefs directly along the OECC; however, there are three artificial reef locations well outside the Offshore Development Area (NEODP 2020). Surveys have revealed isolated man-made objects to be avoided in the OECC and one debris pile/possible shipwreck in the OECC, approximately 11 km (5.9 nm) southwest of Covell's Beach. Possible sensitive habitats, mainly in the Muskeget Channel area, were also identified in surveys as described in COP Volume II.

Eelgrass was identified in multiple locations along the OECC with the largest patch having sparse to moderate distributions in and around the Spindle Rock boulder pile near the landfall site. Several isolated rooted plants were observed at the Phase 1 (Craigville Public Beach and Covell's Beach) and Phase 2 (Dowses Beach and Wianno Avenue) landfall site options, but none were considered part of an eelgrass bed. A patch of eelgrass was found outside the OECC to the southwest of the Phase 2 landfall sites at the very end of a video transect (CR Environmental 2020). This may indicate the edge of a bed that extends to the southwest or inshore but does not occur within the New England Wind OECC.

4.0 EFH Designations in the Offshore Development Area

The EFH designations described in this section correspond to those currently accepted and designated by the New England Fishery Management Council, Mid-Atlantic Fishery Management Council, South Atlantic Fishery Management Council, and NOAA Highly Migratory Species Division (NEFMC 2017). Many EFH designations are determined for each cell in a 10' latitude by 10' longitude square grid in state and federal waters. The SWDA intersects eight cells and the OECC intersects six cells (Figure 4.0-1). The specific FMPs with protective designations of EFH include:

- New England Fishery Management Council
  - Northeast Multispecies FMP
  - Atlantic Sea Scallop FMP
  - Monkfish FMP
  - Atlantic Herring FMP
  - Skate FMP
- Mid-Atlantic Fishery Management Council
  - Atlantic Mackerel, Squid, and Butterfish FMP
  - Spiny Dogfish FMP
  - Summer Flounder, Scup, and Black Sea Bass FMP
  - Bluefish FMP
  - Atlantic Surf clam and Ocean Quahog FMP
- NOAA Highly Migratory Species Division
  - Consolidated Atlantic Highly Migratory Species FMP
- South Atlantic Fishery Management Council
  - Coastal Migratory Pelagics FMP



New England Wind

Figure 4.0-1

EFH Grid Units as Designated by NOAA Fisheries that Intersect with the SWDA, OECC, and Phase 2 OECC Western Muskeget Variant

Essential Fish Habitat is designated for 48 fish species within the SWDA, OECC, and Western Muskeget Variant (see Table 4.0-1). Both substrate and water habitats are cited as EFH within both the SWDA and OECC. HAPC is also designated for Atlantic cod (*Gadus morhua*) and summer flounder (*Paralichthys dentatus*) and overlaps with the OECC and Western Muskeget Variant (juvenile Atlantic cod only) but not the SWDA. EFH and HAPC designations that overlap with the Offshore Development Area are described for individual species below.

Bottom habitats protected as EFH range from areas with substrates comprised of cobble or gravel (Complex habitat), for juvenile Atlantic cod, to areas with muddy and sandy substrates (Soft Bottom habitat), for juvenile and adult winter flounder (*Pseudopleuronectes americanus*). The importance of bottom habitat varies between species and within life stages. Coarse substrate, such as gravel or cobble, is considered EFH for the egg, larval, and juvenile life stages of many species because it provides a place for fish to find food, hide from predators, and shelter from strong currents. Studies have found that survivorship of juvenile Atlantic cod was enhanced in areas with coarse substrates (Lindholm et al. 2001; Grabowski et al. 2018). Alternatively, flatfish, such as winter flounder, prefer sandy or muddy habitats where they can easily bury themselves to avoid predation or wait for prey (Pereira et al. 1999).

Heterogeneous Complex habitat occurs primarily in the northern and Muskeget Channel portions of the OECC (including the Western Muskeget Variant). The substrate in these areas consists of sand/mud and gravel mixes, mostly with a very low (5-10%) gravel component. Although considered Complex under the NMFS (2021) guidelines, this habitat is likely used by EFH species that prefer Soft Bottom habitats due to the low relief and gravel component of the substrate. Skate, flounder, scup, crab (cancer and spider), and whelks were the most commonly observed species in the 2020 video transects near areas with gravelly substrates (RPS 2021).

Other bottom habitats, such as bedforms or sand waves, are also important habitat for fish species and provide structured habitat in sandy areas, where such habitat is typically void. Some evidence suggests that bedform habitat such as sand waves, can enhance fish survival by providing refuge from predators (Scharf et al. 2006). Most of the OECC will pass through Soft Bottom habitat, and underwater video samples collected along the OECC indicated that Soft Bottom habitats in the southern portion of the OECC had the highest abundances per meter for both vertebrates and invertebrates (COP Volume II Appendix II-H; RPS 2021). However, the OECC also passes through a variety of other sediment types, including areas with gravel and pebble-cobble substrate and dispersed boulders (see Annex I and COP Volume II). These coarser substrates, like pebble-cobble and boulders, were found mainly in Muskeget Channel and are important for habitat for the juveniles of some fish species, like Atlantic cod (Grabowski et al. 2018).

In addition to hard substrate, benthic flora is also considered EFH and HAPC for fauna in the region. Eelgrass is important habitat that provides forage opportunities and refuge to fish and invertebrate species (Hily and Bouteille 1999). In the OECC, a sparse to moderate distribution of eelgrass was discovered and mapped near the Spindle Rock boulder pile in the Phase 1 landfall portion of the OECC. Several isolated rooted plants were also observed on multiple transects in

2019 at the Phase 1 and Phase 2 landfall areas, but none were considered part of an eelgrass bed. A patch of eelgrass was also found to the southwest and outside of the Phase 2 landfall area at the very end of a video transect (CR Environmental 2020). This may indicate the edge of a bed that extends to the southwest or inshore but does not occur within the New England Wind OECC.

Water column or pelagic habitats protected as EFH range from surface waters (for witch flounder [*Glyptocephalus cynoglossus*] eggs) to the entire water column (for juvenile and adult bluefin tuna [*Thunnus thynnus*]), and demersal waters (for juvenile and adult scup [*Stenotomus chrysops*]). Although demersal fish species are strongly associated with bottom substrates, many species have pelagic egg and larval stages and use currents for dispersal of the early life stages. Pelagic species reside within the water column during all life stages and may occupy different strata based on the stage. For example, Atlantic mackerel (*Scomber scombrus*) eggs are free-floating and remain near the water surface, while larvae are typically observed in mid-water column below 10 m (32.8 ft).

Daily, seasonal, and annual ocean current patterns and production regimes dictate the foraging and migratory behaviors of some pelagic species. Highly migratory pelagic fish, such as Atlantic albacore tuna (*Thunnus alalunga*), are generally only observed in northern Atlantic waters for two months, September and October, to take advantage of productive late summer/early fall production. Frontal zones, or areas where water masses converge, are particularly important pelagic habitat as they are often important feeding locations where plankton become concentrated. The location of the SWDA is susceptible to intrusions of warm water from off the shelf or cold shelf water from the Gulf of Maine that could periodically create fronts and associated times of increased presence of pelagic species, particularly in the summer and fall. However, EFH has been designated for the following species for one or more life stages in the SWDA and/or OECC (see Table 4.0-1).

Review of the underwater video transects collected across the entire Offshore Development Area of New England Wind provided insight into species that use various habitats that occur throughout. Fish or invertebrate species with EFH designated in the Offshore Development Area that were observed in the OECC (including the Western Muskeget Variant) include: Atlantic surf clam (*Spisula solidissima*), black sea bass (*Centropristis striata*), little skate (*Leucoraja erinacea*), red hake (*Urophycis chuss*), scup (*Stenotomus chrysops*), sea scallop (*Placopecten magellanicus*), spotted hake (*Urophycis regia*), squid (Cephalopoda) and egg mop, summer flounder (*Paralichthys dentatus*), windowpane flounder (*Scopthalmus aquosas*), and winter skate (*Leucoraga ocellata*). Fish or invertebrate species with EFH designated in the Offshore Development Area that were observed in the SWDA include: little skate, red hake, flounder (Pleuronectiformes), monkfish (*Lophius americanus*), sea scallop, silver hake (*Merluccius bilinearis*), squid, windowpane flounder, and winter skate.

Table 4.0-1 EFH Designated Species in the Southern Wind Development Area (SWDA), Offshore Export Cable Corridor (OECC), and Phase 2 OECC Western Muskeget Variant (WMV) of New England Wind. C = Complex Habitat; S = Soft Bottom Habitat; HC = Heterogeneous Complex; P = Pelagic

	Eggs			Larvae/ Neonate[1]			Juveniles			Adults			HAPC
Species	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	
American plaice (*Hippoglossoides platessoides*)				P									
Atlantic albacore tuna (*Thunnus alalunga)*	-	-		-	-		P	P	P	P	P	P	
Atlantic bluefin tuna *(Thunnus thynnus)*[3]							P	P		P	P	P	
Atlantic butterfish *(Peprilus triacanthus)*	P			P			S	S	S	S	S	S	
Atlantic cod *(Gadus morhua)*	C	C	C	C	C	C	C	C	C	C	C	C	OECC[5]
Atlantic herring *(Clupea harengus)*	HC			P			P,HC	P,HC	P,HC	P,HC	P,HC	P,HC	
Atlantic mackerel *(Scomber scombrus)*	P	P	P	P	P	P	P	P	P	P			
Atlantic sea scallop (*Placopecten magellanicus*)	C,S	C,S	C,S	C,HC	C,HC	C,HC	C,HC	C,HC	C,HC	S,HC	S,HC	S,HC	
Atlantic skipjack tuna *(Katsuwonus pelami)*							P	P		P	P	P	
Atlantic surf clam *(Spisula solidissima)*	-	-		-	-			S	S		S	S	

Table 4.0-1 EFH Designated Species in the Southern Wind Development Area (SWDA), Offshore Export Cable Corridor (OECC), and Phase 2 OECC Western Muskeget Variant (WMV) of New England Wind (Continued)

Species	Eggs			Larvae/ Neonate[1]			Juveniles			Adults			HAPC
	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	
Atlantic wolffish (*Anarhichas lupus*)[2,3]	C	C	C	P,HC	P,HC	P,HC	HC	HC	HC	HC	HC	HC	
Atlantic yellowfin tuna (*Thunnus albacares*)							P	P	P	P			
Barndoor skate (*Dipturus laevis*)[1]	-	-		-	-		S,C			S,C			
Basking shark (*Cetorhinus maximus*)[3]	-	-	-	-	-	-	P	P	P	P	P	P	
Black sea bass *(Centropristis striata)*							C,HC	C,HC	C,HC	C,HC	C,HC	C,HC	
Blue shark (*Prionace glauca)*	-	-	-	P	P		P	P		P	P		
Bluefish *(Pomatomus saltatrix)*										P	P	P	
Cobia *(Rachycentron canadum)*	P,HC	P,HC		P,HC	P,HC		P,HC	P,HC		P,HC	P,HC		
Common thresher shark *(Alopias vulpinus)*[2]	-	-	-	P	P	P	P	P	P	P	P	P	
Dusky shark *(Carcharhinus obscurus)*[2, 3]	-	-	-	P	P		P	P		P	P		
Haddock *(Melanogrammus aeglefinus)*	C,S			P	P		P,HC			HC			
King mackerel *(Scomberomorus cavalla)*[2]	P,HC	P,HC		P,HC	P,HC		P,HC	P,HC		P,HC	P,HC		
Little skate *(Leucoraja erinacea)*	-	-	-	-	-	-	S,HC	S,HC	S,HC	S,HC	S,HC	S,HC	

Table 4.0-1 EFH Designated Species in the Southern Wind Development Area (SWDA), Offshore Export Cable Corridor (OECC), and Phase 2 OECC Western Muskeget Variant (WMV) of New England Wind (Continued)

Species	Eggs			Larvae/ Neonate[1]			Juveniles			Adults			HAPC
	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	
Longfin inshore squid *(Loligo pealeii)*		C,S,HC	C,S,HC	-	-	-	P	P	P	P	P	P	
Monkfish *(Lophius americanus)*	P	P	P	P	P	P	S,HC			S,HC	S,HC		
Northern shortfin squid *(Illex illecebrosu)*				-	-	-					P	P	
Ocean pout *(Macrozoarces americanus)*	C	C	C	-	-	-	S,HC	S,HC	S, HC	S,HC	S,HC		
Ocean quahog *(Artica islandica)*	-	-	-	-	-	-	S,HC	S,HC		S,HC	S,HC		
Pollock (*Pollachius virens)*	P	P		P	P		S,HC	S,HC					
Porbeagle shark *(Lamna nasus)*[2,3]	-	-	-	P			P			P			
Red hake *(Urophycis chuss)*	P	P		P,S,HC	P,S,HC		S,HC	S,HC		S	S		
Sand tiger shark (*Carcharias taurus*)[3]	-	-	-	HC	HC	HC	HC	HC	HC				
Sandbar shark *(Carcharhinus plumbeus)*	-	-	-				P	P	P	P	P		
Scup *(Stenotomus chrysops)*							S,HC	S,HC	S, HC	S,HC	S,HC	S, HC	
Shortfin mako shark *(Isurus oxyrinchus)*[2]	-	-	-	P			P			P			
Silver hake (*Merluccius bilinearis*)	P	P	P	P	P	P	S			S			
Smooth dogfish (*Mustelus canis*)[2]	-	-	-	S,HC	S,HC	S, HC	S,HC	S,HC	S, HC	S,HC	S,HC	S, HC	

Table 4.0-1 EFH Designated Species in the Southern Wind Development Area (SWDA), Offshore Export Cable Corridor (OECC), and Phase 2 OECC Western Muskeget Variant (WMV) of New England Wind (Continued)

Species	Eggs			Larvae/ Neonate[1]			Juveniles			Adults			HAPC
	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	
Spanish mackerel (*Scomberomorus maculatus*)[2]	P,HC	P,HC		P,HC	P,HC		P,HC	P,HC		P,HC	P,HC		
Spiny dogfish (*Squalus acanthias*)	-	-	-	-	-	-	S,HC	S,HC	S, HC	S,HC	S,HC	S, HC	
Summer flounder (*Paralichthys dentatus*)	S,P	S,P	S, P	P	P	P		S,HC	S, HC	S,HC	S,HC	S, HC	OECC
Tiger shark (*Galeocerdo cuvier*)	-	-	-				P			P			
White hake (*Urophycis tenuis*)					P	P	P,S,HC	P,S,HC	P, S, HC				
White shark (*Carcharodon carcharias*)[2]	-	-	-	P	P	P	P	P	P	P	P	P	
Windowpane flounder (*Scophthalmus aquosus*)	P	P	P	P	P	P	S	S	S	S	S	S	
Winter flounder (*Pseudopleuronectes americanus*)		S,HC	S, HC	S,HC	S,HC	S, HC	S,HC	S,HC	S, HC	S,HC	S,HC	S, HC	
Winter skate (*Leucoraja ocellata*)	-	-	-	-	-	-	S,HC	S,HC	S, HC	S,HC	S,HC	S, HC	
Witch flounder (*Glyptocephalus cynoglossus*)	P	P		P	P	P				S,HC			
Yellowtail flounder (*Limanda ferruginea*)	P	P	P	P	P	P	S	S	S	S	S	S	

Notes:

1. Shark species emerge from egg cases fully developed and are referred to as neonates.
2. Indicates EFH designations are the same for all life stages or designations are not specified by life stage.
3. Indicates Species of Concern.
4. "-" indicates EFH has not been designated for this life stage or the life stages are not relevant to that species life cycle.
5. HAPC is also designated for juvenile Atlantic cod in the Western Muskeget.

American Plaice

American plaice (*Hippoglossoides platessoides*) EFH is designated in the SWDA for the larval life stage. Area designated as EFH includes scattered pelagic habitats in the Gulf of Maine, Georges Bank, and southern New England. Eggs and larvae are passively transported via currents and while eggs have been mostly observed farther north of the Offshore Development Area, larvae have been observed between Georges Bank and Delaware (Johnson et al. 2004).

Atlantic Albacore Tuna

Albacore tuna EFH is designated in the SWDA, OECC, and Western Muskeget Variant for juvenile and adult life stages. EFH for juvenile albacore tuna is designated as offshore the US Atlantic east coast from Cape Cod to Cape Hatteras. Juveniles migrate to northeastern Atlantic waters in the summer for feeding. Adult albacore tuna EFH is also designated along the US Atlantic east coast from Cape Cod to Cape Hatteras generally farther offshore than EFH for juveniles. Adults are commonly found in northern Atlantic waters in September and October for feeding. Albacore tuna are top pelagic predators and opportunistic foragers (NMFS 2009a).

Atlantic Bluefin Tuna (Species of Concern)

Bluefin tuna EFH is designated in the SWDA and OECC for juvenile and adult life stages and in the Western Muskeget Variant for adults. EFH for juvenile bluefin tuna is waters off Cape Cod to Cape Hatteras. EFH for adult bluefin tuna is pelagic waters from the mid-coast of Maine to southern New England. Bluefin tuna inhabit northeastern waters to feed and move south to spawning grounds in the spring. Both juveniles and adults exhibit opportunistic foraging behaviors and diets typically consist of fish, jellyfish, and crustaceans (Atlantic Bluefin Tuna Status Review Team 2011). Bluefin tuna is considered a Species of Concern because they support important recreation and commercial fisheries and population size is unknown (NMFS 2011a).

Atlantic Butterfish

Atlantic butterfish (*Peprilus triacanthus*) EFH is designated in the SWDA for all life stages and in the OECC and Western Muskeget Variant for juvenile and adult life stages. EFH is designated for butterfish eggs in pelagic habitats with depths under 1,500 m (4,921 ft) and average temperatures between 6.5 to 21.5° Celsius (°C [48–71 °F]) in inshore estuaries and embayments from Massachusetts Bay to the south shore of Long Island, New York, in Chesapeake Bay, and in patches on the continental shelf/slope from Maine southward to Cape Hatteras, North Carolina. EFH for butterfish larvae is designated as pelagic habitats in inshore estuaries and embayments from Boston Harbor to Chesapeake Bay and over the continental shelf, from the Gulf of Maine to Cape Hatteras.

Butterfish larvae are common in high salinity and mixing zones where bottom depths are between 41–350 m (134–1,148 ft). EFH for juvenile and adult butterfish is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound on the inner and outer continental shelf from the Gulf of Maine to Cape Hatteras. Juvenile and adult butterfish are generally found over sand, mud, and mixed substrates in bottom depths between 10–280 m (33–918 ft] (NOAA 2007). Juvenile and adult butterfish feed primarily on planktonic prey though adults may eat squids and fishes as well (Cross et al. 1999). Butterfish are found in the Offshore Development Area throughout the year and are present in nearshore areas in the fall, and therefore may be impacted by cable installation (NEFSC n.d.).

Atlantic Cod

Atlantic cod EFH is designated in the SWDA, OECC, and Western Muskeget Variant for egg, larvae, juvenile, and adult life stages. EFH for Atlantic cod eggs is designated as surface waters from the Gulf of Maine to southern New England. Cod eggs are found in the fall, winter, and spring in water depths less than 110 m (361 ft). EFH for larval cod is pelagic waters (depths of 30–70 m [98–230 ft]) from the Gulf of Maine to southern New England and are primarily observed in the spring (Lough 2004). EFH for juvenile cod is designated as bottom habitats with substrates composed of cobble or gravel from the Gulf of Maine to southern New England. EFH for adult cod is designated as bottom habitats with substrates composed of rocks, pebbles, or gravel from the Gulf of Maine to southern New England and the middle Atlantic south to Delaware Bay. Inshore juvenile Atlantic cod HAPC is designated in coastal areas (from the shore to 20 m depth contour) from Maine to Rhode Island, and inshore waters around Cape Cod to Martha's Vineyard and Nantucket (NEFMC 2017) (Figure 4.0-2). These areas include all habitats within the OECC and Western Muskeget Variant that contain structurally complex areas, including eelgrass, mixed sand and gravel, and rocky habitats (NEFMC 2017). These habitats are particularly important for juvenile Atlantic cod as it provides protection from predation and readily available prey sources.

Cod spawn primarily in bottom habitats composed of sand, rocks, pebbles, or gravel during fall, winter, and early spring (NOAA 2007). Cod spawning in the SWDA is not likely due to low abundance and lack of "rough bottom habitat" suitable for spawning. SMAST bottom trawl surveys conducted between spring 2019 and winter 2022 caught 23 individual Atlantic cod and a map of Atlantic cod abundance developed by the New England Fishery Management Council shows no or low abundance around the SWDA (NEFMC 2022). Benthic surveys showed that the SWDA is wholly dominated by soft bottom habitat: unconsolidated substrate dominated by sand and silt-sized particles. The SWDA contains areas of localized ripple scour depressions, with medium and coarse sand grains within the ripples, but the ripples provide less than a meter of vertical relief and there were no complex habitats identified.

Juvenile and adult cod are opportunistic foragers and consume a wide variety of items including small crustaceans, benthic invertebrates, and fish (Lough 2004). Atlantic cod were not included as the most dominant finfish species in the MA WEA, designated by BOEM, in any season per New England Fisheries Science Center (NEFSC) bottom trawl surveys; however, they were present in over 30% of the Region 2 (OECC) spring trawls conducted by Massachusetts Department of Marine Fisheries.

Atlantic Sea Herring

Atlantic sea herring (*Clupea harengus*) EFH is designated in the SWDA for all life stages and OECC and Western Muskeget Variant for juvenile and adult life stages. Herring eggs adhere to the bottom; therefore, EFH is designated as inshore and offshore benthic habitats mainly in the Gulf of Maine, Georges Bank, and Nantucket Shoals in depths of 5–90 m (16–295 ft) on coarse sand, pebbles, cobbles, and boulders and/or macroalgae (NEFMC 2017). EFH for larval Atlantic sea

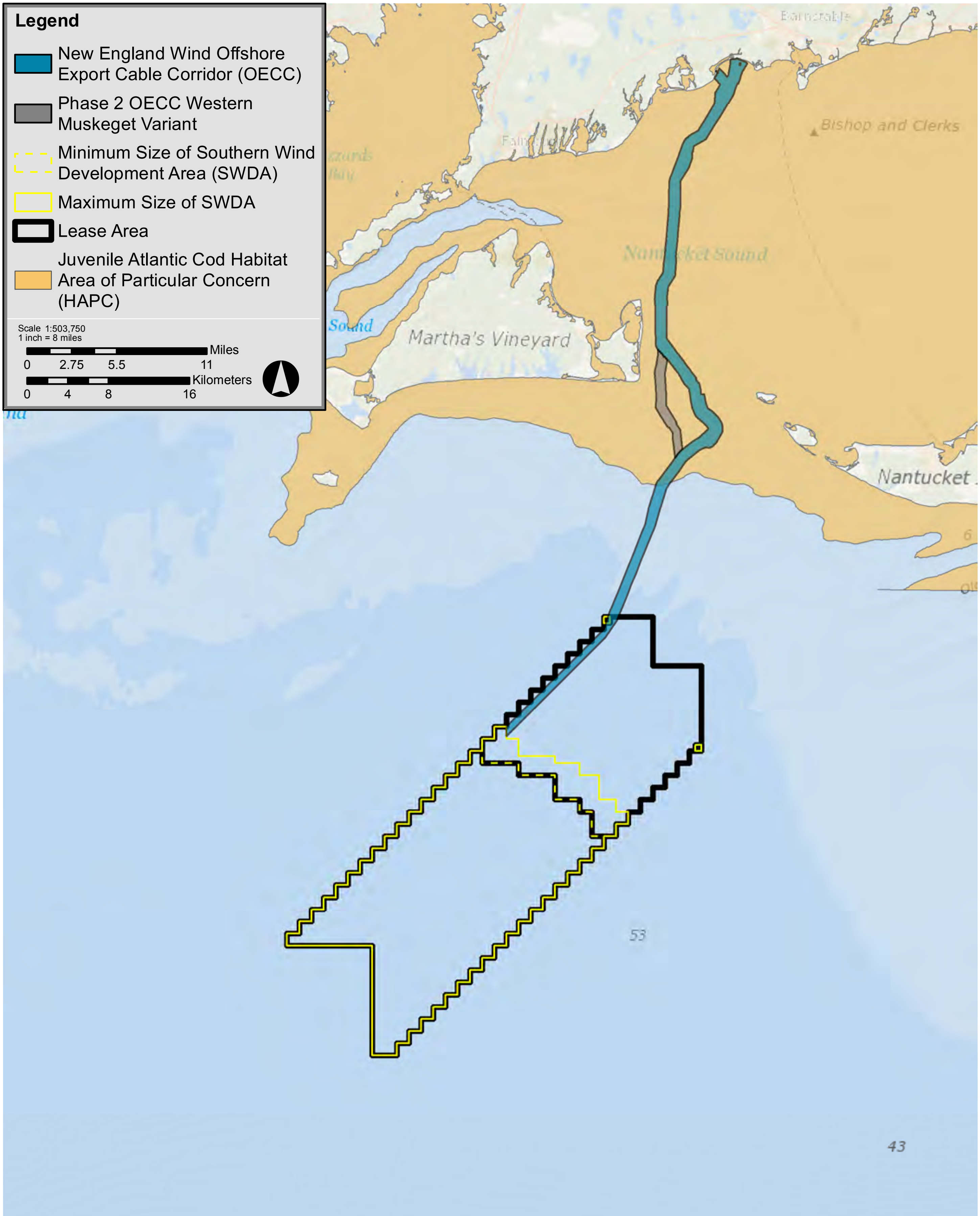


Figure 4.0-2

Habitat Area of Particular Concern for Juvenile Atlantic Cod (Gadus morhua) as Designated by the New England Fishery Management Council (NEFMC) herring is pelagic waters in the Gulf of Maine, Georges Bank, and southern New England. Larvae are free-floating and generally observed between August and April in areas with water depths from 50–90 m (164–295 ft). EFH for juvenile and adult herring is pelagic and bottom habitats in the Gulf of Maine, Georges Bank, and southern New England. Juvenile and adult herring are found in areas with water depths from 20–130 m (66–427 ft). Herring opportunistically feed on zooplankton, with forage species changing as herring size increases (Reid et al. 1999). Atlantic sea herring were captured in the NEFSC Multispecies Bottom Trawl Survey (1948–2016) throughout the year within the SWDA.

Atlantic Mackerel

Atlantic mackerel EFH is designated in the SWDA for all life stages and in the OECC and Western Muskeget Variant for egg, larval, and juvenile stages. EFH for mackerel (egg and larval stages) is pelagic habitats in inshore estuaries and embayments from Great Bay to Long Island, inshore and offshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras (NOAA 2007). Eggs float in the upper 10–15m (33–49 ft) of the water column, while larvae can be found in depths ranging from 10–130m (33–427 ft) (Studholme et al. 1999). EFH for juvenile Atlantic mackerel is designated in pelagic waters in the OECC. The depth preference of juvenile mackerel shifts seasonally as they are generally found higher in the water column (20–50 m [66–164 ft]) in the fall and summer, deeper (50–70 m [66–230 ft]) in the winter, and widely dispersed (30–90 m [98–295 ft]) in the spring (NEFSC n.d.; Studholme et al. 1999). EFH for adult mackerel includes pelagic habitats the same region as for juveniles, but in waters with bottom depths less than 170 m (230 ft). Juvenile and adult mackerel feed on small crustaceans, larval fish, and other pelagic species.

Atlantic Sea Scallop

Atlantic sea scallop (*Placopecten magellanicus*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for all life stages (egg, larvae, juveniles, adults). All life stages have the same EFH spatial designation, which extends across much of the greater Atlantic region. Because sea scallop eggs are heavier than seawater and remain on the seafloor until the larval stage, EFH is designated in benthic habitats in inshore areas and the continental shelf. During the larval stage, scallops are free-swimming and occur within the water column and near the seafloor. EFH for the larval stage (referred to as “spat”) includes benthic and pelagic habitats in inshore and offshore areas through the region. Hard substrate is particularly important as it provides essential habitat for settling larvae, which were found to have higher survival rates when attaching to hard surfaces rather than shifting sand or macroalgae. EFH for juvenile and adult sea scallops include sand and gravel substrates in the benthic habitats in depths of 18–110 m (59–361 ft) (NEFMC 2017).

Atlantic Skipjack Tuna

Skipjack tuna (*Katsuwonus pelami*) EFH is designated in the SWDA and OECC for juvenile and adult life stages and in the Western Muskeget Variant for adults. EFH for adult skipjack tuna includes coastal and offshore habitats between Massachusetts and South Carolina. EFH for juveniles is delineated within the same region, except in offshore waters only. Skipjack tuna are opportunistic foragers that feed primarily in surface waters but have also been caught in longline fisheries at greater depths (NMFS 2017).

Atlantic Surf Clam

Atlantic surf clam (*Spisula solidissima*) EFH is designated in the OECC and Western Muskeget Variant for juvenile and adult life stages. EFH for surf clams is throughout the substrate, to a depth of three feet below the water/sediment interface, from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic exclusive economic zone (EEZ). Surf clams are generally located from the tidal zone to a depth of about 38 m (125 ft) (NOAA 2007).

Atlantic Wolffish (Species of Concern)

Atlantic wolffish (*Anarhichas lupus*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for egg, larvae, juvenile, and adult life stages. EFH for wolffish eggs is bottom habitats over the continental shelf and slope within the Gulf of Maine south to Cape Cod. Wolffish eggs are deposited in rocky substrates in brood nests and are present throughout the year. EFH for wolffish larvae is water from the surface to the seafloor within the Gulf of Maine south to Cape Cod. EFH for juvenile and adult wolffish is bottom habitats of the continental shelf and slope within the Gulf of Maine south to Cape Cod. The depth range for all life stages ranges from 40–240 m (131–787 ft). Spawning is thought to occur in September and October. Wolffish utilize rocky habitats for shelter and nesting and softer substrate habitats for feeding (NOAA 2007). Although the diets of wolffish can vary, generally they feed on mollusks, crustaceans, and echinoderms (NMFS 2009b). Atlantic wolffish is considered a Species of Concern because the stock is overexploited and severely depleted. Wolffish biomass has shown a consistent downward trend since the 1980s and continues to decline because of capture as bycatch in the otter trawl fishery (NMFS 2009b).

Atlantic Yellowfin Tuna

Yellowfin tuna (*Thunnus albacares*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for the juvenile life stage and in a small portion of the SWDA for the adult life stage. EFH for juveniles and adults is in offshore pelagic and coastal waters from Cape Cod to the mid-east coast of Florida and North Carolina, respectively. The diet of Yellowfin tuna primarily consists of *Sargassum* or *Sargassum*-associated fauna (NMFS 2009a).

Barndoor Skate

Barndoor skate (*Dipturus laevis*) EFH is designated for juveniles and adults in the SWDA and includes benthic habitats on the continental shelf, in depths between 40–400 m (131–1,312 ft), and on the continental slope, in depths up to 750 m (2,461 ft), within Georges Banks and southern New England. Substrates included in the EFH are mud, sand, and gravel (NEFMC 2017). Barndoor skates have a relatively wide range which extends from Newfoundland to North Carolina. In southern New England, both juveniles and adults were most frequently observed in the summer, with few rare sightings of adults during the winter (Packer et al. 2003a).

Atlantic Basking Shark (Species of Concern)

Atlantic basking shark (*Cetorhinus maximus*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for juvenile and adult life stages. EFH for other life stages has not been identified because of insufficient information. EFH for juvenile and adult basking sharks is designated in the US Atlantic east coast from the Gulf of Maine to the northern Outer Banks of North Carolina (NMFS 2017). Basking sharks are generally observed in the northwestern and eastern Atlantic coastal regions from April to October and are thought to follow zooplankton distributions (Sims et al. 2003). Basking shark aggregations have been observed offshore Cape Cod, Martha's Vineyard, and Morishes Inlet, Long Island (NOAA 2016). Basking sharks are considered a Species of Concern because of interactions with vessels, being caught as bycatch, and low reproductive rates, which leads to slow recovery (NMFS 2011a).

Black Sea Bass

Black sea bass (*Centropristis striata*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for juvenile and adult life stages. EFH for juvenile and adult black sea bass is demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras (NOAA 2007). Juveniles prey on benthic and epibenthic crustaceans and small fish while adults tend to forage more generally for crustaceans, fish, and squids. Adults are generally associated with structurally complex habitats. Juveniles and adults are most commonly observed in the SWDA and OECC in the spring and fall (Drohan et al. 2007; NEFSC n.d.; NEODP 2020).

Blue Shark

Blue shark (*Prionace glauca*) EFH is designated in the SWDA and OECC for neonate, juvenile, and adult life stages. EFH for neonate blue shark is in areas offshore Cape Cod through New Jersey (NMFS 2017). EFH for juvenile and adult blue sharks is waters from the southern part of the Gulf of Maine to Cape Hatteras (Lent 1999). Blue sharks are highly migratory and observed in New England from late May through October. Blue sharks feed primarily on small pelagic fishes and cephalopods (Nakano et al. 2008).

Bluefish

Bluefish (*Pomatomus saltatrix*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for the adult life stage. Bluefish inhabit pelagic waters in and north of the Middle Atlantic Bight for much of the year but make seasonal migrations south in the winter (Shepherd and Packer 2005). Bluefish opportunistically forage on regionally and seasonally abundant fish species.

Cobia, Spanish Mackerel, and King Mackerel

Cobia (*Rachycentron canadum*), Spanish mackerel (*Scomberomorus maculatus*), and king mackerel (*Scomberomorus cavalla*) are categorized as coastal migratory pelagic fish and have the same EFH designations (SAFMC 1998). EFH for these three species is designated in the SWDA and OECC for egg, larvae, juvenile, and adult life stages. EFH for all life stages occurs in the South- and Mid-Atlantic Bights and includes sandy shoals of capes and offshore bars, high profile rocky bottom, and barrier island ocean-side waters, from the surf to the shelf break zone. EFH also includes *Sargassum* from the Gulf Stream shoreward. For cobia, EFH also includes high salinity bays, estuaries, seagrass habitats, and the Gulf Stream, which disperses pelagic larvae. Although EFH is designated within the Offshore Development Area, these species prefer warmer waters (above 18 °C [34°F]) and are not regularly present so far north (NOAA 2014).

Common Thresher Shark

Common thresher (*Alopias vulpinus*) shark EFH is designated in the SWDA, OECC, and Western Muskeget Variant for all life stages. EFH for all life stages is coastal and pelagic waters from Cape Cod to North Carolina and in other localized areas off the Atlantic coast. Common thresher sharks occur in coastal and oceanic waters but are more common within 64–80 km (35–43 NM) of the shoreline. Small pelagic fishes and pelagic crustaceans make up much of common thresher shark diet (NMFS 2017).

Dusky Shark (Species of Concern)

Dusky shark (*Carcharhinus obscurus*) EFH is designated in the SWDA and OECC for neonate, juvenile, and adult life stages. EFH for neonate dusky shark includes offshore areas of southern New England to Cape Lookout, North Carolina (NMFS 2017). EFH for juvenile and adult dusky sharks is waters over the continental shelf from southern Cape Cod to Florida (NMFS 2009a). Dusky sharks migrate to northern areas of their range in the summer and return south in the fall as water temperatures decrease. Throughout their range, dusky sharks forage on bony fishes, cartilaginous fishes, and squid (NMFS 2011b). Dusky shark is a Species of Concern because the northwestern Atlantic/Gulf of Mexico population is estimated to be at 15% to 20% of the mid-1970s abundance (Cortés et al. 2006). Although commercial and recreation fishing is prohibited, the main threat to the dusky shark population is from bycatch and illegal harvest.

Haddock

Haddock (*Melanogrammus aeglefinus*) EFH is designated in the SWDA for egg, larval, juveniles, and adult life stages and along the OECC for the larval stage. Although adult haddock spawn near the sea floor, eggs are buoyant and suspend in the water column. EFH for haddock eggs is surface waters over Georges Bank southwest to Nantucket Shoals and some coastal areas from Massachusetts Bay to Cape Cod Bay (NOAA 2007). Adult spawning generally occurs from February to May and eggs are observed from March through May (Brodziak 2005). EFH for haddock larvae is surface waters from Georges Bank to Delaware Bay and some coastal areas from Massachusetts Bay to Cape Cod Bay. Larvae can be observed from January through July with peaks in April and May and feed on phytoplankton, copepods, and invertebrate eggs. EFH for juvenile haddock is benthic habitats as shallow as 20 m (66 ft). EFH for adult haddock is bottom habitats with substrates consisting of broken ground, pebbles, smooth hard sand, and smooth areas between rocky patches on Georges Bank and around Nantucket Shoals. Adult haddock are demersal benthivores and primarily consume ophiuroids and amphipods (Brodziak 2005; NOAA 2007). Haddock was one of the dominant species captured in the NEFSC Multispecies Bottom Trawl Surveys in spring, summer, and fall. Adult haddock move offshore into deeper waters in the winter, which may explain the lower capture rates during this season (Brodziak 2005; NEFSC n.d.).

Little Skate

Little skate (*Leucoraja erinacea*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for juvenile and adult life stages. EFH is similar for both life stages and includes intertidal and sub-tidal benthic habitats in coastal waters of the Gulf of Maine and in the mid-Atlantic region. EFH primarily occurs on sand and gravel substrates, but also is found on mud (NEFMC 2017).

Longfin Inshore Squid

Longfin inshore squid (*Loligo pealeii*) EFH is designated in the OECC and Western Muskeget Variant for egg, juvenile (pre-recruit), and adult (recruit) life stages and in the SWDA for juvenile and adult life stages. EFH for longfin inshore squid eggs is inshore and offshore bottom habitats from Georges Bank to Cape Hatteras. Longfin inshore squids lay eggs in masses referred to as “mops” that are demersal and anchored to various substrates and hard bottom types, including shells, lobster pots, fish traps, boulders, submerged aquatic vegetation, sand, and mud (NOAA 2007). Female longfin squid lay these egg mops during three-week periods, which can occur throughout the year (Hendrickson 2017). Known longfin squid spawning grounds, which coincide with areas of concentrated squid fishing, intersect with the OECC. EFH for juveniles and adults, also referred to as pre-recruits and recruits, is pelagic habitats inshore and offshore continental shelf waters from Georges Bank to South Carolina. Pre-recruits and recruits inhabit inshore areas in the spring and summer and migrate to deeper, offshore areas in the fall to overwinter (NOAA 2007). Forage base for longfin inshore squid varies with individual size, where small squids feed on planktonic organisms and large squids feed on crustaceans and small fishes (Jacobson 2005).

Monkfish

Monkfish (*Lophius americanus*) EFH is designated in the SWDA and OECC for egg, larval, and adult life stages, in the Western Muskeget Variant for eggs and larvae, and in the SWDA for juveniles. EFH for monkfish eggs and larvae is surface and pelagic waters of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Monkfish eggs float near the surface in veils that dissolve and release zooplanktonic larvae after one to three weeks (MA DMF 2017). Monkfish eggs and larvae are generally observed from March to September. EFH for demersal juvenile and adult monkfish is bottom habitats composed of a sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud along the outer continental shelf in the middle Atlantic, mid-shelf off southern New England, and all areas of the Gulf of Maine. EFH for adult monkfish also includes the outer perimeter of Georges Bank (NOAA 2007). Per the Southern New England Juvenile Fish Habitat Research study, adult monkfish were present in the SWDA from December through April and most abundant in February and March (Siemann and Smolowitz 2017). Larval monkfish feed on zooplankton, juveniles feed on small fish, shrimp, and squid, and adult monkfish eat other monkfish, crabs, lobsters, squid, and octopus (MA DMF 2017).

Northern Shortfin Squid

Northern shortfin squid (*Illex illecebrosus*) EFH is designated in the OECC and Western Muskeget Variant for the adult life stage. EFH for adult northern shortfin squid is pelagic habitat on the continental shelf and slope from Georges Bank to South Carolina and in inshore waters of the Gulf of Maine and southern New England. Adult northern shortfin squid primarily forage for fish, euphausiids, and smaller squids (MAFMC and NOAA 2011).

Ocean Pout

Ocean pout (*Macrozoarces americanus*) EFH is designated in the SWDA and OECC for egg, juvenile, and adult life stages and in the Western Muskeget Variant for eggs and juveniles. All ocean pout life stages are demersal and therefore have similar EFH designations. EFH for all life stages is bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay (NOAA 2007). Ocean pout eggs are laid in masses on hard bottom surfaces and develop from late fall and winter. Larvae are generally observed from late fall through spring. Juveniles and adults can be found throughout the year, though they move and shift habitats seasonally to remain in preferred temperature range (2–10 °C [36–50 °F]) (Steimle et al. 1999b). Primary prey species shifts depending on location, ocean pout near Nantucket Shoals target Jonah crabs (*Cancer borealis*), though sand dollars are also common in their diet (Steimle et al. 1999b).

Ocean Quahog

Ocean quahog (*Artica islandica*) EFH is designated in the SWDA and OECC for all life stages. EFH for all life stages is designated throughout the substrate, to a depth of 0.9 m (3 ft) below the water/sediment interface from Georges Bank and the Gulf of Maine throughout the Atlantic EEZ (NOAA 2007). Ocean quahogs feed on phytoplankton and support the diet of invertebrate and fish predators, including sea stars, ocean pout, haddock, and Atlantic cod (Cargnelli et al. 1999a).

Pollock

Pollock (*Pollachius virens*) EFH is designated in the SWDA and OECC for egg, larval, and juvenile life stages. Pollock eggs are buoyant upon fertilization and occur in the water column (Cargnelli et al. 1999b). EFH for pollock eggs is pelagic inshore and offshore habitat in the Gulf of Maine, Georges Bank, and southern New England (NEFMC 2017). The larval stage lasts between three and four months and is also pelagic. EFH designations for larvae are similar to those for eggs and includes pelagic inshore and offshore habitats in the Gulf of Maine, Georges Bank, and farther south in the Mid-Atlantic region, with bays and estuaries also included in these regions. As juveniles, pollock migrate between inshore and offshore waters with movements typically linked to water temperatures (Cargnelli et al. 1999b). Due to these migrations, EFH for juvenile pollock is designated as inshore and offshore pelagic and benthic habitats intertidal zone to 180 m (591 ft) in the Gulf of Maine, Long Island Sound, and Narragansett Bay, between 40 and 180 m (131-591 ft) on western Georges Bank and the Great South Channel, and in mixed and full salinity waters in a number of bays and estuaries north of Cape Cod. Habitat types included in this designation consist of rocky bottom habitats with attached macroalgae and shallow eel grass beds, which provides refuge from predators (NEFMC 2017). Adult pollock typically remain offshore and EFH is not designated in the Offshore Development Area.

Porbeagle Shark (Species of Special Concern)

Porbeagle shark (*Lamna nasus*) EFH is combined for all life stages due to insufficient data on the individual life stages and designated EFH overlaps with the SWDA. EFH for porbeagle shark includes offshore and coastal waters of the Gulf of Maine (excluding Cape Cod and Massachusetts Bay) and offshore waters from Georges Bank to New Jersey. Porbeagle sharks commonly inhabit deep, cold temperate waters and forage primarily on fish and cephalopod species (NMFS 2017). Porbeagle shark is a Species of Special Concern due to massive population declines caused by overfishing (NMFS 2013).

Red Hake

Red hake (*Urophycis chuss*) EFH is designated in the SWDA and OECC for all life stages. EFH for red hake eggs and larvae is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Red hake eggs are generally observed from May through November while larvae are commonly observed from

May through December. EFH for juvenile red hake is bottom habitats with a substrate of shell fragments in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras (NOAA 2007). Juvenile red hake are pelagic and congregate around floating debris for a time before descending to the bottom (Steimle et al. 1999a). EFH for adult red hake is bottom habitats in depressions with sandy or muddy substrates in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Although adult red hake are generally demersal, they can be found in the water column (Steimle et al. 1999a). Red hake larvae primarily consume copepods; juveniles prey upon small benthic and pelagic crustaceans; and adults prey upon benthic and pelagic crustaceans, fish, and squid (Steimle et al. 1999a).

Sand Tiger Shark (Species of Concern)

Sand tiger shark (*Carcharias taurus*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for neonates and juveniles (NMFS 2017). EFH for sand tiger shark neonates is along the US Atlantic east coast from Cape Cod to northern Florida. Neonate sand tiger sharks inhabit shallow coastal waters within the 25 m (82 ft) isobath (NMFS 2017). EFH for juvenile sand tiger sharks is designated in habitats between Massachusetts and New York and between New Jersey and Florida (NFMS 2017). The sand tiger shark is a Species of Concern because population levels are estimated to be only 10% of pre-fishery conditions. Population declines were primarily caused by historic overfishing while continued decline is due to capture as bycatch. Although fishing is restricted for sand tiger sharks, low fecundity has limited their ability to recover (NMFS 2010b).

Sandbar Shark

Sandbar shark (*Carcharhinus plumbeus*) EFH is designated in the SWDA and OECC for the juvenile and adult life stages and in the Western Muskeget Variant for juveniles. EFH for juvenile sandbar shark includes coastal areas of the US Atlantic between southern New England and Georgia (NMFS 2017). EFH for adult sandbar sharks is coastal areas from southern New England to Florida. Sandbar sharks are a bottom-dwelling shark species that primarily forages for small bony fishes and crustaceans (NMFS 2009a).

Scup

Scup EFH is designated in the SWDA, OECC, and Western Muskeget Variant for juvenile and adult life stages. EFH for juvenile and adult scup are the inshore and offshore demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras (NOAA 2007). Juvenile scup feed mainly on polychaetes, epibenthic amphipods, and small crustaceans, mollusks, and fish eggs while adults have a similar diet, they also feed on small squid, vegetable detritus, insect larvae, sand dollars, and small fish (Steimle et al. 1999c). Scup occupy inshore areas in the spring, summer, and fall and migrate offshore to overwinter in warmer waters on the outer continental shelf (Steimle et al. 1999c). Scup was a dominant finfish species captured in the NEFSC Multispecies Bottom Trawl survey during spring, summer, and fall surveys and in the Massachusetts Division of Marine Fisheries trawl surveys in the spring and fall.

Shortfin Mako Shark

Shortfin mako shark (*Isurus oxyrinchus*) EFH is designated in the SWDA. EFH for all life stages is combined and considered the same due to insufficient data needed to differentiate EFH by life stage. EFH for shortfin mako shark is coastal and offshore habitats from Cape Cod to Cape Lookout, North Carolina and additional offshore areas in the Gulf of Maine, Florida, and Gulf of Mexico. Shortfin mako shark feed on swordfish, tuna, other sharks, clupeids, crustaceans, and cephalopods (NMFS 2017).

Silver Hake

Whiting, also known as silver hake (*Merluccius bilinearis*), EFH is designated in the SWDA, OECC, and Western Muskeget Variant for egg and larvae life stages and in only the SWDA for juveniles and adults. EFH for the egg and larval stages is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Whiting eggs and larvae are observed all year with peaks in egg observations from June through October and peaks in larvae observations from July through September. EFH for juvenile and adult life stages is bottom habitats of all substrate types in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras (NOAA 2007). Whiting are considered ravenous predators at all feeding life stages. Adults are semi-pelagic, nocturnal predators and primarily feed on fish, crustaceans, and squid (Lock and Packer 2004).

Smooth Dogfish

Due to insufficient information on the individual life stages (neonate, juvenile, and adult), EFH for smooth dogfish (*Mustelus canis*) is designated for all life stages combined and occurs in the SWDA, OECC, and Western Muskeget Variant. EFH for smooth dogfish includes coastal areas and inshore bays and estuaries from Cape Cod Bay to South Carolina (NMFS 2017). Smooth dogfish are primarily demersal and undergo temperature stimulated migrations between inshore and offshore waters. Throughout their region, diets are dominated by invertebrates, especially American lobster (*Homarus americanus*); however, they also feed on small bony fishes throughout New England (NMFS 2017).

Spiny Dogfish

Spiny dogfish (*Squalus acanthias*) EFH is designated in the SWDA and OECC for juvenile and adult life stages. EFH for juvenile and adult spiny dogfish is waters on the continental shelf from the Gulf of Maine through Cape Hatteras (NOAA 2007). Spiny dogfish primarily feed on fish, squid, and ctenophores, which they detect through olfaction, vision, acoustics, and sensing electrical fields. Spiny dogfish are a dominant finfish species in the MA WEA throughout the year (NEFSC n.d.).

Summer Flounder

Summer flounder EFH is designated in the SWDA, OECC, and Western Muskeget Variant for egg, larval, and adult life stages and in the OECC and Western Muskeget Variant for the juvenile life stage. EFH for eggs and larvae is pelagic waters found over the continental shelf from the Gulf of Maine to Cape Hatteras. Eggs are generally observed between October and May, while larvae are found from September through February. EFH for juvenile and adult summer flounder is demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras. In addition to EFH designations, there are also HAPC designations throughout the region. HAPC is designated as areas of all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH (NOAA 2007). Juvenile summer flounder inhabit inshore areas such as salt marsh creeks, seagrass beds, and mudflats in the spring, summer, and fall and move to deeper waters offshore in the winter. Adults inhabit shallow coastal and estuarine areas during the warmer seasons and migrate offshore during the winter (Packer et al. 1999). Summer flounder are opportunistic feeders and diets generally correspond to prey availability in relation to flounder size, with smaller individuals primarily consuming crustaceans and polychaetes and larger individuals focusing more on fish prey (Packer et al. 1999).

Tiger Shark

Tiger shark (*Galeocerdo cuvier*) EFH is designated in the SWDA for juvenile and adult life stages. EFH for these life stages extends from Georges Bank to the Florida Keys in offshore pelagic habitats associated with the continental shelf break at the seaward extent of the US EEZ boundary (NMFS 2017). Tiger sharks are a warm water shark species and primarily remain south of the Mid-Atlantic Bight; however, they will occasionally travel farther north during the warmer summer months (NMFS 2017).

White Hake

White hake (*Urophycis tenuis*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for the juvenile life stage and in the OECC and Western Muskeget Variant for larvae (NEFMC 2017). Eggs are buoyant and occur in the water column; therefore, EFH is designated as pelagic habitats in the Gulf of Maine, including Massachusetts and Cape Cod Bays, and the outer continental shelf and slope (NEFMC 2017). Juveniles are pelagic until they reach a certain length and become demersal (Chang et al. 1999a). EFH for the juvenile stage is designated as intertidal and sub-tidal estuarine and marine habitats in the Gulf of Maine, Georges Bank, and southern New England, including mixed and high salinity zones in a number of bays and estuaries north of Cape Cod, to a maximum depth of 300 m (984 ft) (NEFMC 2017). For the demersal phase, EFH occurs on fine-grained, sandy substrates in eel grass, macroalgae, and un-vegetated habitats.

