Essential Fish Habitat Assessment

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List of Abbreviations and Acronyms

Area ID	Announcement of Area Identification
BOEM	Bureau of Ocean Energy Management
CHIRP	compressed high-intensity radiated pulse
COP	Construction and Operations Plan
CPT	cone penetration test
dB	decibels
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ESA	Endangered Species Act
FMP	Fishery Management Plan
HAPC	Habitat Area of Particular Concern
HRG	high-resolution geophysical
MAFMC	Mid-Atlantic Fishery Management Council
MFCMA	Magnuson Fishery Conservation and Management Act of 1976
MMS	Marine Minerals Service
NEFMC	New England Fishery Management Council
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NY Bight	New York Bight
OCS	Outer Continental Shelf
ROW	right-of-way
RUE	right-of-use and easement
SAV	submerged aquatic vegetation
USACE	U.S. Army Corps of Engineers
WEA	Wind Energy Area
YOY	young-of-the-year

E.1 Introduction

Relevant regulations regarding Essential Fish Habitat (EFH) include the Magnuson Fishery Conservation and Management Act of 1976 (MFCMA); Magnuson-Stevens Conservation and Management Act of 1996 (Magnuson-Stevens) and Sustainable Fisheries Act; and Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006.

The MFCMA established the Fishery Management Councils and mandates the preparation of Fishery Management Plans (FMPs) for important fishery resources within the Exclusive Economic Zone (EEZ) in U.S. waters. The Mid-Atlantic Fishery Management Council (MAFMC) and New England Fishery Management Council (NEFMC) prepare FMPs covering the Central Atlantic Wind Auction (CAWA). The 1996 reauthorization of the MFCMA added a requirement for the description of EFH and definitions of overfishing.

"**Essential Fish Habitat**" as defined in the Magnuson-Stevens Act includes "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The final rules promulgated by the National Marine Fisheries Service (NMFS) in 2002 (50 Code of Federal Regulations [CFR] §§600.805 to 600.930) further clarify EFH with the following definitions: "**waters**" refers to aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "**substrate**" refers to sediment, hardbottom, structures underlying the waters, and associated biological communities; "**necessary**" refers to the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "**spawning, breeding, feeding, or growth to maturity"** refers to stages representing a species' full life cycle.

The purpose of this assessment is to evaluate if the Proposed Action would have an "**adverse effect**" on EFH in the proposed Wind Energy Areas (WEAs). The final EFH rules define an adverse effect as follows:

> [A]ny impact which reduces quality and/or quantity of EFH...[and] may include direct or indirect physical, chemical, or biological alterations of the waters or substrate, and loss of, or injury to, benthic organisms, prey species and their *habitat, and other ecosystem components if such modifications reduce the* quantity and/or quantity of EFH. Adverse effects to EFH may result from action occurring within EFH or outside of EFH and may include specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions.

E.2 Proposed Action and Geographic Location

On July 31, 2023, the Bureau of Ocean Energy Management (BOEM) released the Announcement of Area Identification (Area ID) (BOEM 2023a). The Area ID Memorandum documents the analysis and rationale used to develop the WEAs in the Central Atlantic. The Central Atlantic is an offshore area extending generally south from offshore Delaware to Cape Hatteras, North Carolina. BOEM has identified three final WEAs in the Central Atlantic and has deferred WEA identification within a fourth deepwater WEA. BOEM partnered with the National Centers for Coastal Ocean Science (NCCOS) to compile best available data and develop spatial models to identify suitable areas for offshore wind energy in the region (NCCOS 2023).

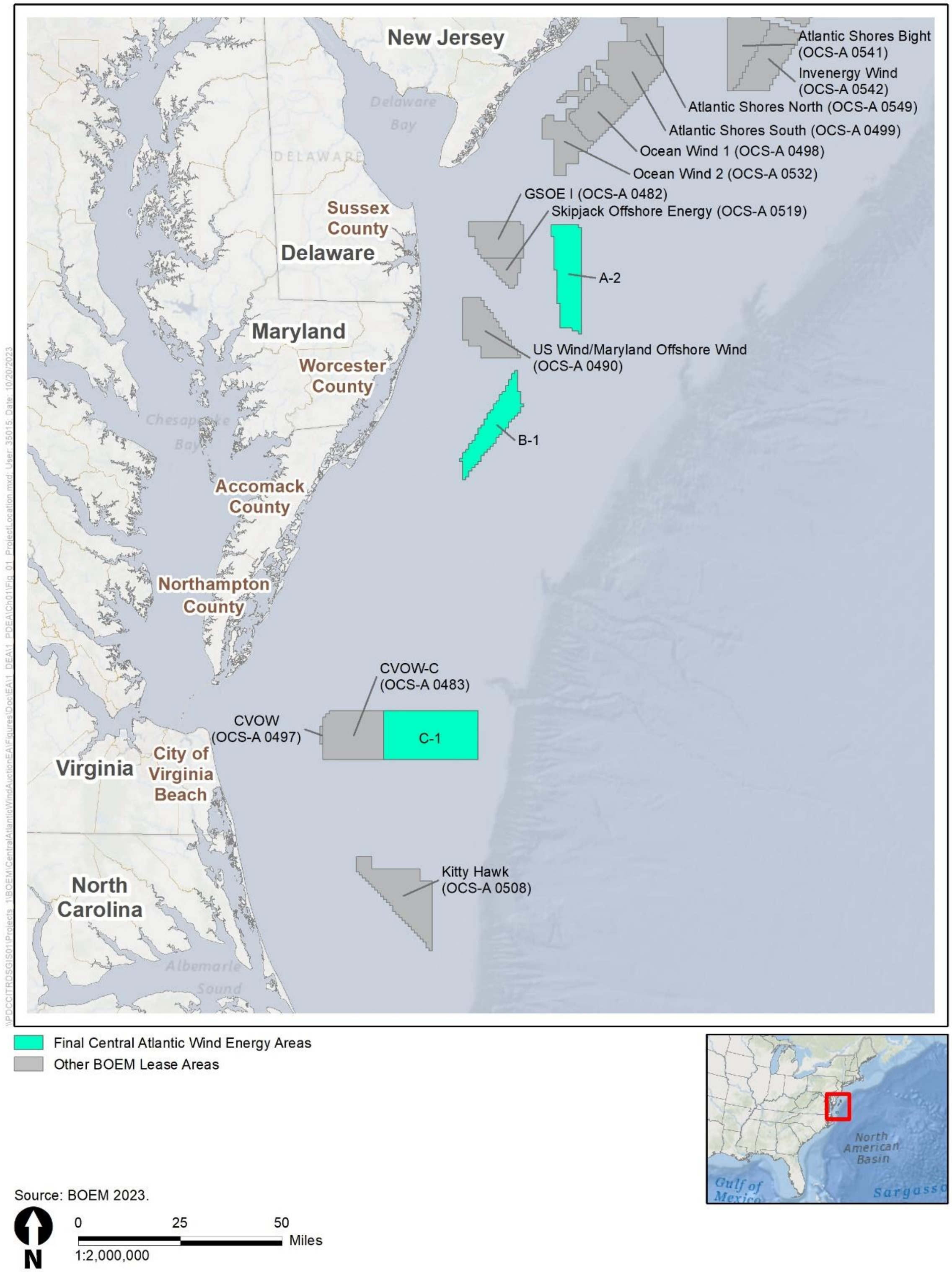
The purpose of the Proposed Action is to issue commercial leases within the WEAs and granting of rights-of-way (ROWs) and rights-of-use and easement (RUEs) in the region of the Outer Continental Shelf (OCS) of the Central Atlantic. BOEM's issuance of these leases and grants is needed to (1) confer the exclusive right to submit plans to BOEM for potential development, such that the lessees and grantees develop plans for BOEM's review and will commit to site characterization and site assessment activities necessary to determine the suitability of their leases and grants for commercial offshore wind production and/or transmission; and (2) impose terms and conditions intended to ensure that site characterization and assessment activities are conducted in a safe and environmentally responsible manner. The issuance of a lease by BOEM to the lessee conveys no right to proceed with development of a wind energy facility; the lessee acquires only the exclusive right to submit a plan to conduct this activity.

Based on the process described in the Area ID Memorandum (BOEM 2023), the WEAs considered in this Environmental Assessment (EA) are described in **Table E-1** and depicted in **Figure E-1**. For the purposes of impact assessment, BOEM is assuming lease areas of approximately 80,000 acres each, which, based on the acreage of the three WEAs, would correspond to four lease areas: one in WEA A-2, one in WEA B-1, and two in WEA C-1. BOEM has deferred WEA identification in deepwater areas at this time.