White Shark

White shark (*Carcharodon carcharias*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for neonate, juvenile, and adult life stages. EFH for neonates is inshore waters out to 105 km (57 NM) from Cape Cod to New Jersey. EFH for juvenile and adult white shark is combined and includes inshore waters out to 105 km (57 NM) from Cape Ann, Massachusetts to Cape Canaveral, Florida (NMFS 2017). As neonates and juveniles below 300 centimeters (120 inches [in]) total length, white shark primarily consume fish. Upon reaching lengths greater than 300 centimeters (120 in), white sharks begin consuming primarily marine mammals (Estrada et al. 2006).

Windowpane Flounder

Windowpane flounder (*Scophthalmus aquosus*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for eggs, larvae, juvenile, and adult life stages. EFH for eggs is surface waters around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Windowpane flounder eggs are generally observed from July to August in northern Atlantic areas. EFH for larvae is pelagic waters around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. EFH for juvenile and adult life stages is bottom habitats that consist of mud or fine-grained sand substrate around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras (NOAA 2007). Juvenile and adult windowpane flounder feed on small crustaceans, especially mysid and decapod shrimp, and fish larvae (Chang et al. 1999b).

Winter Flounder

Winter flounder EFH is designated in the SWDA, OECC, and Western Muskeget Variant for larvae, juvenile, and adult life stages and in the OECC and Western Muskeget Variant for the egg life stage. EFH for eggs is bottom habitats with sandy, muddy, mixed sand/mud, and gravel substrates on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Eggs are primarily observed from February through June. EFH for larvae is pelagic and bottom waters in Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay. Larvae are generally observed from March through July. EFH for juvenile and adult winter flounder is bottom habitats with muddy or sandy substrate in Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay. Winter flounder spawning occurs in the winter with peaks in February and March (NOAA 2007). Previous research has reported that winter flounder spawning is confined to shallow inshore waters; however, a recent study conducted by the Coonamessett Farm Foundation, Inc. identified gravid and, recently, spent winter flounder females in the offshore areas of southern New England, indicating that winter flounder spawning is not confined to shallow inshore waters (Siemann and Smolowitz 2017). Winter flounder are considered opportunistic feeders throughout each life stage and consume a wide range of prey. Adults feed on bivalves, eggs, and fish, but shift diets based on prey availability (Pereira et al. 1999).

Winter Skate

Winter skate (*Leucoraja ocellate*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for juvenile and adult life stages (NEFMC 2017). EFH for juvenile and adult winter skate includes sand and gravel substrates in sub-tidal benthic habitats in depths from the shore to 80–90 m (262–295 ft) from eastern Maine to Delaware Bay, on the continental shelf in southern New England and the mid-Atlantic region, and on Georges Bank. As a demersal species, winter skate consume a large variety of demersal prey including polychaetes, amphipods, and crustaceans (Packer et al. 2003b).

Witch Flounder

Witch flounder EFH is designated in the SWDA and OECC for egg and larvae, Western Muskeget Variant for larvae, and SWDA for the adult life stage. EFH for eggs is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. EFH for larvae is surface waters to 250 m (820 ft) in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Witch flounder eggs are generally observed from March through October, while larvae are observed from March through November (NOAA 2007). Witch flounder diets consist primarily of polychaetes and crustaceans (Cargnelli et al. 1999c).

Yellowtail Flounder

Yellowtail flounder (*Limanda ferruginea*) EFH is designated in the SWDA, OECC, and Western Muskeget Variant for egg, larvae, juvenile, and adult life stages. EFH for eggs and larvae is surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, and the southern New England continental shelf south to Delaware Bay. Eggs are most often observed from April through June and larvae are observed from May through July. EFH for juvenile and adult yellowtail flounder is bottom habitats with sandy or mixed sand and mud substrates on Georges Bank, the Gulf of Maine, and the southern New England shelf south to Delaware Bay (NOAA 2007). Yellowtail flounder forage primarily for benthic macrofaunal and diets largely consist of amphipods, polychaetes, and crustaceans (Johnson et al. 1999).

Table 4.0-2 provides a summary of the annual presence of each life stage of the EFH species within the Offshore Development Area.

Table 4.0-2 Annual Presence of Each Life Stage of EFH Species in the Offshore Development Area[1]

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
American plaice (*Hippoglossoides platessoides*)			L	L	L	L	L					
Atlantic albacore tuna (*Thunnus alalunga*)[2]						J	J	J A	J A	J A		
Atlantic bluefin tuna (*Thunnus thynnus*)[2]							J A	J A	J A	J A	J A	
Atlantic butterfish (*Peprilus triacanthus*)[2]	J A	J A	E J A	E J A	E J A	All	All	All	L J A	L J A	L J A	J A
Atlantic cod (*Gadus morhua*)[2]	E J A	E J A	All	All	All	J A	J A	J A	E J A	E J A	E J A	E J A
Atlantic mackerel (*Scomber scombrus*)[2]	A	A	A	E L A	All	All	J A	J A	A	A	A	A
Atlantic herring (*Clupea harengus*)[2]	All	All	All	All	A	A	A	All	All	All	All	All
Atlantic sea scallop (*Placopecten magellanicus*)[2]	J A	J A	J A	J A	J A	All	All	All	All	All	L J A	L J A
Atlantic skipjack tuna (*Katsuwonus pelami*)[2]					J A	J A	J A	J A	J A	J A	J A	
Atlantic surf clam (*Spisula solidissima*)[2]	All	All	All	All	All	All	All	All	All	All	All	All
Atlantic wolffish (*Anarhichas lupus*)[3]	All	All	All	All	All	All	All	All	All	All	All	All
Atlantic yellowfin tuna (*Thunnus albacares*)[2]						J A	J A	J A	J A			
Barndoor skate (*Dipturus laevis*)[3]				J A	J A	J A	J A	J A	J A	J A		
Basking shark (*Cetorhinus maximus*)	E A	E A				J A	J A	J A	A	A	A	E A
Black sea bass (*Centropristis striata*)[2]				J A	All	All	All	All	All	All	L J A	J A
Blue shark (*Prionace glauca*)					J A	J A	J A	J A	J A	J A		
Bluefish (*Pomatomus saltatrix*)[2]						J A	J A	J A	J A	J A		
Cobia (*Rachycentron canadum*)	R	R	R	R	R	R	R	R	R	R	R	R
Common thresher shark (*Alopias vulpinus*)[2]	All	All	All	All	All	All	All	All	All	All	All	All
Dusky shark (*Carcharhinus obscurus*)						J A	J A	J A	J A			
Haddock (*Melanogrammus aeglefinus*)[2]	L J A	L J A	All	All	All	L J A	L J A	J A	J A	J A	J A	J A
King mackerel (*Scomberomorus cavAlla*)[3]	R	R	R	R	R	R	R	R	R	R	R	R
Little skate (*Leucoraja erinacea*)[2]	All	All	All	All	All	All	All	All	All	All	All	All
Longfin inshore squid (*Loligo pealeii*)[2]	All	All	All	All	All	All	All	All	All	All	All	All
Monkfish (*Lophius americanus*)[2]	J A	J A	All	All	All	All	All	All	All	J A	J A	J A
Northern shortfin squid (*Illex illecebrosu*)[2]	A	A	A	A	A	A	A	A	A	A	A	A
Ocean pout (*Macrozoarces americanus*)	All	All	L J A	L J A	L J A	J A	J A	J A	J A	J A	All	All
Ocean quahog (*Artica islandica*)[2]	All	All	All	All	All	All	All	All	All	All	All	All
Pollock (*Pollachius virens*)[2]	EL	EL		J	J	J	J	J	J		E	EL
Porbeagle shark (*Lamna nasus*)[3]	All	All	All	All	All	All	All	All	All	All	All	All
Red hake (*Urophycis chuss*)[2]	J A	J A	J A	J A	All	All	All	All	All	All	All	L J A
Sand tiger shark (*Carcharias taurus*)					N J	N J	N J	N J	N J			

Table 4.0-2 Annual Presence of Each Life Stage of EFH Species in the Offshore Development Area[1] (Continued)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sandbar shark (*Carcharhinus plumbeus*)						J A	J A	J A	J A			
Scup (*Stenotomus chrysops*)[2]					All	All	All	All	L J A	L J A		
Shortfin mako shark (*Isurus oxyrinchus*)[3]						J A	J A	J A	J A	J A		
Silver Hake *(Merluccius bilinearis)*[2]	All	All	All	All	All	All	All	All	All	All	All	All
Smooth dogfish (*Mustelus canis*)[2,3]				All	All	All	All	All	All	All	All	
Spanish mackerel (*Scomberomorus maculatus*)[3]	R	R	R	R	R	R	R	R	R	R	R	R
Spiny dogfish (*Squalus acanthias*)[2]	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A
Summer flounder *(Paralichthys dentatus)*[2]	All	All	E J A	E J A	E J A	J A	J A	J A	L J A	All	All	All
Tiger shark (*Galeocerdo cuvier*)						J A	J A	J A	J A			
White hake (*Urophycis tenuis)*[2]						E J	E J	E J	E J	E J	J	
White shark *(Carcharodon carcharias)*[3]					J A	J A	J A	J A	J A	J A	J A	
Windowpane flounder *(Scophthalmus aquosus)*[2]	J A	J A	J A	J A	J A	J A	All	All	J A	J A	J A	J A
Winter flounder *(Pseudopleuronectes americanus)*[2]	J A	E J A	All	All	All	All	L J A	J A	J A	J A	J A	J A
Winter skate (*Leucoraja ocellata*)[2]	J	J	J A	J A	J A				J A	J A	J A	J
Witch flounder *(Glyptocephalus cynoglossus)*[2]	L J A	L J A	All	All	All	All	All	All	All	All	L J A	L J A
Yellowtail flounder *(Limanda ferruginea)*[2]	J A	J A	J A	E J A	All	All	L J A	J A	J A	J A	J A	J A

Notes:

1. E=Eggs, L=Larvae, N=Neonate, J=Juvenile, A=Adult, All=All life stages potentially present throughout the year, and R=Rare.
2. Species of commercial or recreational importance.
3. Indicates EFH designations are the same for all life stages or designations are not specified by life stage.

5.0 Potential Impacts of New England Wind

Potential impacts to finfish and invertebrates are related to the specific sizes of offshore components (WTGs, ESPs, and associated foundations and scour protection) included in each Phase of New England Wind and the portion of the seafloor occupied. This section therefore assesses the full 130 WTG/ESP buildout of the SWDA.

As described in Section 3 of COP Volume III, the seafloor impacts presented for the full buildout of the SWDA assume the smallest area for Phase 1 and the largest possible area for the greater potential seafloor disturbance associated with Phase 2 (e.g. larger areas of scour protection and larger areas of cable installation impacts). This section also presents the maximum amount of seafloor disturbance within the SWDA associated with the maximum size of each individual Phase. For seafloor impacts within the OECC, because New England Wind includes the installation of five offshore export cables—two for Phase 1 and three for Phase 2—seafloor impacts are presented for the installation of five cables within the OECC.

The impact producing factors for EFH are provided in Table 5.0-1. The estimated maximum area of potential temporary and permanent impact to benthic habitat in the SWDA and OECC (with and without the Western Muskeget Variant) are presented in Table 5.0-2. Values are primarily based the percentage of each habitat type in the SWDA and OECC (including the Western Muskeget Variant) and should be considered approximate since the specific locations of permanent and temporary impacts (such as placement of cable protection and location of any needed dredging) are highly dependent upon the ongoing export cable engineering process and the final selected cable routes.

Table 5.0-1 Impact Producing Factors for Essential Fish Habitat

Impact Producing Factors	Southern Wind Development Area	Offshore Export Cable Corridor	Onshore Development Areas	Construction & Installation	Operations & Maintenance	Decommissioning
Habitat alteration	•	•		•	•	•
Suspended sediments	•	•		•	•	•
Sediment deposition	•	•		•	•	•
Water withdrawals	•	•		•	•	•
Noise	•	•		•	•	•
Electromagnetic fields	•	•			•	
Cable installation/ maintenance	•	•		•	•	

Table 5.0-2 New England Wind (Phases 1 and 2) Approximate Maximum Area of Potential Temporary (Temp.) and Permanent (Perm.) Impacts to Benthic Habitat during Construction within the SWDA and OECC with and without the Phase 2 OECC Western Muskeget Variant.

Habitat Type	Southern Wind Development Area				Offshore Export Cable Corridor				Western Muskeget Variant (4 Cables in OECC Through Eastern Muskeget + 1 Cable in Phase 2 OECC Western Muskeget Variant)[1]				Western Muskeget Variant (3 Cables in OECC Through Eastern Muskeget + 2 Cables in Phase 2 OECC Western Muskeget Variant)[2]			
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.
	Km²		Acres		Km²		Acres		Km²		Acres		Km²		Acres	
Complex	0	0	0	0	0.2	0.08	48	20	0.29	0.1	71	25	0.3	0.11	75	27
Heterogeneous Complex	0	0	0	0	0.8	0.1	198	25	0.84	0.1	206	25	0.83	0.1	205	25
Large Grained Complex	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-
Soft Bottom	4.11	1.19	1,014	295	1.48	0.04	366	10	1.34	0.04	331	10	1.32	0.03	326	7

Notes:

1. The area of impacts to habitat type varies with the specific export cable alignment selected. The single Phase 2 export cable alignment used in this analysis has the greatest estimated impacts to Complex and Heterogenous Complex habitats within the Western Muskeget Variant. If a different cable alignment was selected, there could be fewer impacts to Complex and Heterogenous Complex habitats.
2. The Proponent may install one or two Phase 2 offshore export cables within the Western Muskeget Variant; however, it is highly unlikely that more than one cable could be installed within the Western Muskeget Variant due to multiple technical reasons related to challenging site conditions. These technical reasons include the highly variable bathymetry and steep slopes, the presence of Mutton Shoal directly to the east of a bathymetric depression (which severely restricts the available area for cable installation), the presence of greater areas of large sand waves compared to the OECC, the presence of navigational buoys, and the migration of Wasque Shoal (which poses a significant risk to the overall stability and capacity of any export cables installed within the Western Muskeget Variant).

5.1 Construction and Installation

5.1.1 Habitat Alteration (Phases 1 and 2)

Southern Wind Development Area—Overview (Phases 1 and 2)

Impacts to EFH would be expected near the proposed WTGs and ESPs as a result of foundation installation, scour protection installation, and the use of jack-up and/or anchored vessels for the installation of each WTG and ESP. WTG/ESP foundations may have scour protection consisting of rock or stone placed around the base of the foundation.[3] This design may promote deposition of a sand/silt matrix in the interstices of the boulder framework with the eventual burial some of the scour protection (USDOE MMS 2009). Tidal currents may expose portions of the scour protection at the surface for short periods of time. However, the bi-directional nature of these currents should lead to establishment of a dynamic equilibrium, allowing the average condition of the scour-protected zone to be buried by sand.

Since all of the SWDA is comprised of Soft Bottom habitat (homogeneous fine sand and silt-sized sediments), bottom habitat may be temporarily or permanently altered to hard bottom substrate through the installation of cable protection (rocks, concrete mattresses, gabion rock bags, or half-shell pipes or similar) in areas where the inter-array, inter-link, or offshore export cables within the SWDA cannot achieve sufficient burial depth. The Proponent intends to avoid or minimize the use of cable protection to the greatest extent feasible through careful site assessment and thoughtful selection of the most appropriate cable installation tool to achieve sufficient burial. Although scour and/or cable protection has the potential to turn exposed, biodiversity-poor soft bottoms into species-rich ecosystems (Langhamer 2012), these flat, expansive, sand/mud habitats are designated as EFH for multiple demersal fish species, such as winter flounder and red hake. Bottom and pelagic habitat will also be permanently altered to hard substrate from the installation of WTG/ESP foundations and associated scour protection. Groundfish species (including winter, yellowtail, and windowpane flounder as well as red hake) and shellfish species (including ocean quahog) prefer soft sand or mud habitats. Other demersal species (including haddock, Atlantic cod, longfin squid, monkfish, and ocean pout) prefer hard, structured habitats. Conversion of the fine, unstructured habitats in the SWDA into complex, hard habitats through the addition of WTG/ESP foundations, associated scour protection, and potential cable protection (if required) will likely create more EFH for species that depend on hard and complex structure at the expense of EFH for species that prefer fine, unconsolidated substrate. Given the abundance of similar fine, unconsolidated habitats in the SWDA and surrounding area, loss of these habitats will result in a very small change in the total EFH for species that depend on them in the region. The BOEM Draft Environmental Impact Statement (DEIS) (2018) for Vineyard Wind 1 determined that effects from added scour and cable protection would possibly have long-term moderate benefit.

[3] As described further in COP Volume I, if jacket and bottom-frame foundations are used for WTGs or ESPs, these foundation types may or may not have scour protection.

Additional EFH alteration is expected from the use of jack-up or anchored vessels and from installation of the inter-array, inter-link, and offshore export cables within the SWDA. Anchored vessels may be equipped with spud legs that are deployed to secure the cable laying vessels while its anchors are being repositioned. Bottom habitat in the direct path of the inter-array, inter-link, and offshore export cables within the SWDA will be disturbed from the surface to a depth of 1.5–2.5 meters (5–8 ft). Additionally, to monitor weather and sea state conditions during Phase 1 and Phase 2 construction, the Proponent expects to temporarily deploy one or more meteorological oceanographic ("metocean") buoys in up to 50 locations within the SWDA (only within areas that will have been surveyed). Anchors for the metocean buoys will also temporarily disturb bottom habitat.

The following sections present impacts within the maximum size of New England Wind, within the maximum size of Phase 1, and within the maximum size of Phase 2. As described in COP Volume III, due to the range of buildout scenarios for Phases 1 and 2, the sum of the maximum design scenarios for Phase 1 and Phase 2 does not equal the total maximum design scenario of New England Wind.

Southern Wind Development Area—Maximum Impact (Phases 1 and 2)

As detailed in Appendix III-T of the COP, within the maximum size of the SWDA and encompassing both Phases 1 and 2, the amount of Soft Bottom habitat permanently altered to Complex or Heterogeneous Complex habitat from the installation of WTG/ESP foundations, associated scour protection, and potential cable protection (if required) would be approximately 1.17 km^2 (289 acres). The amount of temporary disturbance to Soft Bottom habitat from the use of jack-up or anchored vessels, cable installation, and metocean buoy anchors would be approximately 4.08 km^2 (1,008 acres).[4] The total area of alteration within the SWDA due to foundation and scour protection installation; jack-up and/or anchored vessel use; inter-array, inter-link, and offshore export cable installation; potential cable protection (if required); and metocean buoy anchors is 5.19 km^2 (1,283 acres), which is 1.1% of the maximum size of the SWDA.

Sediment deposition may also occur within the SWDA from inter-array, inter-link, and offshore export cable installation (offshore export cables in the SWDA would extend from the northern SWDA boundary to the ESPs). Given the broad similarity in grain sizes throughout the SWDA, modeling of sediment transport and deposition potential in the SWDA was conducted for one representative inter-array cable route (see Appendix III-A of the COP).

[4] The impacts from anchor sweep are not quantified at this time due to the difficulty of estimating potential anchoring practices at the New England Wind planning stage.

Simulations of typical and maximum impact cable installation methods in the SWDA indicated that deposition of 1 millimeter[5] (mm) (0.04 in) or greater (i.e. the threshold of concern for demersal eggs) extended up to 100 m (328 ft) from the route centerline for typical installation parameters (see Appendix III-A of the COP). At this deposition thickness, there are limited areas with potential temporary negative impacts to demersal eggs or species of similar sensitivity and habitat. The sediment dispersion modeling with typical and maximum impact installation techniques (see Appendix III-A of the COP) also indicated that, for the representative cable installation activities in the SWDA, there would be no area of deposition greater than 5 mm (0.2 in) for the typical installation parameters, and only small areas (0.01 km^2 [2.5 acres] for representative section) of deposition greater than 5 mm (0.2 in) for the maximum impact installation parameters. For both the typical and maximum impact installation parameters, there were no areas with deposition above 10 mm (0.4 in). Due to a lack of coarse, complex substrate in the SWDA, no permanent changes to EFH are expected from sediment deposition.

Southern Wind Development Area—Phase 1

As detailed in Appendix III-T of the COP, within the maximum size of Phase 1, bottom habitat primarily consists of sand and mud-sized sediments. The amount of permanent habitat alteration from sandy, soft bottom habitats to permanently altered to hard, structured habitats through the installation of WTG/ESP foundations, associated scour protection, and potential cable protection (if required) would be approximately 0.35 km^2 (86 acres).

The amount of temporary habitat disturbance from the use of jack-up and/or anchored vessels, cable installation, and metocean buoy anchors would be approximately 1.70 km^2 (421 acres). The total area of alteration within the maximum size of Phase 1 due to foundation and scour protection installation; jack-up and/or anchored vessel use; inter-array, inter-link, and offshore export cable installation; potential cable protection (if required); and metocean buoy anchors is 2.03 km^2 (502 acres), which is 0.9% of the maximum size of the Phase 1 SWDA.

As described further above, sediment deposition may also occur within the SWDA in Phase 1 from inter-array, inter-link, and offshore export cable installation (offshore export cables in the SWDA would extend from the northern SWDA boundary to the ESP[s]). Such impacts will be typically limited to within approximately 100 m (328 ft) or less from the route, which is the modeled extent of deposition of 1 mm (0.04 in) or greater (i.e. the threshold of concern for demersal eggs). Due to a lack of coarse, complex substrate in the SWDA, no permanent habitat changes are expected from sediment deposition.

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5 For demersal eggs, deposition greater than 1 mm (0.04 in) can result in the burial and mortality of that life stage (Berry et al. 2011). Although the early life stages of some warm, shallow water coral species can be sensitive to deposition levels of 0.2 mm (0.008 in), the coral species likely present in the region, star coral (*Astrangia poculata*), is a cold-water species that is less sensitive to sedimentation (Peters and Pilson 1985).

Southern Wind Development Area—Phase 2

As detailed in Appendix III-T of the COP, within the maximum size of the Phase 2 SWDA, all bottom habitat is classified as Soft Bottom habitat with fine and mud-sized sediments throughout. The amount of permanent habitat alteration from the installation of WTG/ESP foundations, associated scour protection, and potential cable protection (if required) would be approximately 0.89 km^2 (221 acres). The amount of temporary habitat disturbance from the use of jack-up and/or anchored vessels, cable installation, and metocean buoy anchors would be approximately 2.77 km^2 (686 acres). The total area of alteration within the maximum size of Phase 2 due to foundation and scour protection installation; jack-up and/or anchored vessel use; inter-array, inter-link, and offshore export cable installation; potential cable protection (if required); and metocean buoy anchors is 3.63 km^2 (897 acres), which is 1.2% of the maximum size of the Phase 2 SWDA.

As described further above, sediment deposition may also occur within the SWDA in Phase 2 from inter-array, inter-link, and offshore export cable installation (offshore export cables in the SWDA would extend from the northern SWDA boundary to the ESP[s]). Such impacts will be typically limited to within approximately 100 m (328 ft) or less from the route, which is the modeled extent of deposition of 1 mm (0.04 in) or greater (i.e., the threshold of concern for demersal eggs). Due to a lack of coarse, complex substrate in the SWDA, no permanent habitat changes are expected from sediment deposition.

Offshore Export Cable Corridor—Overview (Phases 1 and 2)

Potential impacts to benthic habitats within the OECC (including the Western Muskeget Variant) may occur from cable installation, anchoring, dredging, and installation of cable protection. As noted in Table 3.0-2, such impacts will occur within a variety of habitat types. Most of the OECC and the OECC including the Western Muskeget Variant are classified as Soft Bottom habitat (61% and 54%, respectively) or Heterogeneous Complex habitat (30% and 32%, respectively), with smaller percentages of Complex Habitat (9% and 13%, respectively) and Large Grained Complex Habitat (<0.1% and <0.05%, respectively)

Benthic habitat in the direct path of the cable installation vessels, vessel anchors, and anchor sweep zone will be disturbed while cables are being installed along the OECC (including the Western Muskeget Variant). Additionally, dredging in sand wave areas prior to cable installation will result in the temporary disturbance of habitat. Sand waves are designated as EFH for whiting (silver hake) and may assist in their foraging mechanisms or provide shelter from current flows (Auster et al. 2003). Benthic Features, such as sand waves, provide important structured habitat for fishes and invertebrates (Scharf et al. 2006) and these habitats are dynamic and change frequently. If dredging is required, disposal of dredged materials will only occur within sand wave areas; dumping of dredged materials will be prohibited in hard bottom habitats. Therefore, any dredging disturbances to EFH are likely to be temporary.

In addition, temporary to permanent habitat alteration from Complex or Heterogeneous Complex to Soft Bottom habitat may occur along limited sections of the OECC (including the Western Muskeget Variant) when installing cables in coarse pebble-cobble substrates, as finer, sandy substrates may settle over gravel (granule-size or larger) substrates. However, because sedimentation thicknesses are typically expected to be less than 5 mm, larger grains (>5 mm) will likely not be completely covered, and dynamic processes will uncover smaller (2-5 mm) grains with time.

As in the SWDA, conversion of fine, unstructured habitats in the OECC into complex, hard habitats through addition of cable protection would likely create more EFH for species that depend on hard and complex structure at the expense of EFH for species that prefer fine, unconsolidated substrate. The Proponent intends to avoid or minimize the use of cable protection to the greatest extent feasible through careful site assessment and thoughtful selection of the most appropriate cable installation tool to achieve sufficient burial. Crossing of Complex habitat is likely unavoidable, particularly in the Muskeget Channel area. Many of these hard-bottom habitats are designated as HAPC for juvenile Atlantic cod (HAPC for cod specifically includes mixed sand and gravel and rocky habitats). Additionally, these structurally complex habitats provide shelter and refuge habitat for small fishes and invertebrates and substrates for attachment epibenthic organisms (Auster 1998).

Eelgrass, important EFH habitat for many species and included in the designation of HAPC for summer flounder, is present within the OECC near the Phase 1 landfall sites and may also be present outside of the OECC near the Phase 2 landfall sites. The cables will be routed within the OECC to avoid impacts to eelgrass. In addition, presence of any native species of macroalgae, seagrasses, or freshwater and tidal macrophytes in any size bed, as well as loose aggregations within the OECC qualify that habitat type as HAPC for summer flounder. Presence of these habitat types were noted in site characterization video surveys and will be avoided.

Offshore Export Cable Corridor—Maximum Impact (Phases 1 and 2)

As detailed in Appendix III-T, within the OECC for Phases 1 and 2, the amount of permanent habitat alteration from the potential installation of cable protection (if required) would be approximately 0.22 km^2 (54 acres). The amount of temporary habitat disturbance from cable installation, anchoring, the potential dredging of the tops of sand waves in certain locations, the potential for limited vessel grounding in the nearshore, and the limited use of jack-up vessels for cable splicing would be approximately 2.48 km^2 (612 acres).[6] Total seafloor impacts in the OECC would be approximately 2.60 km^2 (642 acres). Table 5.0-2 provides an estimate of permanent and temporary impacts by habitat type; these values should be considered approximate since the

[6] The impacts from anchor sweep are not quantified at this time due to the difficulty of estimating potential anchoring practices at the New England Wind planning stage.

specific locations of permanent and temporary impacts (such as placement of cable protection and location of any needed dredging) are highly dependent upon the ongoing export cable engineering process and the final selected cable routes.

If the Western Muskeget Variant is used for one or two Phase 2 export cables, the amount of permanent habitat alteration for both Phases combined from the potential installation of cable protection (if required) would be approximately 0.23–0.24 km^2 (57–60 acres). The amount of habitat disturbance for both Phases combined from cable installation, anchoring, the potential dredging of the tops of sand waves in certain locations, the potential for limited vessel grounding in the nearshore, and the limited use of jack-up vessels for cable splicing would be approximately 2.47–2.49 km^2 (611–614 acres). Total seafloor impacts in the OECC for both Phases combined would be approximately 2.61 km^2 (646 acres) (see Appendix III-T). Table 5.0-2 provides an estimate of permanent and temporary impacts by habitat type.

Modeling of sediment transport potential was conducted for one representative cable installation within the OECC that is illustrative of expected impacts for each of the five cables that may be installed within the OECC and for the Western Muskeget Variant (see Appendix III-A of the COP). Simulations of typical and maximum impact cable installation parameters (without sand wave removal) in the OECC indicate that deposition of 1 mm (0.04 in) or greater (i.e. the threshold of concern for demersal eggs) was constrained to within 100 m (328 ft) from the route centerline and there was no deposition above 5 mm (see Appendix III-A of the COP). Under CMECS, gravel includes particles with >2 mm (0.08 in) to < 4,096 mm (161 in) diameter, therefore, only gravel particles between 2 – 5 mm have the potential to be fully buried through deposition from cable installation. At this deposition thickness, there would be limited areas with potential temporary negative impacts to demersal eggs or species of similar sensitivity and habitat. In areas along the OECC where sand wave dredging was simulated to occur, deposition greater than 1 mm (0.04 in) associated with the trailing suction hopper dredge (TSHD) was mainly constrained to within 1 km (0.54 NM) but extended up to 2.3 km (1.2 NM) in isolated patches when subject to swift currents through Muskeget Channel. Modeling results also indicate that there would be some small areas of deposition greater than 20 mm (0.8 in) from dredging and cable installation activities extending up to 900 m (0.49 NM) from the route centerline. At this deposition thickness, there are limited areas with potential temporary or permanent negative impacts to the hard-bottom habitats and associated sessile or immobile species or life stages.

The OECC is the same for Phases 1 and 2 until approximately 2–3 km (1–2 mi) from shore, at which point the OECC will diverge for each Phase to reach separate landfall sites in Barnstable. Modeling of the Phase 1 Landfall Site was considered as a conservative representation of a worst-case plume for the Phase 2 Landfall Site because this location has a relatively high fraction of fine sediments compared with those of Phase 2.

Offshore Export Cable Corridor—Phase 1

As detailed in Appendix III-T, the maximum impacts within the OECC for Phase 1 includes approximately 0.09 km^2 (22 acres) for the potential installation of cable protection (if required). The amount of habitat disturbance from cable installation, anchoring, the potential dredging of the tops of sand waves in certain locations, the potential for limited vessel grounding in the nearshore, and the limited use of jack-up vessels for cable splicing would be approximately 1.01 km^2 (251 acres) for Phase 1. Total seafloor impacts in the OECC would be approximately 1.06 km^2 (263 acres) for Phase 1.

Offshore Export Cable Corridor—Phase 2

As detailed in Appendix III-T, the maximum impacts within the OECC for Phase 2 includes approximately 0.13 km^2 (32 acres) for the potential installation of cable protection (if required). The amount of habitat disturbance from cable installation, anchoring, the potential dredging of the tops of sand waves in certain locations, the potential for limited vessel grounding in the nearshore, and the limited use of jack-up vessels for cable splicing would be approximately 1.46 km^2 (361 acres) for Phase 2. Total seafloor impacts in the OECC would be approximately 1.53 km^2 (379 acres) for Phase 2.

Offshore Export Cable Corridor- Phase 2 Western Muskeget Variant

If the Western Muskeget Variant is used for Phase 2, there will be either (1) one export cable installed in the Western Muskeget Variant and two export cables installed in the OECC or (2) two export cables installed in the Western Muskeget Variant and one export cable installed in the OECC.[7] In either scenario involving the Western Muskeget Variant, the amount of permanent habitat alteration from the potential installation of cable protection (if required), which alters habitat through the addition of artificial hard substrate, would be approximately 0.14–0.15 km^2 (35–38 acres) for Phase 2. The amount of temporary habitat disturbance from cable installation, anchoring, the potential dredging of the tops of sand waves in certain locations, the potential for limited vessel grounding in the nearshore, and the limited use of jack-up vessels for cable splicing would be approximately 1.46–1.47 km^2 (360–364 acres). Total seafloor impacts in the Phase 2 OECC Western Muskeget Variant would be approximately 1.54–1.55 km^2 (381–383 acres).

[7] While the project design envelope allows for one or two offshore export cables to be installed within the Western Muskeget Variant, it is highly unlikely that more than one cable could be installed within the Western Muskeget Variant due to multiple technical reasons related to challenging site conditions.

5.1.2 Suspended Sediments and Water Withdrawals (Phases 1 and 2)

Southern Wind Development Area and Offshore Export Cable Corridor—Overview (Phases 1 and 2)

Potential impacts to EFH within the water column include increased suspended sediments and water withdrawals which could potentially lead to temporary contraction of EFH areas from localized changes in habitat.

Increased suspended sediments during construction and installation in the SWDA and OECC will temporarily impact water column EFH. As described in Section 6.6.2 of COP Volume III, increased suspended sediment impairs the visual abilities of fishes and may result in increased susceptibility to predation and decreased foraging, filter feeding, and respiration abilities, reducing growth potential for many species. Sublethal and lethal concentrations of suspended sediment differ by species and life stage. Previous research indicates that reductions in growth and mortality of the most sensitive species is 10 milligrams per liter (mg/L) for 24 hours.

The value for the most sensitive species is derived from studies of tropical coral that are not present within the SWDA or OECC; however, cold-water corals have been found along the OECC. The available literature does not provide a definitive threshold for cold-water corals; therefore, the 10 mg/L threshold for tropical coral is conservatively retained as a potential threshold for the most sensitive species (i.e. cold-water coral) that may be present. The suspended sediment threshold for the next most sensitive benthic species that may be present within the Offshore Development Area, which likely provides a more reasonable conservative threshold, is 100 milligrams per liter (mg/L) persisting for over 24 hours (Wilber and Clarke 2001); this value is referred to herein as the suspended sediment sensitivity threshold. Therefore, based on known thresholds, suspended sediment concentrations that do not exceed 100 mg/L for more than 24 hours are not anticipated to cause adverse effects to sensitive marine organisms with EFH.

Within the SWDA and OECC, mortality of species with EFH for pelagic or planktonic early life stages may occur during water withdrawal from the cable laying vessel. Entrainment of early pelagic life stages via water withdrawals would result in 100% mortality because of the stresses associated with being flushed through the pump system and temperature changes (USDOE MMS 2009).

Southern Wind Development Area—Maximum Impact (Phases 1 and 2)

Given the broad similarity in grain sizes throughout the SWDA, modeling of sediment transport potential in the SWDA was conducted for one representative inter-array cable route (see Appendix III-A of the COP). The modeled route was conservatively selected as one of the longer potential inter-array cable routes and in a location where grain sizes were slightly finer (though grain size is broadly similar throughout the SWDA). These model results are representative of inter-array, inter-link, or offshore export cable installation within the SWDA, for either Phase 1 or Phase 2.

Modeling indicated that under typical or maximum-impact cable installation methods, the maximum anticipated suspended sediment concentrations that persisted for at least 60 minutes would be greater than 200 mg/L but less than 650 mg/L and would occur in an area of 1.6 km^2 (395 acres) or less. These concentrations would drop rapidly to below 50 mg/L within a maximum of one to two hours. Concentrations of suspended sediments with lower concentrations (10 mg/L) would extend up to 2.2 km (1.2 NM) from the inter-array cable centerline and be suspended at any given location for less than four hours. Therefore, these concentrations and durations of exposure are below those causing sublethal or lethal effects to fish and invertebrates, limiting the impact to pelagic EFH during cable installation.

Within the SWDA, mortality of species with EFH for pelagic or planktonic early life stages may occur during water withdrawal from the cable laying vessel. Water withdrawals for the maximum size of the SWDA can be estimated using the following assumptions:

- Cable installation occurs at a rate of up to 200 meters per hours (m/hr) (656 feet per hour [ft/hr])[8]
- A jetting technique uses 11,300–45,000 liters per minute (3,000–12,000 gallons per minute) of water
- The maximum total length of inter-array, inter-link, and offshore export cables within the SWDA is 701 km (379 NM)

Under these assumptions, water withdrawal volumes for the maximum size of the SWDA are expected to be approximately 2.4–9.5 billion liters (0.6–2.5 billion gallons).

Southern Wind Development Area—Phase 1

As described further above and in Appendix III-A, modeling indicated that suspended sediments would settle our rapidly, within four hours. The modeled concentrations and durations of exposure are below those causing sublethal or lethal effects to fish and invertebrates, limiting the impact to pelagic EFH during cable installation.

Water withdrawals for the maximum size of Phase 1 can be estimated using the above assumptions and a maximum total length of inter-array, inter-link, and offshore export cables within the SWDA of approximately 281 km (152 NM). Under these assumptions, water withdrawal volumes are expected to be approximately 1.0–3.8 billion liters (0.3–1.0 billion gallons) for Phase 1.

[8] The final installation speed will be specific to the contractor and cable installation equipment and may be different than listed here. A speed of 200 m/hr is used to provide a general estimate of water usage.

Southern Wind Development Area—Phase 2

As described further above and in Appendix III-A, modeling indicated that suspended sediments would settle our rapidly, within four hours. The modeled concentrations and durations of exposure are below those causing sublethal or lethal effects to fish and invertebrates, limiting the impact to pelagic EFH during cable installation.

Water withdrawals for the maximum size of Phase 2 can be estimated using the above assumptions and a maximum total length of inter-array, inter-link, and offshore export cables within the SWDA of approximately 495 km (267 NM). Under these assumptions, water withdrawal volumes are expected to be approximately 1.7–6.7 billion liters (0.4–1.8 billion gallons) for Phase 2.

Offshore Export Cable Corridor— Maximum Impact (Phases 1 and 2)

Modeling of sediment transport potential was conducted for one representative cable installation within the OECC that is illustrative of expected impacts for each of the five cables that may be installed within the OECC.

Installation along the OECC may require discontinuous (i.e. intermittent) dredging of the tops of sand waves to achieve sufficient burial depths. As described in Appendix III-A of the COP, this will likely be accomplished with a TSHD or by jetting for smaller sand waves. Sediment dispersion modeling of cable installation with and without sand wave removal and with multiple methods along the OECC indicated that concentrations of suspended sediments above 10 mg/L extended up to a maximum of 16 km (8.6 NM) from the cable trench centerline. Most of the sediment settles out in less than three hours; however, suspended sediments at this concentration can persist for between four to six hours in smaller areas (less than 1.2 km^2 [297 acres]). However, the furthest sediment plume extents are created when TSHD is used. For model results without THSD (i.e. just cable installation), concentrations of suspended sediments above 10 mg/L extended up to a maximum of only 2.1 km (1.1 NM) from the cable trench centerline. Pelagic EFH may be affected by the mobilization and suspension of sediments during dredging and installation activities, but all sediments settle out of suspension within six hours, thus concentrations do not exceed the potential impact thresholds for fish and invertebrates within those waters.

The Proponent may elect to use a vertical injector cable installation tool with deeper penetration such that dredging of the tops of sand waves is not required to achieve sufficient burial depths. A representative section of deeper installation was modeled, and results indicated that concentrations of suspended sediments above 10 mg/L extended up to a maximum of 1.2 km (0.6 NM) from the cable trench centerline. Most of the sediment settles out in less than three hours; however, suspended sediments at this concentration can persist for between four to six hours in smaller areas (less than 0.1 km^2 [22 acres]). Overall, this method is not anticipated to affect fish and invertebrates within pelagic habitats because all sediments settle out of suspension six hours, and thus do not exceed the sublethal and lethal sensitivity thresholds.

The OECC is the same for Phases 1 and 2 until approximately 2-3 km (1-2 mi) from shore, at which point the OECC will diverge for each Phase to reach separate landfall sites in Barnstable. Modeling of the Phase 1 Landfall Site was considered as a conservative representation of a worst-case plume for the Phase 2 Landfall Site because this location has a relatively high fraction of fine sediments compared with those of Phase 2. Within the OECC, mortality of species with EFH for pelagic or planktonic early life stages may occur during water withdrawal from the cable laying vessel. Water withdrawals for the five offshore export cables within the OECC can be similarly estimated using the following assumptions:

- Cable installation occurs at a rate of up to 120 m/hr (394 ft/hr)[9]
- A jetting technique uses 11,300–45,000 liters per minute (3,000–12,000 gallons per minute) of water
- The maximum total length of offshore export cables (outside the SWDA) is 412 km (222 NM)

Under these assumptions, water withdrawal volumes for installation of Phase 1 and Phase 2 cables within the OECC are expected to be approximately 2.3–9.3 billion liters (0.6–2.4 billion gallons).

Offshore Export Cable Corridor—Phase 1

As described further above and in Appendix III-A, modeling indicated that suspended sediments would settle our rapidly, within four to six hours. The modeled concentrations and durations of exposure are below those causing sublethal or lethal effects to fish and invertebrates, limiting the impact to pelagic EFH during dredging and cable installation.

The maximum water withdrawals within the OECC for Phase 1 can be estimated using the above assumptions and a maximum total length of export cables (outside the SWDA) for Phase 1 of approximately 166 km (89 NM). Under these assumptions, water withdrawal volumes are expected to be approximately 0.9–3.7 billion liters (0.2–1.0 billion gallons) for Phase 1.

Offshore Export Cable Corridor—Phase 2

As described further above and in Appendix III-A, modeling indicated that suspended sediments would settle our rapidly, within four to six hours. The modeled concentrations and durations of exposure are below those causing sublethal or lethal effects to fish and invertebrates, limiting the impact to pelagic EFH during dredging and cable installation.

The maximum water withdrawals within the OECC for Phase 2 can be estimated using the above assumptions and a maximum total length of offshore export cables (outside the SWDA) for Phase

[9] The final installation speed will be specific to the contractor and cable installation equipment and may be different than listed here. A speed of 120 m/hr is used to provide a general estimate of water usage.

2 of approximately 246 km (133 NM). Under these assumptions, water withdrawal volumes are expected to be approximately 1.4–5.5 billion liters (0.4–1.5 billion gallons) for Phase 2.

Offshore Export Cable Corridor— Phase 2 Western Muskeget Variant

Modeling of sediment transport potential was conducted for one representative cable installation within the OECC including the Western Muskeget Variant that is illustrative of expected impacts for each of the one or two cables that may be installed within the Western Muskeget Variant. Given the similarities in substrate type, ocean conditions, and the shorter corridor distance within the Western Muskeget Variant, suspended sediment concentrations and durations are similar to the values presented for the OECC (see Appendix III-A for additional details). The increased concentrations of suspended sediments are not expected to affect fish and invertebrates within pelagic habitat because of the very limited duration of suspension before settlement.

Similarly, potential effects to water column EFH as a result of water withdrawals for installation of the Western Muskeget Variant cables are expected to be the same or less than those presented above for the OECC because of the shorter length of the cable.

5.1.3 Increased Sound Exposure (Phases 1 and 2)

Southern Wind Development Area and Offshore Export Cable Corridor—Overview (Phases 1 and 2)

During the construction of New England Wind, proposed action-related underwater sounds would include repetitive, high-intensity (impulsive) sounds produced by pile driving, and continuous (non-impulsive), lower-frequency sounds produced by vessel propulsion and cable installation. Intensity of produced sound would vary with some sounds being louder than ambient noise. Ambient noise can influence how fish detect other sounds as fish have localized noise filters that separate background noise and other sounds simultaneously (Popper and Fay 1993). Ambient noise within Lease Area OCS-A 0501 was measured as, on average, between 76.4 and 78.3 decibels (dB) re 1 $\mu Pa^2/Hz$ (Alpine Ocean Seismic Surveying, Inc. 2017). This study was performed prior to the segregation of Lease Area OCS-A 0501 into OCS-A 0501 and OCS-A 0534.

As described in Section 6.6 of COP Volume III, noise generated from New England Wind could potentially impact species with EFH in the SWDA and OECC during construction. All fishes have hearing structures that allow them to detect sound particle motion. Some fishes also have swim bladders near or connected to the ear that allows them to detect sound pressure, which increases hearing sensitivity and broadens hearing abilities (Hawkins and Popper 2017; Popper et al. 2014). The most relevant metric associated with sound perception for most fish species is particle motion; however, except for a few species, there is an almost complete lack of relevant data on particle motion sensitivity in fish (Popper and Fay 2011; Popper et al. 2014).

In general, increased sound sensitivity and the presence of a swim bladder makes a fish more susceptible to injury from anthropogenic sounds because loud, usually impulsive, noises can cause swim bladders to vibrate with enough force to inflict damage to tissues and organs around the bladder (Casper et al. 2012; Halvorsen et al. 2011). The most sensitive species are those with swim bladders connected or close to the inner ear, such as Atlantic herring and Atlantic cod; these species can acquire both recoverable and mortal injuries at lower noise levels than other species (Popper et al. 2014; Thomsen et al. 2006). Fish with swim bladders not connected or near inner-ear structures, such as yellowfin tuna, also primarily detect noise through particle motion, and are therefore less sensitive to noise. The least sound-sensitive fish species include those that do not have a swim bladder, including flatfish like winter flounder and elasmobranchs.

The Popper et al. (2014) criteria for impulsive pile driving sound are described in Table 5.1-1. NMFS lists separate "interim guidance" of peak onset of injury or mortality regardless of source type, fish size or hearing type, and a cumulative Sound Exposure Level (SEL) onset of injury or mortality for fish 2 grams (g; 0.07 ounces) or larger; and fish smaller than 2 g (0.07 ounces) (FHWG 2008;Table 5.1-2). There is no American National Standards Institute (ANSI)-accredited behavioral threshold for fish.

To assess the potential impacts of anthropogenic sound on fish, Popper et al. (2014) classified fishes into three animal groups comprising: (1) fishes with swim bladders whose hearing does not involve the swim bladder or other gas volumes (e.g. tuna [*Thunnus* sp.], or Atlantic salmon [*Salmo salar]*); (2) fishes whose hearing does involve a swim bladder or other gas volume (e.g. Atlantic cod or herring); and (3) fishes without a swim bladder (e.g. sharks) that can sink and settle on the substrate when inactive (Carroll et al. 2017; Popper et al. 2014). Quantitative acoustic criteria are therefore defined for these species. The suite of generally accepted acoustic thresholds used in this assessment to determine potential effects on fish exposed to sounds likely to occur during construction are described in Table 5.1-2.

Table 5.1-1 Acoustic Thresholds Used to Evaluate Impacts to Fish Exposed to Impulsive Impact Pile Driving Sound[1]

Faunal group	Mortality or potential mortal injury[2]		Impairment				Behavior
			Recoverable Injury		Temporary Threshold Shift	Masking[3]	
	L_{PK}	$L_{E,24hr}$	L_{PK}	$L_{E,24hr}$	$L_{E,24hr}$		
Fishes without swim bladder	>213	>219	>213	>216	>>186[4]	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fishes with swim bladder not involved in hearing	> 207	210	>207	203	>186	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fishes with swim bladder involved in hearing	>207	207	>207	203	186	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Eggs and larvae	>207	>210	(N) Moderate (I) Low (F) Low		(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Notes:

1. Adapted from ANSI-accredited Popper et al. 2014; all thresholds are unweighted. Recoverable injury thresholds were modeled for this study (Appendix III-M).
2. L_{PK} = peak sound pressure (dB re 1 µPa); $L_{E,24hr}$ = 24 hr cumulative sound exposure level (dB re 1 µPa^2·s).
3. Relative risk defined at three levels (low, moderate, high) for distances: N = near (tens of meters), I = intermediate (hundreds of meters), and F = far (thousands of meters).
4. >> = much greater than.

Table 5.1-2 General Interim Acoustic Thresholds for Fish Currently Used or Recommended by NMFS and BOEM[1]

Fish group	Injury		Behavior
	L_{PK}	$L_{E,24hr}$	L_p
Fish ≥2 g	206[4,5]	187[4,5]	150[5]
Fish <2 g		183[4,5]	
Fish without swim bladder[6]	213	216	-
Fish with swim bladder not involved in hearing[6]	207	203	-
Fish with swim bladder involved in hearing[6]	207	203	-

Notes:

1. All thresholds are unweighted.
2. L_{PK} = peak sound pressure (dB re 1 µPa); $L_{E,24hr}$ = 24 hr cumulative sound exposure level (dB re 1 µPa^2·s).
3. L_p = root mean square sound pressure (dB re 1 µPa).
4. NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008).
5. References in the NMFS Greater Atlantic Regional Fisheries Office (GARFO) (2016) tool: Andersson et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011), Wysocki et al. (2007).
6. Popper et al. 2014.

Exposure to anthropogenic sound sources could have a direct consequence on the functionality and sensitivity of the sensory systems of marine invertebrates. Numerous studies have investigated the effect of sound on marine invertebrates but have been conducted in confined environments that make it difficult to control and assess the acoustic conditions. Moreover, by measuring and reporting only the pressure component of sound, the results are of reduced relevance for assessing any observed effects. Most crustacean species lack swim bladders and are considered less sensitive to sound, though understanding of the impact of sound on invertebrates is limited (Edmonds et al. 2016). The BOEM DEIS (2018) for Vineyard Wind 1 determined that impacts on fishes and invertebrates from vessel sounds and pile driving during construction would be minor and short term.

Southern Wind Development Area—Phases 1 and 2

Impact Pile Driving

Sound generated from pile driving could potentially impact fishes and invertebrates nearby because the high-intensity, impulsive sounds of pile driving can produce noise over 200 dB at the source and have been linked to mortality, ruptured gas bladders, damage to auditory processes, and altered behavior in some fish species (Casper et al. 2012; Popper and Hastings 2009; Riefolo et al. 2016).

Impact pile driving is carried out using an impact hammer, which consists of a falling ram that strikes the top of a pile repeatedly and drives it into the ground. When the ram strikes the pile, the impact creates stress waves traveling down the length of the pile, which couples with the surrounding medium, radiating acoustic energy into the water (Appendix III-M). Pile driving also generates vibration waves in the sediment, which can radiate acoustic energy back into the water from the seabed. The sound from impact pile driving is transient, repetitive, and discontinuous (McPherson et al. 2017; Reinhall and Dahl 2011). Pile driving can be conducted both above the surface and subsea and has a typical strike interval of 1.5 to 2 seconds. The characteristics of these sounds are described in more detail in Appendix III-M of the COP.

Field measurements of pile driving show that source, or near-source levels are typically in the range of 210 to 250 dB re 1 µPa (Bailey et al. 2010; McHugh 2005; Tougaard et al. 2009) and frequency is predominantly less than 1 kilohertz (kHz) (Robinson et al. 2007; Tougaard and Henriksen 2009), although they can extend to much higher frequencies (MacGillivray 2018), including at least 100 kHz (Tougaard and Henriksen 2009). Sound thresholds derived from Popper et al. (2014) indicate that pile driving sound above 207 dB peak can lead to mortality of the most sensitive fish species, such as Atlantic herring, while noise above 186 dB can lead to impairment. Longfin squid exhibited a startle response to recorded pile driving sound played at 190–194 dB but habituated quickly and startle responses typically diminished within the first eight strikes, although the response returned when the squid were tested again 24 hours later (Jones et al. 2020). The authors did not report any physical harm from the sound exposure but speculated that it could reduce the ability to detect and avoid predators.

The effects of impulsive sound on fish eggs and larvae have been studied in the context of offshore pile driving. Bolle et al. (2012) investigated the risk of mortality in common sole (*Solea solea*) larvae by exposing them to impulsive stimuli in an acoustically well-controlled study. Even at the highest exposure level tested, at an SEL of 206 dB re 1 µPa2·s (corresponding to 100 strikes at a distance of 100 m), no statistically significant differences in mortality were found between exposure and control groups.

Popper et al. (2014) published exposure guidelines for fish eggs and larvae, which are based on pile driving data. The guidelines proposed a precautionary threshold for mortality of fish eggs and larvae of greater than 207 dB re 1 µPa PK, which they note is likely conservative.

There are no studies available on the potential effects of pile driving sounds on plankton and no established acoustic thresholds for plankton. Although air guns are not a proposed action for New England Wind, they provide insight on potential effects from impulsive sound. Parry et al. (2002) studied the abundance of plankton after exposure to impulsive air gun sounds but found no evidence of mortality or changes in catch-rate on a population-level. However, McCauley et al. (2017) found that after exposure to impulsive air gun sounds generated with a single air gun (2,460 cm^3 or 150 in^3), zooplankton abundance decreased and mortality in adult and larval zooplankton increased two- to three-fold when compared with controls. In this first large-scale field experiment on the impact of seismic activity on zooplankton, a sonar and net tows were used to measure the effects on plankton. They determined there was a horizontal maximum effect-range of 1.2 km (0.65 NM). Their findings contradicted the conventional idea of limited and very localized impact of intense sound in general, and seismic air gun signals in particular, on zooplankton. The results indicated that there may be noise-induced effects on these taxa and that these effects may even be negatively affecting ocean ecosystem function and productivity. However, the study was compromised by methodological design issues (small sample sizes, large daily variability in the baseline and experimental data), the statistical robustness of the data, and conclusions (large number of speculative conclusions that appear inconsistent with the data collected over a two-day period). The lead author stressed that even though their conclusions were based on numerous assumptions, the combined likelihood of all measured parameters occurring without being correlated to the air gun survey is extremely low (McCauley, pers. comm.).

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Richardson et al. 2017) simulated the large-scale impact of a seismic survey on zooplankton using the mortality rate found by McCauley et al. (2017). The aim of the CSIRO study was to estimate the spatial and temporal impact of seismic activity on zooplankton on the Northwest Shelf of Western Australian.

The major findings of the CSIRO study were that seismic activity had substantial impacts on zooplankton populations on a local scale within or close to the survey area; however, on a regional scale, the impacts were minimal and not discernible over the entire Northwest Shelf Bioregion. The study found that the time for the zooplankton biomass to recover to pre-seismic levels inside the survey area, and within 15 km (8 NM) of the area, was only three days following the completion of the survey. This relatively quick recovery was due to the fast growth rates of zooplankton as well as the dispersal and mixing of zooplankton from both inside and outside of the impacted region (Richardson et al. 2017).

Fields et al. (2019) exposed zooplankton (copepods) to seismic pulses at various distances up to 25 m (82 ft) from a seismic air gun source. The source levels produced were estimated to be 221 dB re 1 µPa2·s. The study observed an increase in immediate mortality rates of up to 30% of copepods in samples compared to controls at distances of 5 m (16 ft) or less from the air guns. Mortality one week after exposure was significantly higher by 9% relative to controls in the copepods placed 10 m (33 ft) from the air guns. Fields et al. (2019) also reported that no sublethal effects occurred at any distance greater than 5 m (16 ft) from the seismic source. The findings of the study indicated that the potential effects of seismic pulses to zooplankton are limited to within approximately 10 m (33 ft) from the seismic source. Fields et al. (2019) also note that the findings of the McCauley et al. (2017) study are difficult to reconcile with the body of other available research and may, therefore, provide an overly conservative estimate of the potential effects of seismic pulses to zooplankton.

There are indications that New Zealand scallop (*Pecten novaezelandiae*) larvae exposed to extended periods of air gun signals during their ontogeny may be negatively affected as reported by Aguilar de Soto et al. (2013). The authors found an increase in abnormality and mortality rates in scallop larvae after continued exposure to playbacks of intense air gun signals in a laboratory experiment. These results indicated that there may be species-specific differences in sensitivity of early life stages to sound exposure. In addition, research on the response of blue mussels to pile driving indicated that clearance or filtration rate increased with pile driving noise, likely in response to increased metabolic demands triggered by stress (Spiga et al. 2016).

Day et al. (2016a) conducted a study on the effects of exposures of southern rock lobster (*Jasus edwardsii)* and scallop to impulsive sounds produced by an air gun. Their study used field and laboratory experimental approaches to investigate potential impacts of marine seismic surveys on these species. The study used a real air gun and had improved control over experimental parameters compared to other reported studies, as it is likely that particle motion and interface waves are the more relevant stimulus. Accordingly, their results are more relevant than those obtained under laboratory conditions with animals exposed to simulated signals. Day et al. (2016a) provide a regression of particle acceleration versus range for the single 2,460 cm^3 (150 in^3) air gun used in the study and showed that acceleration at the 10 and 100 m (33 and 328 ft) ranges were typically 26 and 5 m s^{-2} (85 and 16 ft s^{-2}), respectively. The study also references an unpublished maximum particle acceleration measurement of 6.2 m s^{-2} (20 ft s^{-2}) from a 3,130 in^3 (51,300 cm^3) air gun array at 477 m (1,565 ft) range in 36 m (118 ft) of water. Consistent with other studies of high-intensity, low-frequency sound exposure of crustaceans and mollusks (Carroll et al. 2017; Edmonds et al. 2016), the study found no evidence of mass mortality directly following air gun exposure. Consequently, the authors rejected the hypothesis that exposure to seismic air guns causes immediate mass mortality. Unlike other studies, this study uncovered a few issues concerning long-term health and ecology. Two reflex behaviors, tail tonicity or extension and righting behavior, were assessed. These reflexes have been used in lobster fishery industries in grading animals for their likelihood of survival. While results for tail tonicity were inconclusive, there was a significant response to exposure in the righting response, which is a more complex reflex requiring neurological control and muscle coordination.

André et al. (2011) and Solé et al. (2013) provide evidence of acoustic trauma in four cephalopod species—common cuttlefish (*Sepia officinalis),* common octopus *(Octopus vulgaris),* European squid *(Loligo vulgaris),* and southern shortfin squid *(Illex condietii*)—which they exposed (underwater) for two hours to low-frequency sweeps between 50–400 hertz (Hz) (1 second duration) generated by an in-air speaker. The received level at the animals' position was 157 dB re 1 µPa with peak levels (unspecified) up to 175 dB re 1 µPa. Both studies reported permanent and substantial morphological and structural alterations of the sensory hair cells of the statocysts following noise exposure, with no indication of recovery.

In a recent experiment, Solé et al. (2017) exposed common cuttlefish to tonal sweeps between 100–400 Hz in a controlled exposure experiment in open water. Their results showed a clear statistical relationship between the cellular damage detected in the sensory cells of the individuals exposed to the sound sweeps and their distance from the sound source. The authors measured the particle motion and pressure of the signals received by the animals, but due to the signal type (frequency sweep), they only provided the maximum received levels or an estimate thereof, respectively. The maximal particle motion level was 0.7 ms^{-2} (2.3 ft^{-2}) observed at 1 m (3.3 ft) depth, the pressure reached levels of 139–142 dB re 1 μPa^2. The reported sound pressure levels were only slightly higher than the hearing threshold determined for longfin squid measured by Mooney et al. (2010). The maximum particle motion (reported in terms of particle acceleration) reported by Solé et al. (2017) is in the same order of magnitude as the behaviorally thresholds measured at 100 Hz by Packard et al. (1990) using a standing wave acoustic tube.

The Proponent conducted acoustic modeling (see Appendix III-M) to estimate the noise propagation of pile driving assuming broadband noise attenuation levels of 6, 10, and 12 dB in relation to thresholds of mortality and recoverable injury for fishes with different hearing structures (based on thresholds in Popper et al. 2014 and presented in Table 5.1-1). The Proponent expects to implement noise attenuation mitigation technology to reduce sound levels by a target of approximately 12 dB or greater; impacts to marine species were assessed based on 10 dB of noise attenuation.

Sound with peak sound pressure (dB re 1 µPa) up to 213 dB and frequency-weighted sound exposure level (dB re 1 $\mu Pa^2 \cdot s$) up to 219 dB was predicted to occur (Table 5.1-3). Popper et al. 2014 does not define quantitative acoustic thresholds for behavioral response in fish. GARFO (2016) uses a 150 dB SPL threshold for all fish (see Appendix III-M).

Distances to injury or behavior disturbance thresholds are presented in Appendix III-M. Impairment from pile driving noise is less likely to occur during construction because a soft-start technique will be employed, and mobile fishes and invertebrates will be able to leave the area before full strength pile driving occurs.

Unexploded Ordnance

Detonation of unexploded ordnance (UXO) could occur, if potential UXOs are discovered in the SWDA or OECC. The Proponent will prioritize avoidance of UXO wherever possible by micro-siting structures and cables around the object. In instances where avoidance, physical UXO removal, or an alternative combustive removal technique (e.g., deflagration) are infeasible due to layout restrictions or are not considered safe for project personnel, UXOs may need to be detonated in situ to conduct seabed-disturbing activities such as foundation installation and cable laying during construction of New England Wind. The exact number and type of UXO that may be present, and which subset of those UXO cannot be avoided by micro-siting, are continuing to be evaluated. To assess the impacts of underwater sound during UXO detonation, acoustic modeling was completed (see Appendix III-M, sub-Appendix J).

Underwater explosive detonations generate impulsive sound waves with high pressure levels that could cause disturbance and/or injury to marine fauna. An explosion produces hot gases that create a large oscillating sphere and a shock wave (Chapman 1985). The extreme increase in pressure followed by a decrease to below ambient pressure caused by an explosive shock wave can cause injury to soft tissues, membranes, and cavities filled with air (Keevin and Hempen 1997). However, these events produce a short signal duration and the extent of impact will depend on the proximity of the receiver to the detention.

Injury to fish from exposures to explosion are called barotrauma injuries. Rapid changes in gas volume and rapid changes in the solubility of gas in the blood and tissues cause barotrauma injuries. When pressure increases, solubility increases and vice versa. Injury mechanisms include bubble formation in fluids/tissues (i.e., decompression sickness), and rapidly expanding gas-filled bodies (i.e., swim bladder) push against surrounding tissues, thereby damaging surrounding tissues [Carlson 2012; Halvorsen 2012a].

Effects of detonation pressure exposures to fish have been assessed according to the Lpk limits for onset of mortality or injury leading to mortality due to explosives, as recommended by the American National Standards Institute (ANSI) expert working group (Popper et al. 2014).

There is no available research in invertebrates on the effect of sound from UXO detonation causes particle motion changes, which may result in behavioral response, injury, mortality, sensory damage, and physiological changes (Fitzgibbon et al. 2017; McCauley et al. 2017). Vibration caused by anthropogenic sound, such as UXO detonation, can propagate to the seabed (Roberts and Elliott 2017). Researchers have reported substrate-borne vibrations from anthropogenic sound to affect their behavior (Roberts et al. 2015) (Roberts et al. 2016).

Vibratory Pile Setting

As described further in Appendix III-M, sub-Appendix K, a vibratory hammer could be used to install the monopile through surficial sediments in a controlled fashion to avoid the potential for a "pile run," where a pile sinks rapidly through surficial sediments. Once the pile has penetrated the surficial sediments with the vibratory hammer, an impact hammer would be used for the remainder of the installation. During vibratory pile driving, piles are driven into the substrate due to longitudinal vibration motion at the hammer's operational frequency and corresponding amplitude. This causes the soil to liquefy, allowing the pile to penetrate into the seabed. Sounds generated by vibratory pile setting are non-impulsive, which are known to be less damaging than impulsive sounds to marine fauna.

There are few data on the effects of vibratory pile driving on fish. Further, generalizations can be difficult because sound affects species differently, particularly with regards to the presence or absence of a swim bladder and its proximity to the ear. Nedwell et al. (2003) detected no changes in activity level or startle response in brown trout, a species with no specialized hearing structures, when exposed to vibratory piling at close ranges (<50 m [164 ft]). There are no direct data available on the behavioral response to continuous noise in fish species with more specialized hearing. The masking of communicative signals, as well as signals produced by predators and prey, may be the most likely behavioral impact to fish (Popper and Hawkins 2019). However, the effect is expected to be short term (Popper et al. 2014). Additionally, high risks of any behavioral impacts from continuous sound sources (e.g., vibratory pile driving) are likely to only occur at close range to the source (Popper et al. 2014).

There are no data linking continuous noise to mortality or permanent injury in fish (Popper et al. 2014). Continuous noise has been linked to temporary threshold shift (TTS) in some fish species; however, exposure times to these sounds were at least 12 hours (Amoser and Ladich 2003, Smith et al. 2006). Overall, the sounds emitted by vibratory setting of piles for wind farm construction are expected to be of short duration and intermittent, and the risk of impact on fish from this activity is expected to be low.

There is a lack of data involving the effects of vibratory pile installations on invertebrates. Among the marine invertebrates, some can detect particle motion and are sensitive to noise (André et al. 2016; Popper et al. 2014; Jézéquel et al. 2023). Being invertebrates generally do not possess air-filled spaces like lungs, middle ears, or swim bladders, they have been considered less susceptible than fish to noise and vibration. Invertebrates display measurable behavioral responses to noise, such as interruptions to feeding and resource gathering, startle responses, and escape behaviors (Mooney et al. 2020; Roberts et al. 2015).

Drilling

As described further in Appendix III-M, sub-Appendix L, there may be instances during construction of New England Wind where large sub-surface boulders or hard sediment layers are encountered, which will require drilling to pass through these barriers. It is conservatively estimated that drilling could occur up to 24 hours per day. During drilling activities, a drill head produces vibrations that propagate as sound through the sediment and water column (Hall and Francine 1991, Nguyen 1996, Willis et al. 2010). Most measurements of offshore drilling sounds have been made for oil exploration and production drilling. The sound levels associated with those drilling operations have been documented to be within the hearing range of fish injury and behavioral thresholds (Popper et al. 2014). Underwater sound emitted by project construction drilling activities is not expected to produce injury to marine fauna but is likely to be audible and could elicit temporary behavioral responses.

It is unclear whether the sound emitted by marine drilling activities is likely to impact the behavior of fish. McCauley (1998) determined that any effects to fish from sounds produced by marine drilling activity would likely be temporary behavioral changes within a few hundred meters of the source. For instance, measured source levels during drilling operations reached 120 dB at 3–5 km, which may have caused fish avoidance (McCauley 1998). The available literature suggests that continuous sound produced by drilling operations may mask acoustic signals of fish that convey important environmental information (McCauley 1994, Popper et al. 2014). Recordings of planktivorous fish choruses showed that the fish were still active during drilling operations off the coast of the Timor Sea; however, it is likely that partial masking of their calls would have occurred (McCauley 1998).

There are no data to support a clear link between anthropogenic sound and permanent injury or mortality in fish, particularly with non-impulsive sound sources (Popper and Hawkins 2019). Continuous sound has been linked to TTS in some species of fish; however, exposure times to these sounds were at least 12 hours (Amoser and Ladich 2003, Smith et al. 2006). The sounds emitted by marine drilling operations for wind farm construction are expected to be short-term and intermittent. It is therefore unlikely that the acoustic characteristics of this source will cause prolonged acoustic masking to fish, and the risk of impact from this activity is expected to be low.

There are very few data on the effect of sound from drilling on marine invertebrates. Sole et al. (2022) reported a decreased survival rate in cephalopod (cuttlefish) larvae exposed to drilling sound levels (167 dB re 1 μPa^2). Importantly, levels below 163 dB re 1 μPa^2 did not elicit severe damage. Evidence from research on the levels of particle motion associated with behavioral responses in blue mussels indicates that the threshold of sensitivity in this species falls within vibration levels measured near blasting, pile driving, and impact drilling (Roberts et al. 2015). Studies have indicated reception of vibration in bivalves and an associated behavioral response, which included closing syphons and, in more active mollusks, moving away from the substrate (Mosher 1972, Ellers 1995, Kastelein 2008).

<u>Vessel Traffic</u>

Vessel traffic associated with construction would result in temporary, transient, and continuous non-impulsive noise primarily originating from the vessel propulsion system. Sound emission from vessels, especially from vessels using dynamic positioning (DP), depends on vessel operational state and is strongly weather-dependent. Zykov et al. (2013) and McPherson et al. (2019) report a maximum broadband source level of 192 dB re 1 µPa for numerous vessels with varying propulsion power using DP.

Vessel noise can represent a chronic impact for fish species (Popper 2003), whose communication is mainly based on low-frequency sound signals (Ladich and Myrberg 2006; Myrberg and Lugli

2006). Continuous noise above 170 dB root-mean-square (rms) for 48 hours can lead to injury, while exposure to noise of 158 dB rms or above for 12 hours can lead to behavioral disturbance (Hawkins and Popper 2017; Popper et al. 2014). Vessel noise can also cause avoidance behavior that interferes with feeding and breeding, alter schooling behaviors and migration patterns, and mask important environmental auditory cues (Barber 2017; CBD 2012). Recent studies have shown that vessel noise can induce endocrine stress response (Wysocki et al. 2006); diminish hearing ability; and mask intra-specific relevant signals in exposed fish species (Amoser et al. 2004; Codarin et al. 2009; Scholik and Yan 2002; Vasconcelos et al. 2007).

Masking communication is of concern because although fishes are generally not loud (120 dB re 1 µPa [at 1 m (3.3 ft)], with the loudest on the order of 160 dB re 1 µPa), species make unique noises that allow for individual identification (Normandeau Associates 2012). In addition, vessel noise has the capacity to provoke short-term changes in the spatial position and group structure of pelagic fish in the water column (Buerkle 1973; Handegard et al. 2003; Mitson and Knudsen 2003; Olsen et al. 1983; Ona et al. 2007; Sarà et al. 2007; Schwarz and Greer 1984; Soria et al. 1996; Vabø et al. 2002).

Fish can respond to approaching vessels by diving towards the seafloor or by moving horizontally out of a vessel's path (Berthe and Lecchini 2016; Ona et al. 2007). Nedelec et al. (2016) investigated the response of reef-associated fish by exposing them in their natural environment to playback of motorboat sounds. They found that juvenile fish increased hiding and ventilation rate after a short-term boat sound playback, but responses diminished after long-term playback, indicating habituation to sound exposure over longer durations. These results were corroborated by Holmes et al. (2017) who also observed short-term behavioral changes in juvenile reef fish after exposure to boat noise as well as desensitization over longer exposure periods.

Therefore, areas of high vessel traffic may result in habituation by localized fishes. As stated in the BOEM Environmental Assessment and the Alternative Energy Programmatic Environmental Impact Statement that were prepared for the assessment and designation of wind energy areas by BOEM, regular vessel traffic occurs throughout this area, thus implying that biological resources in the area are presumably habituated to this noise (BOEM 2007; BOEM 2014).

There is a moderate risk within tens to hundreds of meters proximity to the source, that sounds emitted by trenching, vessel operations and cables may elicit behavioral reaction in fish without a swim bladder and those with a swim bladder not involved in hearing; at larger distances the risk is low. The risk that fish with a swim bladder involved in hearing display behavioral reactions near the sources is high, at intermediate distances the risk is moderate, and, at greater distances, the risk is low (Popper et al 2014). As stated in the BOEM Environmental Assessment and the Alternative Energy Programmatic Environmental Impact Statement that were prepared for the assessment and designation of wind energy areas by BOEM, regular vessel traffic occurs throughout this area; thus, implying that biological resources in the area are presumably habituated to this noise (BOEM 2007; BOEM 2014). In addition, the BOEM DEIS for Vineyard Wind 1 determined that short- and long-term impacts from construction noise will have minor impacts on finfish and invertebrate species (BOEM 2018).

Offshore Export Cable Corridor—Phases 1 and 2

The principal noise from OECC (including the Western Muskeget Variant) installation would be from tugs and other vessels used for cable installation. Fish in the OECC would be able to hear the vessels, but sound levels will be below those that cause injury or stress (USDOE MMS 2009). Cable installation is not expected to be a significant source of noise; if a jetting technique is used, there will be the sound of water rushing from the nozzles (USDOE MMS 2009). Neither of these sound sources are expected to significantly impact EFH, especially after construction and installation activities for New England Wind have ceased.

5.1.4 Avoidance, Minimization, and Mitigation Measures (Phases 1 and 2)

Southern Wind Development Area and Offshore Export Cable Corridor—Phases 1 and 2

The SWDA is located in the MA WEA, which was identified as suitable for wind energy development after a multi-year, multi-agency public process partially because of its relatively low amount of important fish and invertebrate habitat, therefore reducing potential for impacts. As described in Section 2.3 of COP Volume I, the OECC was also sited taking environmental factors into consideration.

Several mitigation measures will be employed to avoid and minimize potential impacts to EFH within the SWDA and OECC. These measures include the following:

- Application of a soft-start procedure to the pile driving process, which delivers initial pile drives at a lower intensity, allowing fish to move out of the activity area before the full-power pile driving begins.

- The Proponent expects to implement noise attenuation mitigation technology to reduce sound levels by a target of approximately 12 dB or greater.

- Utilize widely-spaced WTGs and ESPs, so that the foundations (and associated scour protection) for the WTGs and ESPs, along with cable protection (if required) for inter-link and inter-array cables, only occupy a minimal portion of the SWDA, leaving a huge portion of the SWDA undisturbed.

- Offshore export cable installation will avoid important habitats and those considered HAPC, such as eelgrass beds and hard bottom sediments, if feasible. It is expected that the identified eelgrass resources near Spindle Rock in proximity to the landfall sites will be avoided (see Figure 6.4-1 of COP Volume III). It is also expected that isolated areas of hard bottom may be avoided, such as at Spindle Rock; however, in areas such as Muskeget Channel where hard bottom extends across the entire corridor, it will not be possible to avoid hard bottom.

- Where feasible and considered safe, use mid-line buoys on anchor lines to minimize impacts from anchor line sweep.

- As described in Sections 3.3.1.8 and 4.3.1.8 of COP Volume I, horizontal directional drilling (HDD) is expected to be used to avoid or minimize impacts to benthic habitat at the Phase 1 and Phase 2 landfall sites.[10]

The Proponent is committed to fisheries science and research as it relates to offshore wind energy development. Working with the Massachusetts School for Marine Science and Technology, the Proponent is currently collecting pre-construction fisheries data (via trawl and drop camera surveys) within the SWDA. The Proponent plans to develop a framework for during and post-construction fisheries studies within New England Wind. In recognition of the regional nature of fisheries science, the Proponent expects that such during and post-construction studies will involve coordination with other offshore wind energy developers in the MA WEA and Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA). New England Wind also expects the development of the fisheries studies will be undertaken in coordination with BOEM, other federal and state agencies, fisheries stakeholders, academic institutions, and other stakeholders. The Proponent is already engaging in collaboration with other developers, fishing industry representatives, and state and federal agencies through its participation in the Responsible Offshore Science Alliance and a Regional Wildlife Science Entity.

The Proponent is also committed to developing an appropriate benthic monitoring framework for New England Wind (see Appendix III-U for the draft framework). The framework for New England Wind considers the draft Benthic Habitat Monitoring Plan for Vineyard Wind 1 in Lease Area OCS-A 0501. Due to the similarities in habitat across the Lease Areas OCS-A 0501 and OCS-A 0534, the monitoring data collected during the Vineyard Wind 1 monitoring effort may also inform potential impacts to and recovery of benthic communities within the SWDA. The Proponent will continue to consult with BOEM and other federal and state agencies as appropriate to further refine the benthic monitoring framework for New England Wind.

5.1.5 Summary of Impacts (Phases 1 and 2)

Southern Wind Development Area and Offshore Export Cable Corridor—Phases 1 and 2

Overall, impacts to EFH in the Offshore Development Area are anticipated to be short-term and localized during construction and installation of New England Wind. Many impacts are expected to be temporary, such as seafloor disturbance from cable installation (including any required dredging along the OECC), the resuspension and settlement of sediments during cable installation and dredging activities, habitat disturbance from the use of jack-up and/or anchored vessels, and water withdrawal during cable installation. In addition, temporary noise from pile driving could potentially impact all species with EFH in the SWDA during construction. However, the use of a

[10] At the Phase 1 and Phase 2 landfall sites, HDD is expected to be used, though open trenching may also be used during Phase 2 if it is not feasible to use the Dowses Beach Landfall Site and open trenching is needed at the Wianno Avenue Landfall Site.

soft start during pile driving will give fish in the SWDA time to avoid the noise source before full impact strikes are made. Sound reduction technologies will also be used to minimize impacts.

Recovery of disturbed habitats is expected, and previous research indicates that communities begin to repopulate within a few months of disturbance (Dernie et al. 2003; Van Dalfsen and Essink, 2001). Alteration of sand wave habitat will likely be temporary and will have little impact on fishes in the area, as these are a dynamic, ever-changing environments. In addition, as explained in Section 6.6.2 of COP Volume III, most mobile pelagic and demersal fishes will be able to avoid areas where habitat disturbance will occur, and mortality of these fishes will be minimal. Sessile benthic organisms and demersal egg or larval life stages will be unable to avoid construction and may be buried by associated habitat disturbance. Burrowing mollusks in the area, such as surf clams and quahogs, will likely be able to avoid most lethal burial depths and are only expected to be slightly impacted and exhibit short-term avoidance/feeding behavior. No population level impacts are expected for any of the species with EFH in the area because the Offshore Development Area represents a very small portion of available habitat in the region.

5.2 Operations and Maintenance

5.2.1 Habitat Alteration (Phases 1 and 2)

Southern Wind Development Area—Phases 1 and 2

The addition of structured habitat in the SWDA from WTG/ESP foundations and associated scour protection as well as cable protection (if required) may act as an artificial reef and would increase EFH for species that prefer Complex habitat and minimally decrease (relative to total area available nearby) EFH for species that prefer Sand Bottom habitat. Previous research on fish habitat utilization after wind farm installation observed that WTG structures were large enough to attract and support new communities of rocky-habitat fishes, but not large enough to negatively impact fish communities that prefer sandy bottom areas between the WTGs (Stenberg et al. 2015). Locally, cobble and boulder-type habitats are particularly important to lobsters because they serve as both nursery grounds for benthic juveniles and as home substrata for adults (Linnane et al. 1999) and addition of scour protection could attract lobsters to these artificial habitats. Within the SWDA, the total area of Soft Bottom habitat permanently altered to Complex or Heterogeneous Complex habitat from installation of WTG/ESP foundations, associated scour protection, and potential cable protection (if required) is 1.19 km^2 (295 acres) of the 453 km^2 (111,939 acres) total area. The addition of new structure in the SWDA, which consists of only Soft Bottom habitat, may increase biodiversity and secondary production but introduced habitats could also provide opportunities for the spread and colonization of nonindigenous species.

The addition of the WTG structure throughout the water column may alter pelagic EFH as WTG foundations provide substrata for shellfish to attach and colonization by these species can change nutrient and plankton concentrations previously observed in the area (Norling and Kautsky 2007; Slavik et al. 2017). For example, biofouling by blue mussels, a filter feeder, on WTG structures in wind farms located in the North Sea notably reduced the daily net primary productivity on a regional scale. However, reduction in primary production resulted in increased production and biodiversity of higher trophic levels (Slavik et al. 2017). Raoux et al. (2017) also observed that total ecosystem activity increased and that high trophic level organisms responded positively to increased biomass near monopiles after the construction of a wind farm. In addition, increases in commercially important species, such as Atlantic cod and whiting, were observed near deep water wind farms (Hille Ris Lambers and ter Hofstede 2009; Løkkeborg et al. 2002). There is also evidence that WTG reef habitats and the resources they provide increase the growth and condition of juvenile Atlantic cod and whiting-pout (*Trisopterus luscus*) (Reubens et al. 2013).

The presence of the WTGs in the SWDA may also alter the local ocean circulation in the region, potentially changing planktonic distributions and dispersal patterns. However, hydrodynamic modeling simulating larval transport around WTGs in the MA WEA found that the presence of WTG structures would not have significant influence on southward larval transport during storm events (Chen et al. 2016).

Offshore Export Cable Corridor—Phases 1 and 2

As in the SWDA, cable protection (rock, concrete mattresses, gabion rock bags, or half-shell pipes [or similar]) may be required along the OECC (including the Western Muskeget Variant) in areas where target burial depths cannot be achieved. The addition of cable protection would locally alter Soft Bottom habitat to Complex habitat. In other areas, cable protection would be placed on bottom habitat already classified as Complex. The maximum amount of potential permanent bottom habitat altered by cable protection would be less than 0.22 km^2 (54 acres) for the OECC for both Phases. If the Western Muskeget Variant is used for one or two Phase 2 export cables, the amount of permanent habitat alteration for both Phases combined from the potential installation of cable protection (if required) would be approximately 0.23–0.24 km^2 (57–60 acres). As noted above for the SWDA, the addition of hard bottom structure in these previously flat, soft sediment areas may attract different species and act as artificial reef habitat. Impacts to EFH would be similar to that explained above and would be expected to include temporary impacts to benthic and pelagic habitat, displacement of mobile juvenile and adult fishes and invertebrates, and some transition from fine, unconsolidated habitat to complex, hard-bottom habitat.

5.2.2 Increased Sound Exposure (Phases 1 and 2)

Southern Wind Development Area and Offshore Export Cable Corridor—Phases 1 and 2

The acoustic characteristics of vessel sounds associated with O&M are the same as those produced during construction. It is reasonable to assume that the amount of sound produced during O&M is similar to, or less than, those generated during the construction phase due to a lower number and smaller size of vessels. Possible sound sources other than vessel operations include the WTGs themselves, which generate sound in the nacelle that is transmitted from the topside to the foundation and then radiated into the water, and subsea cable vibration.

Avoidance of areas around the WTG due to operational noise may occur but is not expected to significantly impact EFH as the SWDA is only a small portion of available habitat in the area.

Operation of WTGs would result in variable, mostly continuous (i.e., during power generation) non-impulsive noise. Underwater noise level is related to WTG power and wind speed, with increased wind speeds creating increased underwater sound (Wahlberg and Westerberg 2005). Operational noise from WTGs is low frequency (60–300 Hz) and at relatively low sound pressure levels near the foundation (100–151 dB re 1 μPa) and decreases to ambient within 1 km (Tougaard et al. 2009, Lindeboom et al. 2011, Dow Piniak et al. 2012; HDR 2019).

At high wind speeds, Wahlberg and Westerberg (2005) estimated permanent avoidance by fish would only occur within a range of 4 m (13 ft) of a WTG. In a study on fishes near the Svante wind farm in Sweden, Atlantic cod and roach (*Rutilus rutilus*) catch rates were significantly higher near WTGs when rotors were stopped, which could indicate fish attraction to WTG structure and avoidance to generated noise (Westerberg 2000 *as cited in* Thomsen et al. 2006). Alternatively, no avoidance behavior was detected, and fish densities increased around WTG foundations of the Lillgrund offshore wind farm in Sweden (Bergström et al. 2013). In addition, ambient noise can influence how fish detect other sounds and a change in background noise could alter how fish perceive and react to biological noise stimuli (Popper and Fay 1993). Ambient noise within the 70.8–224 Hz frequency band in the MA WEA and RI/MA WEA was measured to be between 96 dB and 103 dB 50% of the time with greater sound levels 10% of the time (Kraus et al. 2016).

Underwater sound radiated from operating WTGs is low-frequency and low level (Nedwell and Edwards 2004). At distances of 14 to 20 m (46 to 66 ft) from operational WTGs in Europe, underwater sound pressure levels ranged from 109 dB to 127 dB re 1μPa (Tougaard et al. 2009). Pangerc et al. (2016) recorded sound levels at ~50 m (164 ft) from two individual 3.6 megawatt (MW) WTGs monopile foundations over a 21-day operating period. Miller and Potty (2017) measured an SPL of 100 dB re 1 μPa within 50 m (164 ft) of five General Electric Haliade 150–6 MW wind turbines with a peak signal frequency of 72 Hz. At the Block Island Wind Farm off of Rhode Island, sound levels were found to be 112–120 dB re 1 μPa near the WTG when wind speeds were 2–12 m/s and the WTG sound levels declined to ambient within 1 km from the WTG (Elliott et al. 2019). Tougaard et al. (2009) found that sound level from three different WTG types in European waters was only measurable above ambient sound levels at frequencies below 500 Hz, and Thomsen et al. (2016) suggest that at approximately 500 m from operating WTGs, sound levels are expected to approach ambient levels.

Two recent meta-papers (Tougaard et al. 2020, Stöber and Thomsen 2021) assessed WTG operational sounds by extracting sound levels measured at various distances from operating WTGs from currently available reports. Both studies found sounds to generally be higher for higher powered WTGs, and thus distances to a given sound threshold are likely to be greater for higher powered WTGs. However, as Stöber and Thomsen (2021) point out, direct drive technology could reduce these distances substantially. Importantly, no measurements exist for these larger turbine sizes and few measurements have been made for direct drive turbines so the uncertainty in these estimates is large.

Overall, current literature indicates noise generated from the operation of wind farms is minor and does not cause injury or lead to permanent avoidance of EFH at distances greater than 1 km

[0.6 mi] (Stenberg et al. 2015; Wahlberg and Westerberg 2005). There is the potential to have minimal effects at much closer distances up to within a few meters of the WTG (Bergström et al. 2013) such as masking auditory sensitivity and communication of fishes within a few tens of meters of WTGs (Zhang et al. 2021). The BOEM Essential Fish Habitat Assessment (2019) for Vineyard Wind 1 did not anticipate any detectable impact on species with EFH during New England Wind operation.

Previous impact assessment studies for various cable projects have concluded that sound related to subsea cable installation or cable operation is not a significant issue (Austin et al. 2005; Nedwell et al. 2003). This was based on the prediction that anticipated sound levels would not exceed existing ambient sound levels in the area, although background sound level measurements were often not presented (Meißner et al. 2006). Subsea cables are expected to produce low-frequency tonal vibration sound in the water, since Coulomb forces between the conductors cause the high-voltage alternating current (HVAC) lines to vibrate at twice the frequency of the current (direct current cables do not produce a similar tonal sound because the current is not alternating). Anticipated SPLs arising from the vibration of AC cables during operation are significantly lower than SPLs that may occur during cable installation (Meißner et al. 2006) and may be undetectable in the ambient soundscape of the Offshore Development Area, especially after consideration of the 1.5–2.5 m (5–8 ft) target burial depth.

5.2.3 Electromagnetic Fields (Phases 1 and 2)

Southern Wind Development Area and Offshore Export Cable Corridor—Phases 1 and 2

Electromagnetic fields (EMFs) would be generated by inter-array cables connecting WTGs in the SWDA, inter-link cables between the ESPs, and offshore export cables along the OECC (including the Western Muskeget Variant). Fish use electromagnetic sense for orientation and prey detection and therefore the function of key ecological mechanisms may be impacted by EMFs generated by the cables (Riefolo et al. 2016).

Recent research investigating habitat use around energized cables found no evidence that fishes or invertebrates were attracted to or repelled by EMFs emitted by cables (Love et al. 2017). A white paper review study funded by BOEM determined that there would be negligible, if any, effects on bottom-dwelling commercial and recreational fish species and no negative effects on pelagic commercial and recreational fish species in the southern New England area from EMFs produced by power transmission cables (Snyder et al. 2019). Recent studies funded by BOEM found that although there were changes in the behavior of little skate, an elasmobranch, and American lobster in the presence of energized cables, EMFs from cables did not act as a barrier to movement in any way (Hutchison et al. 2018; 2020). In addition, because EMFs produced by cables decreases with distance, and the target burial depth for the wrapped cables is 1.5–2.5 m (5–8 ft), the EMFs at the seabed would be expected to be weak and likely only detectable by benthic or demersal species (Normandeau et al. 2011). To date, there is no evidence linking anthropogenic EMF from WTG cables to negative responses in fish (Baruah 2016; Normandeau et al. 2011) but some evidence of attraction in a species of cancer crab when EMF strength was hundreds of times greater than expected by modeling for this New England Wind (Scott et al. 2021; Gradient 2020; Gradient 2021). Furthermore, there are already subsea transmission cables present in the region (outside of the Offshore Development Area) with five between Martha's Vineyard and Falmouth and two more between Nantucket and Cape Cod (see Section 7.9 of COP Volume III).

Modeling of the New England Wind-specific cables was conducted to assess potential effects of EMFs. As submarine offshore export cables will not produce any electric fields in the seafloor or ocean due to the shielding effect of the cable covering, modeling of potential effects from the New England Wind cables was focused on magnetic fields (MFs). High voltage alternating current (HVAC) cables (which will be used for Phase 1 and Phase 2) were modeled. All modeling assumed cables were buried beneath 1.5 m (5 ft) of sediments. In areas where sufficient burial is not achieved and cable protection is used, the protection will serve as a physical barrier in the same manner as cable burial, preventing organisms from experiencing the full strength of the magnetic field.

Modeling of the 220 kV and 275 kV HVAC cables demonstrated that MFs at the seafloor from the buried cables decrease with distance, with a maximum MF of 84.3 mG directly above the centerline that decreases to 5.6 mG at 6 m (20 ft) from the centerline (Gradient 2020, Gradient 2021). These model results indicate that MFs are likely only able to be sensed, if at all, directly over the buried cable centerline. Consistent with the modeled MF levels and the findings on 60-Hz AC EMFs (Snyder et al. 2019), and because cables in the Offshore Development Area will have a minimum target burial depth of approximately 1.5 m (5 ft), it is unlikely that demersal or benthic organisms will be affected by MFs from the offshore cable system.

The BOEM EFH Assessment for Vineyard Wind 1 also determined no measurable impacts of EMFs to populations of species with EFH designated in the proposed Vineyard Wind 1 Development Area would be expected (BOEM 2019).

5.2.4 Cable Maintenance (Phases 1 and 2)

Southern Wind Development Area and Offshore Export Cable Corridor—Phases 1 and 2

Cable maintenance and/or repair, as described in COP Volume I, may infrequently occur along limited segments of the offshore cables. Procedures employed to repair segments of cable in the SWDA and OECC (including the Western Muskeget Variant) may involve bringing the cable to the surface for repair, followed by re-installation of the cable. Impacts to EFH and the associated fish or invertebrate species would be similar to those explained above for cable installation and are expected to include displacement of mobile juvenile and adult fish, injury to immobile or slower life stages or species, and temporary disturbance of benthic and pelagic habitat. Such impacts would be confined to the specific area of the repair(s) and, given the limited area(s) where repair(s) may occur, would be considerably less than the impacts during construction.

5.2.5 Other Impacts (Phases 1 and 2)

Geophysical or geotechnical survey work may occur during O&M. Geotechnical sampling may have highly localized impacts to EFH and species with EFH that are limited to the immediate area of the geotechnical sample location or any benthic grab or drop camera sampling stations.

Anchoring of crew transfer vessels or other accommodation vessels may occur within the SWDA during normal operations. If repair work is required, both anchoring (within the SWDA or along the OECC) and the use of jack-up vessels (within the SWDA) may occur. As described in Section 7.8 of COP Volume III, approximately 290 vessel trips are expected per year during O&M for each Phase (assuming each Phase's maximum design scenario), which is significantly less than during construction. Such impacts would be highly localized and short-term.

5.2.6 Avoidance, Minimization, and Mitigation Measures (Phases 1 and 2)

The potential impacts and mitigation measures would be broadly the same as discussed previously for construction and installation with the exception of pile driving mitigation measures and HDD as they are not expected during O&M of New England Wind.

5.2.7 Summary of Impacts (Phases 1 and 2)

Southern Wind Development Area and Offshore Export Cable Corridor—Phases 1 and 2

Impacts that may occur during O&M of New England Wind include alteration of benthic and pelagic EFH, increased noise, EMFs, and maintenance activities. Limited benthic EFH will likely be altered from fine, unconsolidated substrate to structured habitat in the SWDA and may cause changes in fish assemblages in the area. Cable protection may also be used along the OECC (including the Western Muskeget Variant) and increase the amount of Complex or Heterogeneous Complex habitat present in the area. Increased noise from the operation of the WTGs will increase background noise and, as previous research indicates, may elicit avoidance responses in some species. Required maintenance of the WTGs, ESPs, or cables may impact organisms in a similar manner as construction and installation.

In summary, impacts to EFH and the associated species during O&M of New England Wind are expected to be localized and population-scale impacts are unlikely. Little to no direct mortality of EFH species would occur, other than potentially during cable repair, which is expected to be rare and localized. The addition of hard structure habitat will increase the amount of hard bottom EFH and add complexity to the area that did not exist before, which is likely to attract commercially important species that prefer structured habitat. Overall, current literature indicates noise generated from the operation of wind farms is minimal and only localized avoidance behaviors are expected; acclimation to noise may also over time may occur. The addition of EMFs from submarine cables will likely not limit the use of EFH by elasmobranchs or other electro-sensitive fish species because cables will be buried in the substrate or covered with cable protection.

5.3 Decommissioning

5.3.1 Overall Impacts (Phases 1 and 2)

Southern Wind Development Area and Offshore Export Cable Corridor—Phases 1 and 2

Decommissioning activities would include removal of WTG/ESP foundations to below the mudline, removal of scour protection, and retirement in place or removal of cables within the SWDA and OECC (including the Western Muskeget Variant). These activities would be similar to those associated with construction and installation. Removal of the piles from the SWDA would shift habitat type back to pre-construction conditions and likely result in a reversion of local finfish and invertebrate species assemblages to non-structure communities. Cable removal, if required, will result in direct disturbance of EFH along the path of the cables and will resuspend bottom sediments and impact organisms temporarily. No pile driving or associated hydroacoustic impacts are anticipated during decommissioning.

5.3.2 Avoidance, Minimization, and Mitigation Measures (Phases 1 and 2)

The mitigation measures would be the same as discussed previously for construction and installation although pile driving activities and associated mitigation measures are not expected during decommissioning.

6.0 Conclusions

The EFH impact producing factors during the construction and installation, O&M, and decommissioning of New England Wind include pile driving for WTG/ESP foundations, cable installation and maintenance/repair (including cable protection [if required]), scour protection installation, increased vessel traffic, water withdrawals, dredging, use of jack-up and/or anchored vessels, and EMFs. These factors might impact EFH for various species and life stages by direct habitat alterations, suspended sediments in the water column, increased noise, interference by electromagnetic fields, and physical harm. Most potential impacts to EFH are expected to be temporary with the exception of direct habitat alterations. Direct habitat alterations from the installation of WTG/ESP foundations, scour protection, and potential cable protection have the potential to result in permanent (lasting for the duration of New England Wind operations) impacts to EFH, specifically by changing Soft Bottom habitat or open pelagic habitat to structured habitat. However, this habitat alteration would only impact approximately 1.17 km^2 (289 acres) of the 453 km^2 (111,939 acres) SWDA, which is 0.26% of the SWDA, and 0.22 km^2 (54 acres) of the 83.6 km^2 (20,648 acres) OECC, which is 0.26% of the OECC for both Phases. If the Western Muskeget Variant is used for one or two Phase 2 export cables, the amount of permanent habitat alteration for both Phases combined from the potential installation of cable protection (if required) would be approximately 0.23–0.24 km^2 (57–60 acres). The Proponent plans to avoid, minimize, and mitigate all potential impacts to EFH, wherever possible.

7.0 References

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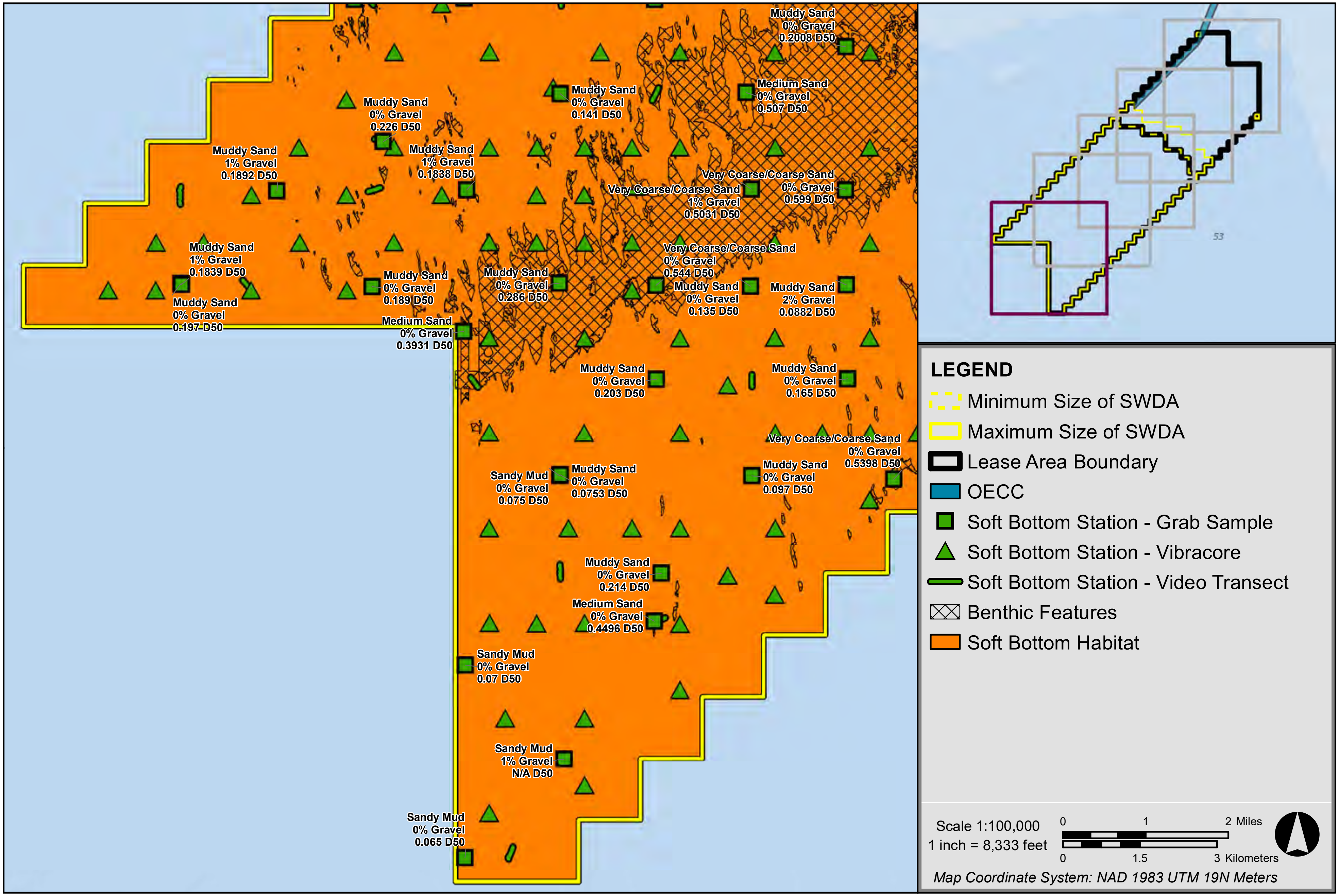
Annex I: Large-Scale Maps of Bottom Habitats and Benthic Features Located Within the Offshore Development Area of New England Wind Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021)

Habitat maps included in Annex I display the characterized delineations of benthic habitat type and Benthic Features along with all ground truthing samples collected in the Offshore Development Area between 2016-2020. Five maps depict the SWDA at a scale of 1:100,000 based on the extensive homogeneous nature of the habitat. Habitat along the OECC (including the Western Muskeget Variant) is presented in a series of 90 maps at a scale of 1:5,000 based on the presence of Heterogenous Complex and Complex habitat observed throughout.

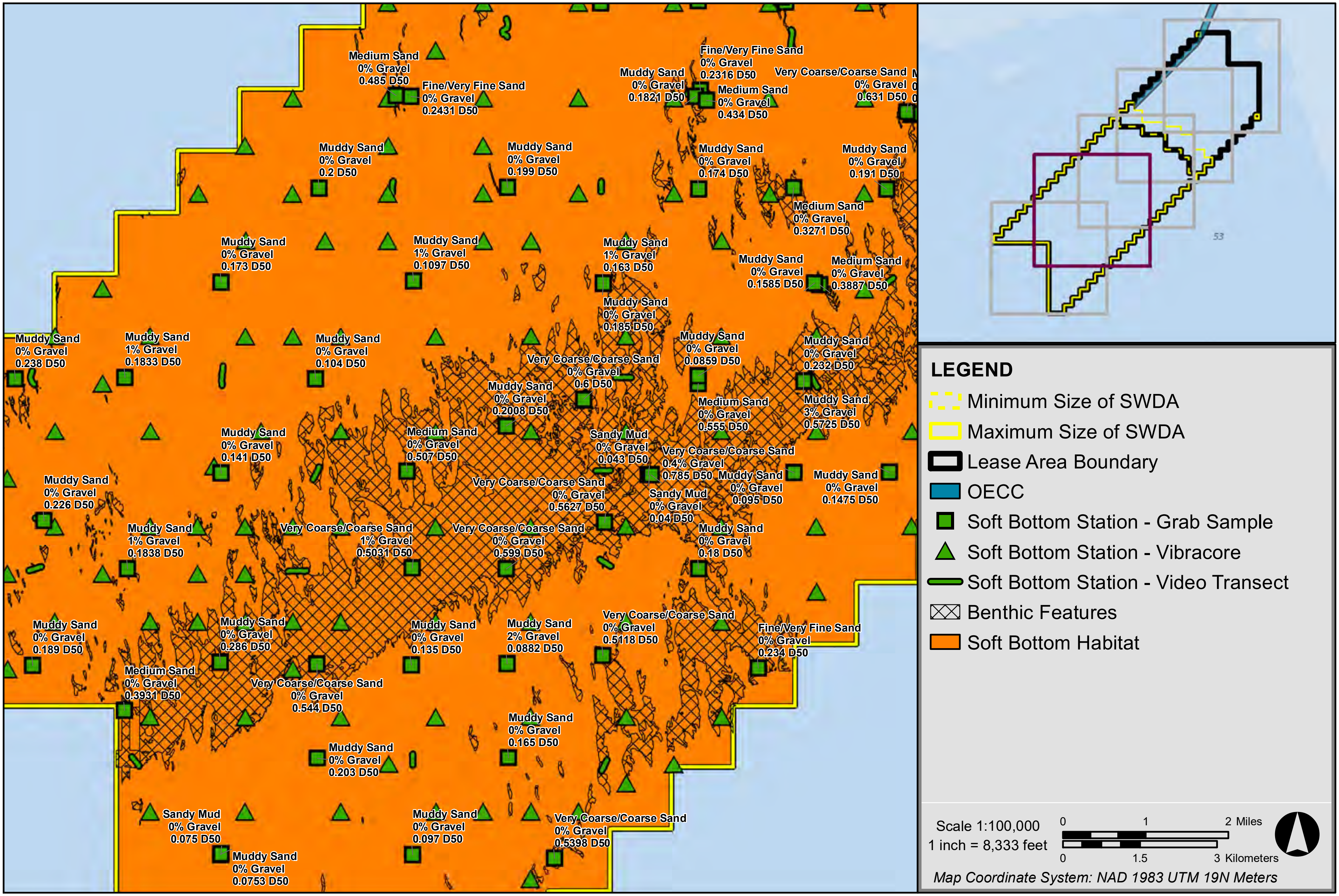


Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind **Figure 1 of 5**

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Southern Wind Development Area (SWDA) are at a Scale of 1:100,000.