Table E-1. Central Atlantic Wind Energy Areas (WEAs) descriptive statistics

Parameter	A-2	B-1	C-1	Total
Acres	101,769	78,283	176,493	356,545
Maximum depth (m)	48	40	148	N/A
Minimum depth (m)	27	21	25	N/A
Closest distance to Delaware (nm)	26.4	24.5	87.2	N/A
Closest distance to Maryland (nm)	28.9	18.9	61.1	N/A
Closest distance to Virginia (nm)	43.4	19.0	30.9	N/A
Closest distance to North Carlina (nm)	128.3	89.9	35.4	N/A

m = meter; N/A = not applicable; nm = nautical mile



Source: BOEM 2023b

Figure E-1. Central Atlantic Wind Energy Areas

The Proposed Action for this assessment is to offer for lease all or some of the WEAs described above (**Table E-1; Figure E-1**) for commercial wind energy development and to grant ROWs and RUEs in support of wind energy development. Under the Proposed Action, BOEM would potentially issue leases that may cover the entirety of the WEAs, issue easements associated with each lease, and issue grants for subsea cable corridors and associated offshore collector/converter platforms. The ROWs, RUEs, and potential easements would all be located within the Central Atlantic and may include corridors that extend from the WEAs to the onshore energy grid. This Draft EA analyzes the reasonably foreseeable effects of activities that are anticipated to occur from the Proposed Action, including site assessment activities on leases and site characterization activities on the leases, grants, and potential easements. Site assessment activities would most likely include the temporary placement of meteorological (met) buoys and oceanographic devices. Activities included within the Proposed Action of this Draft EA do not include the installation of met towers, as met buoys have become the preferred metocean data collection platform for developers. Site characterization activities would most likely include geophysical, geotechnical, and biological surveys.

Table E-2. High-resolution geophysical survey equipment and methods

Equipment Type	Data Collection and/or Survey Types	Description of the Equipment	Line Spacing
Bathymetry/ depth sounder (multi-beam echosounder)	Bathymetric charting	A depth sounder is a microprocessor-controlled, high-resolution survey-grade system that measures precise water depths in both digital and graphic formats. The system would be used in such a manner as to record with a sweep appropriate to the range of water depths expected in the survey area. This assessment assumes the use of multi-beam bathymetry systems, which may be more appropriate than other tools for characterizing those WEAs containing complex bathymetric features or sensitive benthic habitats, such as hardbottom areas.	The lessee would likely use a multi-beam echosounder at a line spacing appropriate to the range of depths expected in the survey area.
Magnetometer	Collection of geophysical data for shallow hazards and archaeological resources assessments	Magnetometer surveys would be used to detect and aid in the identification of ferrous or other objects having a distinct magnetic signature. The magnetometer sensor is typically towed as near as possible to the seafloor and anticipated to be no more than approximately 6 m above the seafloor.	For the collection of geophysical data for shallow hazards assessments (including magnetometer, side-scan sonar, and seabed profiler systems), BOEM recommends surveying at a 150-m line spacing. For the collection of geophysical data for archaeological resources assessments (including magnetometers, side-scan sonar, and all seabed profiler systems), BOEM recommends surveying at a 30-m line spacing.

Equipment Type	Data Collection and/or Survey Types	Description of the Equipment	Line Spacing
Side-scan sonar	Collection of geophysical data for shallow hazards and archaeological resources assessments	This survey technique is used to evaluate surface sediments, seafloor morphology, and potential surface obstructions (MMS 2007). A typical side-scan sonar system consists of a top-side processor, tow cable, and towfish with transducers (or "pingers") located on the sides, which generate and record the returning sound that travels through the water column at a known speed. BOEM assumes that the lessee would use a digital dual-frequency side-scan sonar system with 300–500 kHz frequency ranges or greater to record continuous planimetric images of the seafloor.	For the collection of geophysical data for shallow hazards assessments (including magnetometer, side-scan sonar, and seabed profiler systems), BOEM recommends surveying at a 150-m line spacing. For the collection of geophysical data for archaeological resources assessments (including magnetometers, side-scan sonar, and all seabed profiler systems), BOEM recommends surveying at a 30-m line spacing.
Shallow and medium (seismic) penetration seabed profilers	Collection of geophysical data for shallow hazards and archaeological resources assessments and to characterize subsurface sediments	Typically, a high-resolution CHIRP System seabed profiler is used to generate a profile view below the bottom of the seabed, which is interpreted to develop a geologic cross-section of subsurface sediment conditions under the track line surveyed. Another type of seabed profiler that may be employed is a medium penetration system such as a boomer, bubble pulser, or impulse type system. Seabed profilers are capable of penetrating sediment depth ranges of 3 m to greater than 100 m, depending on frequency and bottom composition.	For the collection of geophysical data for shallow hazards assessments (including magnetometer, side-scan sonar, and sub-bottom profiler systems), BOEM recommends surveying at a 150-m line spacing. For the collection of geophysical data for archaeological resources assessments (including magnetometers, side-scan sonar, and all seabed profiler systems), BOEM recommends surveying at a 30-m line spacing.

BOEM = Bureau of Ocean Energy Management; CHIRP = Compressed High-Intensity Radiated Pulse; kHz = kilohertz; m = meter; MMS = Marine Minerals Service; WEA = Wind Energy Area.

Table E-3. Geotechnical/benthic sampling survey methods and equipment

Survey Method	Use	Description of the Equipment and Methods
Bottom-sampling devices	Penetrating depths from a few centimeters to several meters to obtain samples of soft surficial sediments	A piston core or gravity core is often used to obtain samples of soft surficial sediments. Unlike a gravity core, which is essentially a weighted core barrel that is allowed to free-fall through the water column into the sediments, piston cores have a "piston" mechanism that triggers when the corer hits the seafloor. The main advantage of a piston core over a gravity core is that the piston allows the best possible sediment sample to be obtained by avoiding disturbance of the sample (MMS 2007). Shallow-bottom coring employs a rotary drill that penetrates through several feet of consolidated rock. Drilling produces low intensity, low frequency sound through the drill string. The above sampling methods do not use high-energy sound sources (Continental Shelf Associates Inc. 2004; MMS 2007).
Vibracores	Obtaining samples of unconsolidated sediment; may, in some cases, also be used to gather information to inform the archaeological interpretation of features identified through the HRG survey (BOEM 2020b)	Vibracore samplers typically consist of a core barrel and an oscillating driving mechanism that propels the core barrel into the seabed. Once the core barrel is driven to its full length, the core barrel is retracted from the sediment and returned to the deck of the vessel. Typically, cores up to 6 m long with 8-cm diameters are obtained, although some devices have been modified to obtain samples up to 12 m long (MMS 2007; USACE 1987).
Deep borings	Sampling and characterizing the geological properties of sediments at the maximum expected depths of the structure foundations (MMS 2007)	A drill rig is used to obtain deep borings. The drill rig is mounted on a jack-up barge supported by four "spuds" that are lowered to the seafloor. Geologic borings can generally reach depths of 30–61 m within a few days (based on weather conditions). The acoustic levels from deep borings can be expected to be in the low frequency bands and below the 160 dB threshold established by NMFS to protect marine mammals (Erbe and McPherson 2017).
CPT	Supplementing or using in place of deep borings (BOEM 2020b)	A CPT rig would be mounted on a jack-up barge similar to that used for the deep borings. The top of a CPT drill probe is typically up to 8 cm in diameter, with connecting rods less than 15 cm in diameter.

BOEM = Bureau of Ocean Energy Management; cm = centimeter; CPT = cone penetration test; dB = decibels; HRG = high-resolution geophysical; m = meter; MMS = Marine Minerals Service; NMFS = National Marine Fisheries Service; USACE = U.S. Army Corps of Engineers.

Table E-4. Biological survey types and methods

Biological Survey Type	Survey Guidelines	Survey Method	Timing
Benthic habitat	BOEM. (2019a). Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585, Subpart F www.boem.gov/sites/default/files/renewable-energy-program/Regulatory-Information/BOEM-Renewable-Benthic-Habitat-Guidelines.pdf NMFS. (2021a). Updated Recommendations for Mapping Fish Habitat. March 29th, 2021. https://media.fisheries.noaa.gov/2021-03/March292021_NMFS_Habitat_Mapping_Recommendations.pdf?null	Bottom sediment/fauna sampling and underwater imagery/sediment profile imaging (sampling methods described above under geotechnical surveys)	Concurrent with geotechnical/benthic sampling
Avian	BOEM. (2020a). Guidelines for Providing Avian Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 www.boem.gov/sites/default/files/documents/newsroom/Avian%20Survey%20Guidelines.pdf	Visual surveys from a boat	10 OCS blocks per day (Thaxter and Burton 2009); monthly for 2–3 years
		Plane-based aerial surveys	2 days per month for 2–3 years
Bats	None	Ultrasonic detectors installed on survey vessels being used for other biological surveys	Monthly for 3 months per year between March and November

Biological Survey Type	Survey Guidelines	Survey Method	Timing
Marine fauna (marine mammals, fish, and sea turtles)	BOEM. (2019b). Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 www.boem.gov/sites/default/files/renewable-energy-program/Regulatory-Information/BOEM-Fishery-Guidelines.pdf BOEM. (2019c). Guidelines for Providing Information on Marine Mammals and Sea Turtles for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 www.boem.gov/sites/default/files/renewable-energy-program/Regulatory-Information/BOEM-Marine-Mammals-and-Sea-Turtles-Guidelines.pdf	Plane-based and/or vessel surveys—may be concurrent with other biological surveys, but would not be concurrent with any geophysical or geotechnical survey work	2 years of survey to cover spatial, temporal, and inter-annual variance in the area of potential effect
General Guidelines	BOEM. 2019. Survey Guidelines For Renewable Energy Development https://www.boem.gov/renewable-energy/survey-guidelines-renewable-energy-development BOEM. 2016a. Mid Atlantic Regional Ocean Action Plan https://www.boem.gov/sites/default/files/environmental-stewardship/Mid-Atlantic-Regional-Planning-Body/Mid-Atlantic-Regional-Ocean-Action-Plan.pdf	---	---

BOEM = Bureau of Ocean Energy Management; OCS = Outer Continental Shelf.