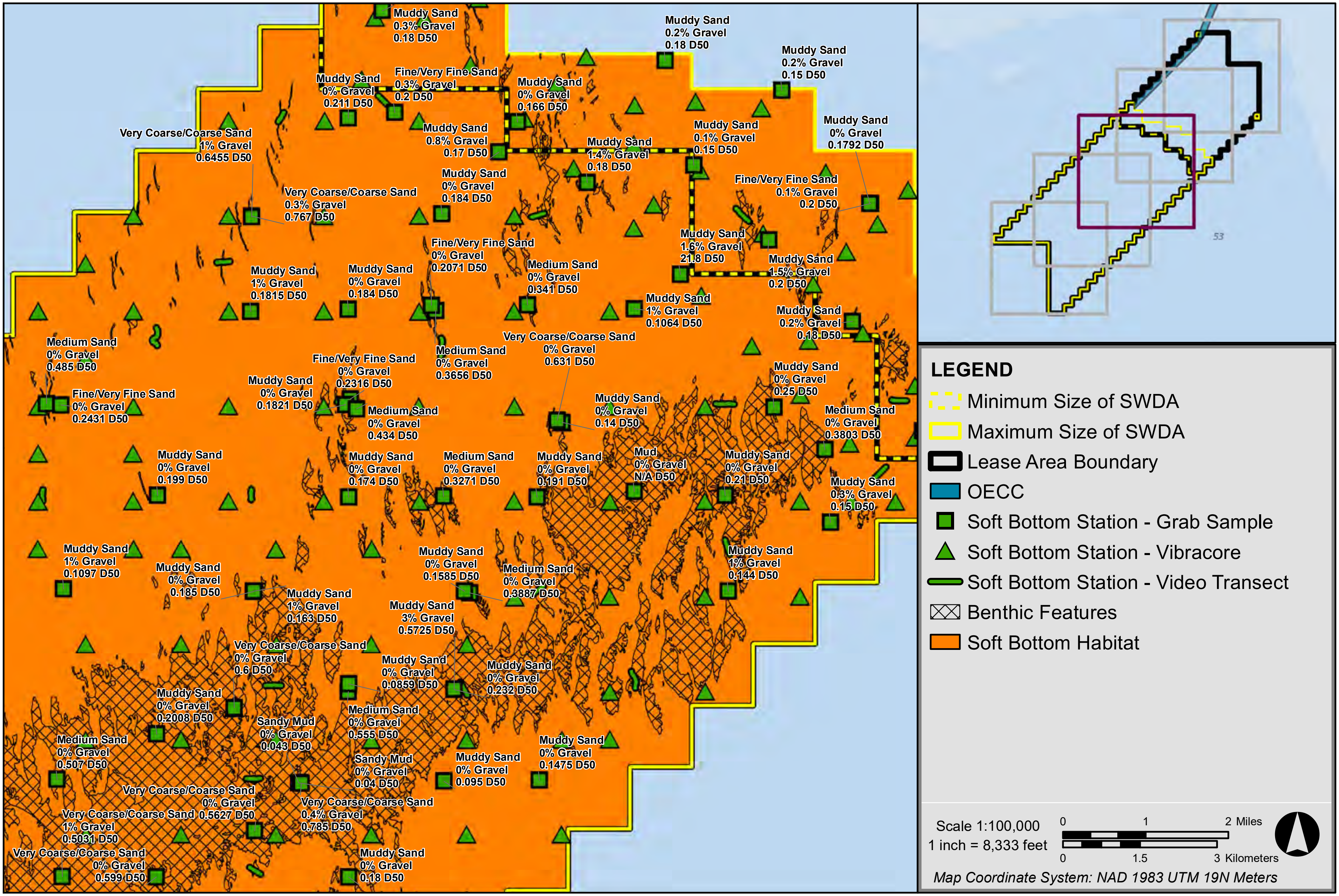
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 2 of 5

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Southern Wind Development Area (SWDA) are at a Scale of 1:100,000.



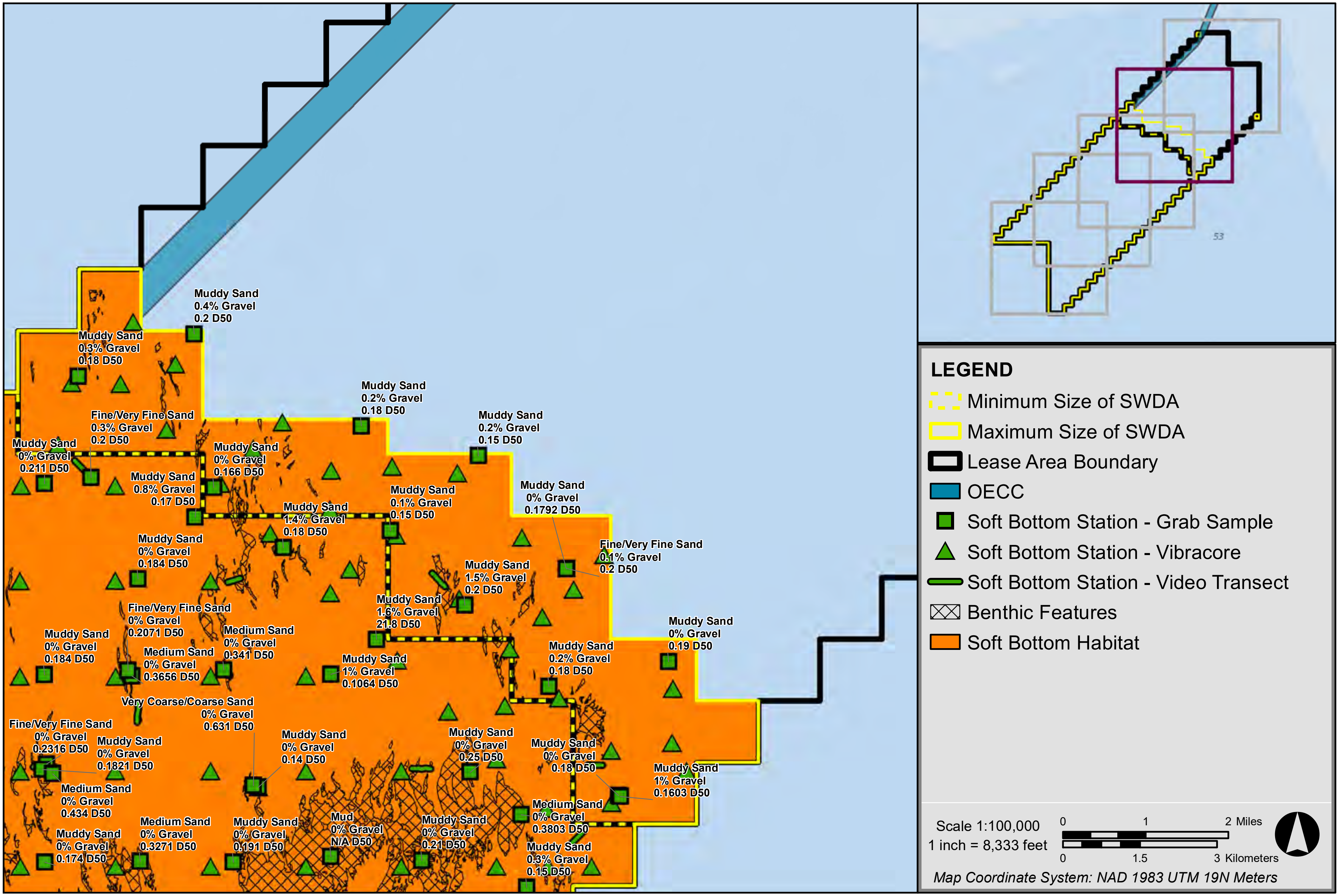
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 3 of 5

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Southern Wind Development Area (SWDA) are at a Scale of 1:100,000.

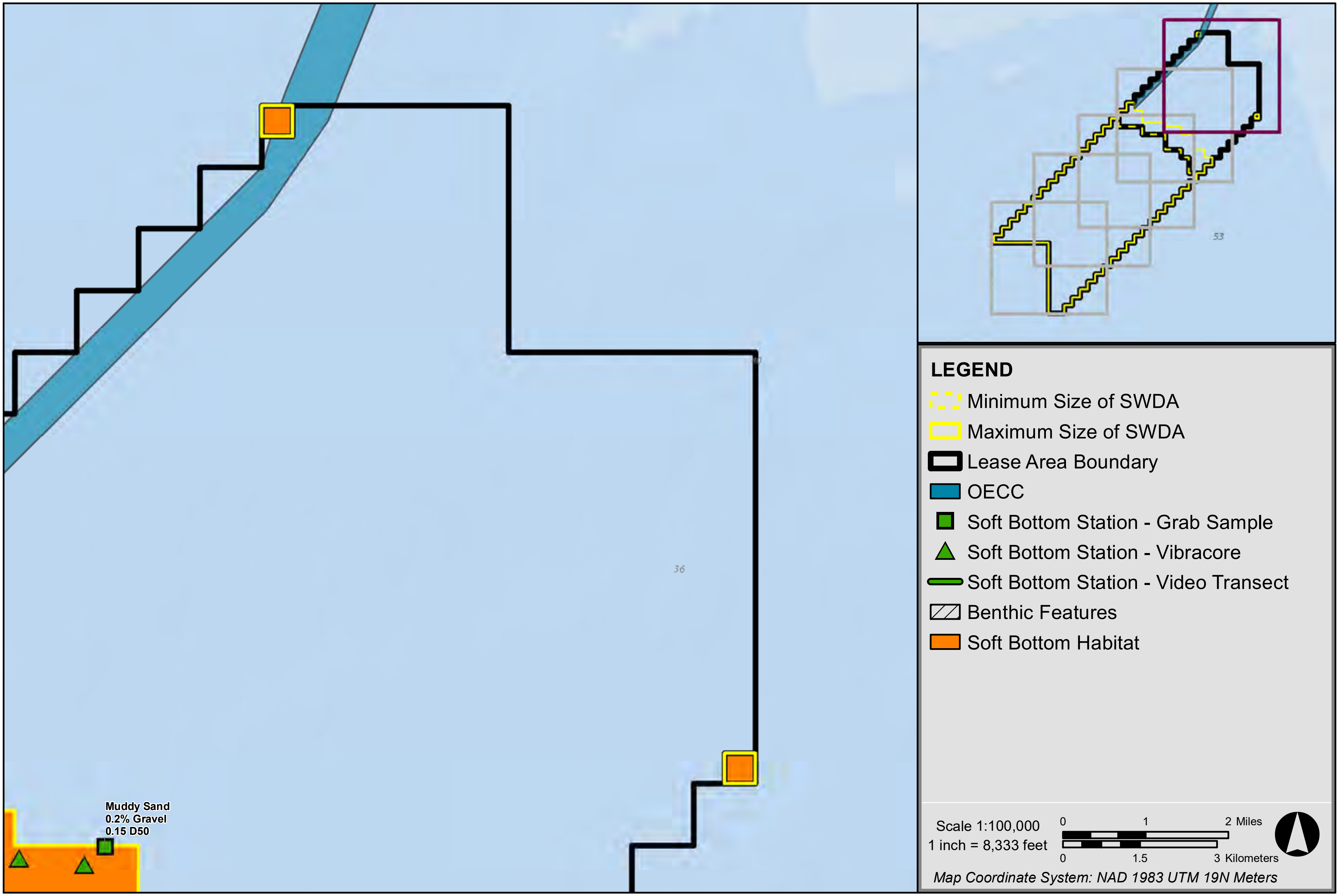


Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind **Figure 4 of 5**

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Southern Wind Development Area (SWDA) are at a Scale of 1:100,000.



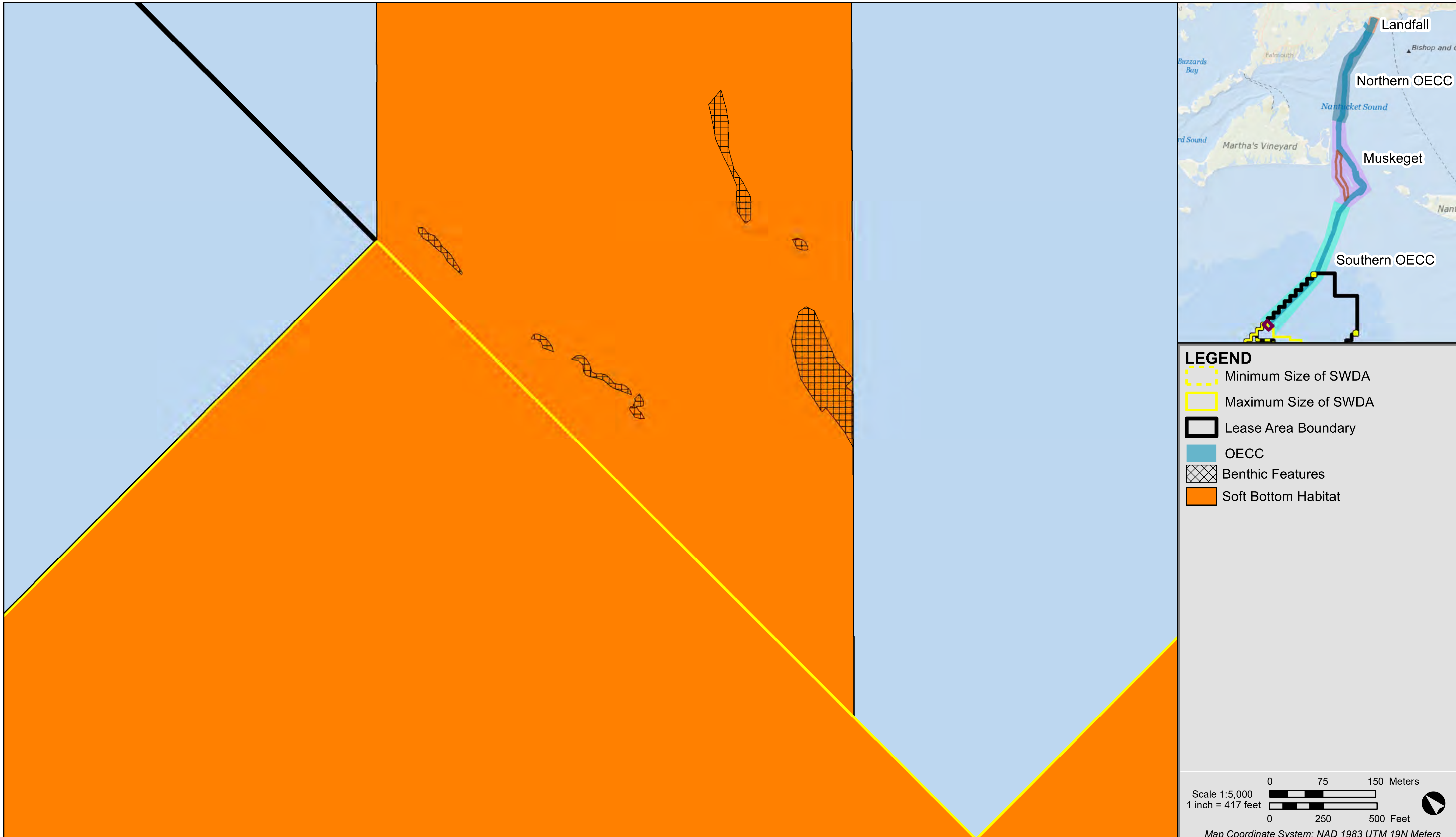
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 5 of 5

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Southern Wind Development Area (SWDA) are at a Scale of 1:100,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 1 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.

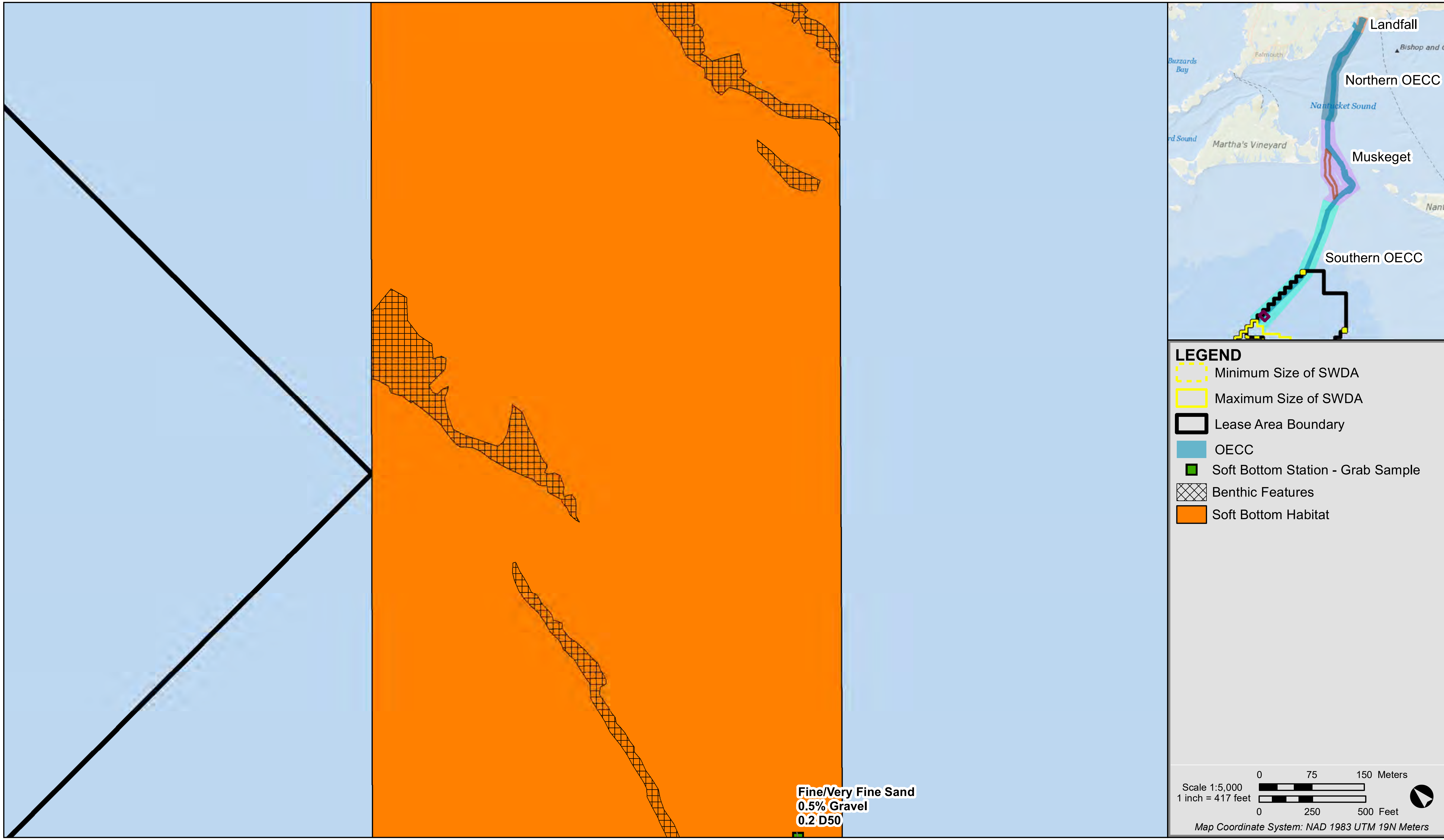
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 2 of 90

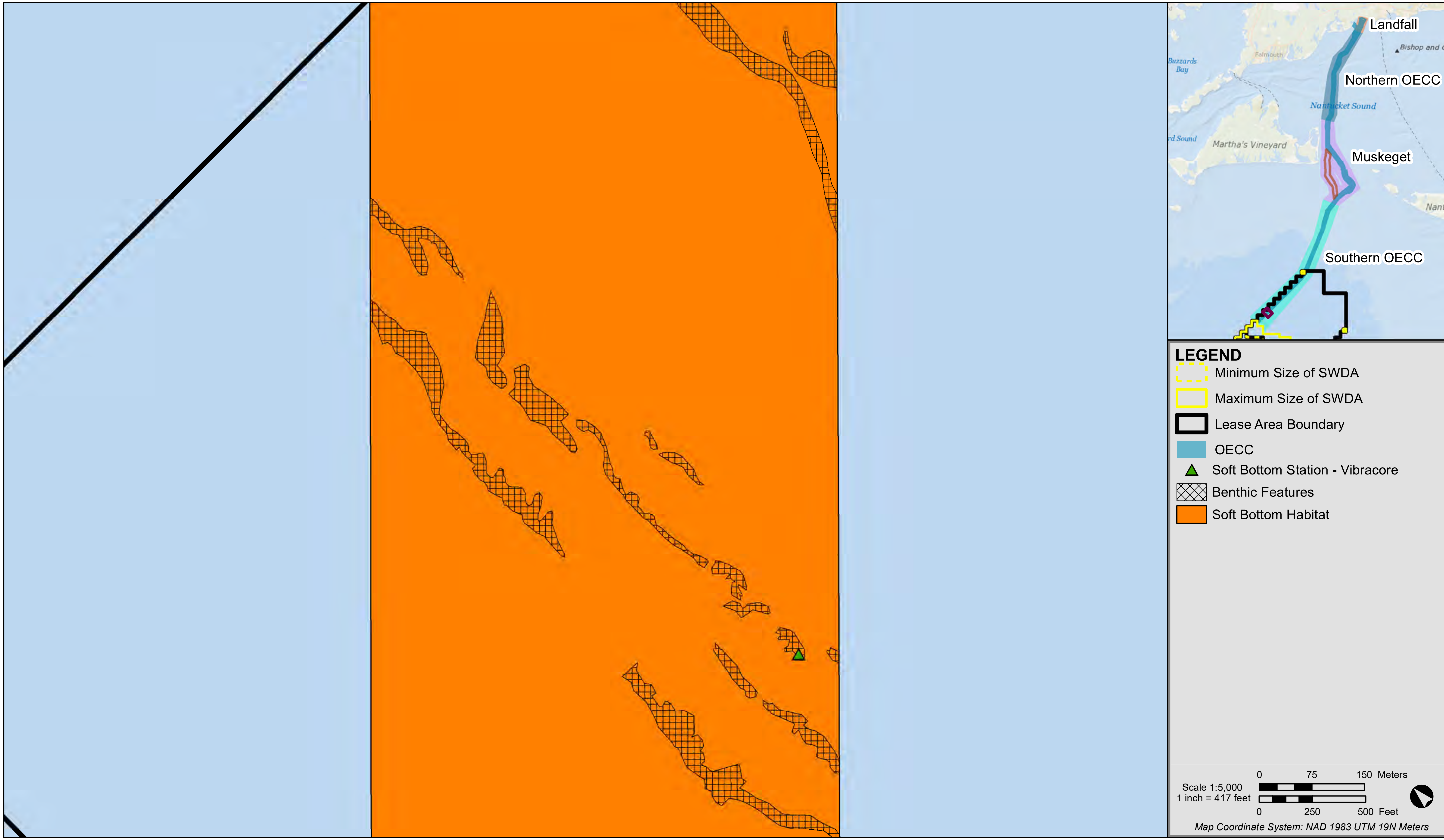
Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

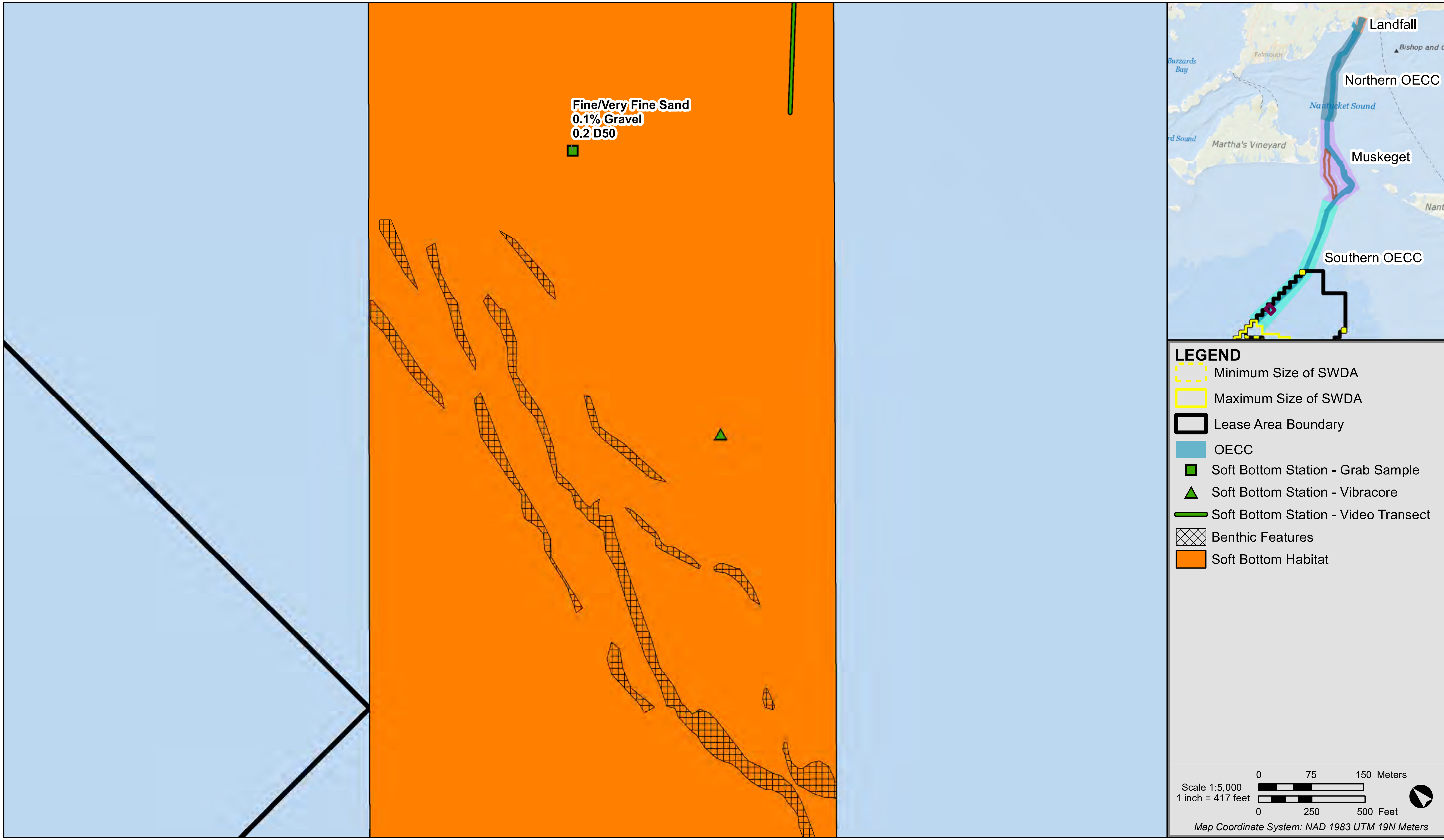
Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

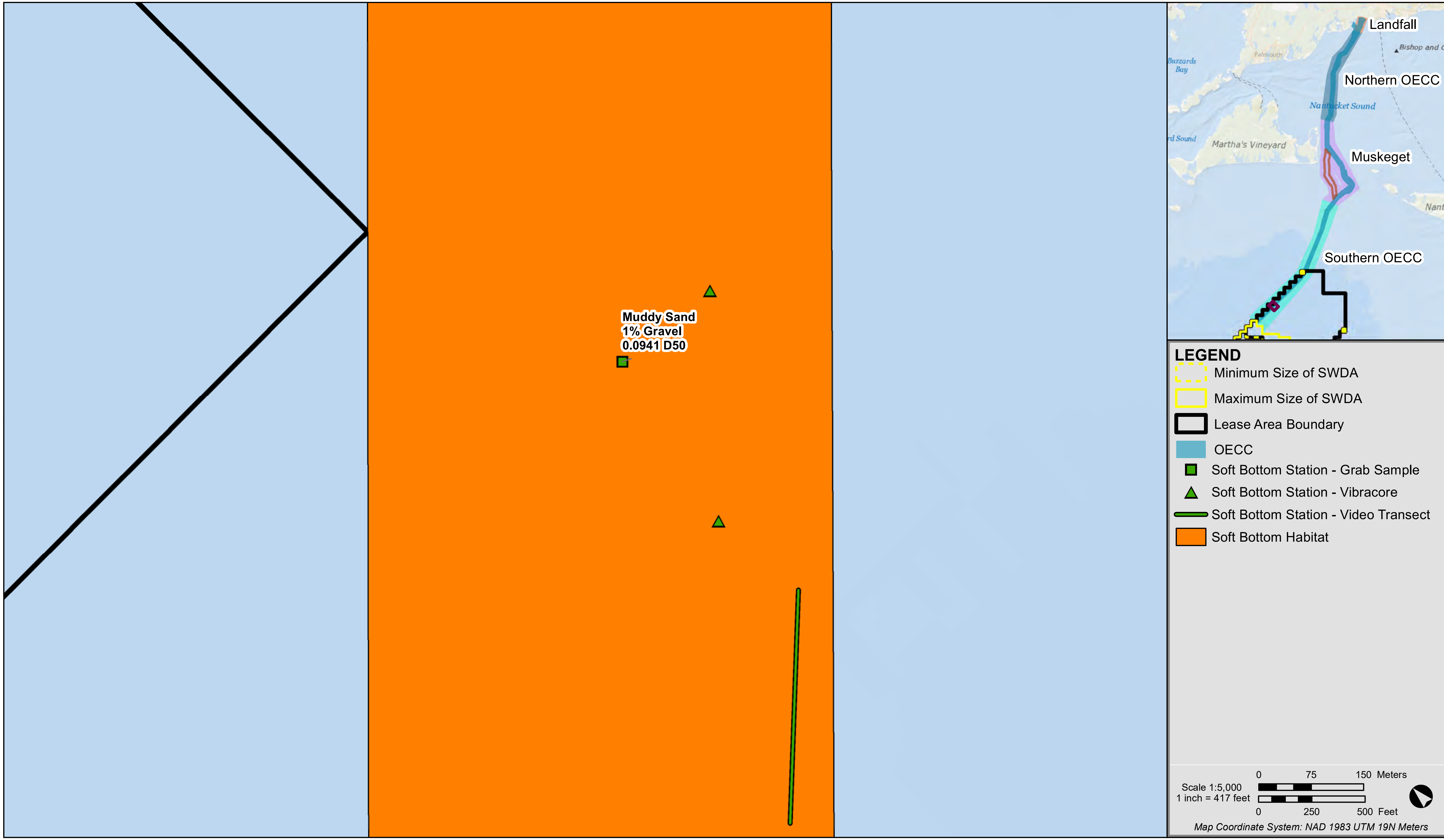
Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

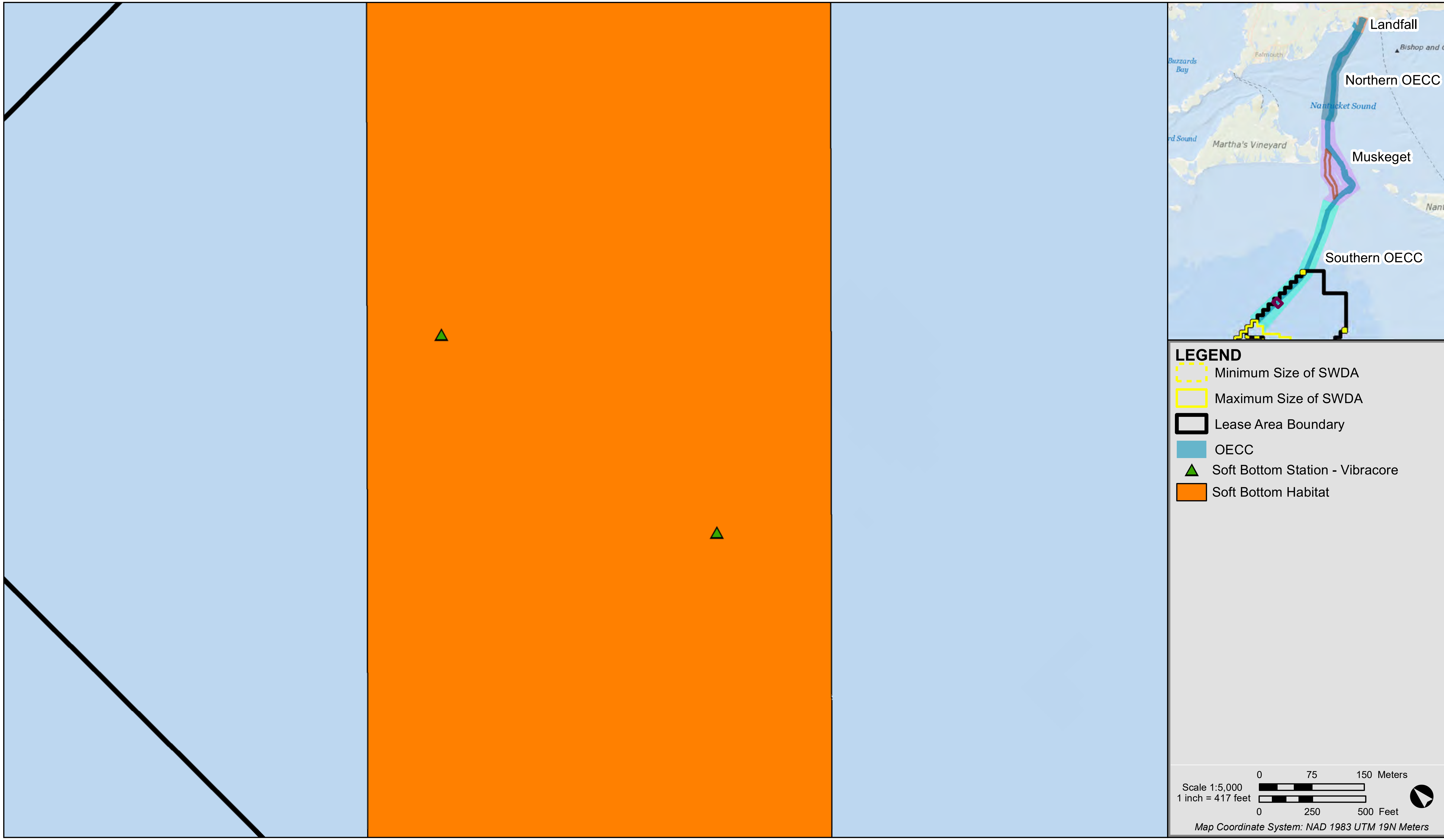
Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

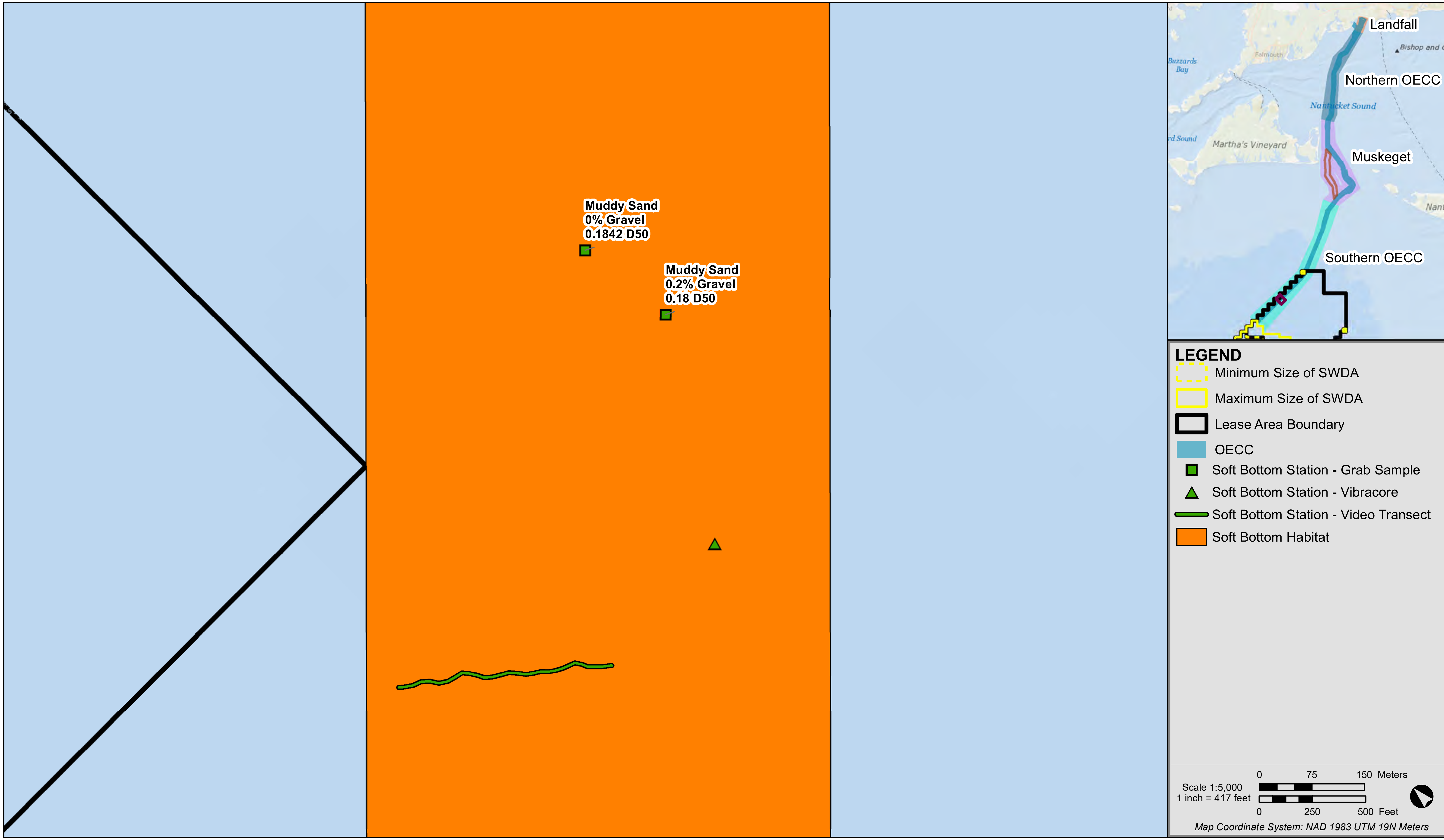
Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021).
Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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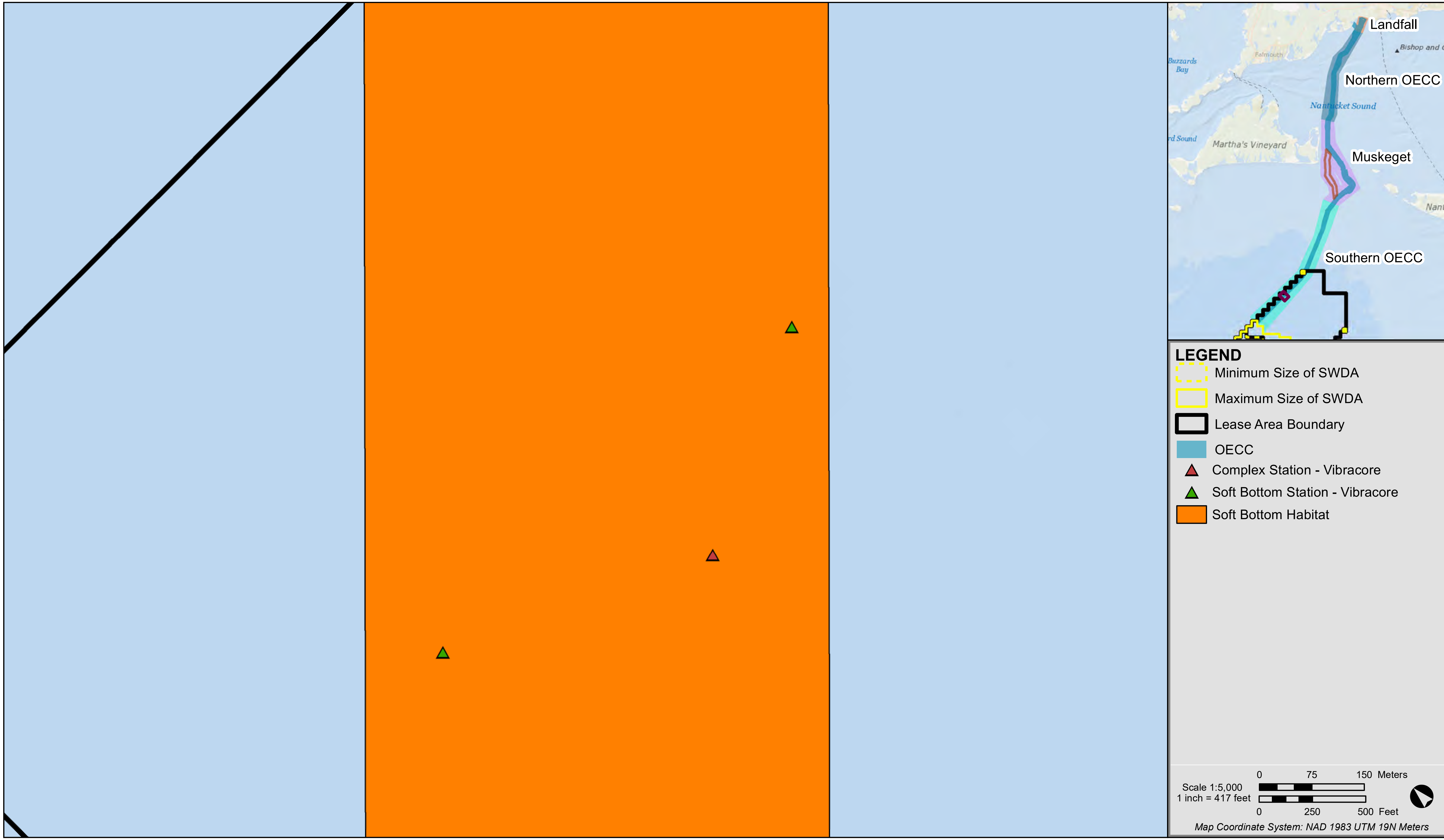

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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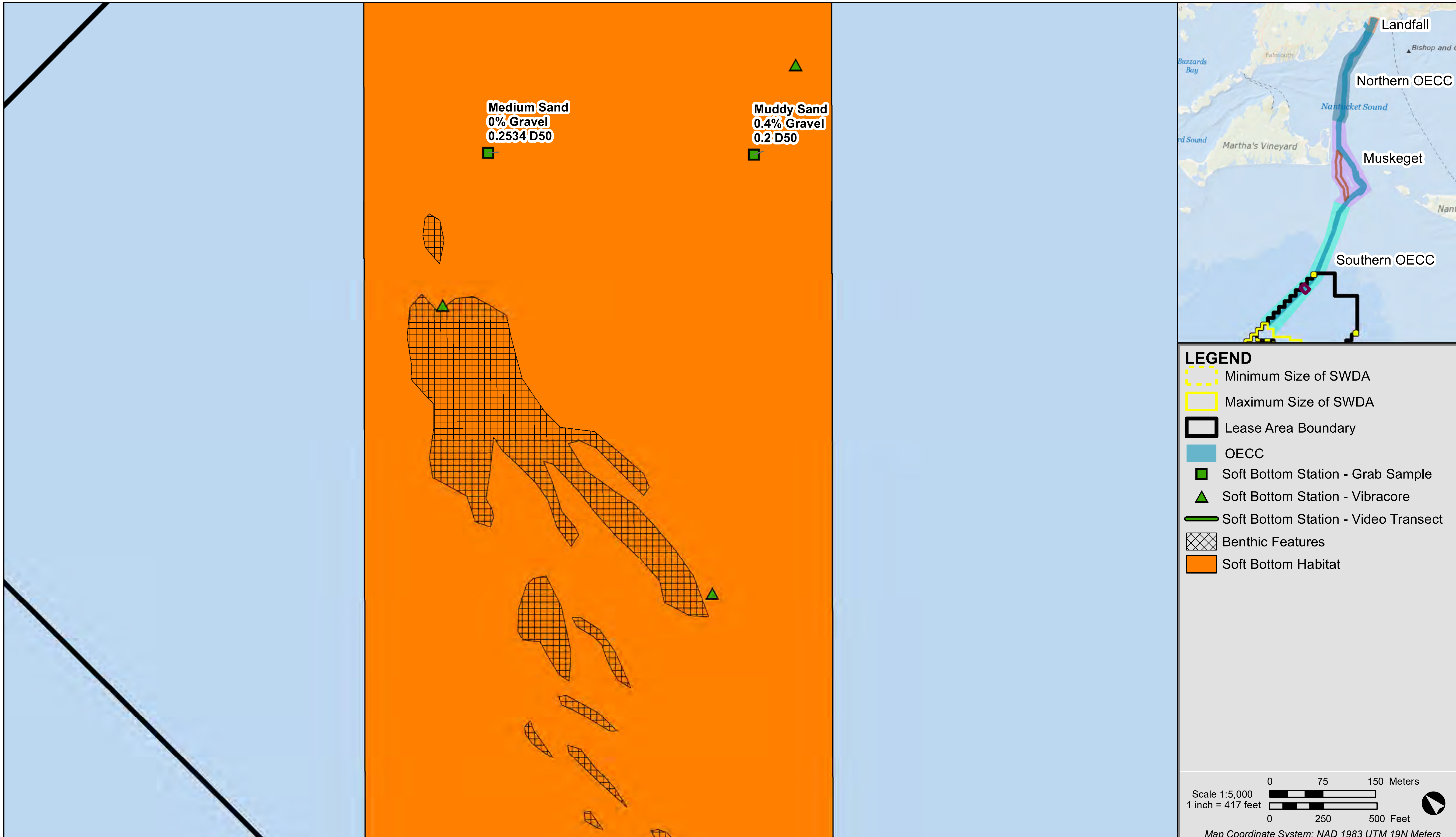

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 13 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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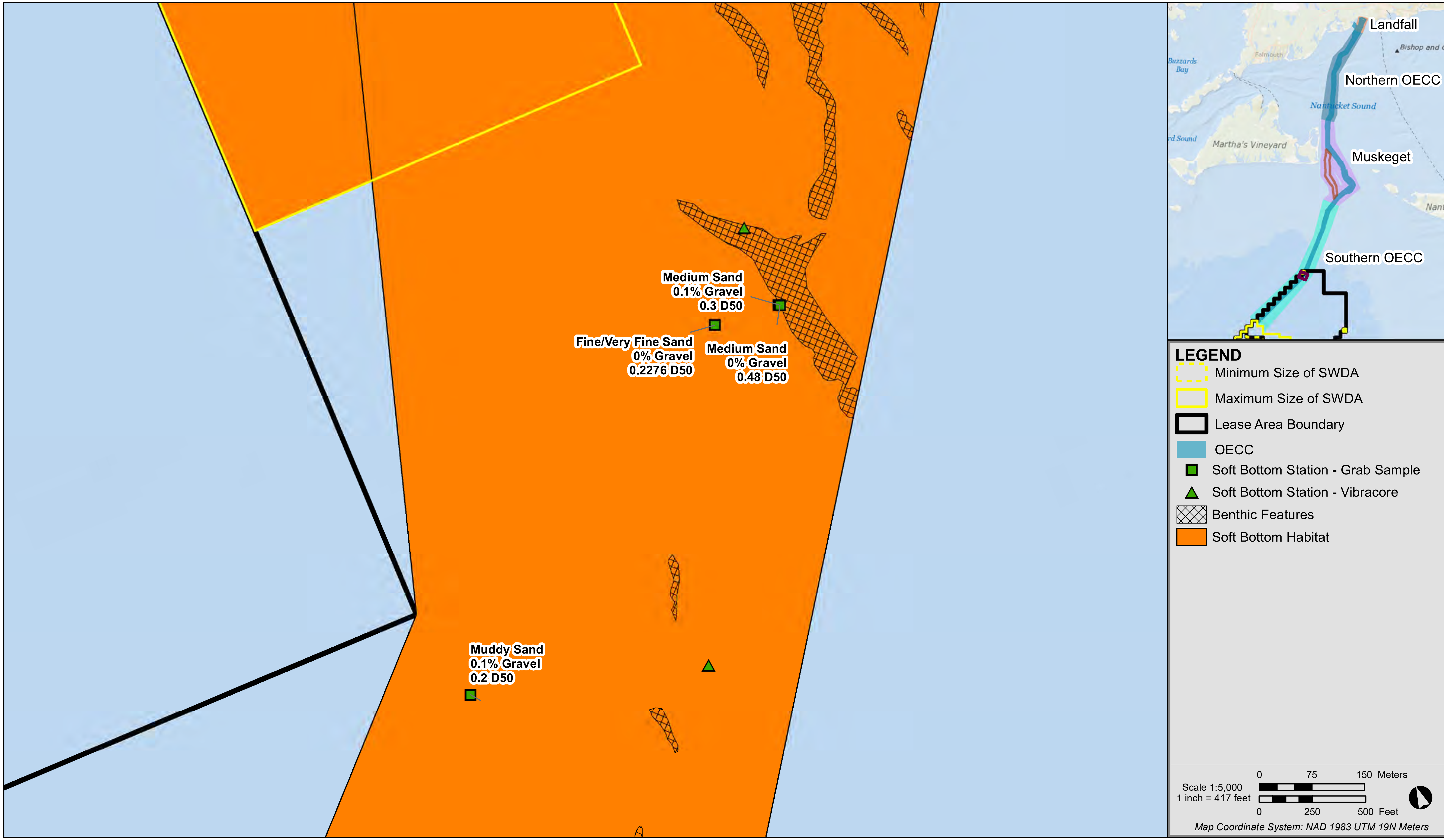

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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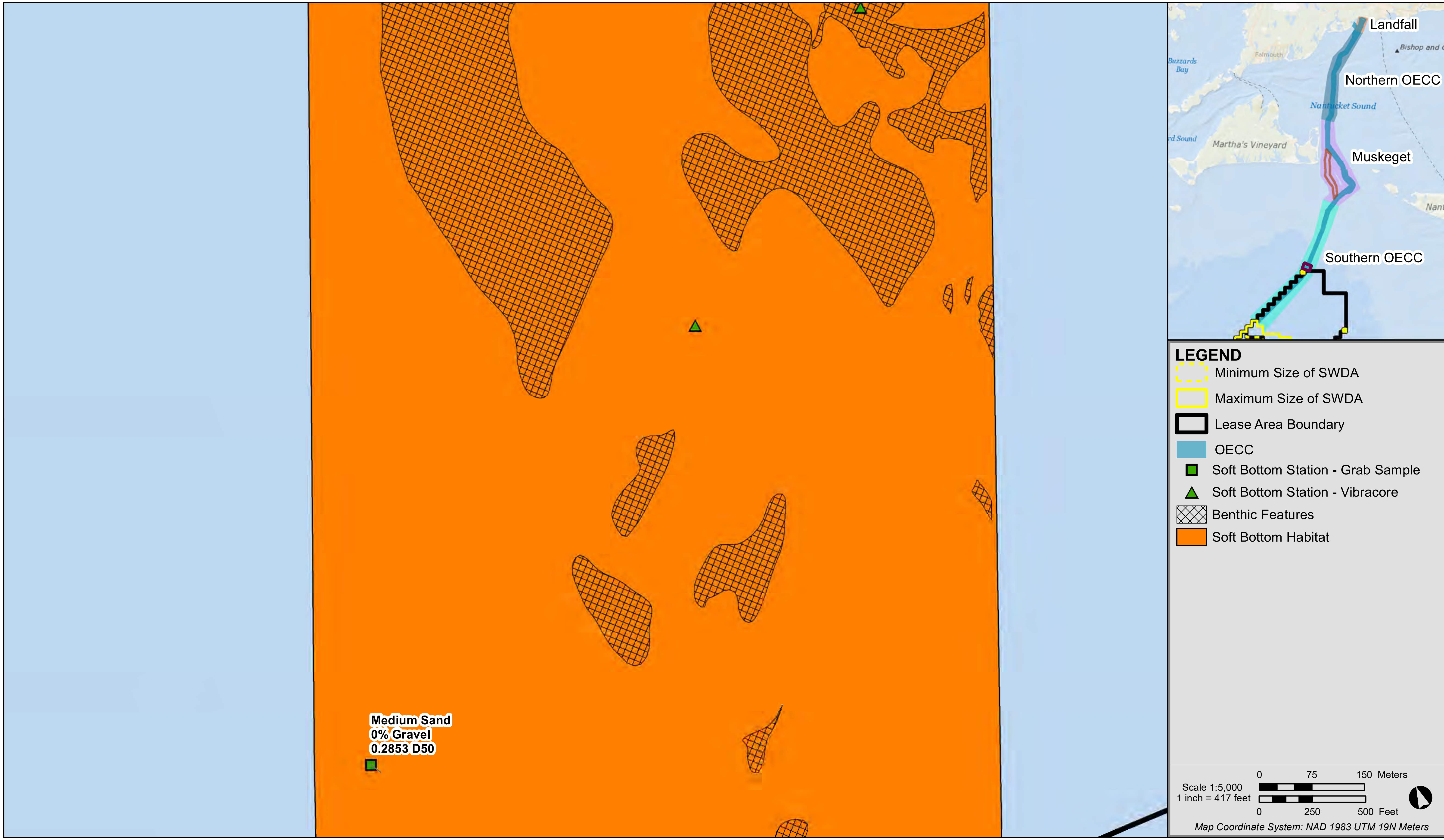

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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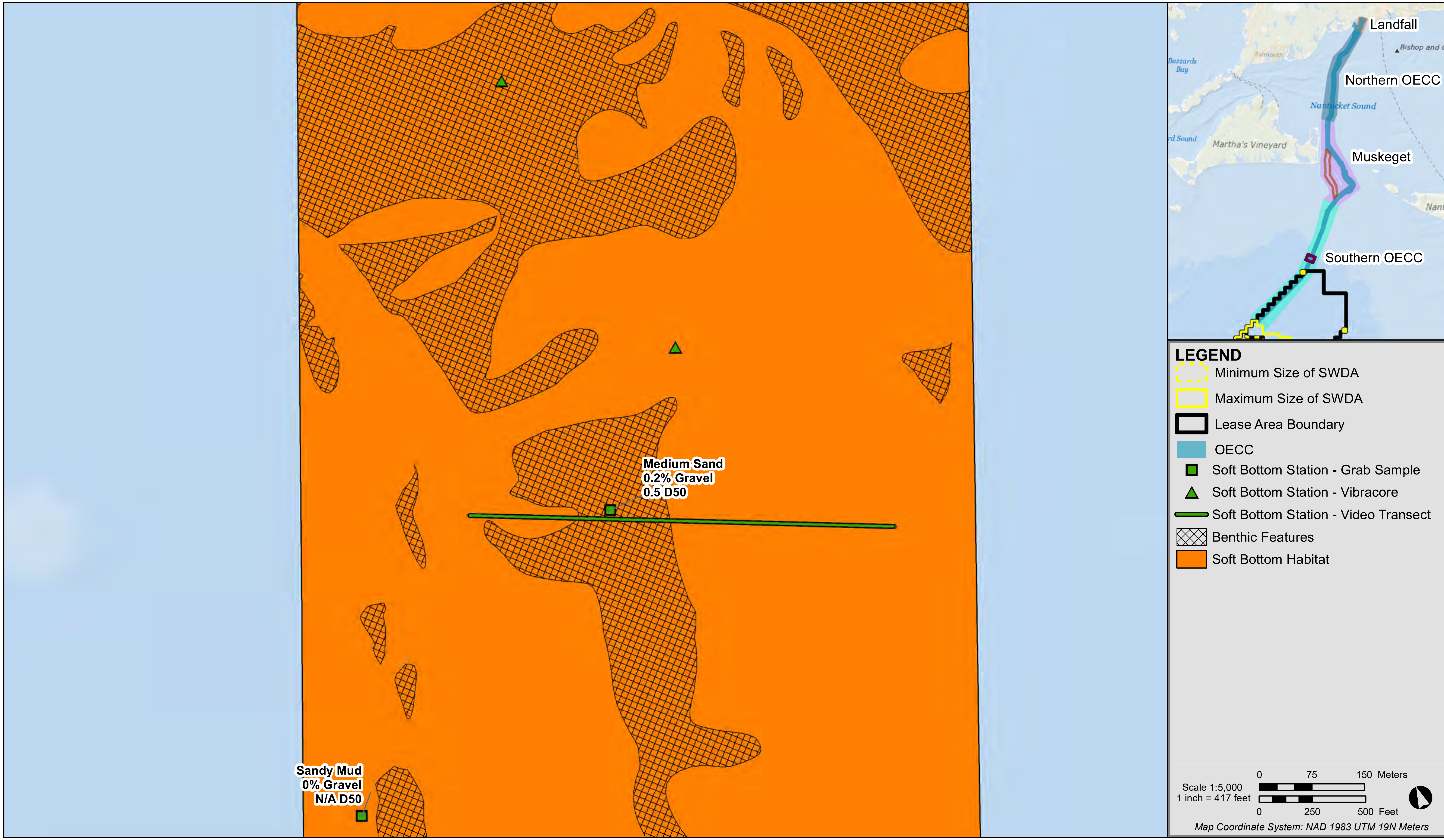

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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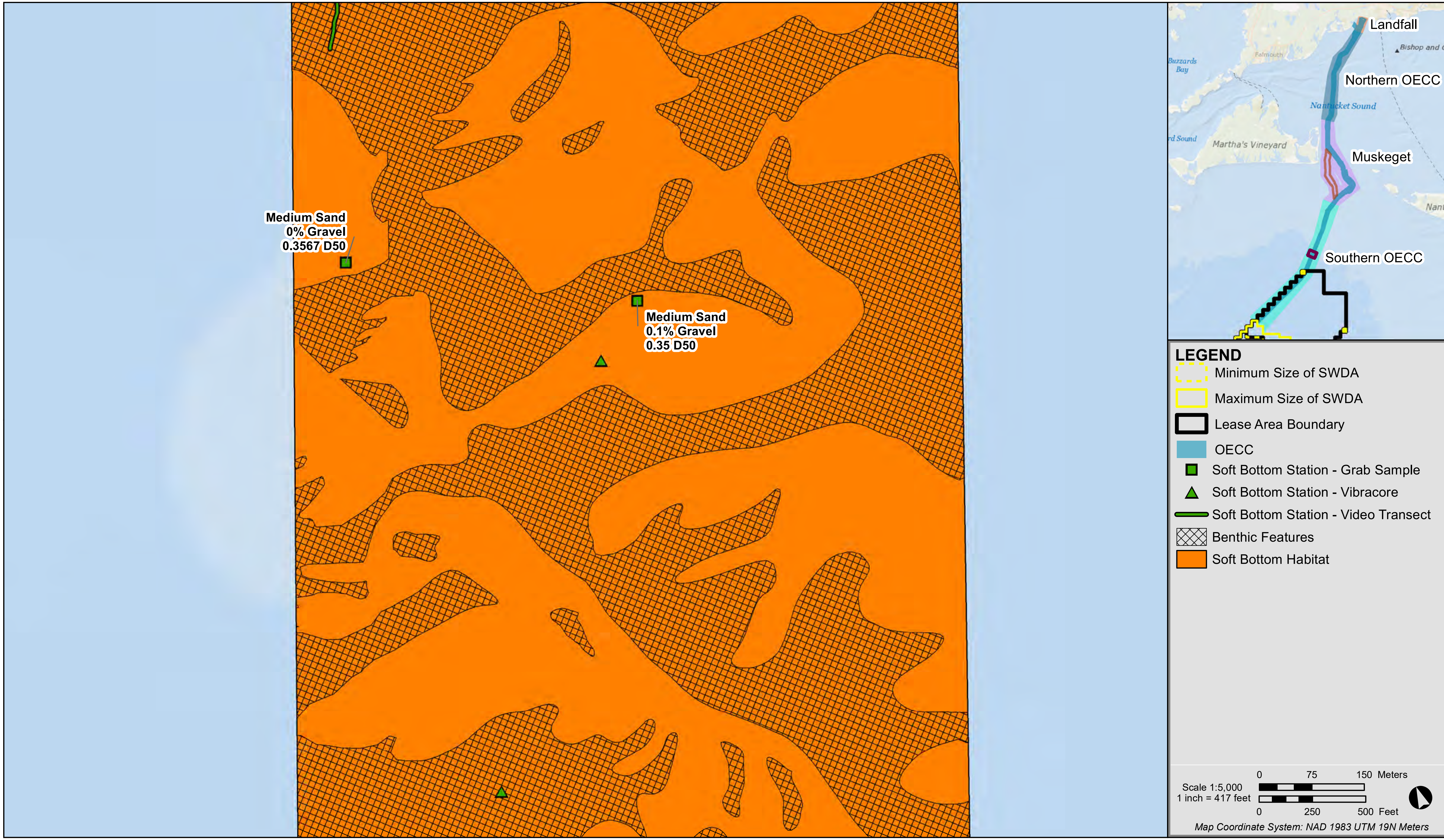

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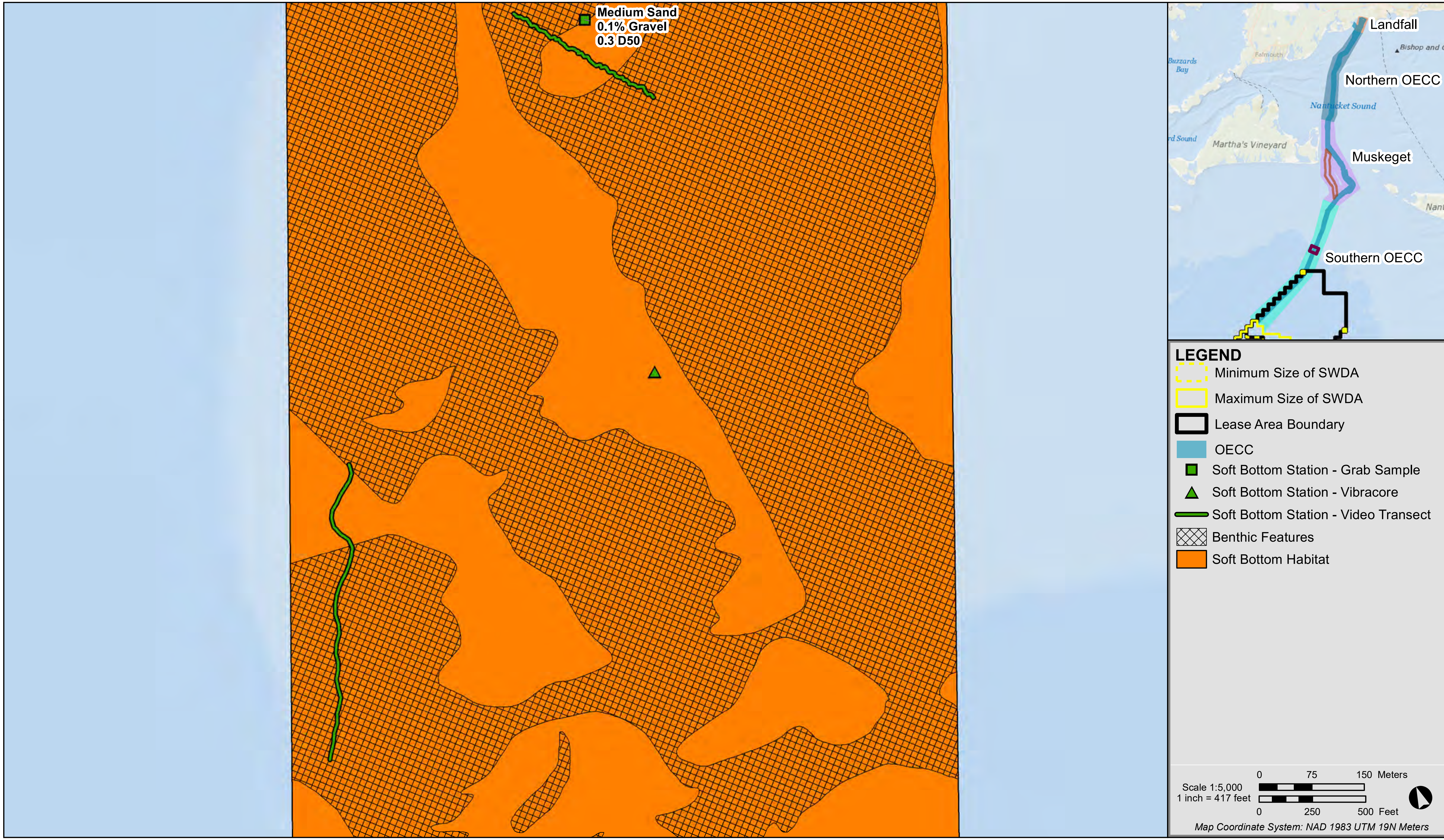


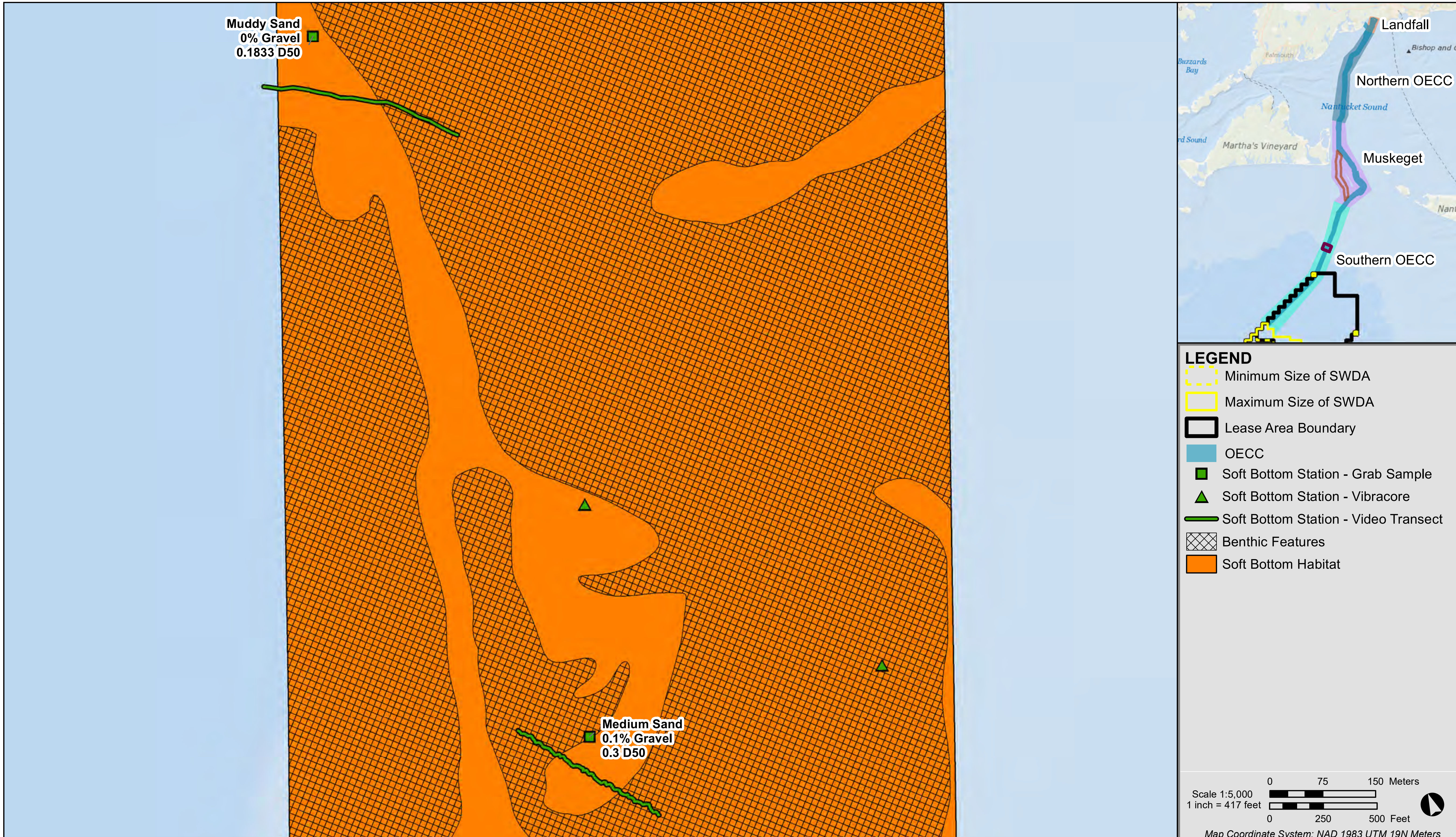
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 21 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.

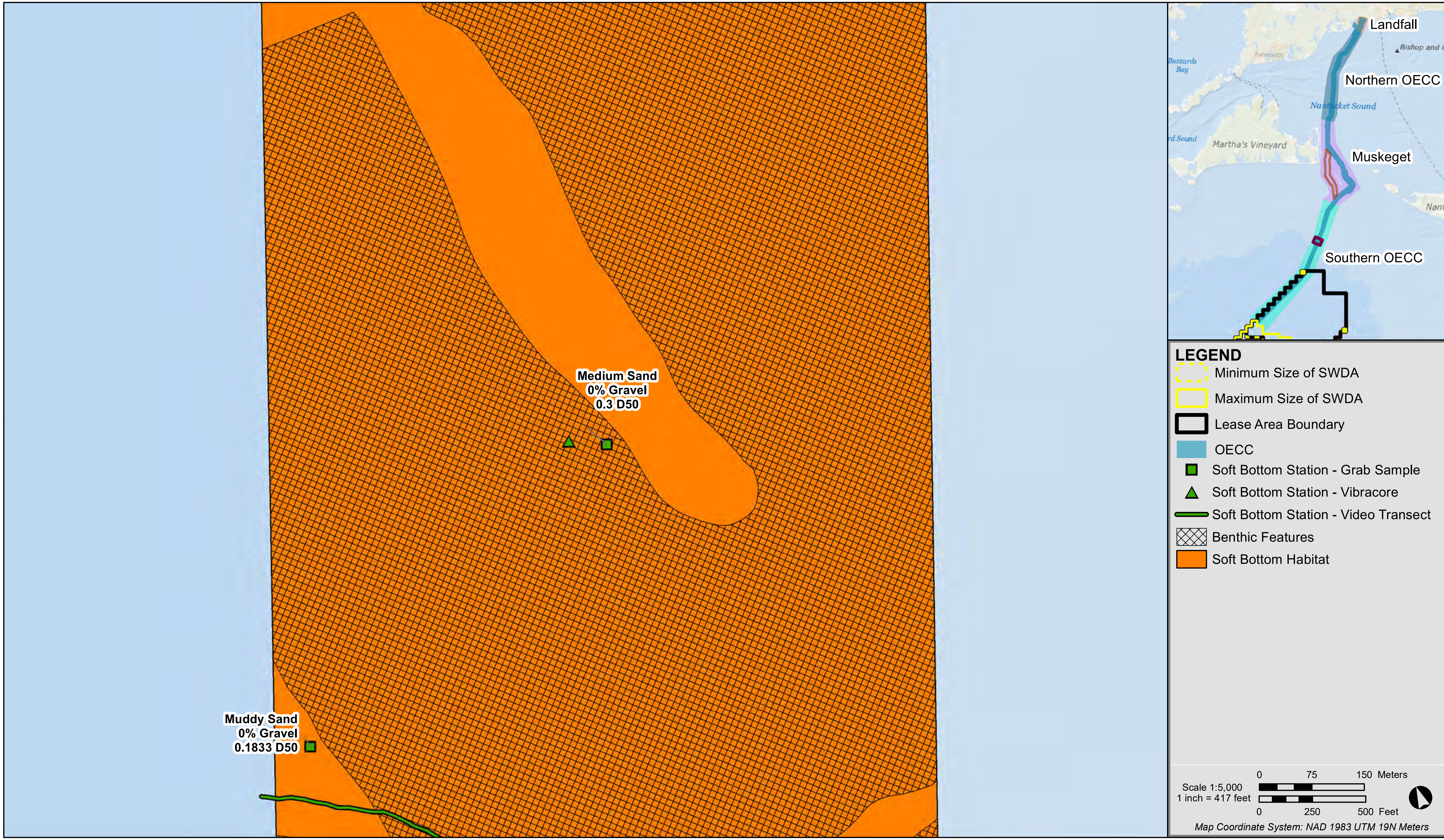


Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

Figure 22 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.

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No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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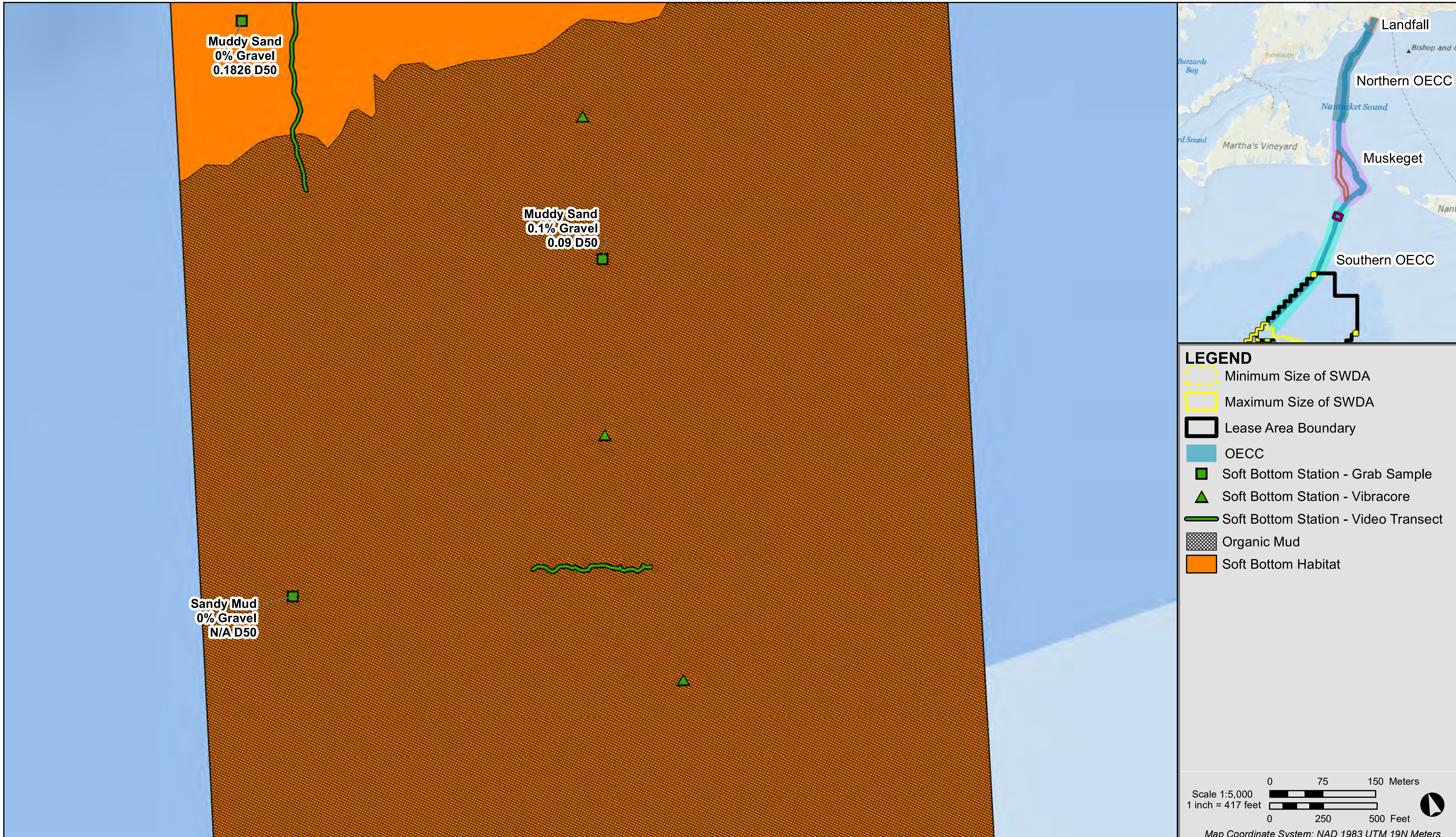

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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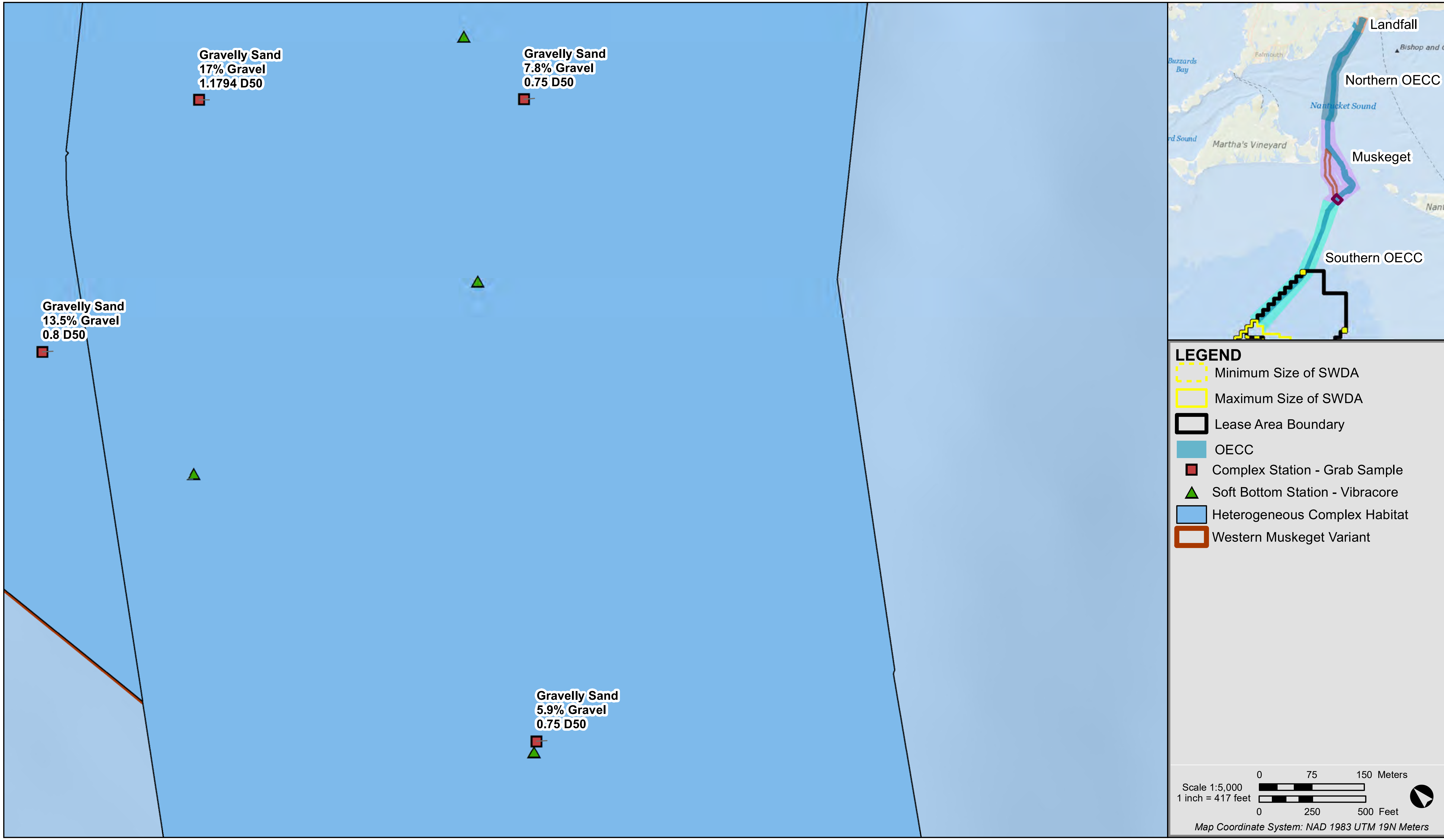
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 32 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021).
Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



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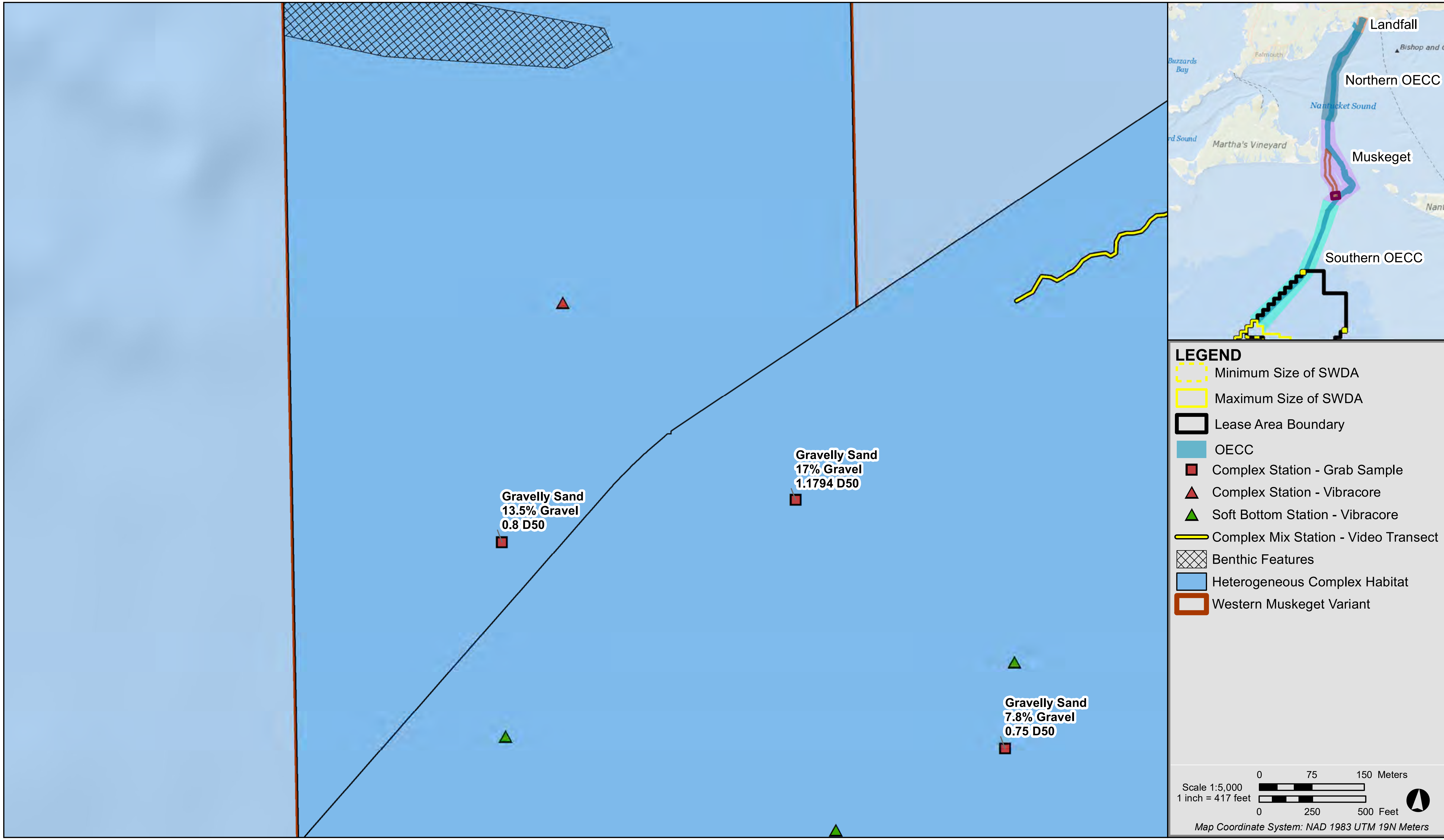

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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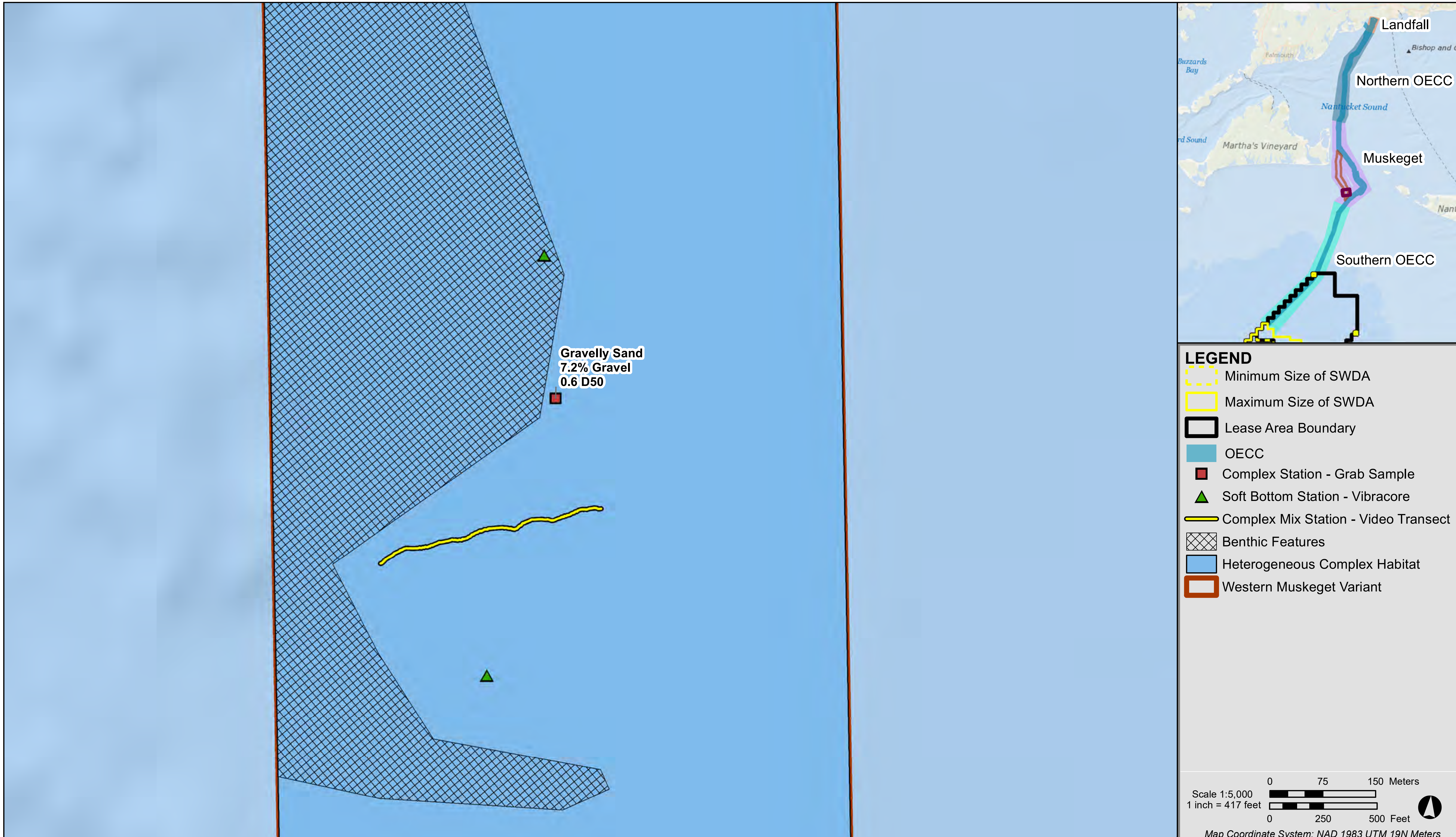
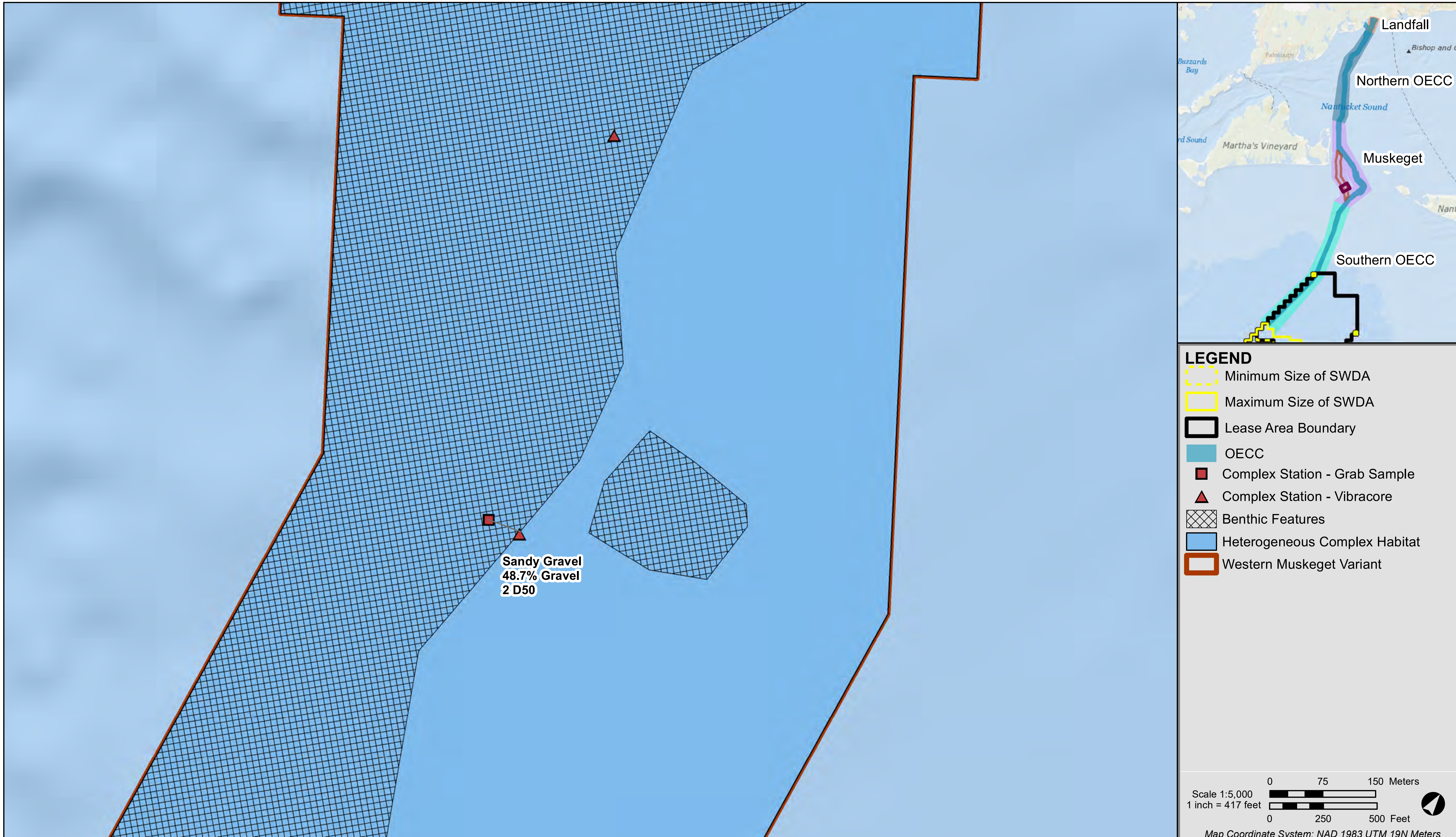


Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

Figure 35 of 90

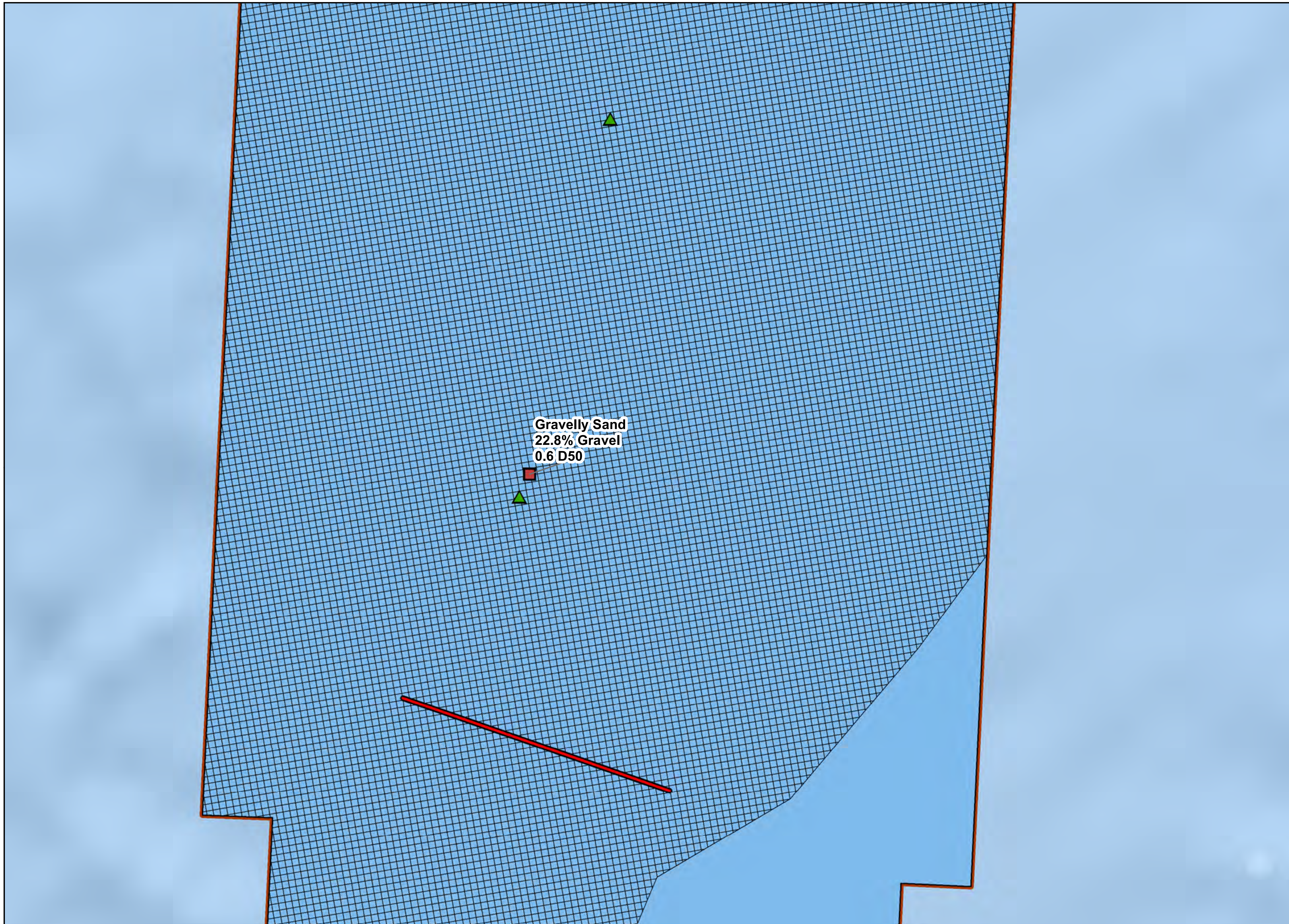
Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021).
Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.

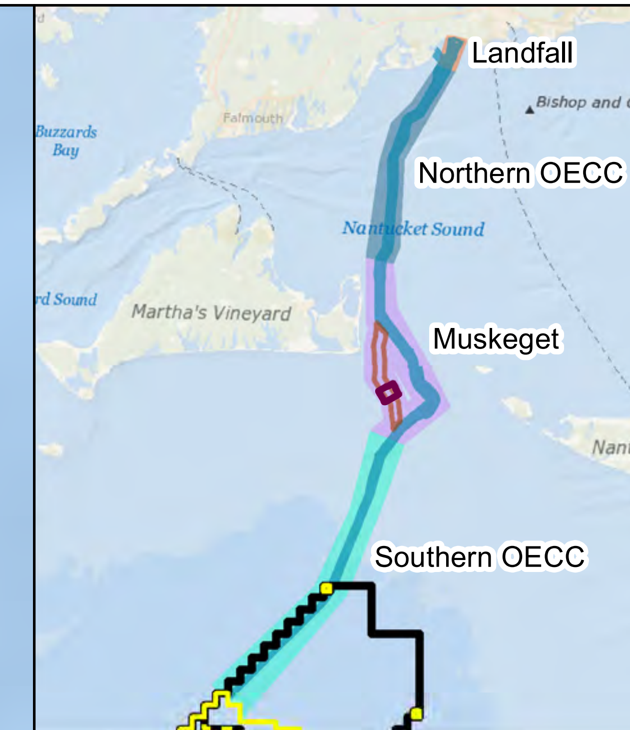


Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.