The timing of lease issuance, as well as weather and sea conditions, would be the primary factors influencing timing of site characterization and site assessment survey activities. Under the reasonably foreseeable site characterization scenario, the sale date is planned for July 24, 2024, and the final sale notice is to be published 45 days prior. BOEM could issue leases as early as mid- to late-2024 and continue through 2025. It is assumed lessees would begin survey activities as soon as possible after receiving a lease and preparing a Site Assessment Plan and a Survey Plan, and when sea states and weather conditions allow for site characterization and site assessment survey activities. The most suitable sea states and weather conditions would occur from April to August (Atlantic Renewable Energy Corporation and AWS Scientific Inc. 2004). For leases issued in 3Q 2024, the earliest surveys would likely begin no sooner than April 2024. Lessees have up to 5 years to perform site characterization activities before they must submit a Construction and Operations Plan (COP) (30 CFR §585.235(a)(2)). For leases issued in 4Q 2024, those lessees' surveys could continue through August 2029 prior to submitting their COPs.

E.3 EFH Presence Within the WEAs

In this section, fish and invertebrate resources expected for the Central Atlantic WEAs are characterized using softbottom, hardbottom, and pelagic ecological/habitat categories. These habitat categories are described and further characterized for offshore, nearshore, and inshore areas when possible, with special attention given to habitats with the potential to have an higher level of sensitivity to possible impacts. Within each category the composition and distribution of key resources as well as important, but lesser-known taxa are described. Detailed information for federally managed species for the Mid-Atlantic Bight and southern New England may be found in NEFMC 2017.

Species composition in the Central Atlantic project area is dynamic, with species migrating into the area from northern and southern waters in response to seasonally changing water temperatures. Because many species distributions overlap between the Mid-Atlantic and New England shelf, the WEAs fall under the jurisdiction of two regional Fishery Management Councils: MAFMC and NEFMC. In addition to these regional councils, the NMFS Highly Migratory Species Management Division, Office of Sustainable Fisheries manages billfishes, Atlantic tunas, swordfish, and sharks within a broad geographic region that encompasses the WEAs (NMFS 2017).

The assessment herein relied on formal EFH descriptions for managed species and life stages provided by MAFMC and NEFMC (MAFMC 1998a, 1998b, 1998c, 1998d; NEFMC 2017). For highly migratory species, NMFS (2017) was consulted. All of these descriptions and information were accessed initially through the Greater Atlantic Regional Fisheries Office, Habitat Conservation Division EFH habitat mapper (NMFS). This data source provided geographical distribution of various life stages of managed species as well as links to the source documents mentioned above with formal EFH descriptions. Tables were prepared listing those species and life stages whose EFH overlapped the area of interest. More comprehensive information on life history and distribution of these managed species may be found in Able and Fahy (2010), BOEM (2014), and NEFMC and NMFS (2017).

The area of interest includes EFH by life stage for 40 managed species, including 5 invertebrate taxa (**Table E-5**), 15 elasmobranch species (sharks, rays, and skates; **Table E-6**), and 20 bony fish taxa (**Table E-7**). EFH for all life stages of Atlantic sea scallop (*Placopecten magellanicus*) and inshore squid (*Doryteuthis pealeii*) are present in the project area (**Table E-5**). The pelagic inshore squid deposits egg masses on the seafloor (**Table E-5**). Atlantic sea scallops are bottom-dwelling as adults but have pelagic eggs and larvae. The bottom-dwelling ocean quahog (*Arctica islanida*) and Atlantic surfclam also release eggs into the water column, but information on egg and larval distribution is not available (**Table E-5**). Information on neonate (newborn) EFH for several shark species (e.g., common thresher, shortfin mako) is lacking for the project area, but EFH is present for neonate/juvenile sandbar shark, sand tiger shark, blue shark, dusky shark, Atlantic angel shark, tiger shark, and spiny dogfish (**Table E-6**). Skates deposit eggs on the seafloor in the project area, although little is known about habitat preferences for eggs or deposition sites. Juveniles and adults of all skate species are present in the area (**Table E-6**). EFH for all life stages (eggs, larvae, juveniles, adults) from 9 of the 20 bony fish species listed in **Table E-7** are present in the project area. Only adult and/or juvenile EFH for albacore tuna, Atlantic herring, bluefin tuna, haddock, scup, skipjack tuna, and yellowfin tuna are documented in the project area (**Table E-7**). Most of the bony fish species have pelagic eggs and larvae.

In addition to species managed under MFCMA, other National Oceanic and Atmospheric Administration (NOAA) Trust Resources—such as American lobster (*Homarus americanus*), Jonah crab (*Cancer borealis*), horseshoe crab (*Limulus polyphemus*), Atlantic menhaden (*Brevoortia tyrannus*), weakfish (*Cynoscion regalis*), American shad (*Alosa sapidissima*), river herrings (*Alosa* spp.), and Atlantic striped bass (*Morone saxatilis*)—occur in the region. These species are managed by the Atlantic States Marine Fisheries Commission. Ecologically important prey species—such as bay anchovy (*Anchoa mitchilli*), killifishes (*Fundulus* spp.), Atlantic silversides (*Menidia menidia*), sand lances (*Ammodytes* spp.), and juveniles of some managed species—are present in the inshore habitats. Analyses of impacts on managed species and EFH will nominally include these additional NOAA Trust Resources due to their economic and ecologic importance in the project area.

Spatially limited EFH called Habitat Areas of Particular Concern (HAPCs) have also been identified in the WEAs. HAPCs are selected using the following criteria:

- Importance of ecological function provided by the habitat.
- Extent to which the area or habitat is sensitive to human induced degradation.
- Whether and to what extent development activities are stressing the habitat.
- Rarity of the habitat type.

Based on these criteria, NEFMC (2017) selected as HAPCs several canyons that lie offshore of Delaware, Maryland, and Virginia including Baltimore, Wilmington, Washington, and Norfolk Canyons. These canyons occur offshore of the WEAs; however, additional HAPCs that are more relevant to sampling and assessment activities include (1) sand tiger shark (*Carcharias taurus*) pupping area in Delaware Bay; (2) sandbar shark (*Carcharhinus plumbeus*) nursery areas in Chesapeake Bay; (3) tilefish (*Lopholatilus chamaeleonticeps*) nursery areas near Norfolk Canyon; and (4) summer flounder (*Paralichthys dentatus*) submerged aquatic vegetation (SAV) nursery areas in all estuaries of the region including Chesapeake Bay and Delaware Bay. The map of HAPCs specific to individual species (**Figure E-2**) shows the potential range of where an HAPC could occur, but an HAPC is restricted to specific conditions within those ranges.

The formal descriptions of the specific conditions for sand tiger shark, sandbar shark, tilefish, and summer flounder HAPCs are as follows:

- **Sand tiger shark (Delaware Bay):** Lower portions of Delaware Bay to areas adjacent to the mouth of Delaware Bay for all life stages. The inshore extent of the HAPC reflects a line drawn from Port Mahon east to Egg Point Island (39°11’N lat.), and from Egg Point Island southeast to Bidwell Creek. The HAPC excludes an area rarely used by sand tiger sharks, which is north of a line between Egg Point Island and Bidwell Creek that includes Maurice Cove. The HAPC spans the mouth of Delaware Bay between Cape Henlopen and Cape May, and also includes adjacent coastal areas offshore of Delaware Bay and areas south (between the Indian River inlet and Cape Henlopen, Delaware).
- **Sandbar shark:** Constitutes important nursery and pupping grounds—which have been identified in shallow areas and at the mouth of Great Bay, New Jersey; in lower and middle Delaware Bay, Delaware; lower Chesapeake Bay, Maryland; and offshore of the Outer Banks, North Carolina—in water temperatures ranging from 15 to 30 degrees Celsius (°C); salinities at least from 15 to 35 parts per thousand (ppt); water depths ranging from 0.8 to 23 meters (m); and sand and mud habitats (NEFMC 2017).
- **Tilefish:** The continental slope off the Northeastern U.S. shelf is cut by more than 20 large canyons between Georges Bank and Cape Hatteras. The Norfolk Canyon is identified as tilefish HAPC and serves as a nursery (NEFMC 2017).
- **Summer flounder SAV nursery area:** 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. In locations where native species have been eliminated from an area, then exotic species are included (www.habitat.noaa.gov/apps/efhmapper/). Note that summer flounder SAV nursery area has not been formally mapped and therefore is not included in **Figure E-2**.