LEGEND

- Minimum Size of SWDA
- Maximum Size of SWDA
- Lease Area Boundary
- OECC
- Complex Station - Grab Sample
- Soft Bottom Station - Vibracore
- Complex Station - Video Transect
- Benthic Features
- Heterogeneous Complex Habitat
- Western Muskeget Variant

Scale 1:5,000
1 inch = 417 feet

0 75 150 Meters

0 250 500 Feet

Map Coordinate System: NAD 1983 UTM 19N Meters

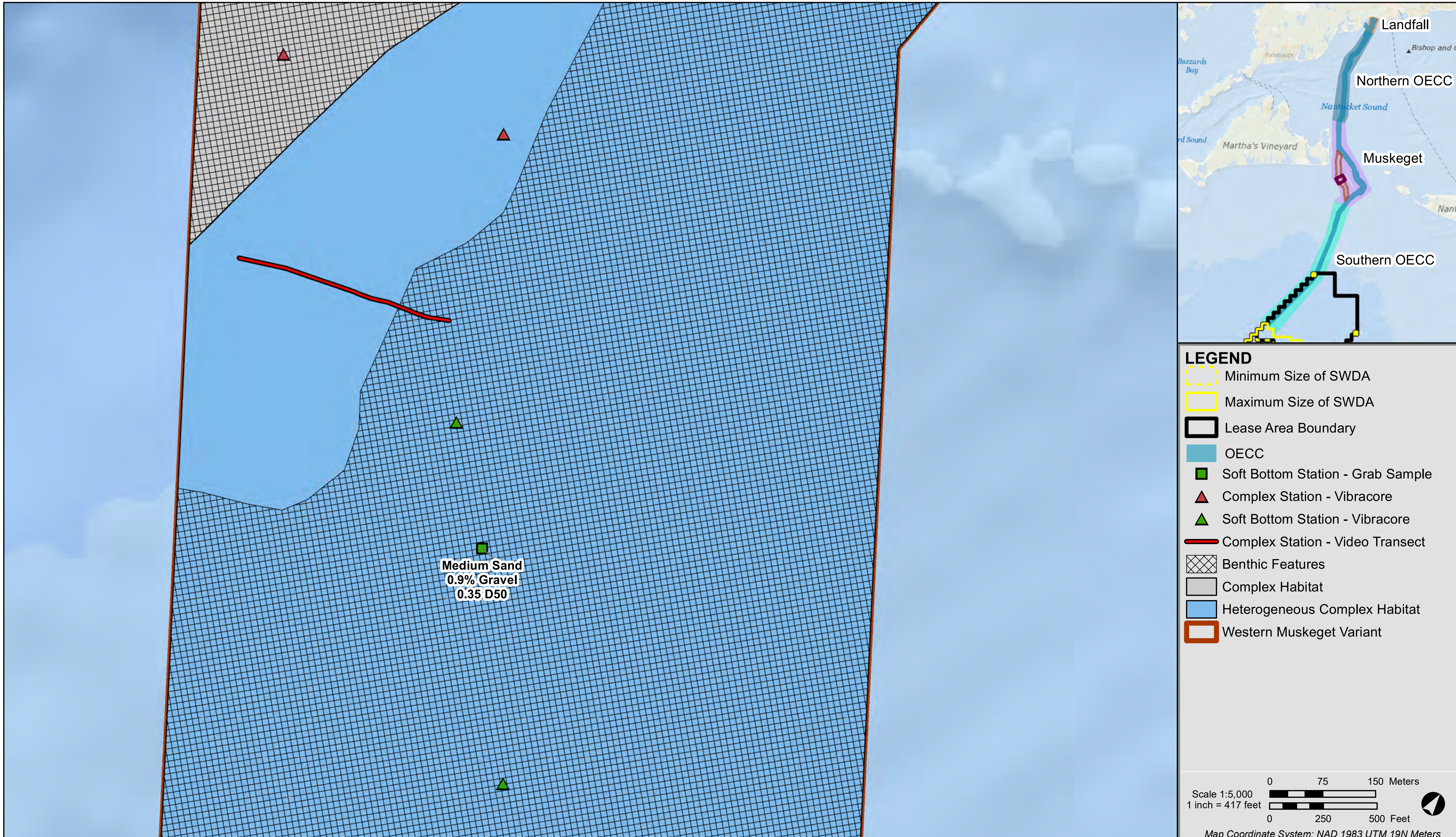
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 37 of 90

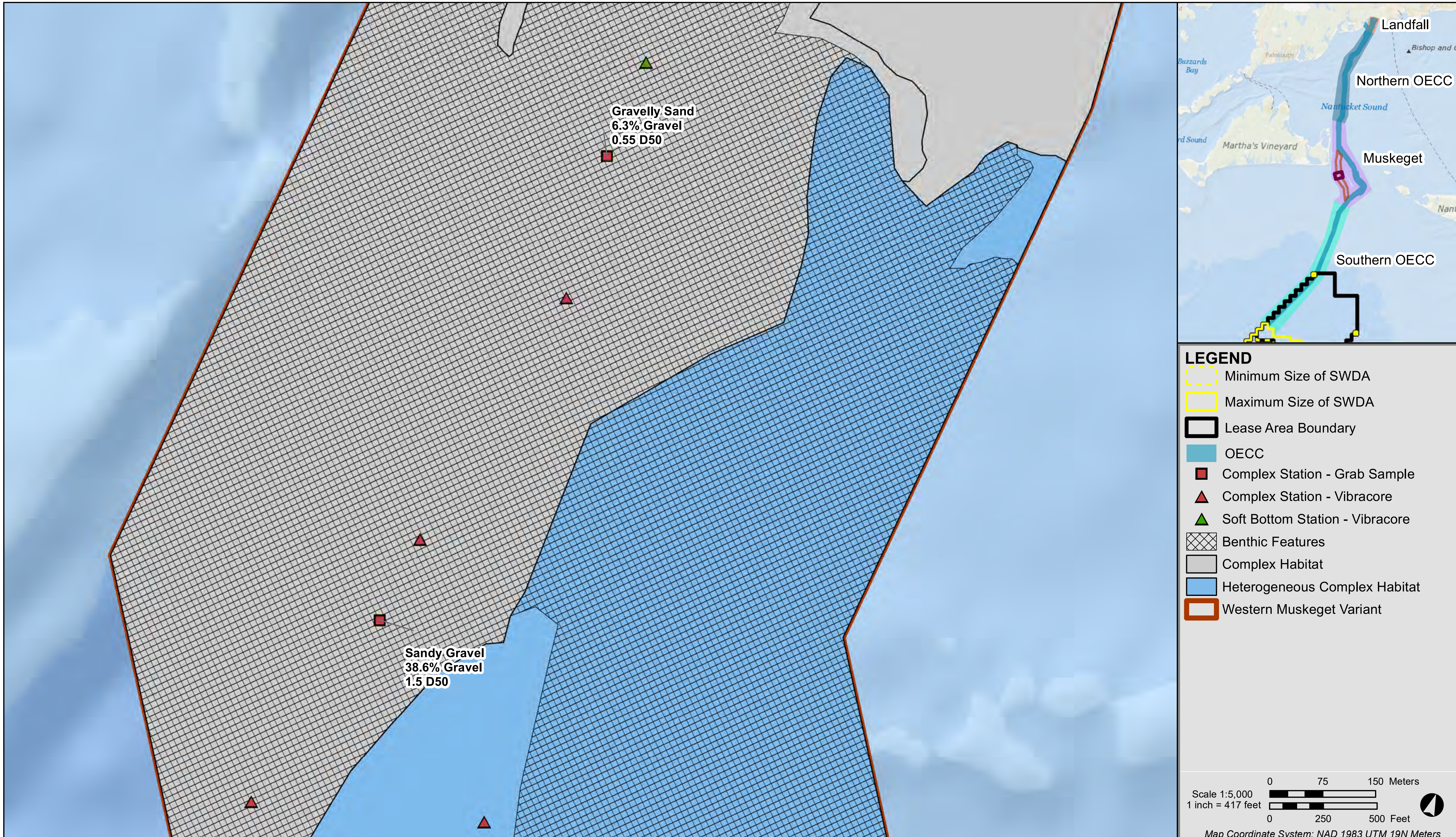
Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

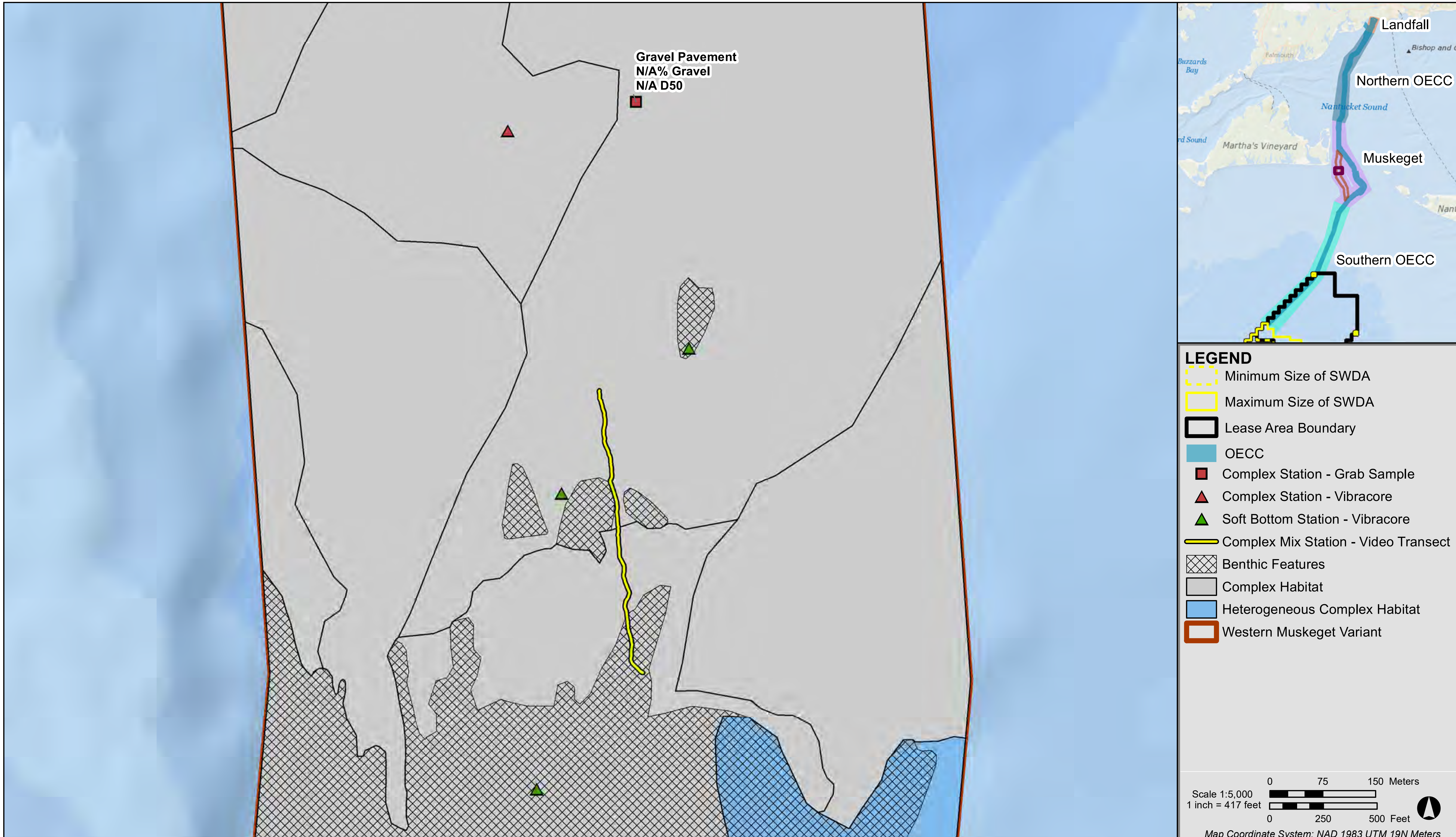
Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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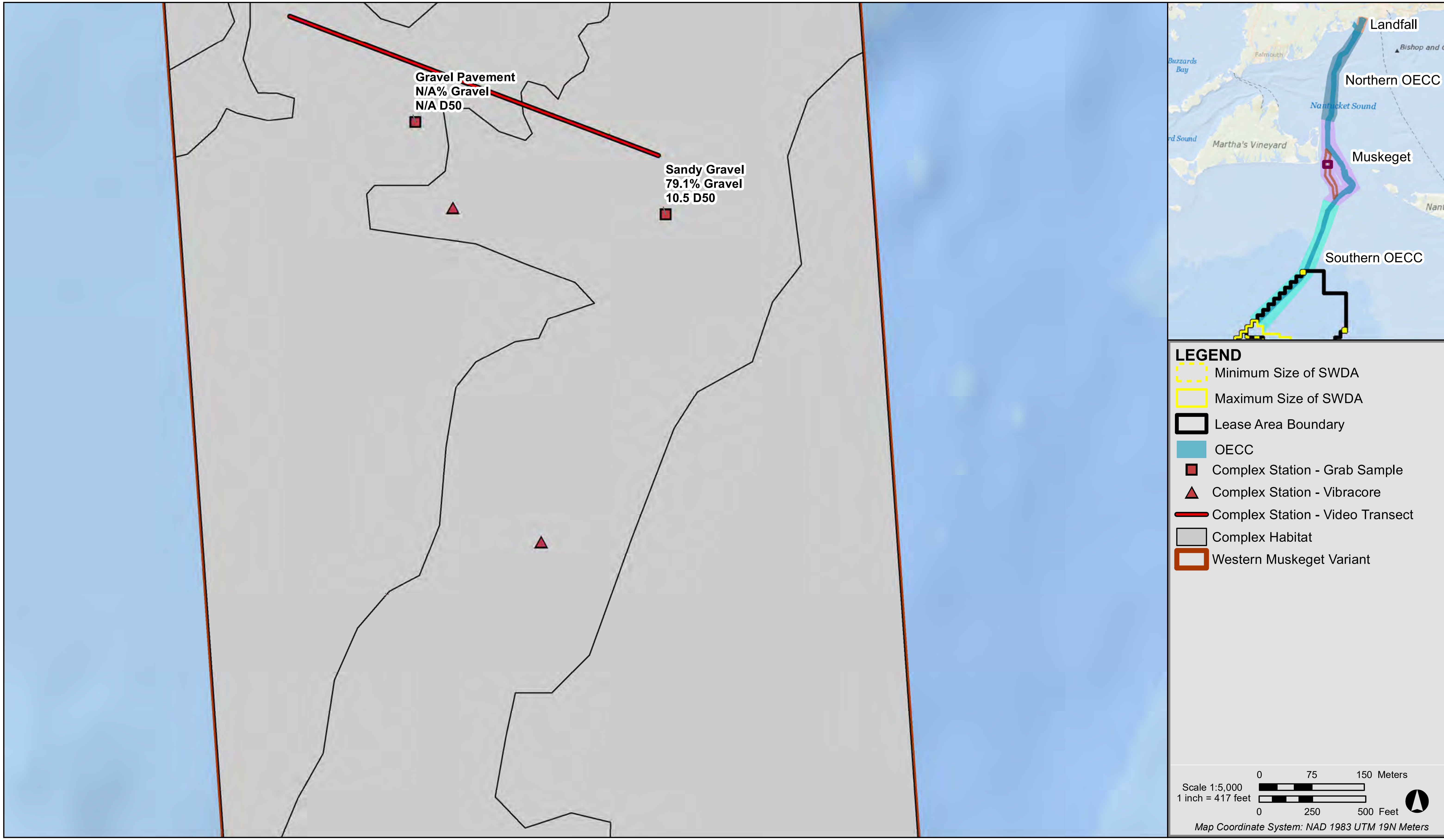

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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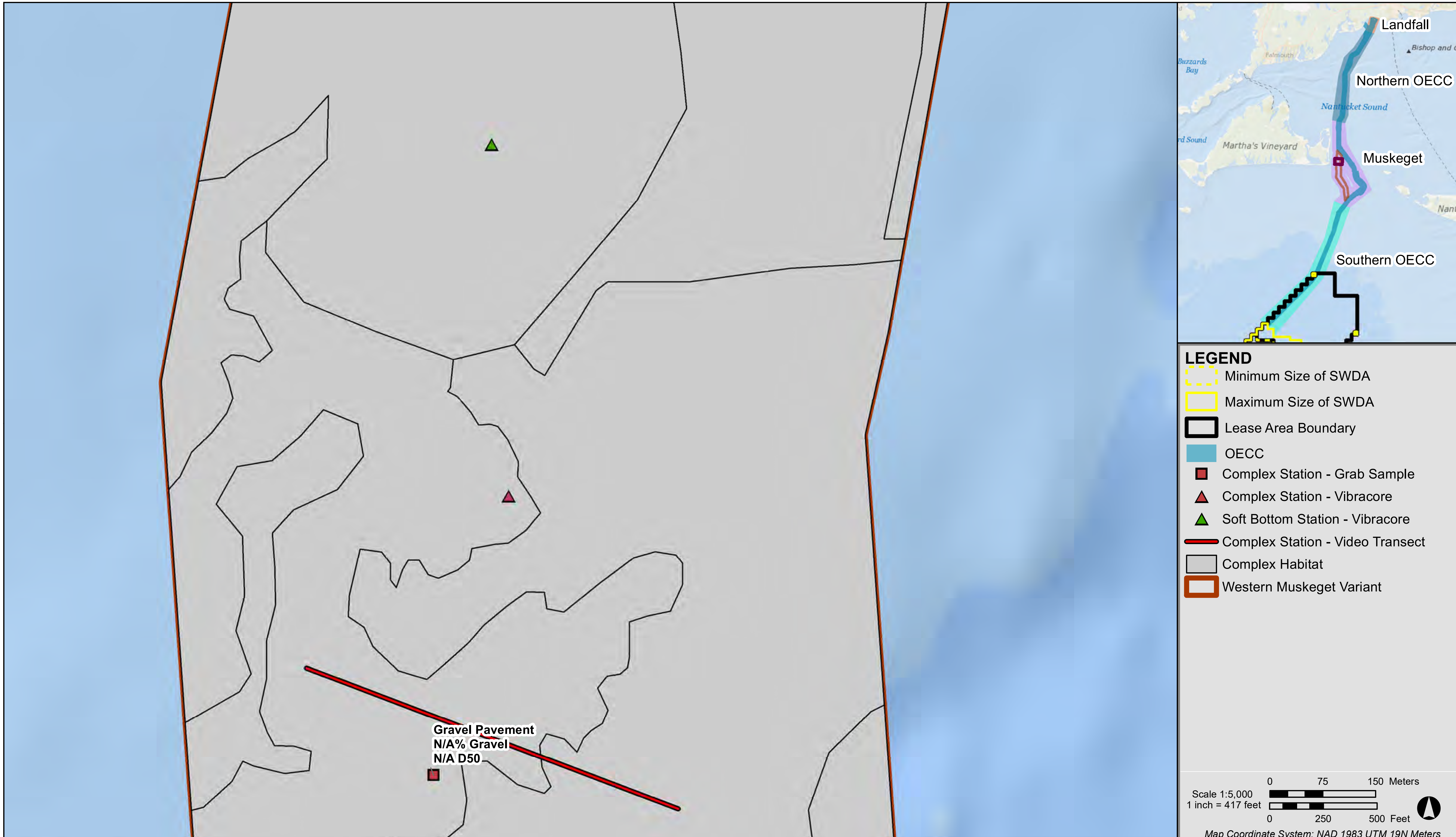

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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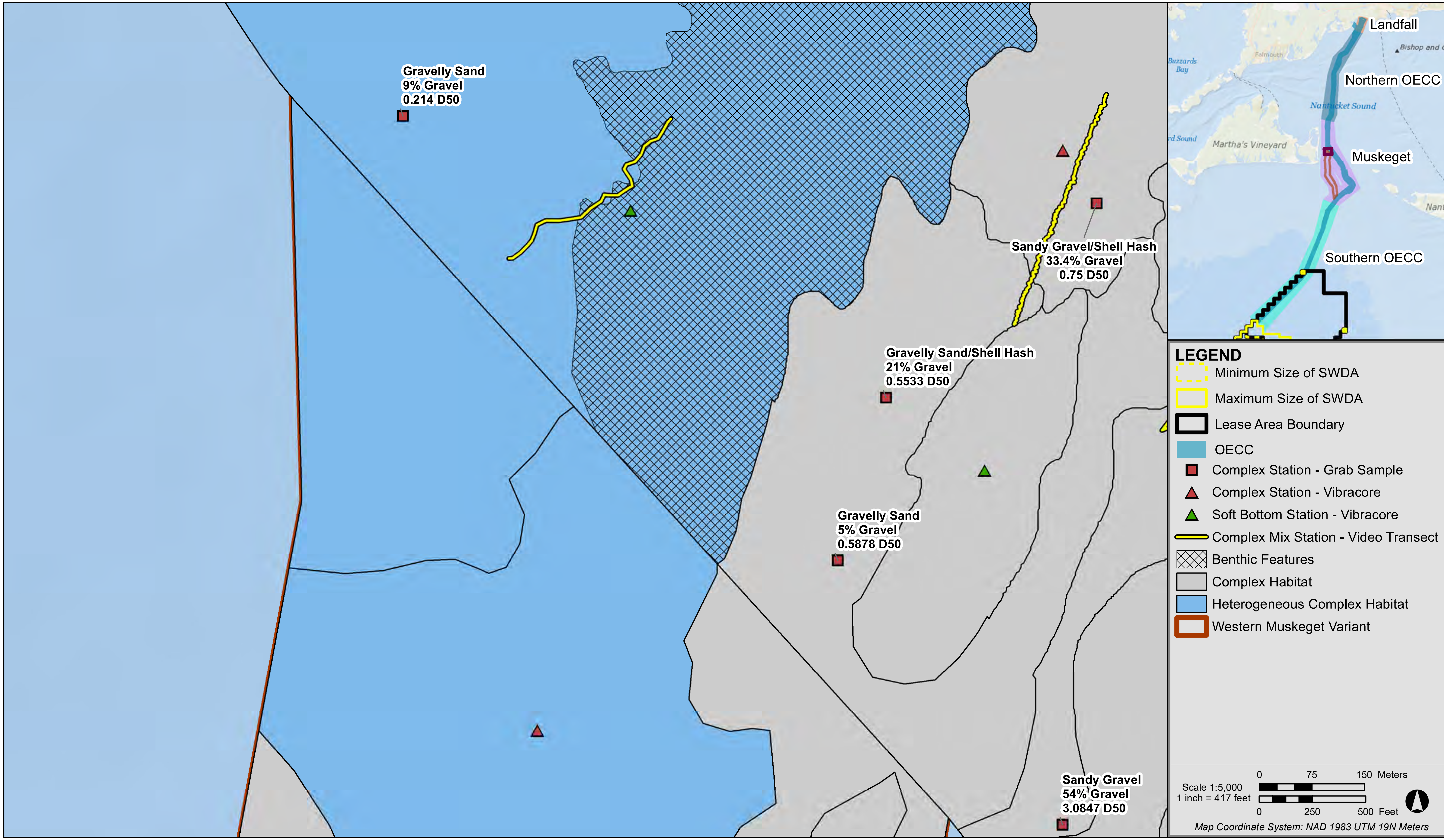

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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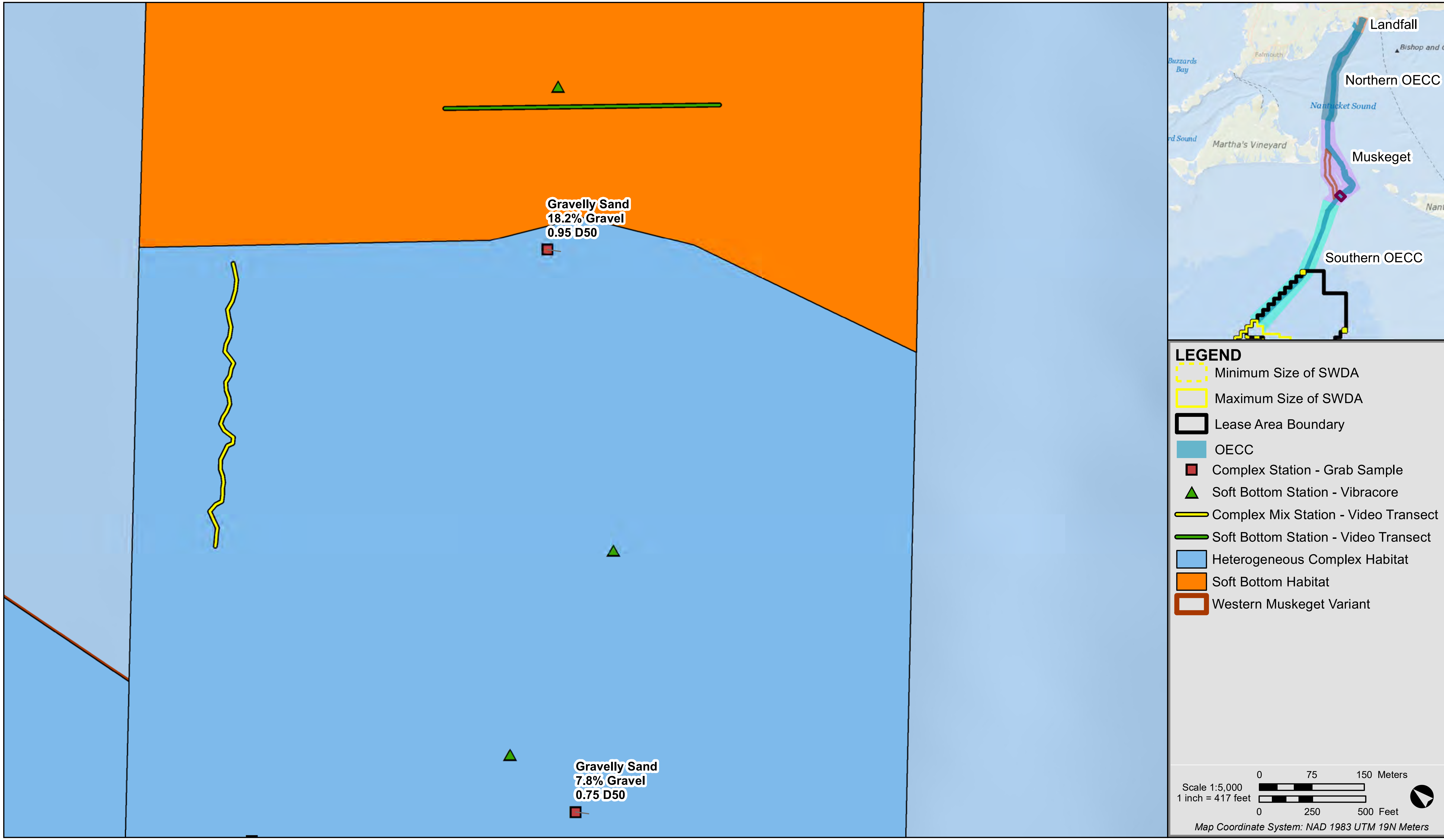

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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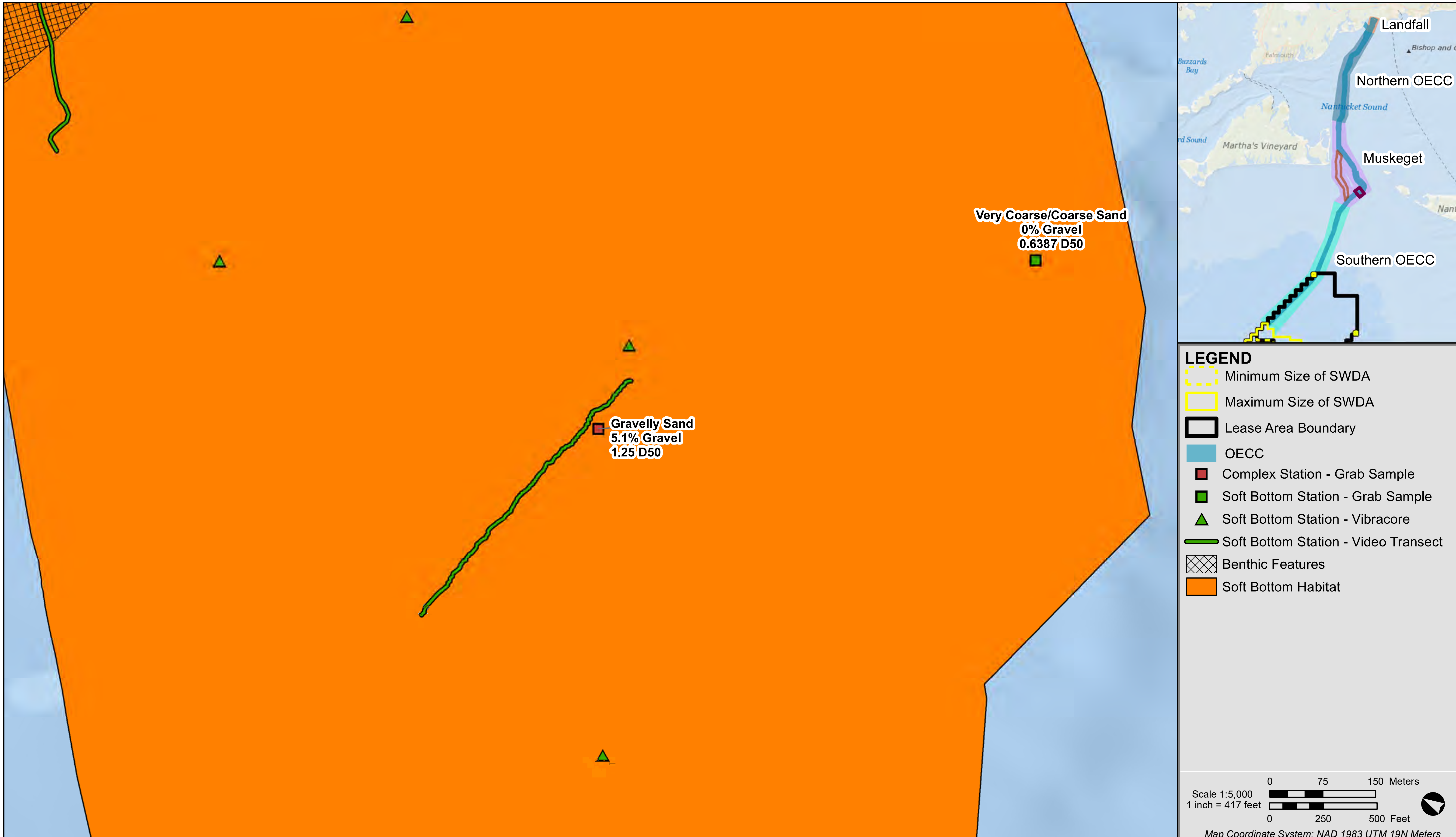

LEGEND

- Minimum Size of SWDA
- Maximum Size of SWDA
- Lease Area Boundary
- OECC
- Complex Station - Grab Sample
- Soft Bottom Station - Grab Sample
- Soft Bottom Station - Vibracore
- Soft Bottom Station - Video Transect
- Benthic Features
- Soft Bottom Habitat

Scale 1:5,000
1 inch = 417 feet
0 75 150 Meters
0 250 500 Feet

Map Coordinate System: NAD 1983 UTM 19N Meters

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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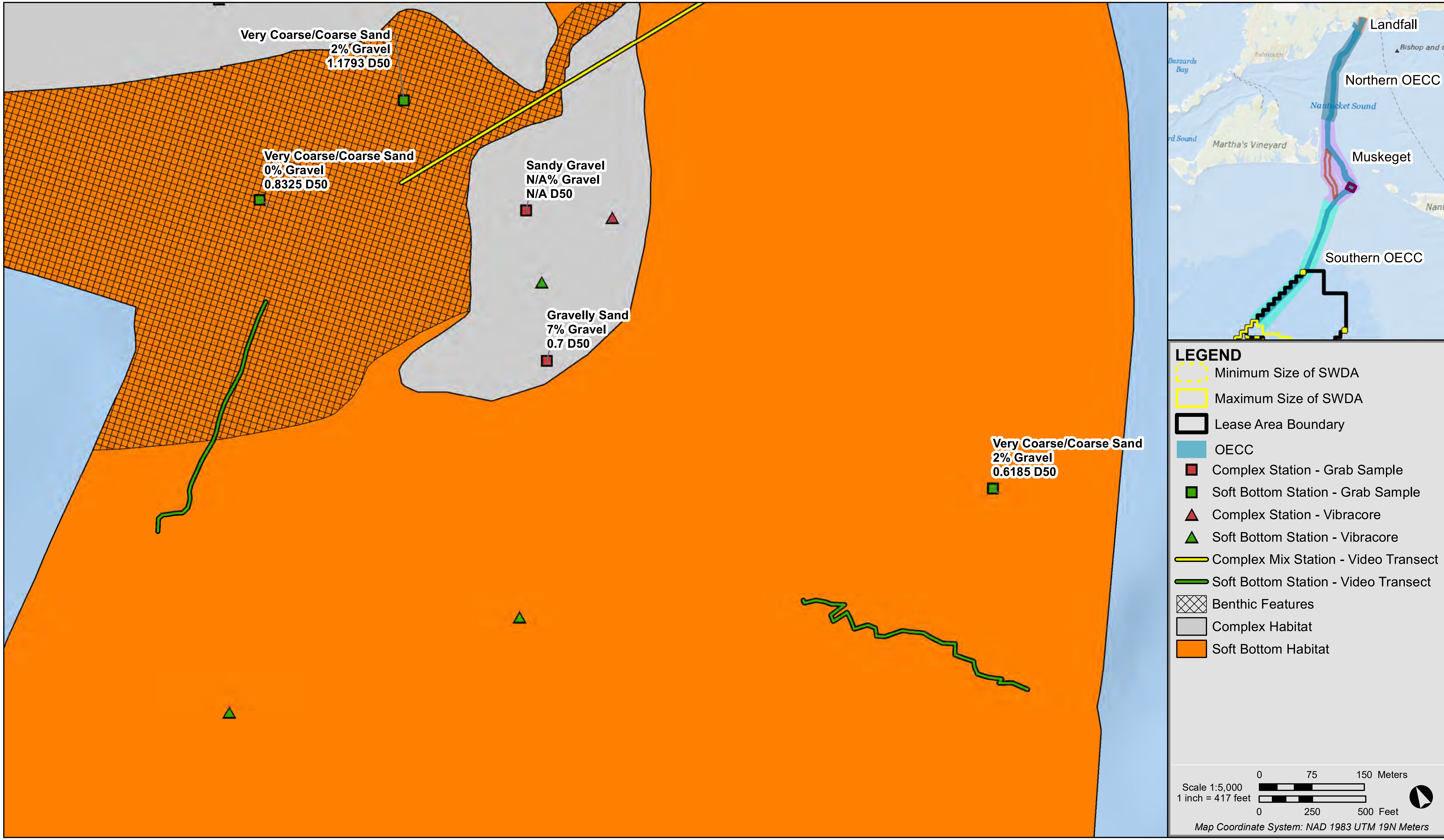

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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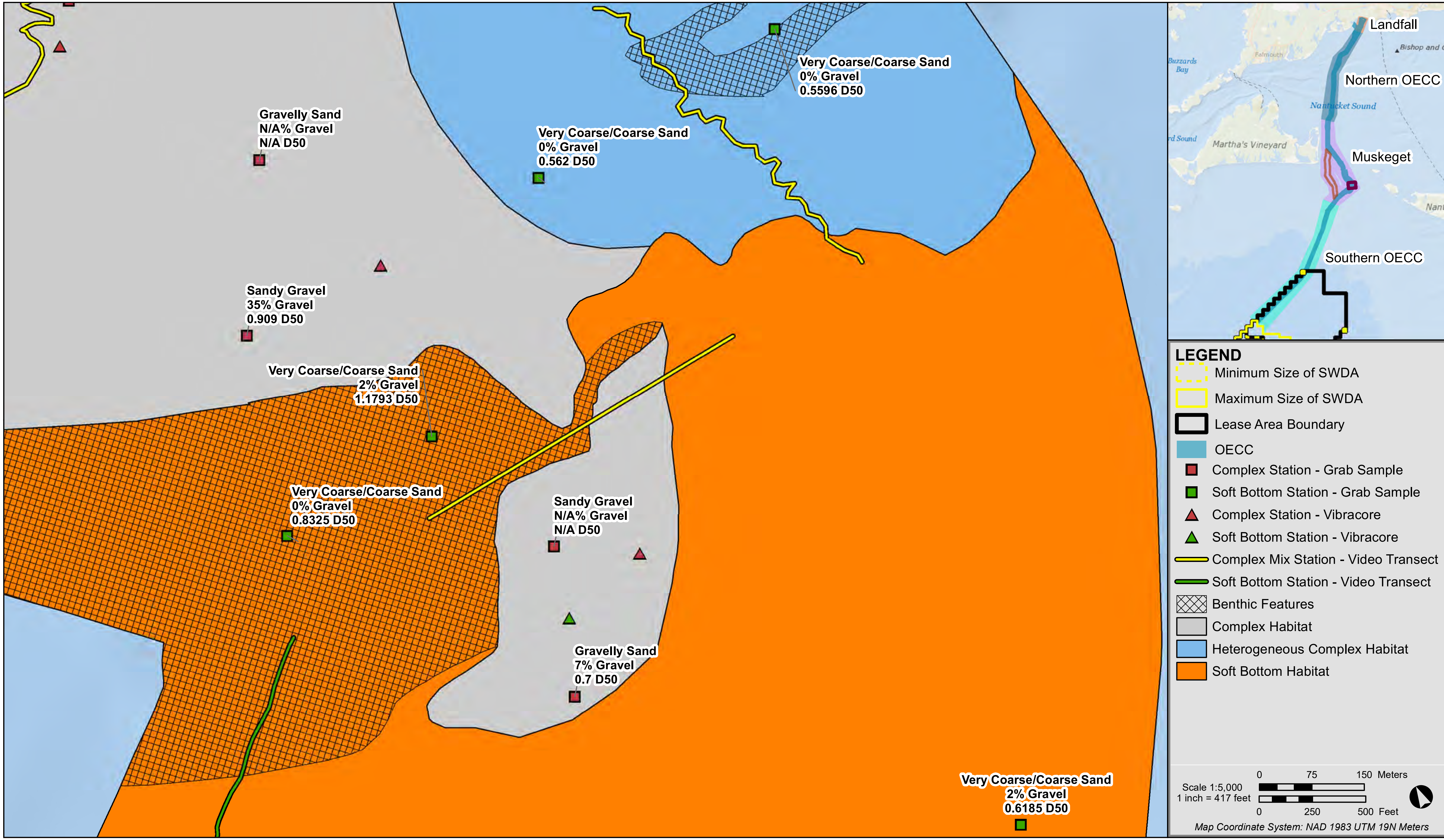

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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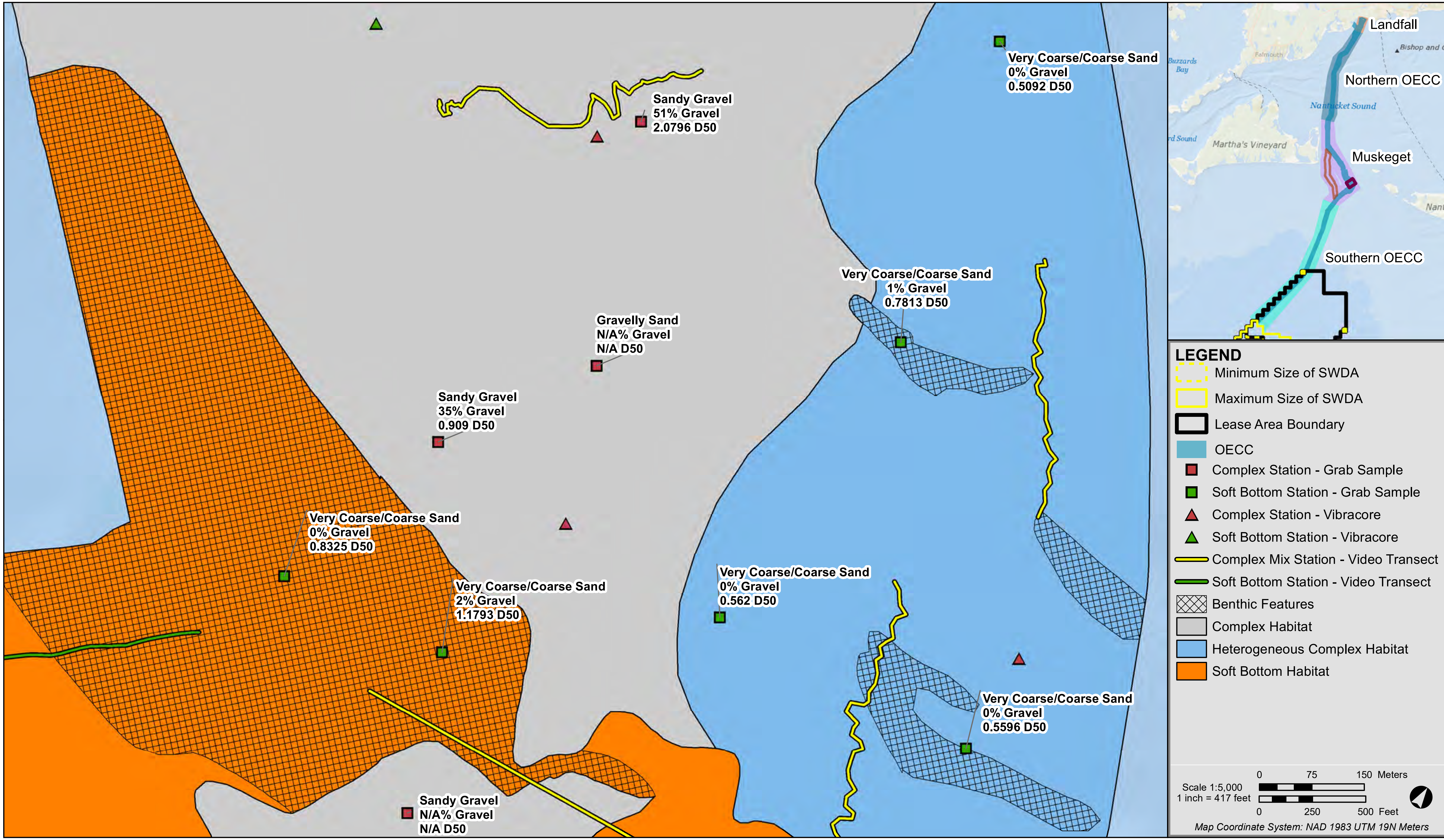


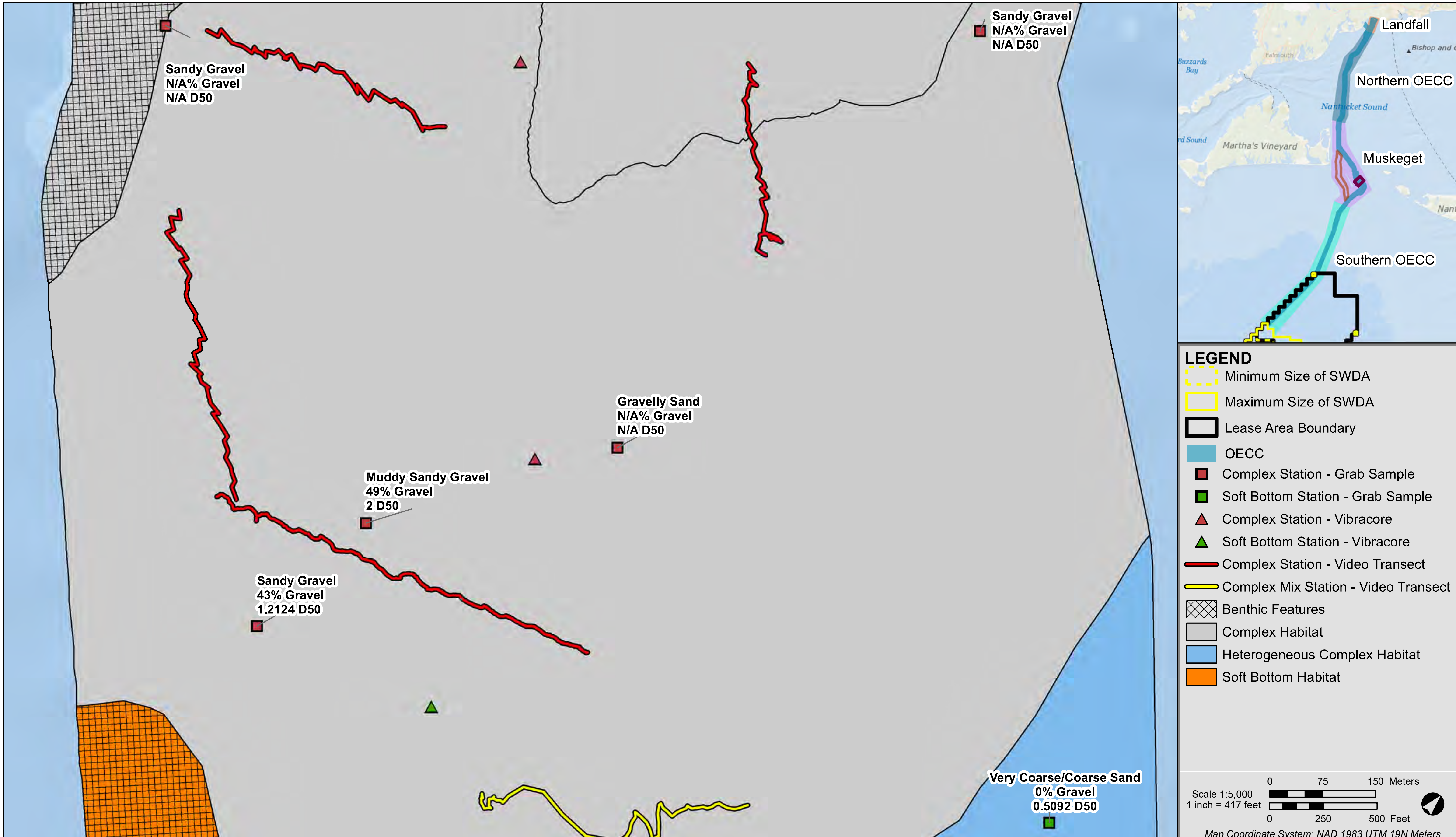
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 50 of 90

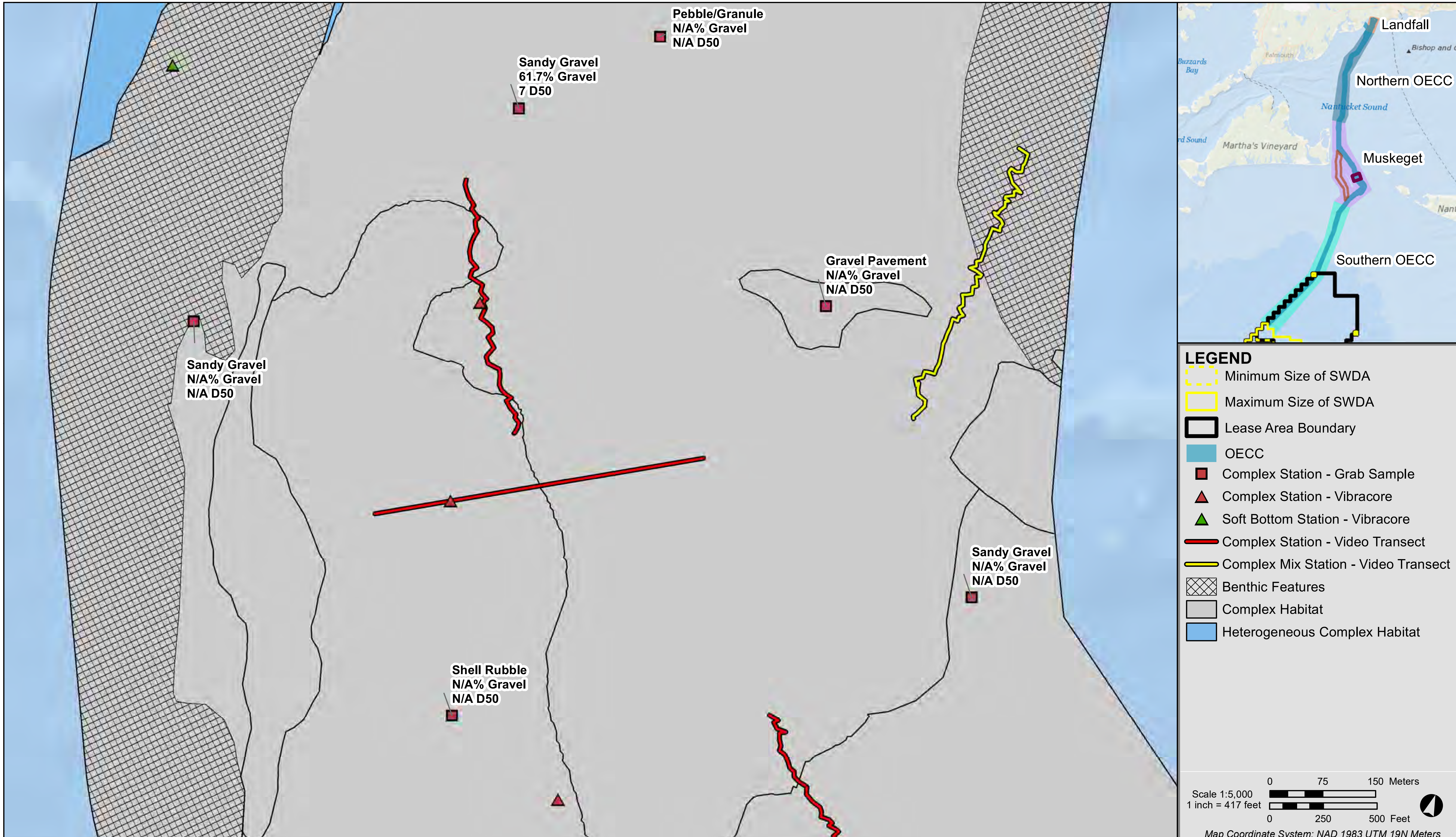
Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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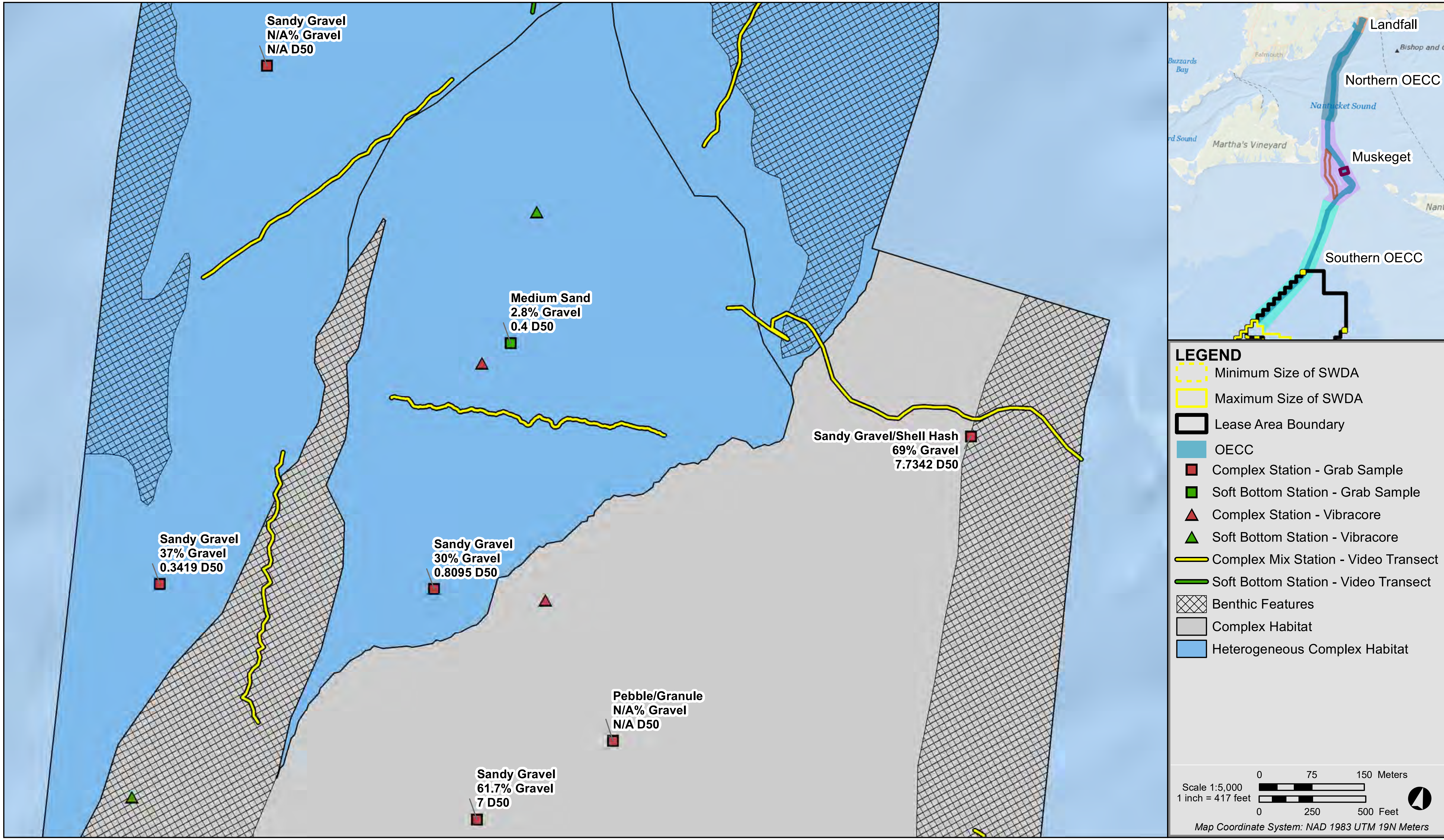

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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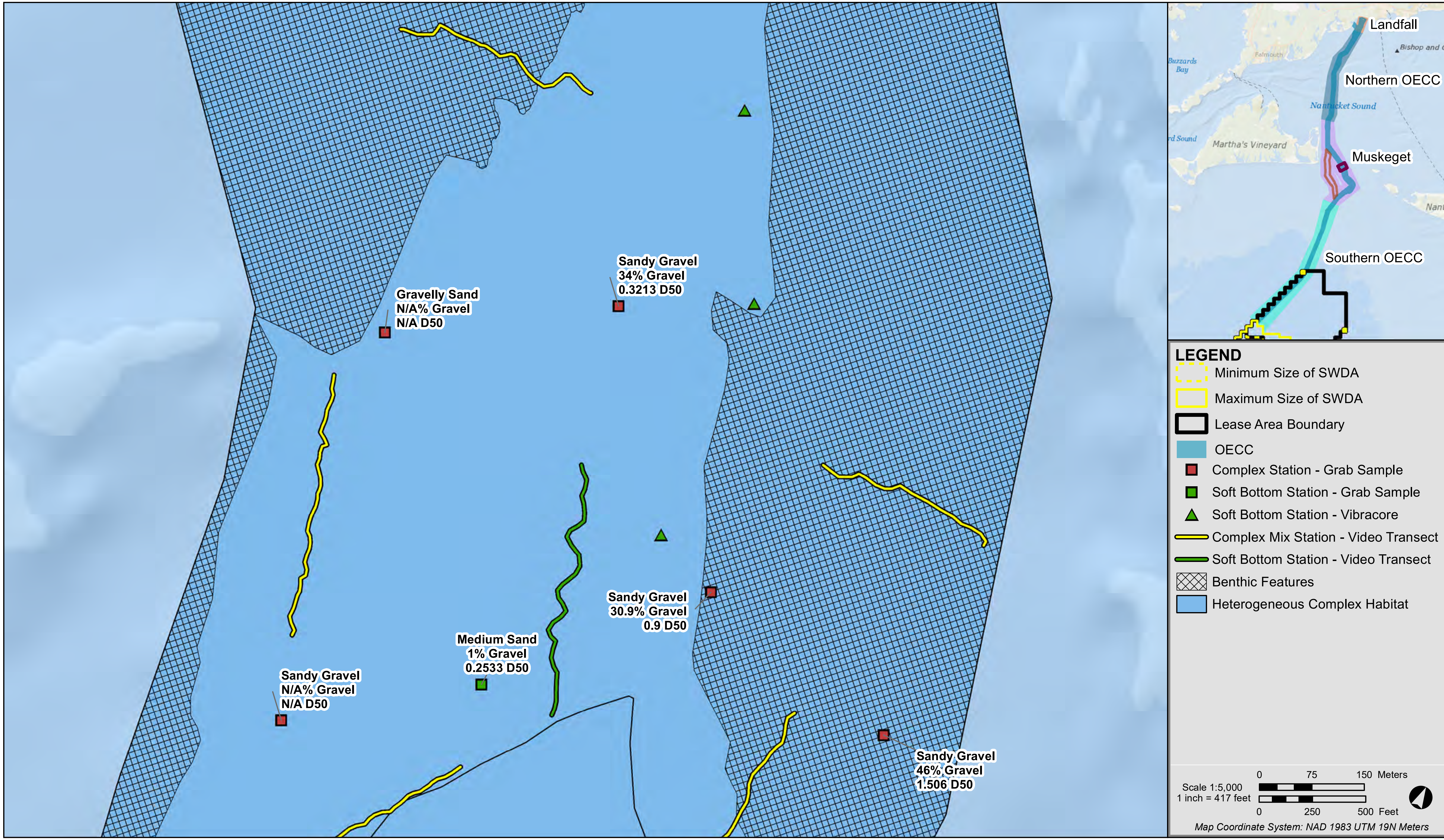