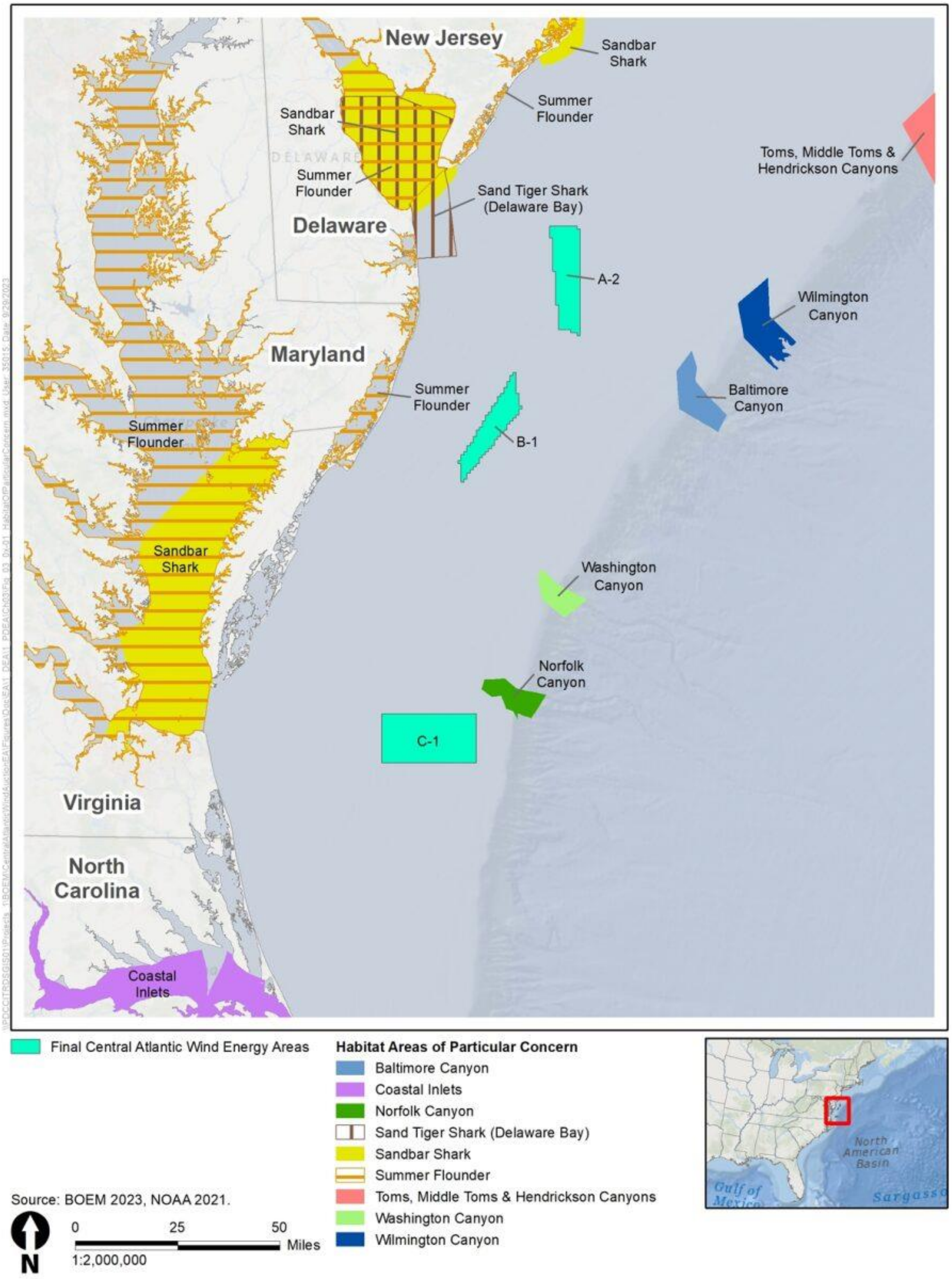


Figure E-2. Habitat Areas of Particular Concern and in the vicinity of the Central Atlantic Wind Energy Areas

Table E-5. Invertebrate species with EFH identified in the vicinity of the Central Atlantic

Species	Eggs/Larvae	Juveniles	Adults
Longfin inshore squid (*Doryteuthis pealeii*)	**Eggs**: Inshore and offshore bottom habitats from Georges Bank southward to Cape Hatteras, generally where bottom water temperatures are between 10–23°C, salinities are between 30–32 ppt, and depth is less than 50 m. Eggs have also been collected in bottom trawls in deeper water at various places on the continental shelf. Like most loliginid squids, *D. pealeii* egg masses or "mops" are demersal and anchored to the substrates on which they are laid, which include a variety of hardbottom types (e.g., shells, lobster pots, piers, fish traps, boulders, rocks), SAV (e.g., *Fucus* sp.), sand, and mud.	Pelagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, in the southwestern Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, and Raritan Bay. EFH for recruit longfin inshore squid is generally found where bottom depths are between 6 and 160 m, bottom water temperatures are 8.5–24.5°C, and salinities are 28.5–36.5 ppt. In the fall, pre-recruits migrate offshore, where they overwinter in deeper waters along the edge of the shelf. They make daily vertical migrations, moving up in the water column at night and down in the daytime. Small immature individuals feed on planktonic organisms, while larger individuals feed on crustaceans and small fish.	Pelagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, in inshore waters of the Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, Raritan Bay, and Delaware Bay. EFH for recruit longfin inshore squid is generally found where bottom depths are between 6 and 200 m, bottom water temperatures are 8.5–14°C, and salinities are 24–36.5 ppt. Recruits inhabit the continental shelf and upper continental slope to depths of 400 m. They migrate offshore in the fall and overwinter in warmer waters along the edge of the shelf. Like the pre-recruits, they make daily vertical migrations. Individuals larger than 12 cm feed on fish, and those larger than 16 cm feed on fish and squid. Females deposit eggs in gelatinous capsules, which are attached in clusters to rocks, boulders, and aquatic vegetation and on sand or mud bottom, generally in depths less than 50 m.
Northern shortfin squid (*Illex illecebrosus*)	N/A	Pelagic waters of the continental shelf from the Gulf of Maine through Cape Hatteras, North Carolina, from shore to 183 m water depths, where water temperatures range from 2.2–22.8°C.	Pelagic waters of the continental shelf from the Gulf of Maine through Cape Hatteras, North Carolina, from shore to 183 m water depths in temperatures ranging between 3.8 and 19°C.

Species	Eggs/Larvae	Juveniles	Adults
Atlantic sea scallop (*Placopecten magellanicus)*	**Eggs:** Benthic habitats in inshore areas and on the continental shelf in the vicinity of adult scallops. Eggs are heavier than seawater and remain on the seafloor until they develop into the first free-swimming larval stage. **Larvae:** Benthic and water column habitats in inshore and offshore areas throughout the region. Any hard surface can provide an essential habitat for settling pelagic larvae (“spat”), including shells, pebbles, and gravel. They also attach to macroalgae and other benthic organisms such as hydroids.	Benthic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic, in depths of 18–110 m. Juveniles (5–12 mm shell height) leave the original substrate on which they settle (see spat, adjacent) and attach themselves by byssal threads to shells, gravel, and small rocks (pebble, cobble), preferring gravel. Juvenile scallops are relatively active and swim to escape predation. While swimming, they can be carried long distances by currents. Bottom currents stronger than 10 cm/sec retard feeding and growth. Essential habitats for older juvenile scallops are the same as for the adults (gravel and sand).	Benthic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic. Essential habitats for adult sea scallops are found on sand and gravel substrates in depths of 18–110 m. In the Mid-Atlantic, they are found primarily between 45 and 75 m. They often occur in aggregations called beds, which may be sporadic or essentially permanent, depending on how suitable the habitat conditions are (temperature, food availability, and substrate) and whether oceanographic features (fronts, currents) exist in the area. Bottom currents stronger than 25 cm/sec (half a knot) inhibit feeding. Growth of adult scallops is optimal between 10 and 15°C in areas of normal salinity.
Surfclam (*Spisula solidissimus*)	N/A	Surfclam juveniles occur throughout the substrate, to a depth of 1 m below the water/sediment interface, within Federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ. Surfclams generally occur from the beach zone to a depth of about 61 m, but abundance is low beyond about 38 m.	See *Juveniles.*
Ocean quahog (*Arctica islandica*)	N/A	Throughout the substrate, to a depth of 1 m below the water/sediment interface, within Federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ. Distribution in the western Atlantic ranges in depths from 9.1 m to about 244 m. Ocean quahogs are rarely found where bottom water temperatures exceed 16°C.	See *Juveniles.*

Sources: MAFMC 1998b; 1998c; NEFMC 2017.
°C = degrees Celsius; cm = centimeter; cm/sec = centimeters per second; EEZ = Exclusive Economic Zone; m = meters; EFH = Essential Fish Habitat; MAFMC = Mid-Atlantic Fishery Management Council; mm = millimeter; N/A = not applicable; NMFS = National Marine Fisheries Service; ppt = parts per thousand; SAV = submerged aquatic vegetation.