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

Figure 54 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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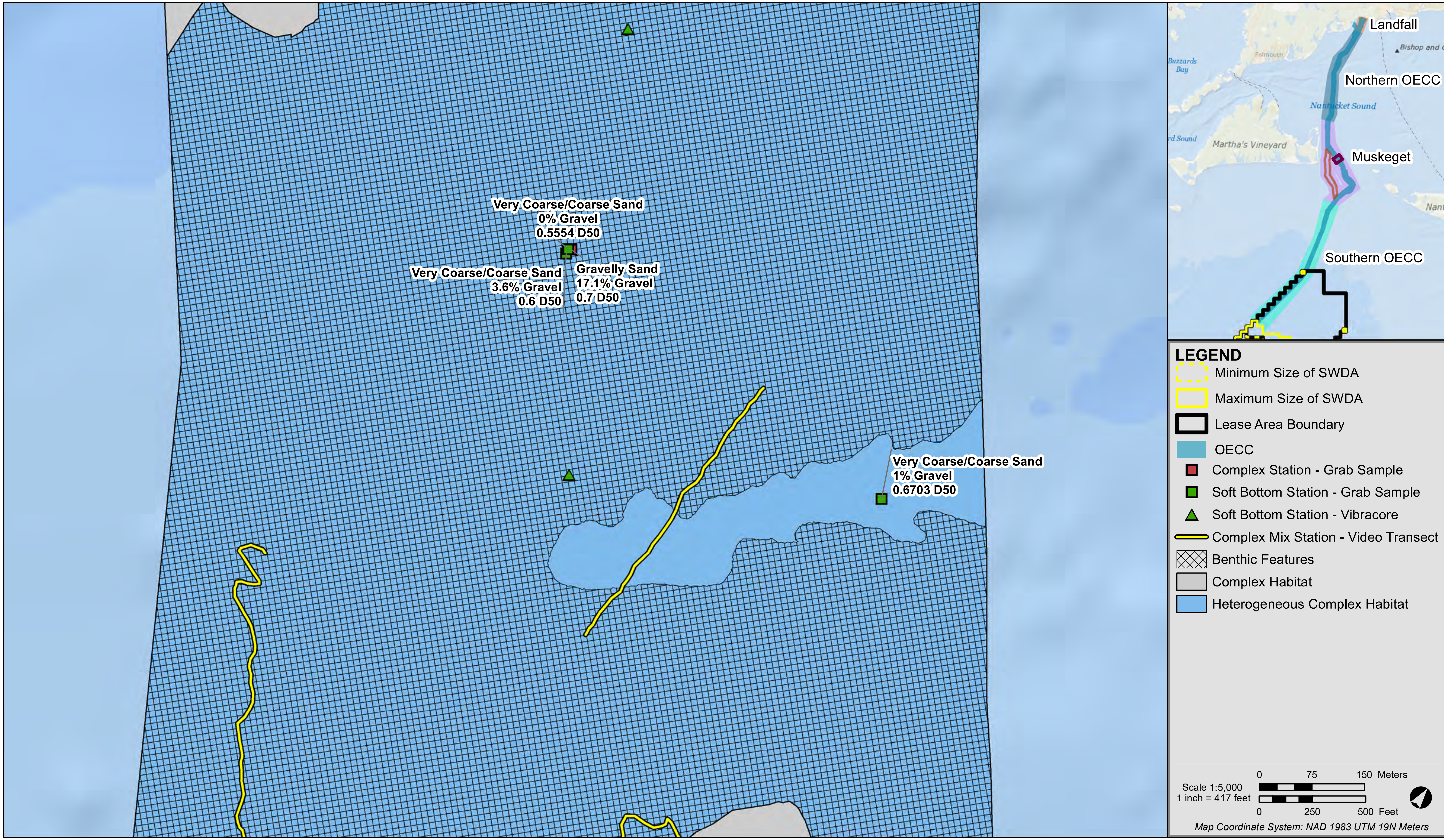

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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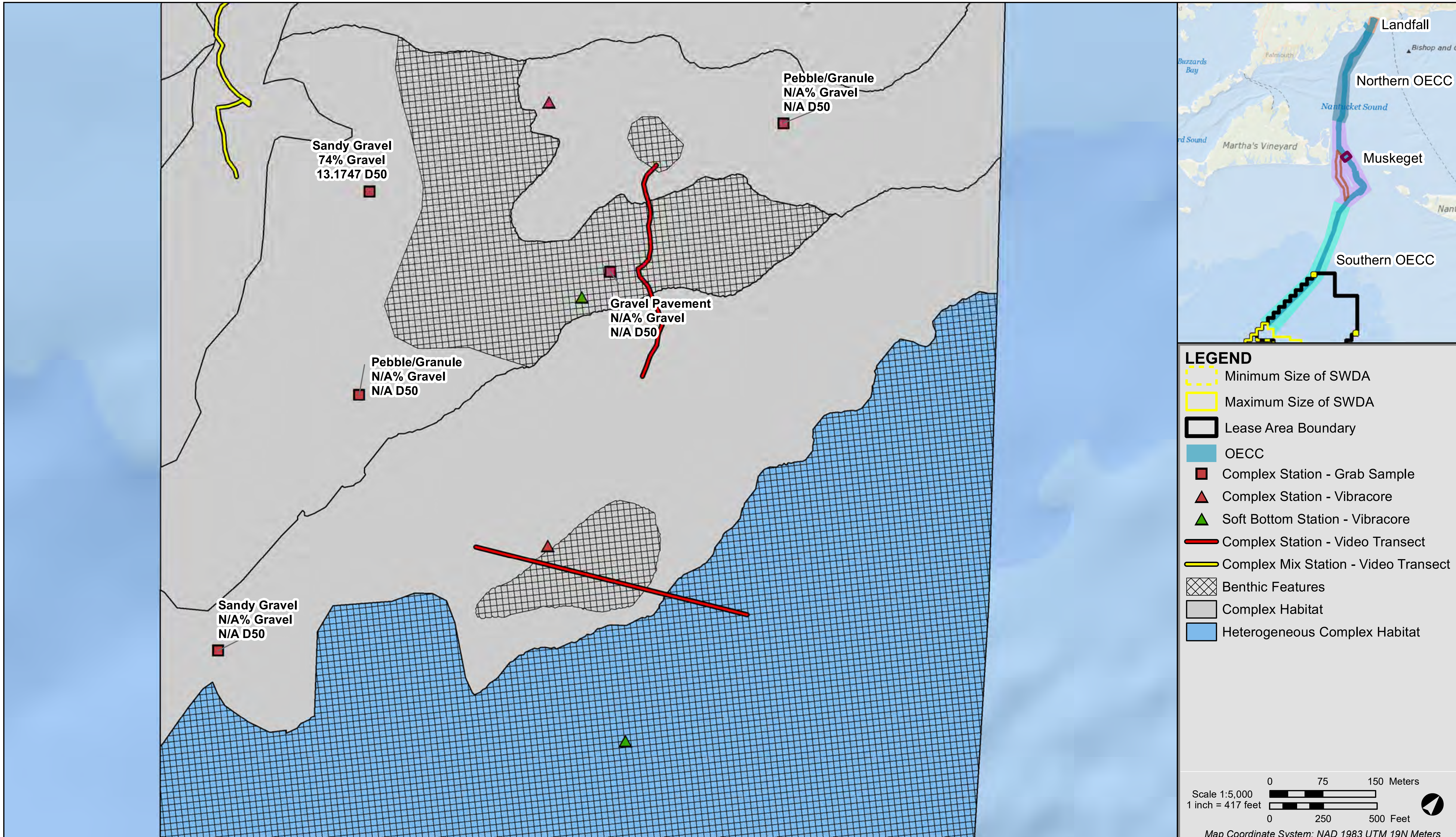

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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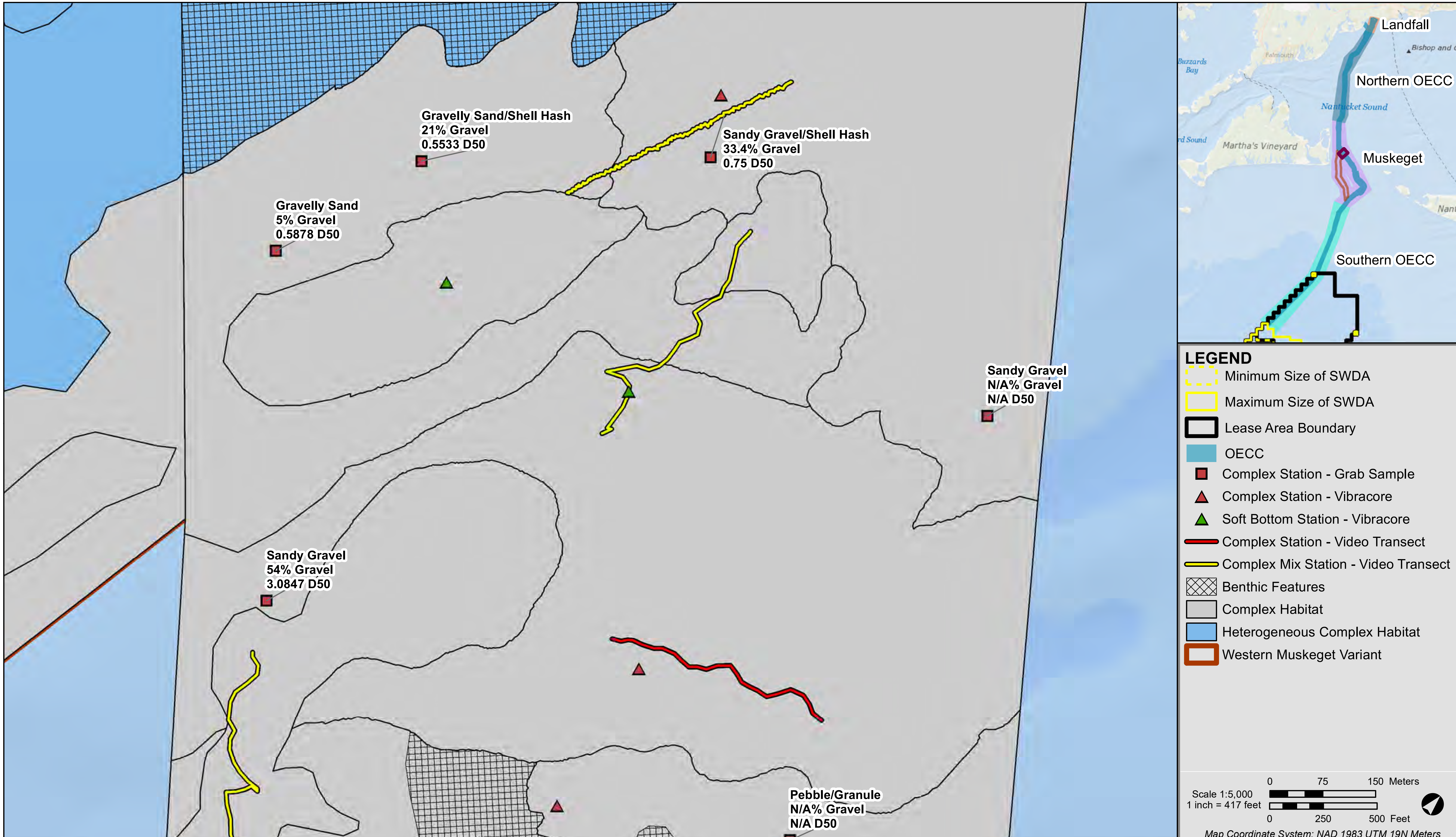

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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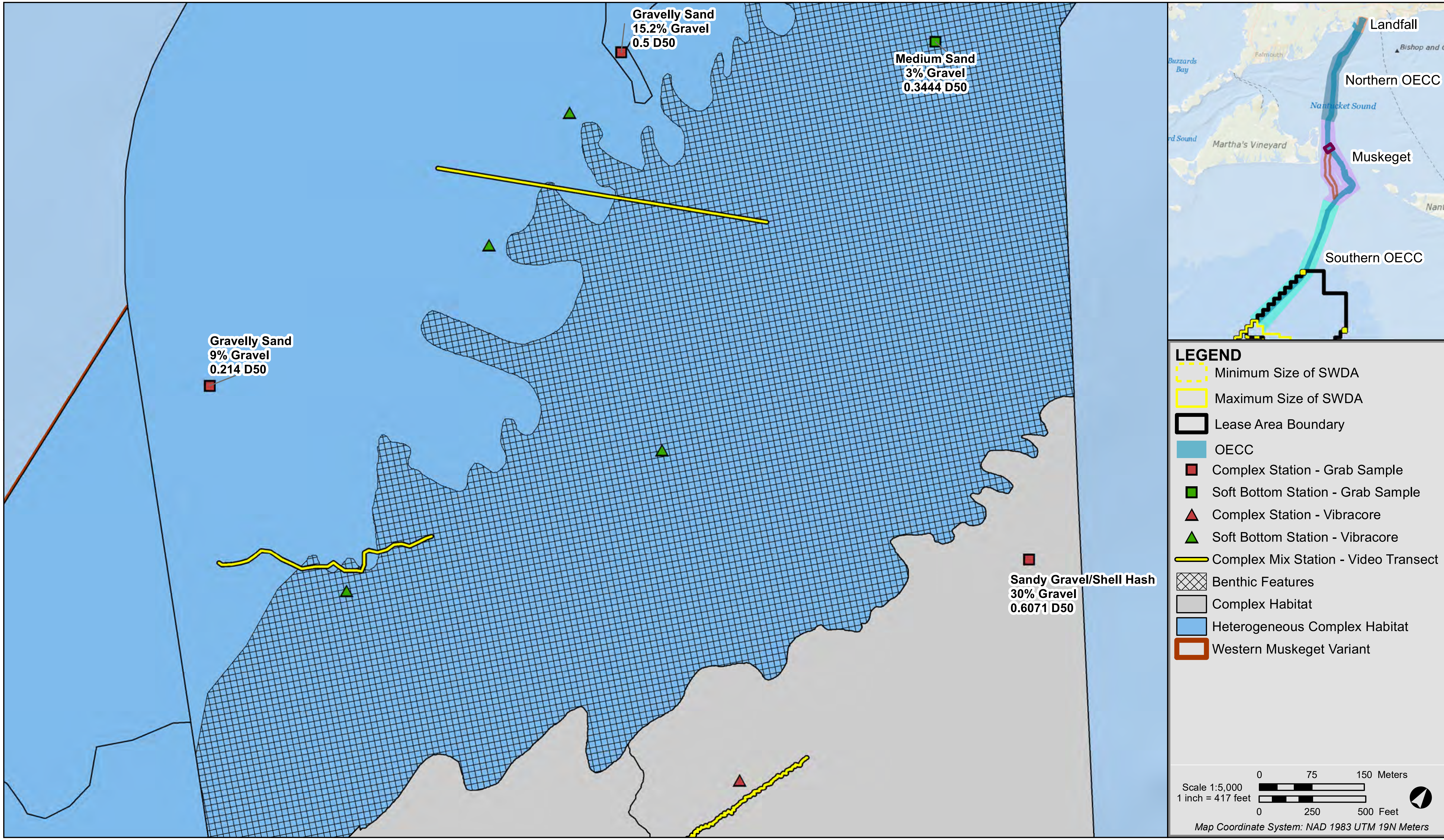

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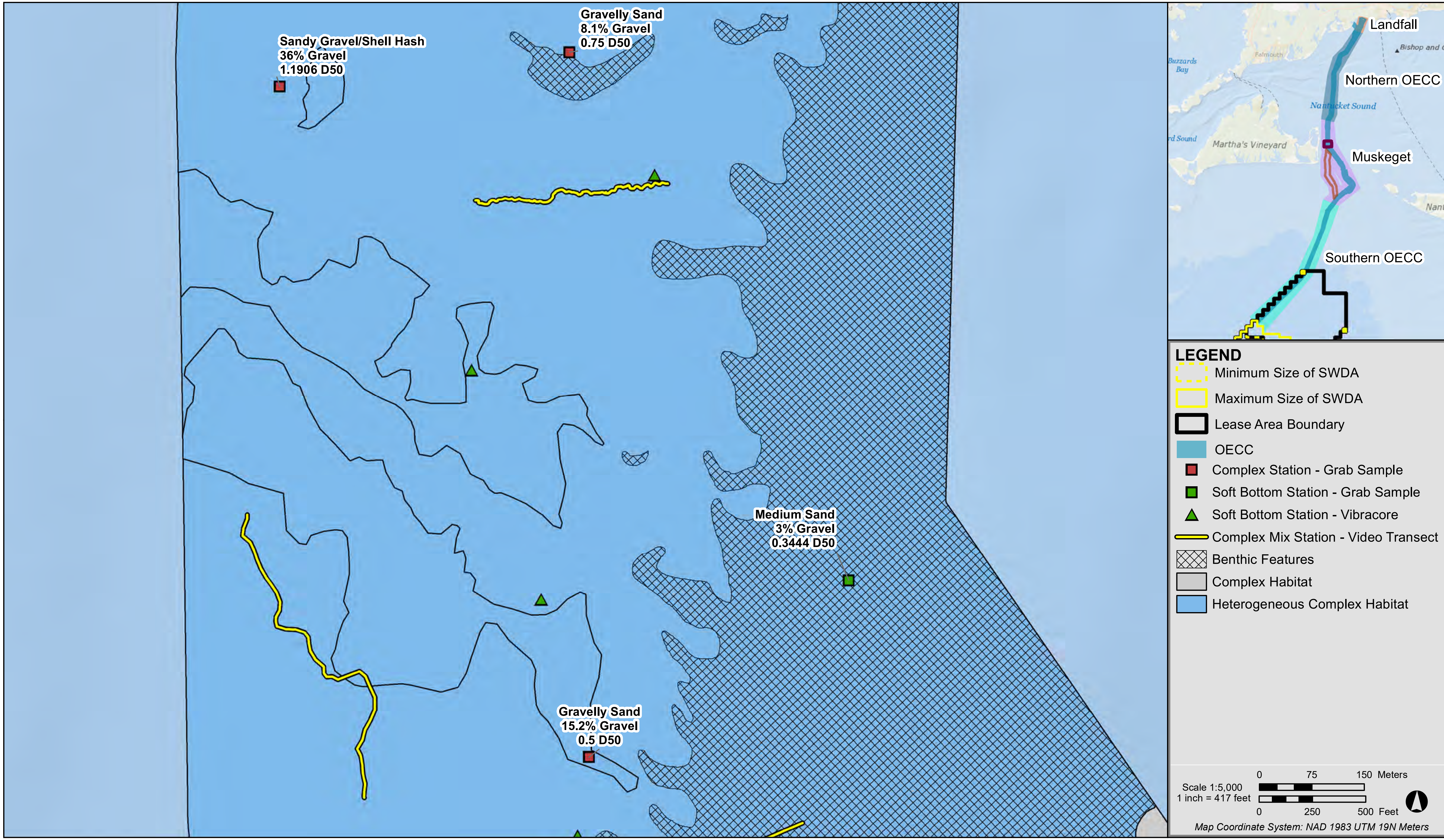

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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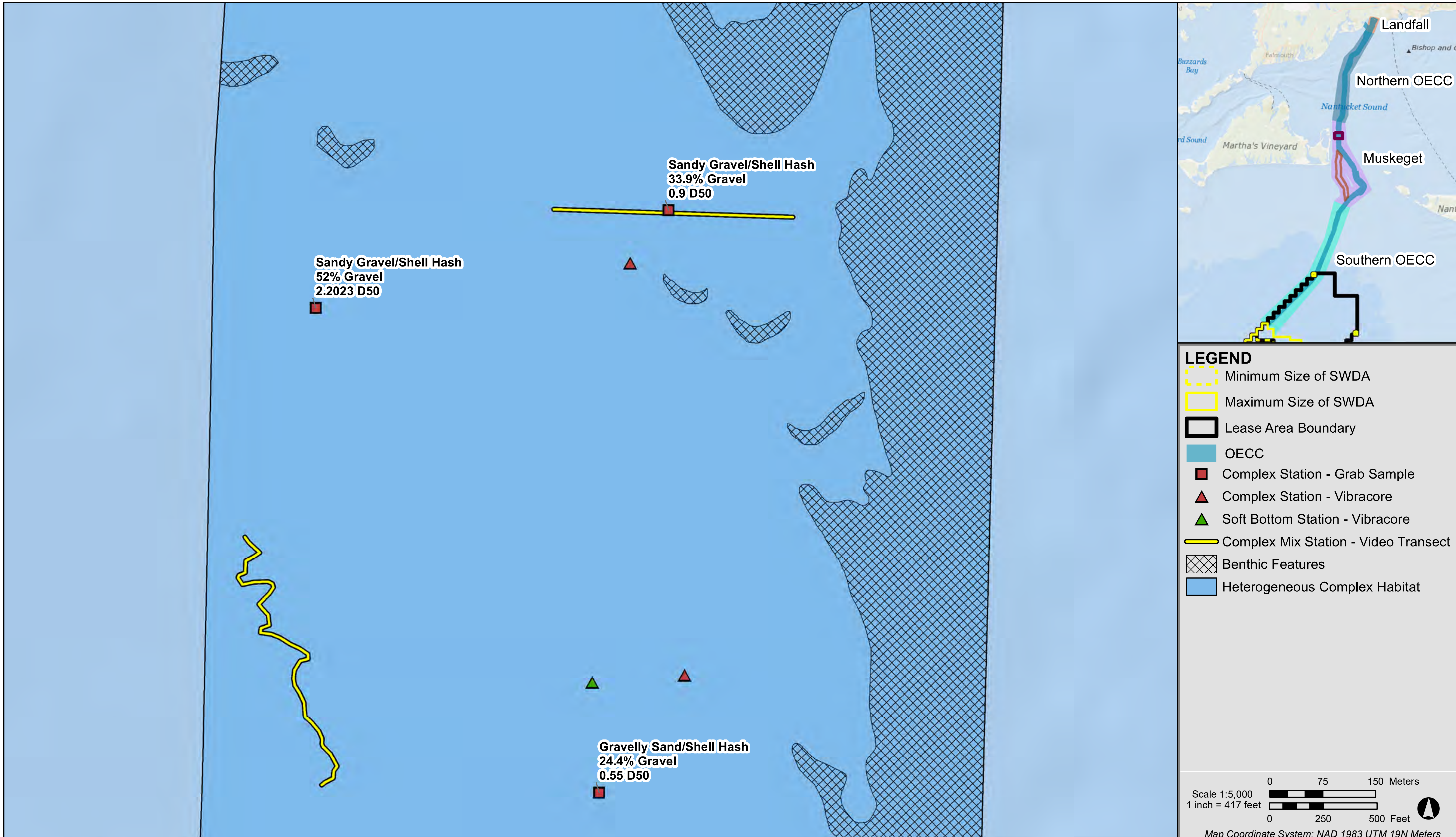
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

Figure 61 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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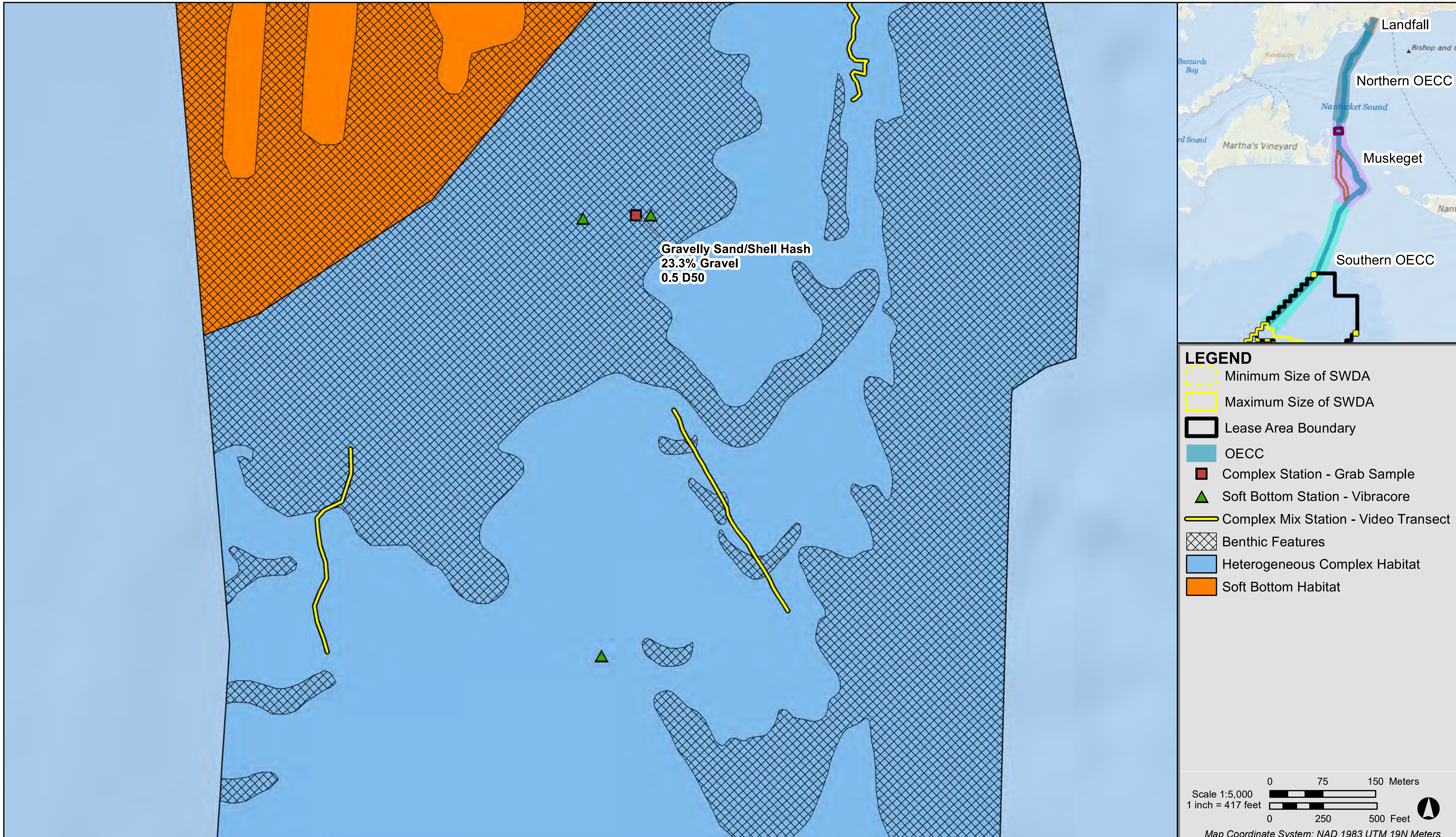


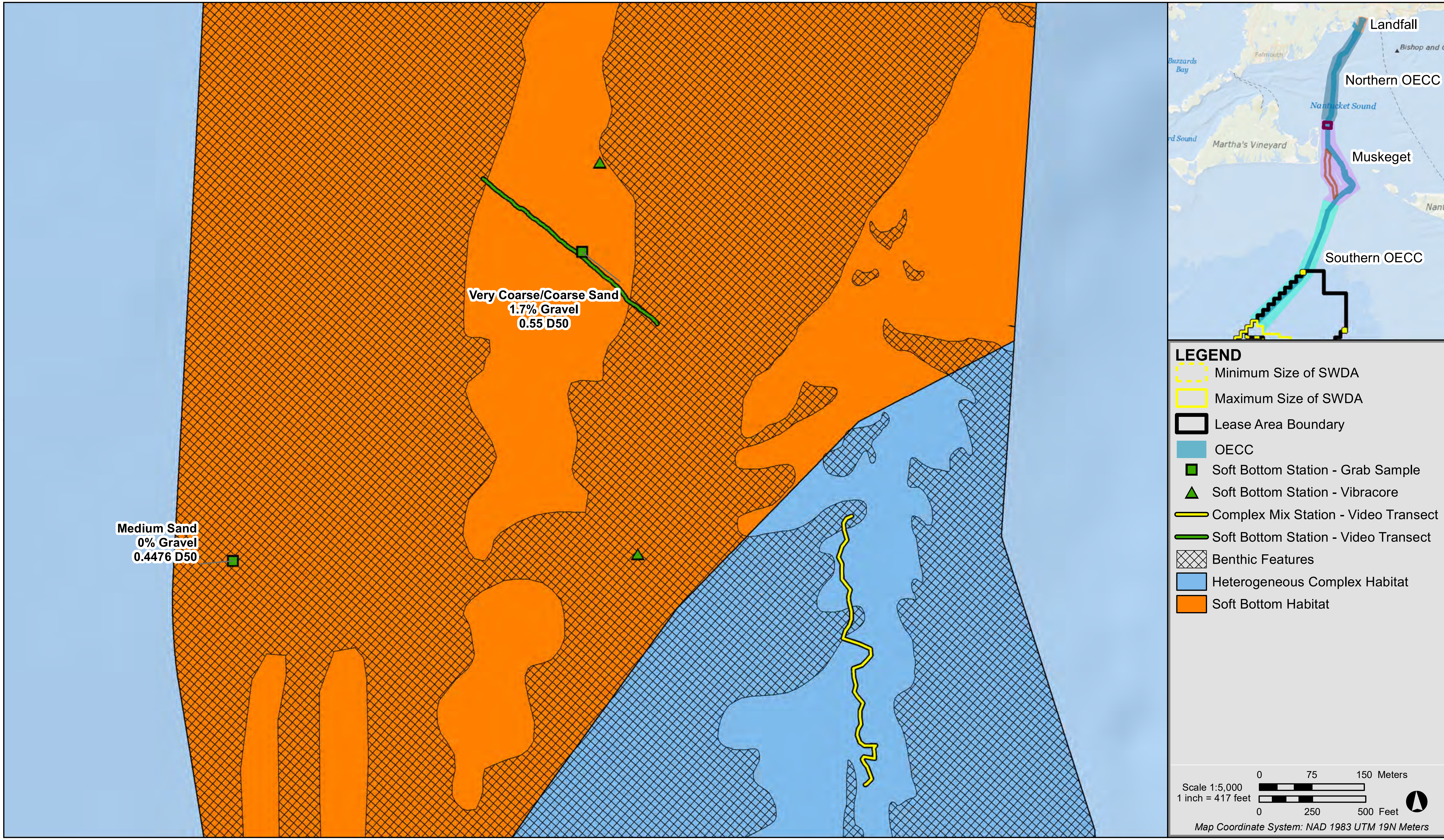
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 63 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

Figure 64 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.

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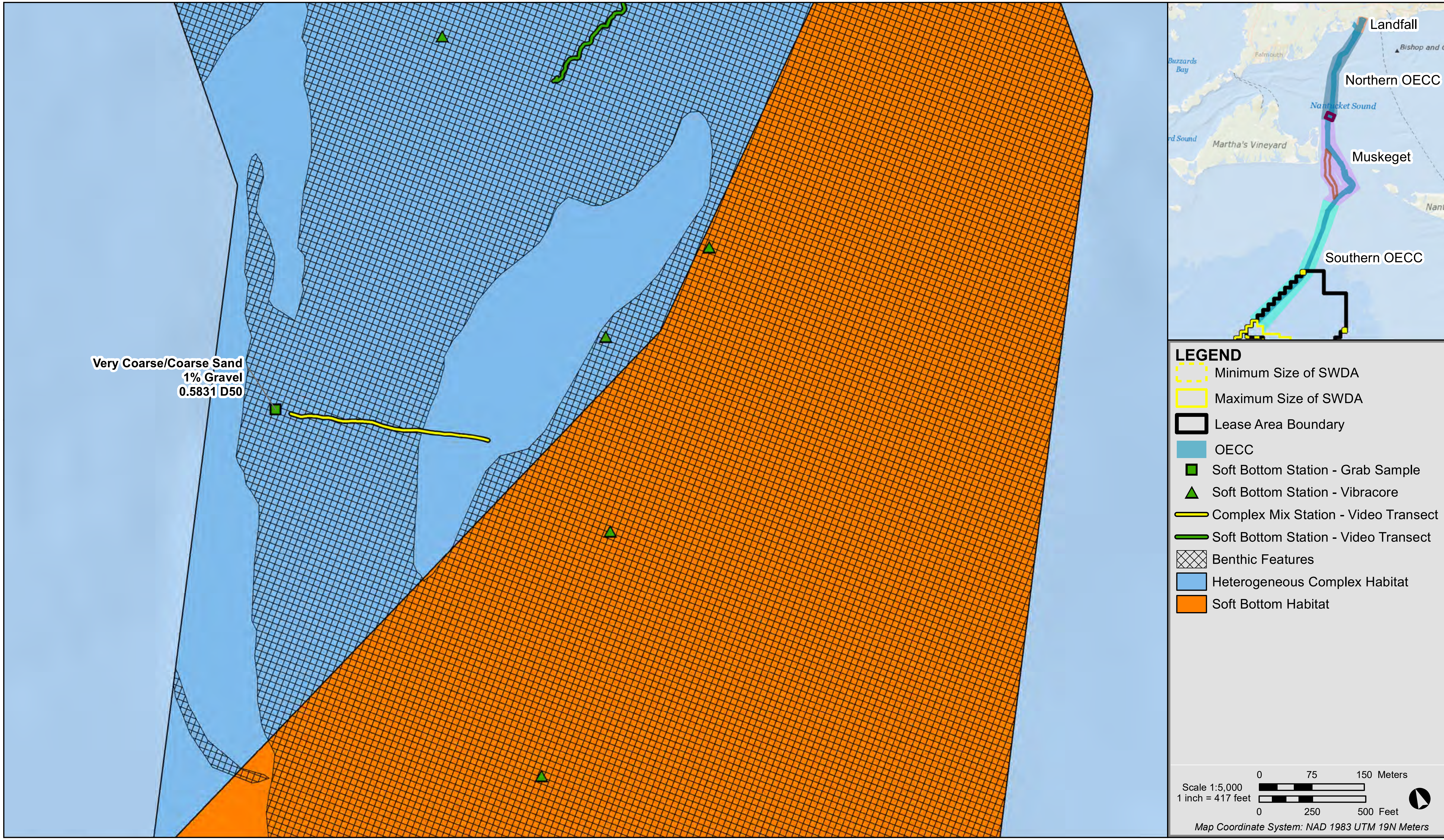

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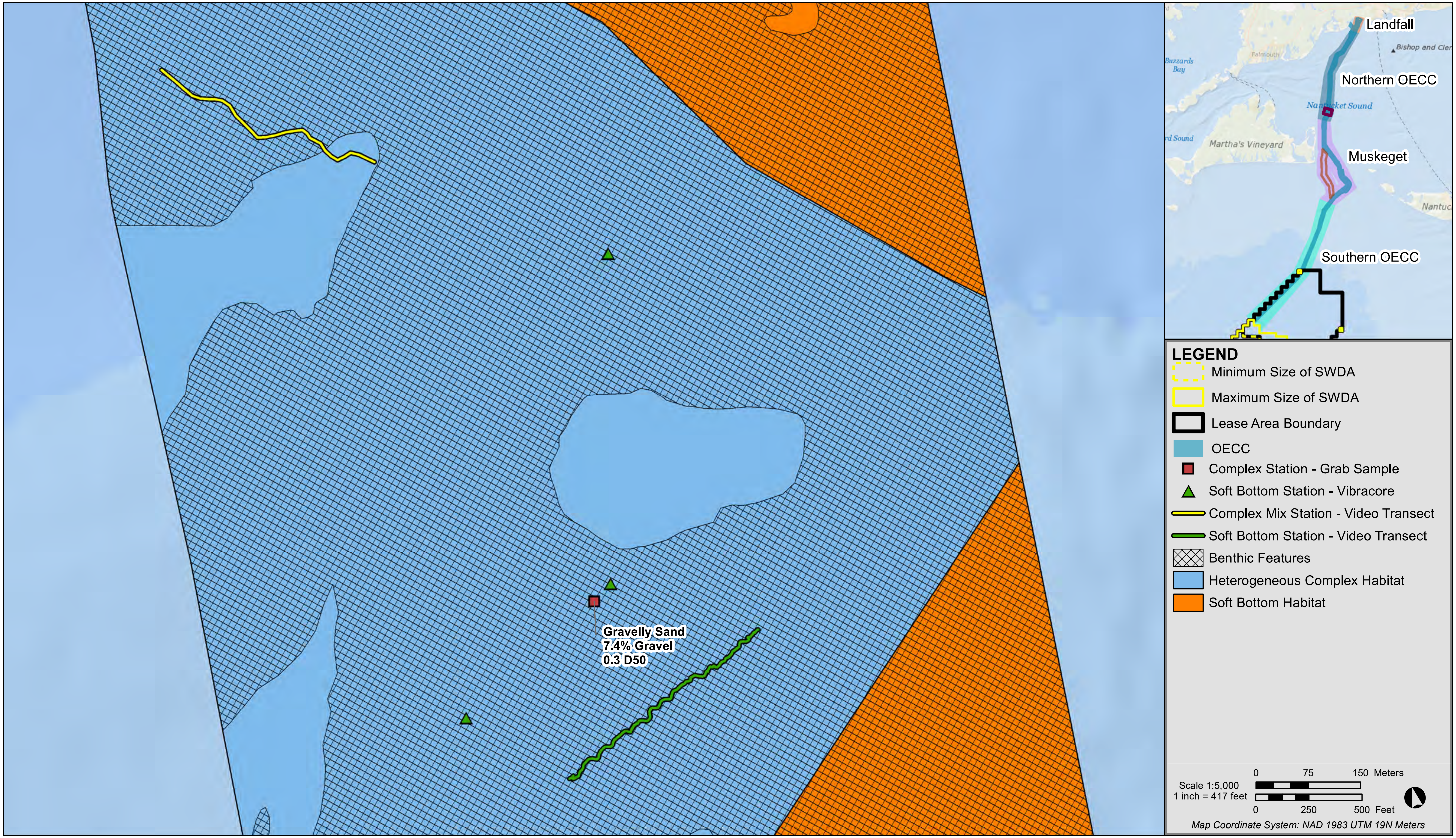
Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021).
Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



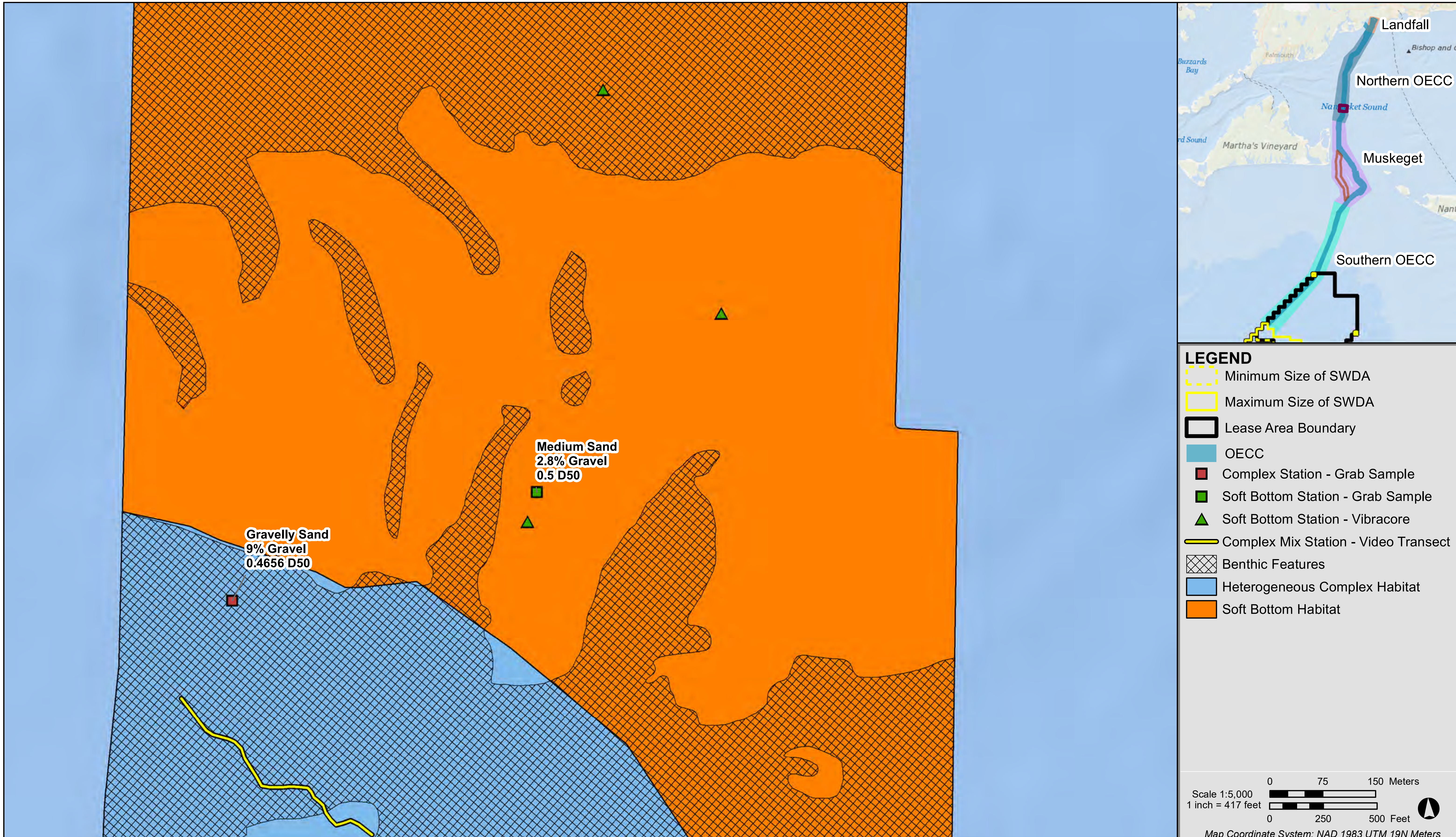
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 67 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.

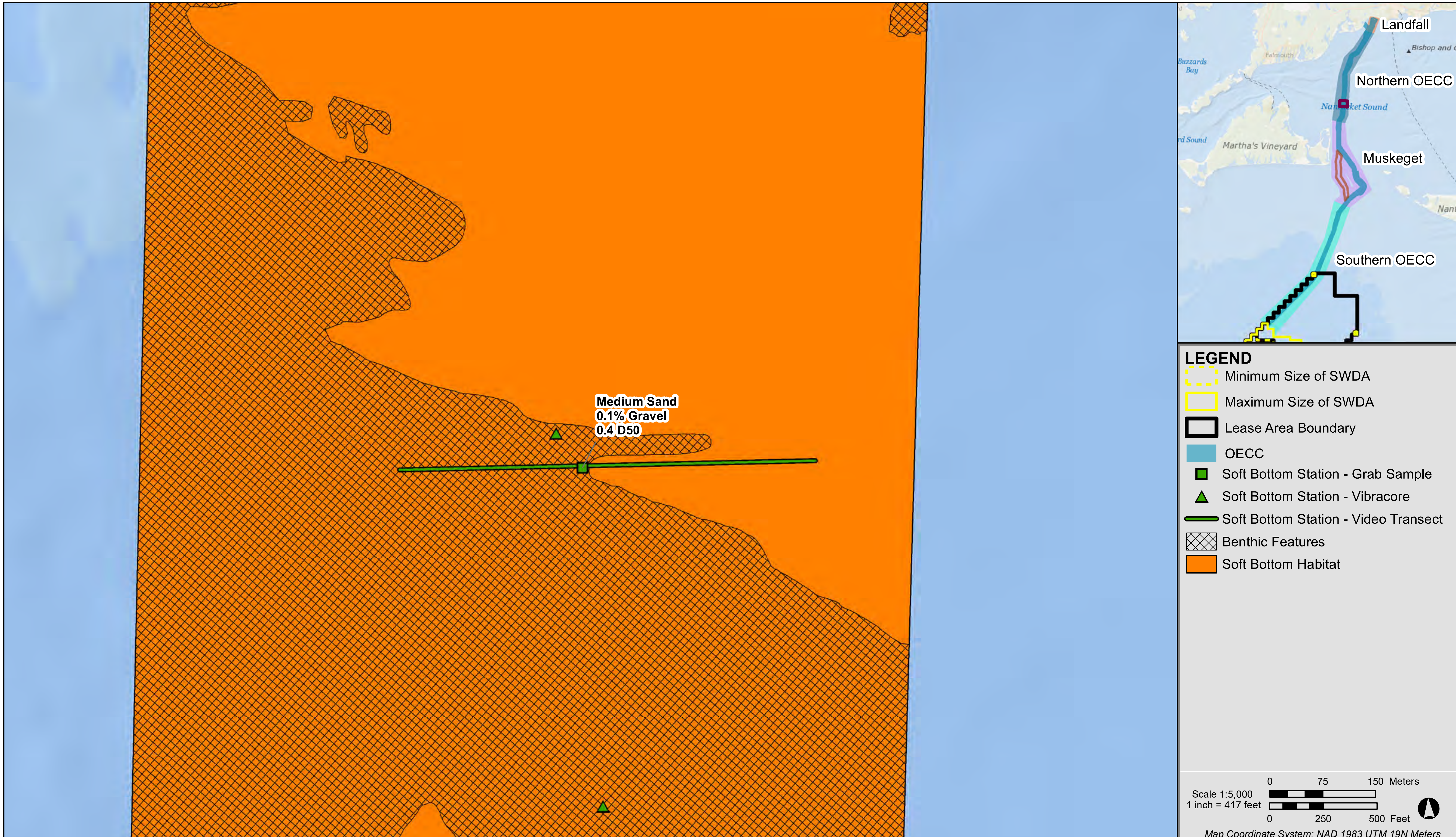


Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

Figure 68 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021).
Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



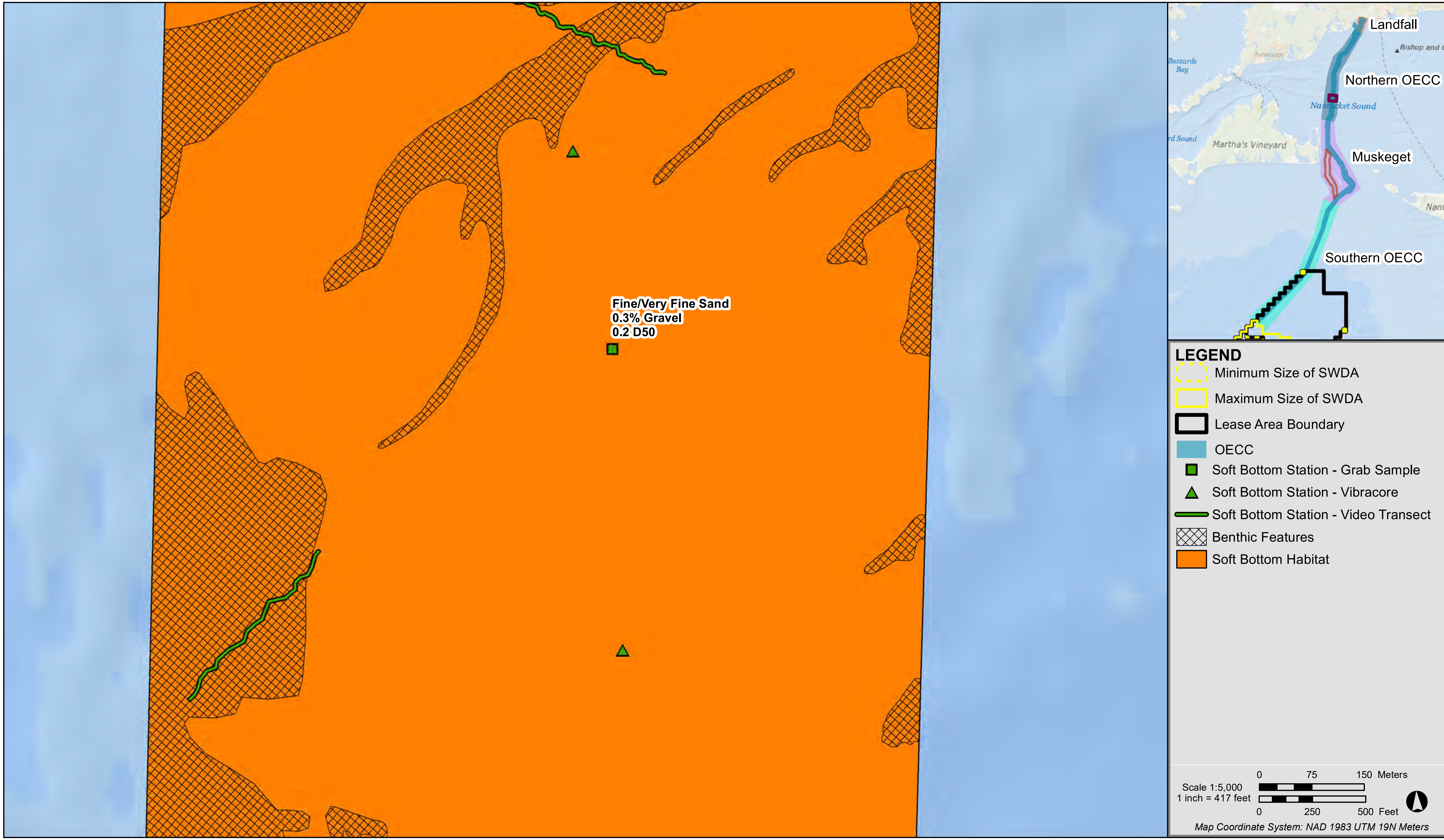
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 69 of 90

Large Scale Maps of Bottom Habitats and Benthic Features Located in the Offshore Development Area Following NMFS's Recommendations for Mapping Essential Fish Habitat (2021). Maps of the Offshore Export Cable Corridor (OECC) are at a Scale of 1:5,000.



Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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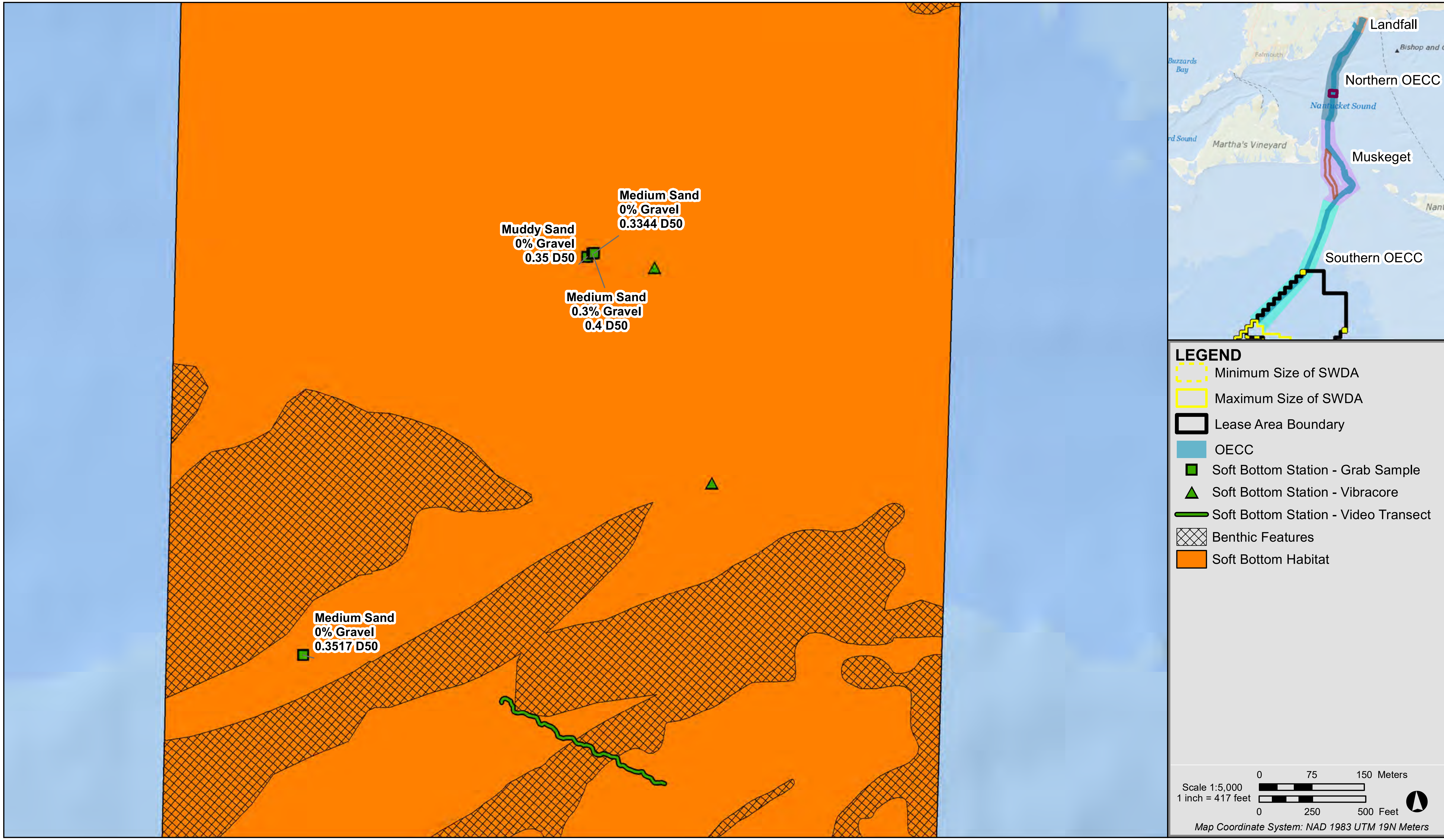

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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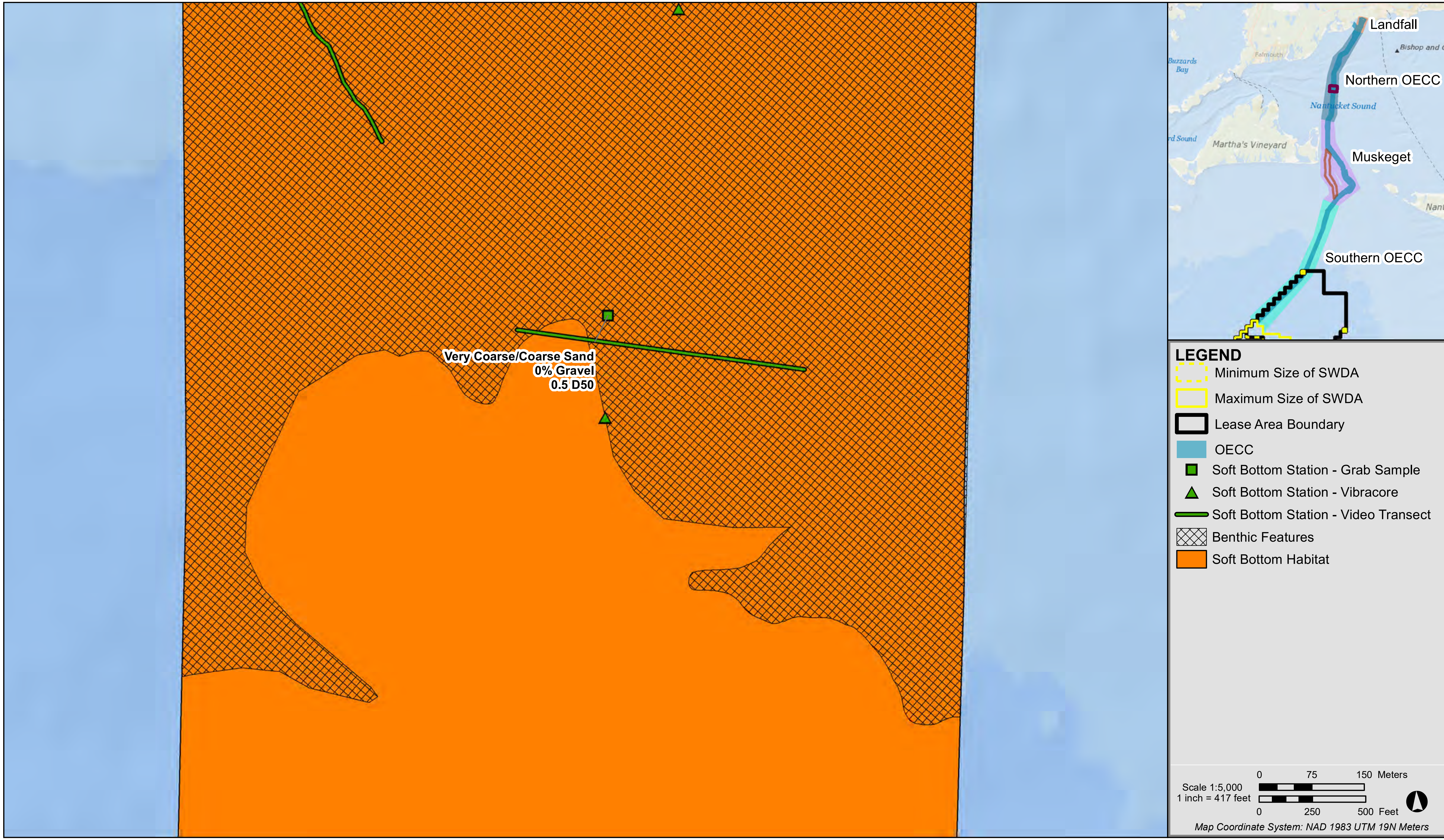

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

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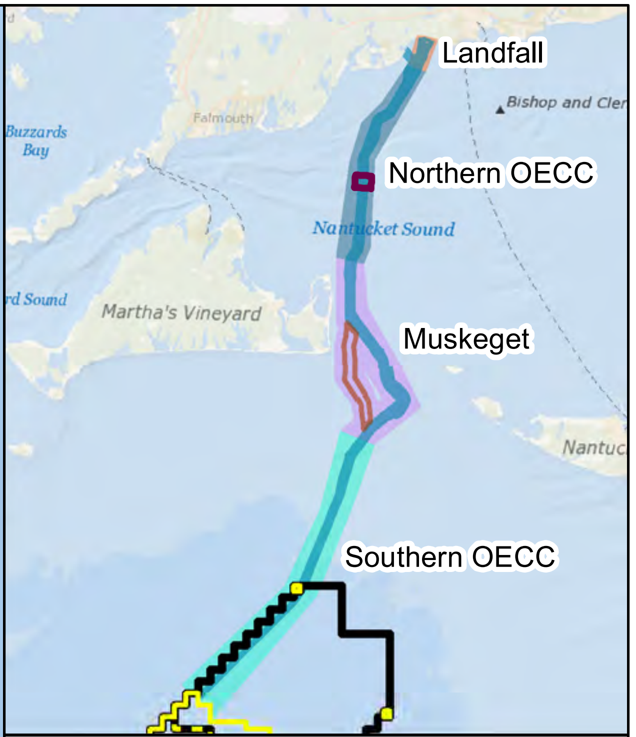

LEGEND
- Minimum Size of SWDA
- Maximum Size of SWDA
- Lease Area Boundary
- OECC
- Complex Station - Grab Sample
- Soft Bottom Station - Grab Sample
- Soft Bottom Station - Vibracore
- Soft Bottom Station - Video Transect
- Benthic Features
- Heterogeneous Complex Habitat
- Soft Bottom Habitat

Scale 1:5,000
1 inch = 417 feet
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Map Coordinate System: NAD 1983 UTM 19N Meters

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

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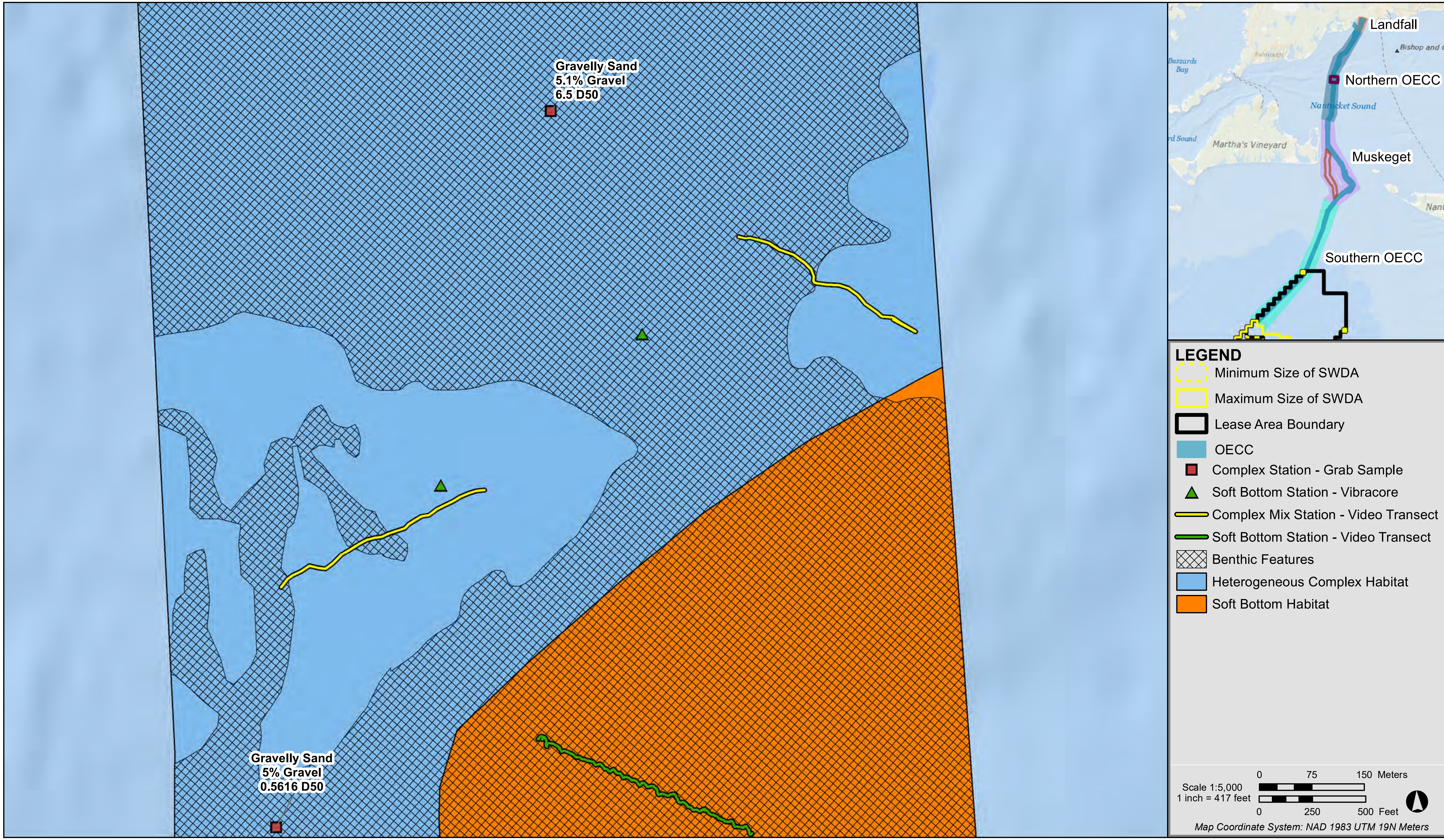

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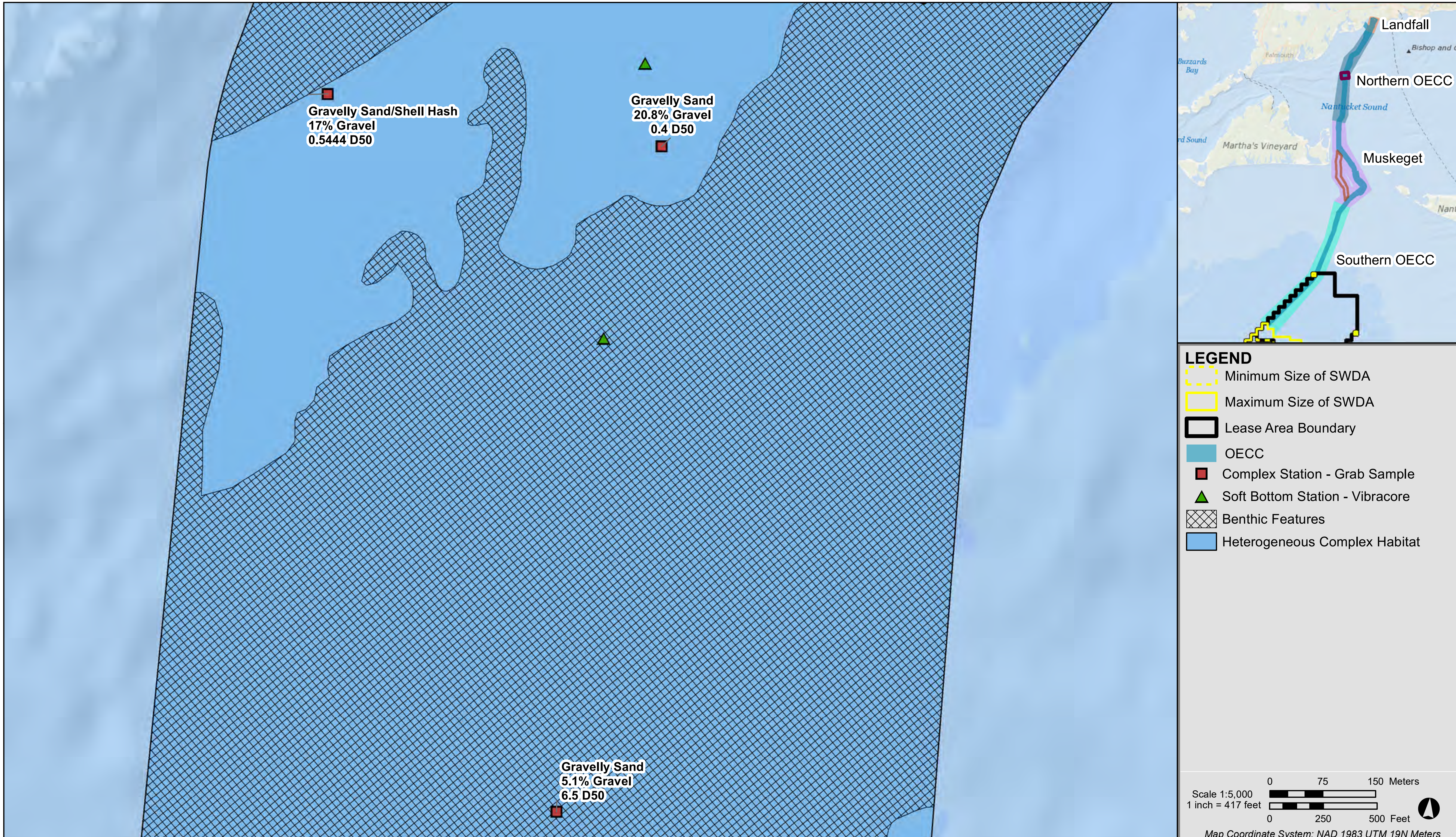

Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org,

No recovery grabs resulted in N/A for % gravel and D50. D50 size is in mm.

New England Wind

Figure 75 of 90

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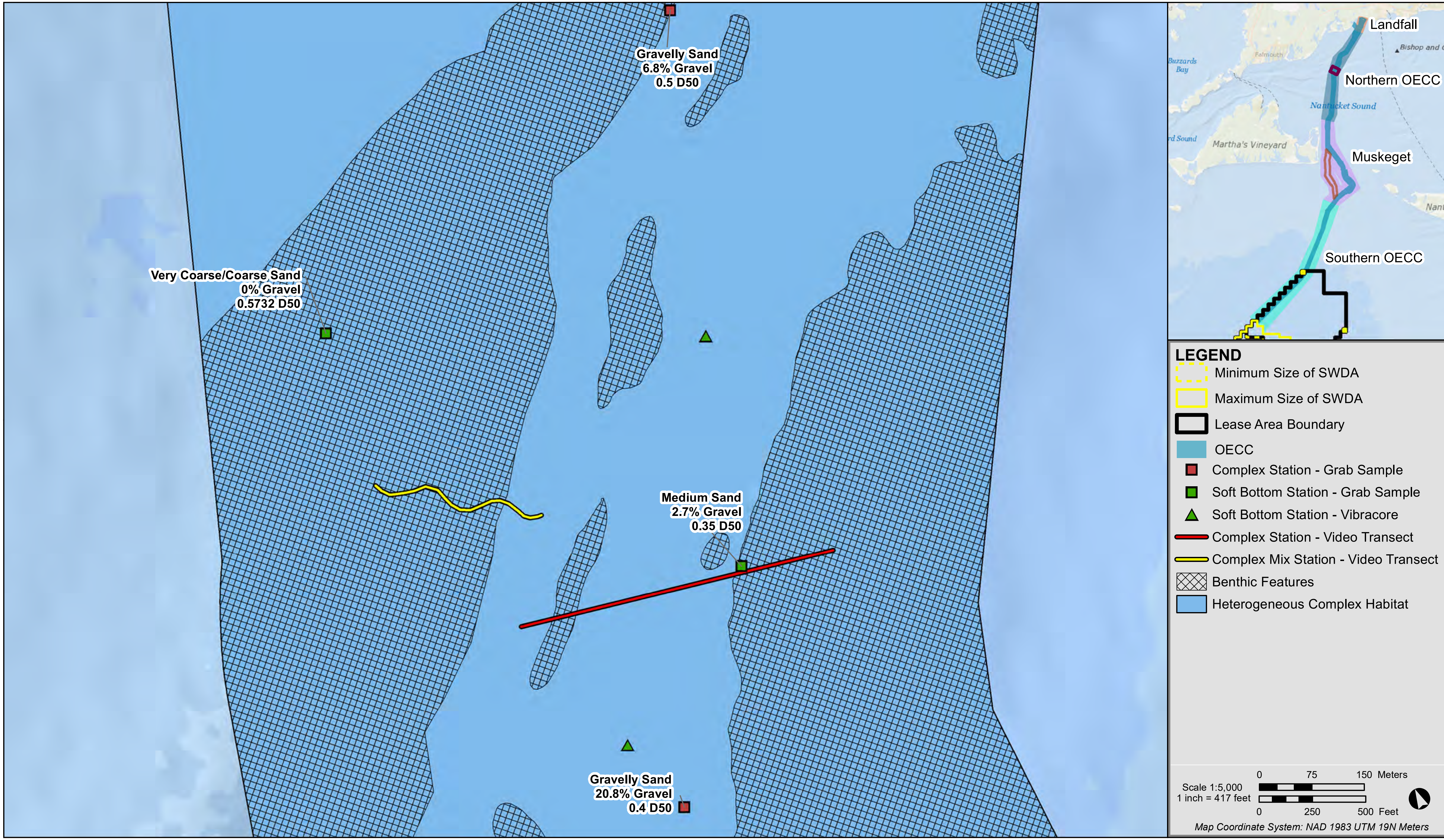

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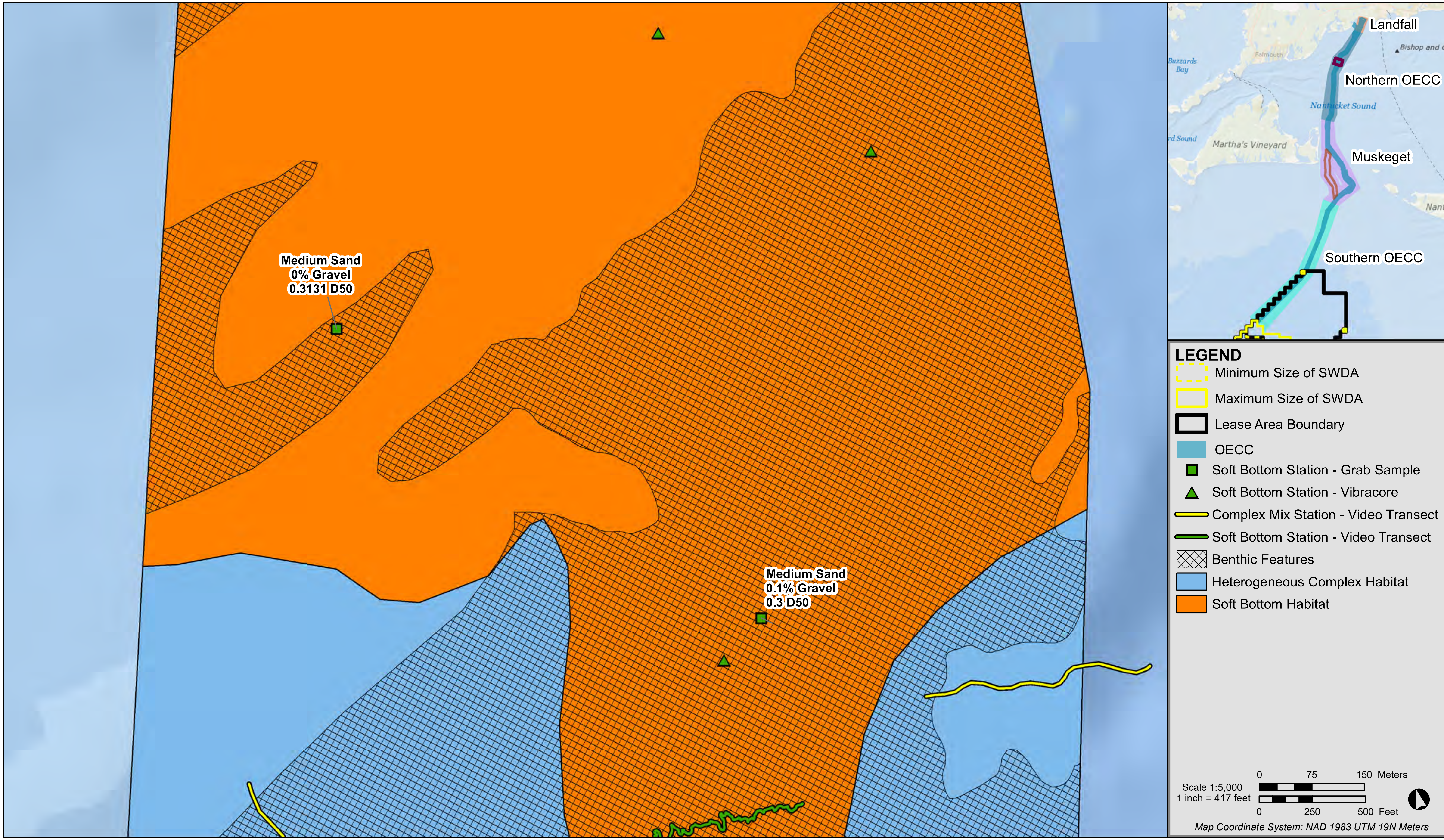

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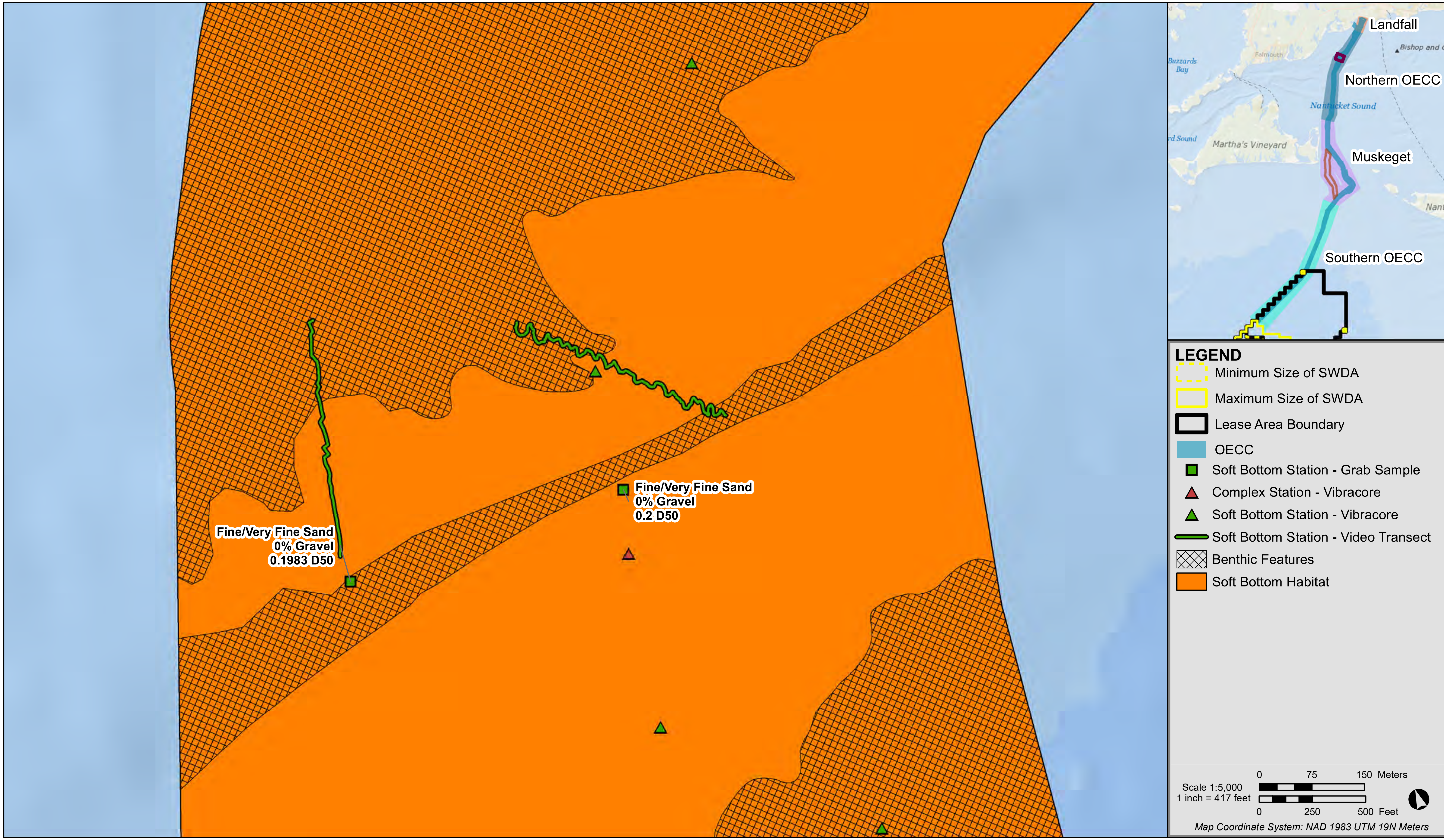

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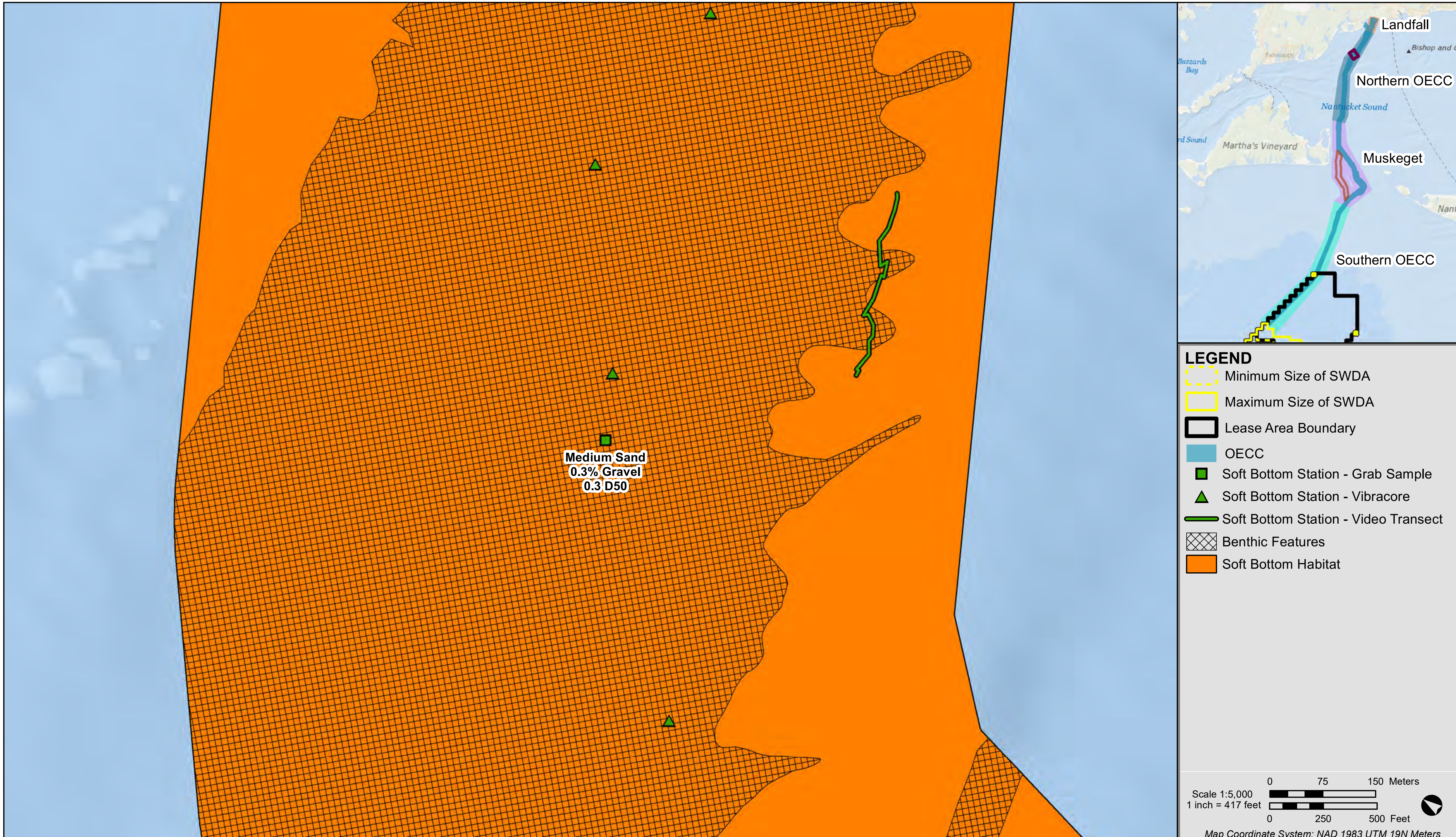

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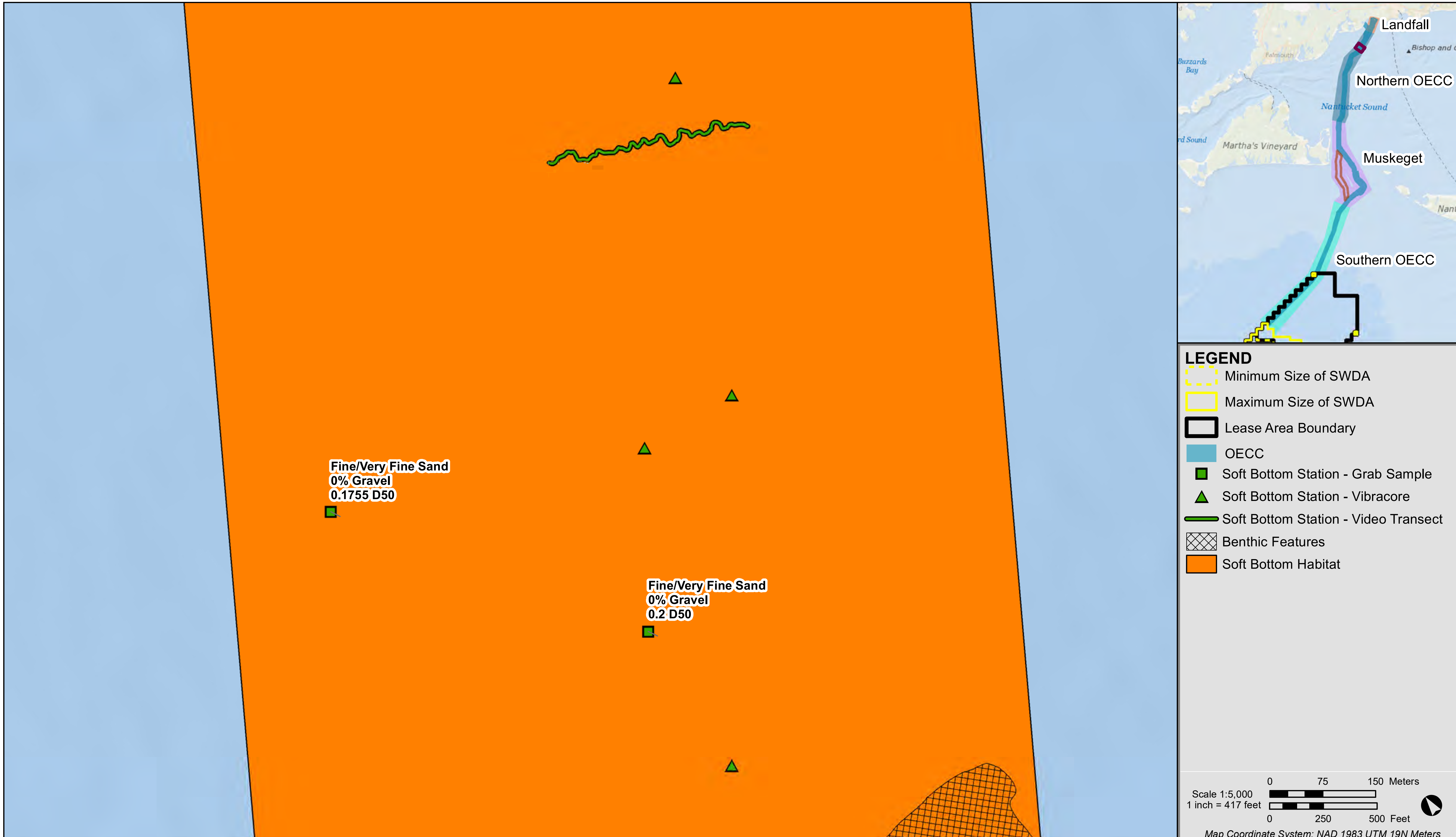

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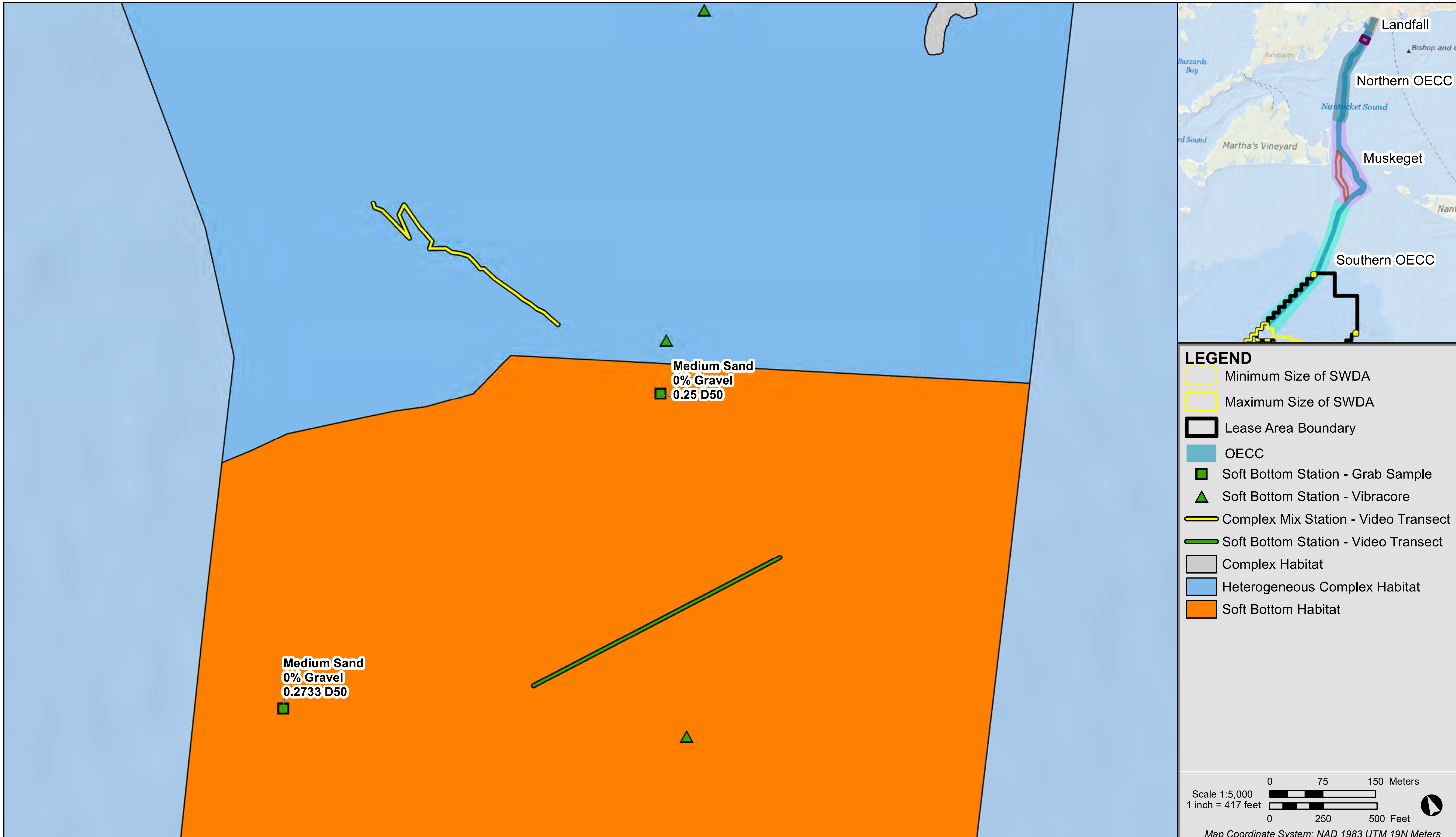

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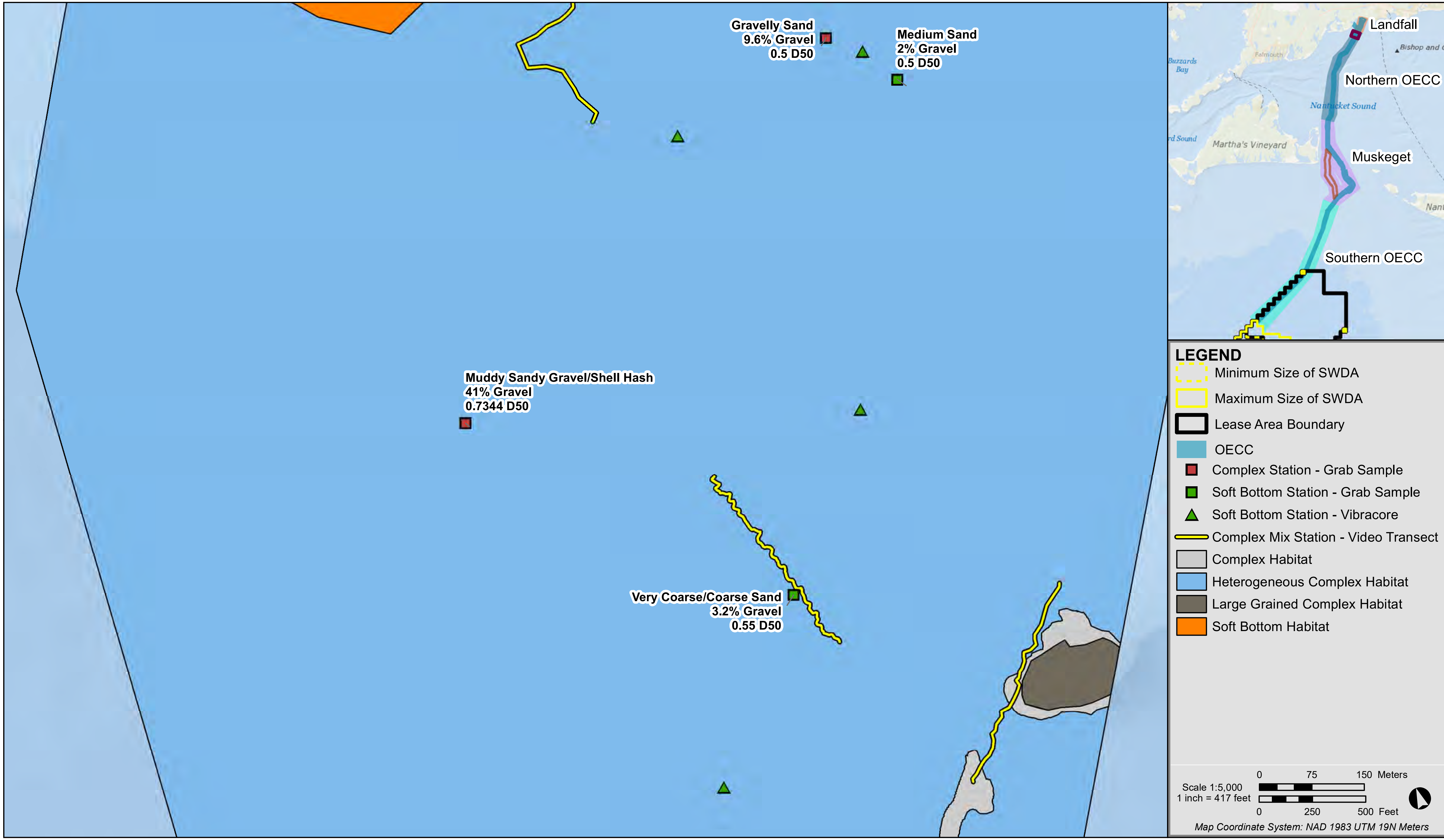

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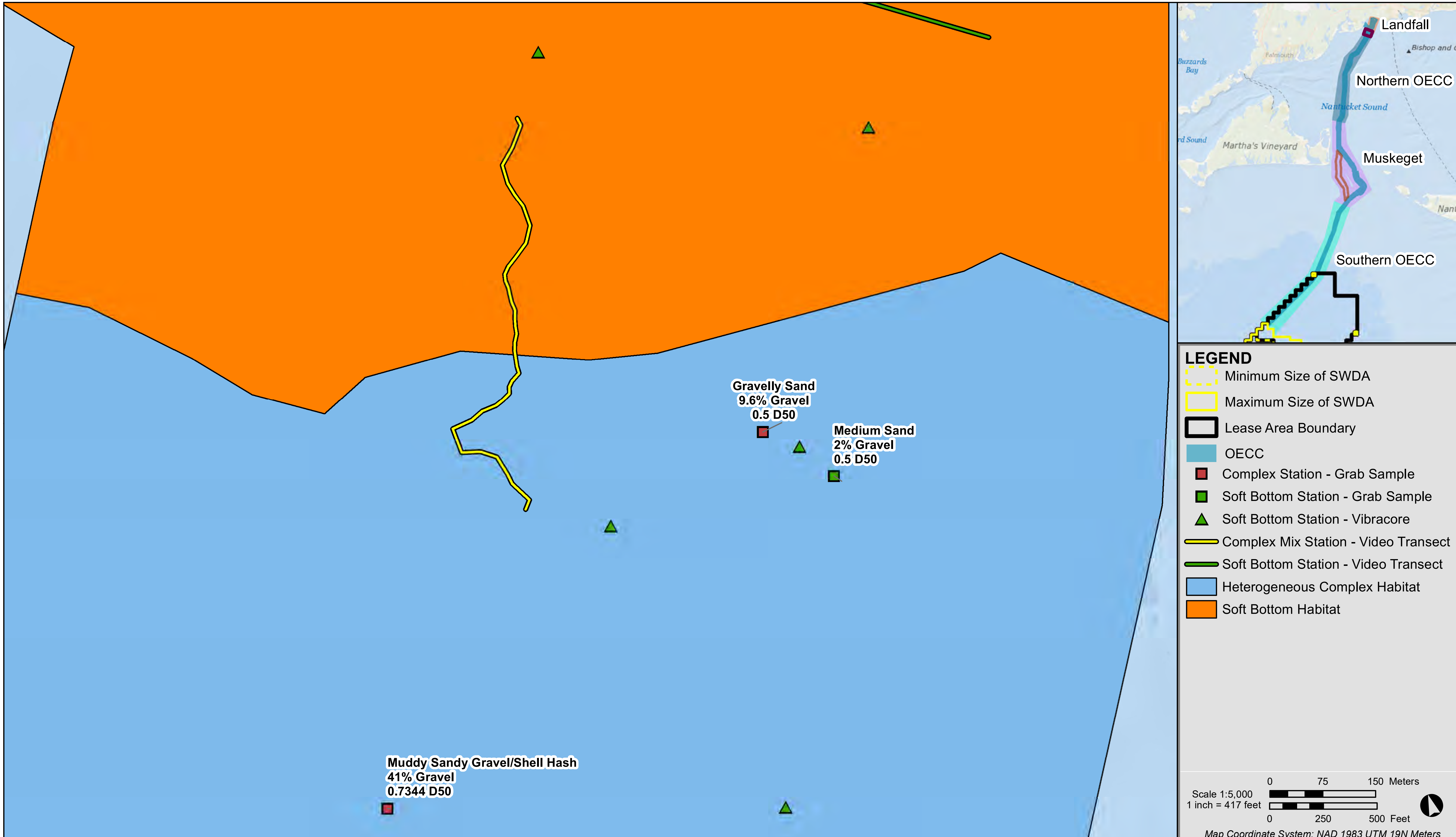

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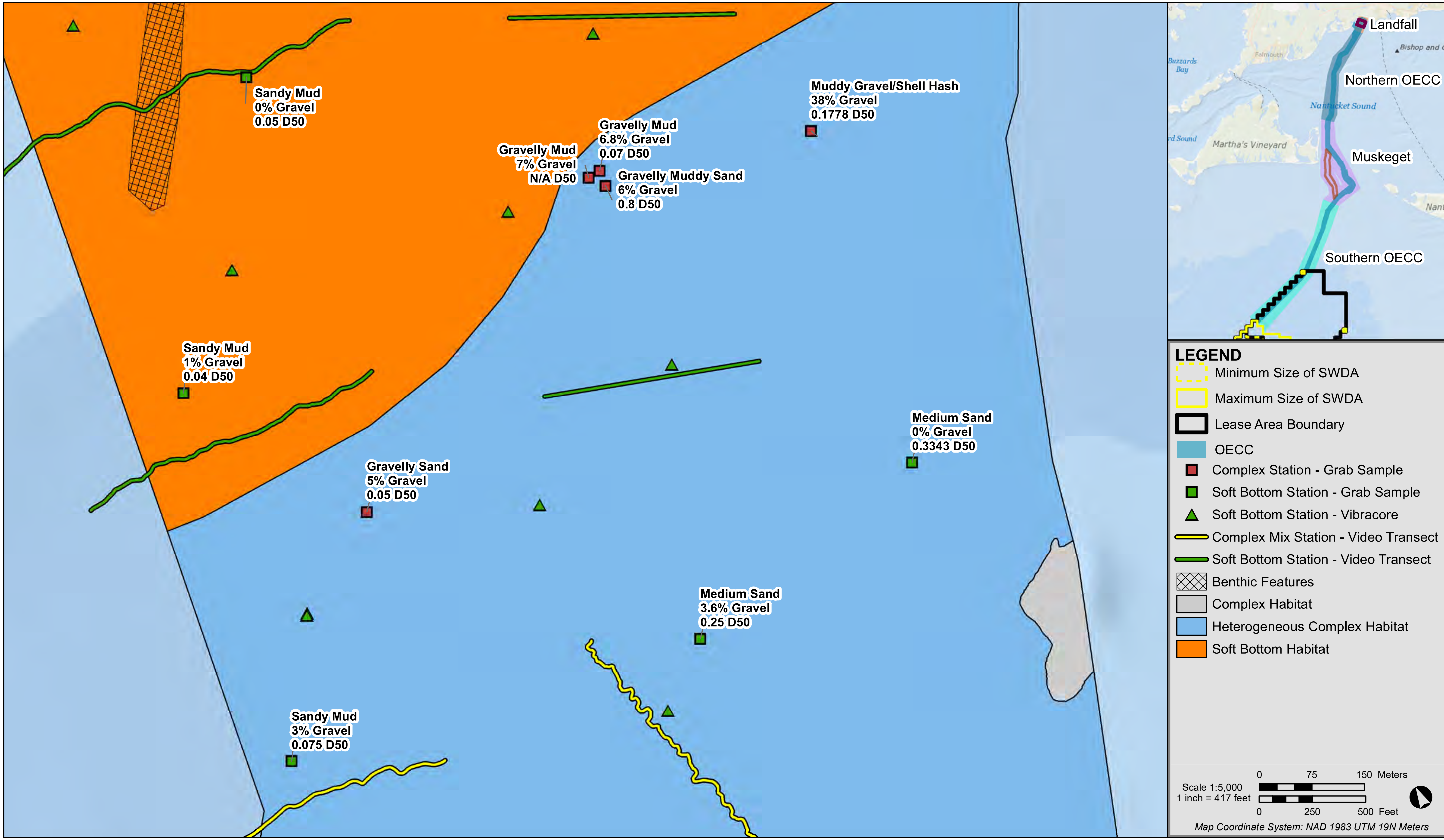

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