Table E-6. Shark and skate species and life stages with EFH identified within the project area

Species	Neonate/ Early Juveniles	Late Juveniles/ Subadults	Adults
Atlantic angel shark (*Squatina dumeril*)	Neonate EFH in the Atlantic Ocean includes continental shelf habitats from Cape May, New Jersey to Cape Lookout, North Carolina.	Insufficient data are available to differentiate EFH between the juvenile and adult size classes; therefore, EFH is the same for those life stages. EFH in the Atlantic Ocean includes continental shelf habitats from Cape May, New Jersey to Cape Lookout, North Carolina.	See *Juveniles*.
Atlantic sharpnose shark Atlantic stock	N/A	EFH for juveniles extends from portions of the lower Chesapeake Bay (Virginia) to the mid-coast of Florida, with seasonal summer distribution in the northern part of the range.	EFH for adults extends from portions of Delaware Bay and Cape May, New Jersey, to the mid-coast of Florida, including portions of Chesapeake Bay, with seasonal summer distribution in the northern part of the range. Offshore depth extent for adults is 180 m.
Blacktip shark		Insufficient data are available to differentiate EFH between the juvenile and adult size classes; therefore, EFH is the same for those life stages. EFH is in the Atlantic coastal areas from Florida to the Maryland/Virginia line (northern extent of EFH is Chincoteague Island), including the mouth of Chesapeake Bay.	See *Late Juveniles*.
Common thresher shark (*Alopias vulpinus*)	Neonate EFH in the Atlantic includes continental shelf habitats from Cape May, New Jersey, to Cape Lookout, North Carolina.	Insufficient data are available to differentiate EFH between the juvenile and adult size classes; therefore, EFH is the same for those life stages. EFH is located in the Atlantic Ocean, from Georges Bank (at the offshore extent of the U.S. EEZ boundary) to Cape Lookout, North Carolina; and from Maine to locations offshore of Cape Ann, Massachusetts.	See *Late Juveniles*.
Shortfin mako *(Isurus oxyrinchus)*	See *Late Juveniles*.	Insufficient data are available for the identification of EFH by life stage; therefore, all life stages are combined in the EFH designation. EFH in the Atlantic Ocean includes pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank	See *Late Juveniles*.

Species	Neonate/ Early Juveniles	Late Juveniles/ Subadults	Adults
		(off Massachusetts) to Cape Cod (seaward of the 200-m bathymetric line).	
Sand tiger shark (*Carcharias taurus*)	Neonate EFH ranges from Massachusetts to Florida, specifically the Plymouth, Kingston, Duxbury Bay system, Sandy Hook, and Narragansett Bay, as well as coastal sounds, lower Chesapeake Bay, Delaware Bay (and adjacent coastal areas).	Juveniles EFH includes habitats between Massachusetts and New York (notably the Plymouth, Kingston, Duxbury Bay system), and between mid-New Jersey and the mid-east coast of Florida. EFH can be described via known habitat associations in the lower Chesapeake Bay and Delaware Bay (and adjacent coastal areas) where temperatures range from 19–25°C, salinities range from 23–30 ppt, and depths range from 2.8–7.0 m, and in sand and mud areas.	In the Atlantic along the mid-east coast of Florida (Cape Canaveral) through Delaware Bay. Important habitats include lower Chesapeake Bay and Delaware Bay (and adjacent coastal areas), where sand tiger sharks spend 95% of their time in waters between 17 and 23°C.
Sandbar shark (*Carcharhinus plumbeus)*	Atlantic coastal areas from Long Island, New York, to Cape Lookout, North Carolina. Important neonate/young-of-the-year EFH includes: Delaware Bay (Delaware and New Jersey) and Chesapeake Bay (Virginia and Maryland), where the nursery habitat is limited to the southeastern portion of the estuaries (salinity is greater than 20.5 ppt and depth is greater than 5.5 m); Great Bay, New Jersey. In all nursery areas between New York and North Carolina, EFH is associated with water temperatures ranging from 15–30°C; salinities ranging from 15–35 ppt; water depths ranging from 0.8–23 m; and sand, mud, shell, and rocky sediments/benthic habitat.	EFH includes coastal portions of the Atlantic Ocean between southern New England (Nantucket Sound, Massachusetts) and Georgia in water temperatures ranging from 20–24°C and depths from 2.4–6.4 m. Important nurseries include Delaware Bay, Delaware and New Jersey; Chesapeake Bay, Virginia; Great Bay, New Jersey; and the waters off Cape Hatteras, North Carolina. For all EFH, water temperatures range from 15–30°C; salinities range from 15–35 ppt; water depth ranges from 0.8–23 m; and substrate includes sand, mud, shell, and rocky habitats.	EFH in the Atlantic Ocean includes coastal areas from southern New England to the Florida Keys, ranging from inland waters of Delaware Bay and the mouth of Chesapeake Bay to the continental shelf break.

Species	Neonate/ Early Juveniles	Late Juveniles/ Subadults	Adults
Dusky shark (*Carcharhinus obscurus*)	EFH in the Atlantic Ocean includes offshore areas of southern New England to Cape Lookout, North Carolina. Specifically, EFH is associated with habitat conditions including temperatures from 18.1–22.2°C, salinities of 25–35 ppt, and depths at 4.3–15.5 m. Seaward extent of EFH for this life stage in the Atlantic is 60 m in depth.	Coastal and pelagic waters inshore of the continental shelf break (<200 m in depth) along the Atlantic East Coast from habitats offshore of southern Cape Cod to Georgia, including the Charleston Bump and adjacent pelagic habitats. Inshore extent for these life stages is the 20-m bathymetric line, except in habitats of southern New England, where EFH is extended seaward of Martha's Vineyard, Block Island, and Long Island. Pelagic habitats of southern Georges Bank and the adjacent continental shelf break from Nantucket Shoals and the Great South Channel to the eastern boundary of the U.S. EEZ. Adults are generally found deeper (to 2,000 m) than juveniles; however, there is overlap in the habitats utilized by both life stages.	See *Late Juveniles.*
Tiger shark (*Gaelocerdo cuvier*)	N/A	EFH in the Atlantic Ocean extends from offshore pelagic habitats associated with the continental shelf break at the seaward extent of the U.S. EEZ boundary (south of Georges Bank, off Massachusetts) to the Florida Keys, inclusive of offshore portions of the Blake Plateau.	See *Late Juveniles*.
Blue shark (*Prionace glauca*)	N/A	Localized areas in the Atlantic Ocean in the Gulf of Maine, from Georges Bank to North Carolina, South Carolina, Georgia, and off Florida.	See *Late Juveniles.*
Spiny dogfish (*Squalus acanthias*)	N/A	Pelagic and epibenthic habitats throughout the region. Sub-adult females are found over a wide depth range in full salinity seawater (32–35 ppt), where bottom temperatures range from 7–15°C. Sub-adult females are widely distributed throughout the region in the winter and spring, when water temperatures are lower, but very few remain in the Mid-Atlantic area in the summer and fall after water temperatures rise above 15°C.	See *Late Juveniles*.

Species	Neonate/ Early Juveniles	Late Juveniles/ Subadults	Adults
Smoothound shark Complex Atlantic stock	See *Late Juveniles*.	At this time, available information is insufficient for the identification of EFH for this life stage; therefore, all life stages are combined in the EFH designation. Smoothhound shark EFH identified in the Atlantic is exclusively for smooth dogfish. EFH in Atlantic coastal areas ranges from Cape Cod Bay, Massachusetts to South Carolina, inclusive of inshore bays and estuaries. EFH also includes continental shelf habitats between southern New Jersey and Cape Hatteras, North Carolina.	See *Late Juveniles*.
Clearnose skate (*Raja eglanteria*)	N/A	EFH for juvenile clearnose skates occurs from the shoreline to 30 m in depth, primarily on mud and sand, but also on gravelly and rocky bottom.	EFH for adult clearnose skates occurs from the shoreline to 40 m in depth, primarily on mud and sand, but also on gravelly and rocky bottom.
Little skate (*Leucoraja erinacea*)	N/A	EFH for juvenile little skates occurs on sand and gravel substrates, but they are also found on mud.	EFH for adult little skates occurs on sand and gravel substrates, but they are also found on mud.
Winter skate (*Leucoraja ocellata*)	N/A	EFH for juvenile winter skates occurs on sand and gravel substrates, but they are also found on mud.	EFH for adult winter skates occurs on sand and gravel substrates, but they are also found on mud.

Sources: MAFMC 2014; NMFS 2017.

°C = degrees Celsius; EEZ = Exclusive Economic Zone; EFH = Essential Fish Habitat; m = meters; MAFMC = Mid-Atlantic Fishery Management Council; N/A = not applicable; NMFS = National Marine Fisheries Service ppt = parts per thousand.

Table E-7. Bony fish species by life stages with EFH identified within project area

Species	Eggs and Larvae	Juveniles/Subadults	Adults
Monkfish (*Lophius americanus*)	**Eggs and Larvae:** Pelagic habitats in inshore areas, and on the continental shelf and slope throughout the region. Monkfish eggs are shed in very large buoyant mucoidal egg "veils." Monkfish larvae are more abundant in the Mid-Atlantic region and occur over a wide depth range, from the surf zone to depths of 1,000–1,500 m on the continental slope.	Sub-tidal benthic habitats in depths of 50–400 m in the Mid-Atlantic, between 20 and 400 m in the Gulf of Maine, and to a maximum depth of 1,000 m on the continental slope. A variety of habitats are essential for juvenile monkfish, including hard sand, pebbles, gravel, broken shells, and soft mud; they also seek shelter among rocks with attached algae. YOY juveniles have been collected primarily on the central portion of the shelf in the Mid-Atlantic, but also in shallow nearshore waters off eastern Long Island, up the Hudson Canyon shelf valley, and around the perimeter of Georges Bank. They have also been collected as deep as 900 m on the continental slope.	N/A
Atlantic herring (*Clupea harengus*)	N/A	Intertidal and sub-tidal pelagic habitats to 300-m depths throughout the region, including bays and estuaries. One- and two-year-old juveniles form large schools and make limited seasonal inshore-offshore migrations. Older juveniles are usually found in water temperatures of 3–15°C in the northern part of their range and as high as 22°C in the Mid-Atlantic. YOY juveniles can tolerate low salinities, but older juveniles avoid brackish water.	Sub-tidal pelagic habitats with maximum depths of 300 m throughout the region, including bays and estuaries. Adults make extensive seasonal migrations between summer and fall spawning grounds on Georges Bank and the Gulf of Maine and overwintering areas in southern New England and the Mid-Atlantic region. They seldom migrate beyond a depth of about 100 m and unless they are preparing to spawn, and they usually remain near the surface. They generally avoid water temperatures above 10°C and low salinities. Spawning takes place on the bottom, generally in depths of 5–90 m on a variety of substrates (see *Eggs*).

Species	Eggs and Larvae	Juveniles/Subadults	Adults
Scup (*Stenotomus chrysops*)	N/A	**Offshore:** EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina. **Inshore:** EFH includes "mixing" and "seawater" salinity zones of estuaries. In general during the summer and spring juvenile scup are found in estuaries and bays between Virginia and Massachusetts in association with various sands, mud, mussel, and eelgrass bed type substrates and in water temperatures greater than 7.2°C and salinities greater than 15 ppt.	**Offshore:** EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina. **Inshore:** EFH is the "mixing" and "seawater" salinity zones of estuaries. Generally, wintering adults (November through April) are usually offshore, south of New York to North Carolina, in waters above 7.2°C.
Black seabass (*Centropristis striatus*)	**Eggs:** EFH is the "mixing" and "seawater" salinity zones of estuaries. Generally, black seabass eggs are found from May through October on the continental shelf, from southern New England to North Carolina. **Larvae:** North of Cape Hatteras, EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina. Generally, the habitats for the transforming larvae (to juveniles) are near the coastal areas and into marine parts of estuaries between Virginia and New York. When larvae become demersal, they are generally found on structured inshore habitat such as sponge beds.	**Offshore:** EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina. **Inshore:** EFH is the "mixing" and "seawater" salinity zones of estuaries. Juveniles are found in the estuaries in the summer and spring. Generally, juvenile black seabass are found in waters warmer than 6°C with salinities greater than 18 ppt and coastal areas between Virginia and Massachusetts, but they winter offshore from New Jersey and south. Juvenile black seabass are usually found in association with rough bottom, shellfish, and eelgrass beds and human-made structures in sandy shelly areas; offshore clam beds and shell patches may also be used during the wintering.	**Offshore:** EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina. **Inshore:** EFH is estuaries. Black seabass are generally found in estuaries from May through October. Wintering adults (November through April) are generally offshore, south of New York to North Carolina. Temperatures above 6°C seem to be the minimum requirements. Structured habitats (natural and human-made), sand, and shell are usually the substrate preference.
Atlantic cod (*Gadus morhua*)	**Eggs:** Pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, and in the high salinity zones of the bays and estuaries.	N/A	N/A

Species	Eggs and Larvae	Juveniles/Subadults	Adults
	Larvae: Pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, and in the high salinity zones of bays and estuaries.		
Haddock (*Melanogrammus aeglefinus*)		Sub-tidal benthic habitats at depths between 40 and 140 m in the Gulf of Maine, on Georges Bank and in the Mid-Atlantic region, and as shallow as 20 m along the coast of Massachusetts, New Hampshire, and Maine. EFH for adult haddock occurs on hard sand (particularly smooth patches between rocks), mixed sand and shell, gravelly sand, and gravel. YOY juveniles settle on sand and gravel on Georges Bank, but are found predominantly on gravel pavement areas within a few months after settlement. As they grow, they disperse over a greater variety of substrate types on the bank. YOY haddock do not inhabit shallow, inshore habitats.	
Pollock (*Pollachius virens*)	**Larvae**: Pelagic inshore and offshore habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, including the bays and estuaries.		
Silver hake (*Merluccius bilinearis*)	**Eggs and Larvae:** Pelagic habitats from the Gulf of Maine to Cape May, New Jersey, including Cape Cod and Massachusetts Bays.	Pelagic and benthic habitats in the Gulf of Maine, including coastal bays and estuaries and on the continental shelf as far south as Cape May, New Jersey; at depths greater than 10 m in coastal waters in the Mid-Atlantic; and at depths between 40 and 400 m in the Gulf of Maine, on Georges Bank, and in the middle continental shelf in the Mid- Atlantic, on sandy substrates. Juvenile silver hake are found in	Pelagic and benthic habitats at depths greater than 35 m in the Gulf of Maine and coastal bays and estuaries; between 70 and 400 m on Georges Bank and the OCS in the northern portion of the Mid-Atlantic Bight; and in some shallower locations nearer the coast, on sandy substrates. Adult silver hake are often found in bottom depressions or in association with sand waves and shell fragments. They have also been observed at

Species	Eggs and Larvae	Juveniles/Subadults	Adults
		association with sand waves, flat sand with amphipod tubes and shells, and in biogenic depressions. Juveniles in the NY Bight settle to the bottom at mid-shelf depths on muddy sand substrates and find refuge in amphipod tube mats.	high densities in mud habitats bordering deep boulder reefs, resting on boulder surfaces, and foraging over deep boulder reefs in the southwestern Gulf of Maine. This species makes greater use of the water column (for feeding, at night) than red or white hake.
Red hake (*Urophycis chuss*)	**Eggs and Larvae:** Pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic, and in bays and estuaries.	Intertidal and sub-tidal benthic habitats throughout the region on mud and sand substrates to a maximum depth of 80 m, including bays and estuaries. Bottom habitats providing shelter are essential for juvenile red hake, including mud substrates with biogenic depressions, substrates providing biogenic complexity (e.g., eelgrass, macroalgae, shells, anemone, polychaete tubes), and artificial reefs. Newly settled juveniles occur in depressions on the open seabed. Older juveniles are commonly associated with shelter or structure and often inside live bivalves.	Benthic habitats in the Gulf of Maine and the OCS and slope in depths of 50 to 750 m and as shallow as 20 m in a number of inshore estuaries and embayments as far south as Chesapeake Bay. Shell beds, soft sediments (mud and sand), and artificial reefs provide essential habitats for adult red hake. They are usually found in depressions in softer sediments or in shell beds and not on open sandy bottom. In the Gulf of Maine, they are much less common on gravel or hardbottom, but they are reported to be abundant on hardbottoms in temperate reef areas of Maryland and northern Virginia.
Summer flounder (*Paralichthys dentatus*)	**Eggs:** North of Cape Hatteras, EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) from the Gulf of Maine to Cape Hatteras, North Carolina. In general, summer flounder eggs are found between October and May, and are most abundant between Cape Cod and Cape Hatteras, with the heaviest concentrations within 9 miles (14 km) of shore off New Jersey and New York. Eggs are most commonly collected at depths of 10–110 m. **Larvae:** North of Cape Hatteras, EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) from	North of Cape Hatteras, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ) from the Gulf of Maine to Cape Hatteras, North Carolina. In inshore waters EFH includes the “mixing” and “seawater” salinity zones of estuaries. In general, juveniles use several estuarine habitats as nursery areas, including salt marsh creeks, seagrass beds, mudflats, and open bay areas in water temperatures greater than 37°C and salinities ranging 10–30 ppt.	North of Cape Hatteras, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ) from the Gulf of Maine to Cape Hatteras, North Carolina. In inshore waters EFH is the “mixing” and “seawater” salinity zones of estuaries. Generally, summer flounder inhabit shallow coastal and estuarine waters during warmer months and move offshore on the OCS at depths of 150 m in colder months.

Species	Eggs and Larvae	Juveniles/Subadults	Adults
	the Gulf of Maine to Cape Hatteras, North Carolina, in nearshore waters (out to 80 km [50 miles] from shore). Inshore, EFH is the "mixing" (0.5–25.0 ppt) and "seawater" (>25 ppt) salinity zones of estuaries. In general, summer flounder larvae are most abundant nearshore (20–80 km [12-50 miles] from shore) at depths between 10 and 80 m. They are most frequently found in the northern part of the Mid-Atlantic Bight from September to February, and in the southern part from November to May.		
Windowpane flounder (*Scophthalmus aquosus*)	**Eggs and Larvae:** Pelagic habitats on the continental shelf from Georges Bank to Cape Hatteras and in mixed and high salinity zones of coastal bays and estuaries throughout the region.	Intertidal and sub-tidal benthic habitats in estuarine, coastal marine, and continental shelf waters from the Gulf of Maine to northern Florida, including mixed and high salinity zones in bays and estuaries. EFH for juvenile windowpane flounder is found on mud and sand substrates and extends from the intertidal zone to a maximum depth of 60 m. YOY juveniles prefer sand over mud.	Intertidal and sub-tidal benthic habitats in estuarine, coastal marine, and continental shelf waters from the Gulf of Maine to Cape Hatteras, including mixed and high salinity zones in bays and estuaries. EFH for adult windowpane flounder is found on mud and sand substrates and extends from the intertidal zone to a maximum depth of 70 m.
Witch flounder (*Glyptocephalus cynoglossus*)	Pelagic habitats on the continental shelf throughout the Northeast region.	Sub-tidal benthic habitats at depths between 50 and 400 m in the Gulf of Maine and as deep as 1,500 m on the OCS and slope, with mud and muddy sand substrates.	Sub-tidal benthic habitats at depths between 35 and 400 m in the Gulf of Maine and as deep as 1,500 m on the OCS and slope, with mud and muddy sand substrates.
Yellowtail flounder (*Pleuronectes ferruginea*)	**Eggs:** Coastal and continental shelf pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region as far south as the upper Delmarva peninsula, including the high salinity zones of bays and estuaries. **Larvae**: Coastal marine and continental shelf pelagic habitats in the Gulf of Maine, and from Georges Bank to Cape Hatteras, including the high salinity zones of bays and estuaries.	Sub-tidal benthic habitats in coastal waters in the Gulf of Maine and on the continental shelf on Georges Bank and in the Mid-Atlantic, including the high salinity zones of bays and estuaries. EFH for juvenile yellowtail flounder occurs on sand and muddy sand at depths between 20 and 80 m. In the Mid- Atlantic, YOY juveniles settle to the bottom on the continental	Sub-tidal benthic habitats in coastal waters in the Gulf of Maine and on the continental shelf on Georges Bank and in the Mid-Atlantic, including the high salinity zones of bays and estuaries. EFH for adult yellowtail flounder occurs on sand and sand with mud, shell hash, gravel, and rocks at depths between 25 and 90 m.

Species	Eggs and Larvae	Juveniles/Subadults	Adults
		shelf, primarily at depths of 40–70 m, on sandy substrates.	
Atlantic mackerel (*Scomber scombrus*)	**Eggs:** EFH for Atlantic mackerel eggs is generally found over bottom depths of 100 m or less with average water temperatures of 6.5 to 12.5°C in the upper 15 m of the water column. **Larvae:** EFH is pelagic habitats in inshore estuaries and embayments from Great Bay, New Hampshire, to the south shore of Long Island, New York, inshore and offshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina (mostly north of 38°N).	EFH is pelagic habitats in inshore estuaries and embayments from Great Bay, New Hampshire, to the south shore of Long Island, New York, inshore and offshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina (mostly north of 38°N).	EFH is pelagic habitats in inshore estuaries and embayments from Passamaquoddy Bay, Maine, to the Hudson River, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina. EFH for adult Atlantic mackerel is generally found over bottom depths less than 170 m and in water temperatures of 5–20°C.
Atlantic butterfish (*Peprilus triacanthus*)	**Eggs:** EFH for Atlantic butterfish eggs are generally found over bottom depths of 1,500 m or less, where average temperatures in the upper 200 m of the water column are 6.5–21.5°C. **Larvae:** EFH is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to the south shore of Long Island, New York, in Chesapeake Bay, and on the continental shelf and slope, primarily from Georges Bank to Cape Hatteras, North Carolina.	EFH is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound, North Carolina; inshore waters of the Gulf of Maine and the South Atlantic Bight; on Georges Bank; on the inner continental shelf south of Delaware Bay; and on the OCS from southern New England to South Carolina. EFH for adult Atlantic butterfish is generally found over bottom depths between 10 and 250 m, where bottom water temperatures are between 4.5 and 27.5°C and salinities are above 5 ppt.	See *Juveniles.*
Bluefish (*Pomatomus saltatrix*)	**Eggs:** North of Cape Hatteras, pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) at mid-shelf depths, from Montauk Point, New York, south to Cape Hatteras in the pelagic waters over the continental shelf (from the coast out to the eastern wall of the Gulf Stream). Bluefish eggs are generally not collected in estuarine waters, and thus there is no EFH designation inshore.	North of Cape Hatteras, pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) from Nantucket Island, Massachusetts, south to Cape Hatteras, North Carolina. Atlantic estuaries from May through October, and South Atlantic estuaries March through December, within the "mixing" and "seawater" zones.	North of Cape Hatteras, over the continental shelf (from the coast out to the limits of the EEZ) from Cape Cod Bay, Massachusetts, south to Cape Hatteras.

Species	Eggs and Larvae	Juveniles/Subadults	Adults
	Generally, bluefish eggs are collected from April through August in temperatures greater than 18°C and normal shelf salinities (>31 ppt). **Larvae:** North of Cape Hatteras, pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) most commonly above 15 m, from Montauk Point south to Cape Hatteras.		
Albacore tuna (*Thunnus alalunga*)	N/A	Offshore, pelagic habitats of the Atlantic Ocean from the outer edge of the U.S. EEZ through Georges Bank to pelagic habitats south of Cape Cod, and from Cape Cod to Cape Hatteras, North Carolina.	N/A
Bluefin tuna (*Thunnus thynnus*)	This life stage has been expanded into two areas of the Slope Sea (off the shelf between North Carolina and Georges Bank, north of the Gulf Stream) due to the presence of extremely young larvae. One area encompasses pelagic habitats on and off the continental shelf (off the coast of North Carolina) and extends to the shoreline between the North Carolina/Virginia line and Oregon Inlet. The other area includes pelagic waters of the Slope Sea, extending to the outer United States' EEZ south of Georges Bank.	Coastal and pelagic habitats of the Mid-Atlantic Bight and the Gulf of Maine, between southern Maine and Cape Lookout, from shore (excluding Long Island Sound, Delaware Bay, Chesapeake Bay, and Pamlico Sound) to the continental shelf break. EFH in coastal areas of Cape Cod are located between the Great South Passage and shore. EFH follows the continental shelf from the outer extent of the U.S. EEZ on Georges Bank to Cape Lookout. EFH is associated with certain environmental conditions in the Gulf of Maine (16–19°C; 0–40 m deep). EFH in other locations associated with temperatures ranging from 4–26°C, often in depths of less than 20 m (but can be found in waters that are 40–100 m in depth in winter).	EFH is located in offshore and coastal regions of the Gulf of Maine from the mid-coast of Maine to Massachusetts; on Georges Bank; offshore pelagic habitats of southern New England; and from southern New England to coastal areas between the mouth of Chesapeake Bay and Onslow Bay, North Carolina.

Species	Eggs and Larvae	Juveniles/Subadults	Adults
Yellowfin tuna (*Thunnus albacares*)	N/A	Offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank and Cape Cod, Massachusetts. Offshore and coastal habitats from Cape Cod to the mid-east coast of Florida and the Blake Plateau.	See *Juveniles.*
Skipjack tuna (*Katsuwonus pelamis*)	N/A	Offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary and the seaward margin of Georges Bank (off Massachusetts); coastal and offshore habitats between Massachusetts and South Carolina.	Coastal and offshore habitats between Massachusetts and Cape Lookout, North Carolina, and localized areas in the Atlantic off South Carolina and Georgia, as well as the northern east coast of Florida.

Sources: MAFMC 1998c; 1998d; 2011; 2014; NEFMC 2017; NMFS 2017.
°C = degrees Celsius; EEZ = Exclusive Economic Zone; EFH = Essential Fish Habitat; km = kilometers; m = meters; MAFMC = Mid-Atlantic Fishery Management Council; N/A = not applicable; NEFMC = New England Fishery Management Council; NMFS = National Marine Fisheries Service; OCS = Outer Continental Shelf; ppt = parts per thousand; YOY = young-of-the-year.

E.4 Analysis of Effects

The purpose of this section is to evaluate if the Proposed Action would have an adverse effect on EFH, including managed and associated species, at the WEAs and potential transmission cable routes. The EFH rules define an adverse effect as "any impact which reduces quality and/or quantity of EFH...[and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction in species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions."

Three types of habitat are included in this analysis: soft bottom benthic, hardbottom benthic, and pelagic (water column). As mentioned above, site assessment activities would most likely include the temporary placement of metocean buoys. Site characterization activities would most likely include geophysical and geotechnical, biological, and oceanographic surveys. Impacts of high-resolution geophysical (HRG) surveys on the water column habitat would be localized and transient, with no significant adverse effect on EFH for any pelagic species. Minor disturbance of soft bottom benthic habitats is expected where met buoys are placed and where geotechnical (bottom samples, deep borings, vibracores, cone penetrometers) and biological sampling (e.g., benthic grabs, bottom trawls, gillnets, ventless traps) may occur. Potential adverse effects resulting from habitat modification and/or loss are expected to be minor due to the small spatial footprint of these activities and rapid re-colonization time of benthic species located in shallow (<20 m) habitats (Newell et al. 1998, Bolam and Rees 2003). Hardbottom habitats would be avoided through the site selection and mapping process, and no adverse effects on these habitats are anticipated.

Equipment used during site characterization and site assessment activities (e.g., towed HRG survey equipment, cone penetration test [CPT] components, grab sampler, buoys, lines, cables) could be accidentally lost during survey operations. Additionally, it is possible (although unlikely) that the met buoy could disconnect from the clump anchor. In the event of lost equipment, recovery operations may be undertaken to retrieve the equipment. Recovery operations may be performed in a variety of manners depending on the equipment lost. A commonly used method for retrieval of lost equipment on the seafloor is through dragging grapnel lines (e.g., hooks, trawls). A single vessel deploys a grapnel line to the seafloor and drags it along the bottom until it catches the lost equipment, which is then brought to the surface for recovery. This process can result in significant bottom disturbances as it requires dragging the grapnel line along the bottom until it hooks the lost equipment, which may require multiple passes in a given area. In addition to dragging a grapnel line along the bottom, after the line catches the lost equipment, it would drag all the components along the seafloor until recovery.

Where lost survey equipment is not able to be retrieved because it is either small, buoyant enough to be carried away by currents, or is completely or partially embedded in the seafloor (for example, a broken vibracore), the equipment may become a potential hazard for bottom-tending fishing gear or cause additional bottom disturbance. For example, a broken vibracore that cannot be retrieved may need to be cut and capped 1 to 2 m below the seafloor. For the recovery of lost survey equipment, BOEM will work with the lessee/operator to develop an emergency response plan. Selection of a mitigation strategy will depend on the nature of the lost equipment, and further consultation may be necessary.

BOEM assumes that during site characterization, a lessee would survey potential transmission cable routes (for connecting future wind turbines to an onshore power substation) from the WEAs to shore using similar site assessments to those described above. BOEM assumes that survey grids for a proposed transmission cable route to shore would likely occur over a 1,000-m-wide corridor centered on the potential transmission cable location. These cable routes would traverse inshore habitats, but at present specific locations are not known. Inshore habitats (soft bottom, SAV, emergent vegetation including salt marshes) represented in bays, estuaries, and river mouths of the project area support various life stages of managed species and their prey. These habitats include HAPCs for juvenile summer flounder, sand tiger sharks, sandbar sharks, and tilefish (**Figure E-2**).

Biological surveys—primarily fishery surveys, including trawl, gillnet, ventless trap, and shellfish surveys—but also placement of fixed gear and passive acoustic monitoring mooring equipment, and the use of sediment profile and plan view imaging equipment would likely result in some direct mortality to finfish and invertebrates. This would include some federally managed species or their prey. There would also be some benthic disturbance and direct mortality to benthic species. However, the dispersed nature of biological survey-related vessel traffic and limited number of surveys reduces the potential for repeated disturbances (Baker and Howson 2021). Generally, methodologies employed in fisheries surveys include returning most of the animals back to the sea as quickly as possible. Nevertheless, sub-sampling and other trauma is expected to result in some mortality; BOEM recognizes that some fisheries surveys could impact listed species under the ESA. This mortality is anticipated to be undetectable within the overall fishery management regime described in **Section 3.3.3** of the EA, and lasting adverse impacts on EFH are not expected.

E.4.1 Soft Bottom Benthic Habitat

The region of interest includes nearshore and offshore sub-tidal subsystems of the continental shelf from the shoreline of the coast to the shelf edge (~100-m water depths). The primary substrate is unconsolidated sediment, as the shelf is overlain mostly by medium-grained sand (0.25 to <0.5 millimeter [mm]). Some discrete patches with different sedimentary compositions exist within the region. Most notably, there are areas of muddy sand to mud (< 0.0625 mm) and gravelly sand to gravel (2 to < 4,096 mm). The medium sand is arranged as a level plain or as ripples and megaripples generally oriented southwest to northeast. Sand waves (ripples) may be 1 to 2 m high at intervals of 2 to 5 kilometers (km) (Guida et al. 2017). The unconsolidated substrates support deep burrowing fauna, small surface burrowing fauna, larger tube-building fauna, scallop beds, clam beds, and sand dollars (*Echinarachnius parma*). Common benthic biota reported by the New York State Energy Research and Development Authority (NYSERDA) (2017) included sand dollars, brachyuran crabs, gastropods, bivalves, burrowing anemones, and sea stars. In softer fine and very fine sand, infaunal tube-building and burrowing polychaetes, as well as abundant beds of thin *Ampelisca* amphipod tubes, were observed as well as orange sponges. Demersal fishes of the region associate with benthic habitats on a variety of spatial scales. Sand ridges provide a distinct habitat for adults, settled juveniles, and larvae for various fish species (Auster et al. 1997; Steves et al. 1999; Vasslides and Able 2008). Burrowing species such as the north stargazer (*Astroscopus guttas*), and snakefish (*Trachinocephalus myops*) may be particularly susceptible to physical modification and/or loss of habitat (Able and Fahey 1998, Sulak 1990). At large scales (i.e., on the order of kilometers), ridges and swales provide relief and habitat complexity, but, for juvenile fishes, structure at smaller scales (i.e., meters to centimeter) is more important (Diaz et al. 2003). Small scale structures used by juvenile fishes as refuge from predation can be either physical (sand waves or bedforms) or biogenic (shell fragments, worm tubes, hydrozoans, and pits) in nature

(Auster et al. 1997). Structure-forming biota present on the seafloor such as worm (*Diopatra*) or amphipod (*Ampelisca*) tubes, orange sponges, or mussel beds also provide habitat for juvenile and newly settled fish species (Diaz et al. 2003). Additionally, inshore habitats can provide nursery habitats for various fish and invertebrate species with either demersal or pelagic eggs. Demersal eggs may be especially susceptible to disturbances, as they are heavier than seawater, and remain on the seafloor until the larval stage (Dahlberg 1979). However, studies suggest that predation may play more of factor in demersal egg survival than environmental disturbances (Dragesund and Nakken 1973). Tables E-5 to E-7 provide descriptions of life stages of select invertebrate (E-5), shark and skate (E-6), and bony fish (E-7) species with EFH identified in the project area (MAFCM 2014, NMFS 2017). Bottom habitats in inshore waters potentially traversed by transmission cables may be composed of detritus—clay-silt and sand-silt-clay sediments—which in some areas may include contaminants (Raposa and Schwartz 2009). Inshore soft bottom habitats also support SAV, shellfish beds, salt marshes, and other features that constitute important nursery areas for many federally managed species (Able and Fahy 2010). For example, the summer flounder juvenile HAPC exists primarily in inshore waters of the region. Important prey species such as Atlantic silversides, anchovies, and killifishes also inhabit inshore habitats. Benthic sampling could also include nearshore and estuarine complex habitats as well as SAV habitats along the proposed transmission cable routes.

Effects on Managed and Associated Species

Demersal species inhabiting soft bottom benthic habitat in the project area include adult and juvenile Atlantic sea scallops, Atlantic surfclams, ocean quahogs, Atlantic lobster, Jonah crab, clearnose skate (*Raja eglanteria*), little skate (*Leucoraja erinacea*), black seabass, monkfish, summer flounder, and windowpane flounder (*Scophthalmus aquosus*). The demersal fishes feed on benthic crustaceans, polychaete worms, mollusks, and various fishes. These and other demersal species may be directly affected by the activities expected for the Proposed Action that would disturb soft bottom habitats. Burrowing species may be affected by habitat modification and/or loss of habitat. Benthic crustaceans, and worms may experience mortality or displacement, thus, impacting their population. Demersal fishes that rely on these species may be indirectly impacted by the removal of prey species. Additionally, as described above, species that have a demersal egg phase are potentially impacted by disturbance to bottom habitat. A complete list of species with identified EFH in the project area is available in Tables E-5 to E-7.

Effects on Soft Bottom Habitat

This analysis covers the biological, geophysical, and geotechnical surveys associated with the Proposed Action that are expected to disrupt soft bottom seafloor habitats. The placement of met buoys is also considered.

Biological Sampling

Biological sampling methods expected to disrupt the seafloor include benthic grabs (e.g., Van Veen) and bottom trawls (e.g., otter and beam trawls, ventless traps). Benthic grab samplers used for assessing infauna assemblages remove on average about 0.1 m^2 of the upper 10 to 15 centimeters (cm) of seafloor sediment. The total area of seabed disturbed by individual sampling events (e.g., collection of a core or grab sample) is estimated to range from 1 to 10 m^2 for each lease area. A similar level of disturbance is to be expected from sampling within inshore transmission cable routes. These small volume samples may temporarily displace bottom feeding fishes and may remove or injure individual Atlantic sea scallops, Atlantic surfclams, or quahogs. These samples may also remove or injure demersal eggs or the egg cases deposited by various skate species. Infauna and epifauna that contribute to the prey base for demersal species such as hakes and skates may be affected by bottom sampling through habitat disturbance and/or removal. While the biological sampling will result in some benthic disturbance and direct mortality of soft bottom assemblages, the dispersed nature and limited number of these surveys will impact only a small area of available soft bottom habitat in the region and the surveys are not expected to have long-term adverse effects on EFH of managed species. Potential effects are anticipated to be short-term and localized to the area of impact.

Bottom trawl sampling expected for the proposed Central Atlantic WEA leasing is expected to follow the guidelines described by BOEM (2019b). Geotechnical/benthic sampling of the WEAs would require a sample at every potential wind turbine location (which would only occur in the portion of the WEA where structural placement is allowed) and one sample per kilometer of offshore export cable corridor. The amount of effort and vessel trips required to collect the geotechnical samples varies greatly by the type of technology used to retrieve the sample (**Table 2-6** of the EA). The area of seabed disturbed by individual sampling events (e.g., collection of a core or grab sample) is estimated to range from 1 to 10 m^2 (BOEM 2014a; Fugro Marine GeoServices Inc. 2017). Some vessels require anchoring for brief periods using small anchors; however, approximately 50% of deployments for this sampling work could involve a boat having dynamic positioning capability (i.e., no seafloor anchoring impacts) (BOEM 2014a).

Recovery of bottom grabs, otter trawls, beam trawls, or ventless traps lost during a survey may entail dragging grapnel lines, which could also disturb demersal habitats. Such recovery efforts are expected to occur infrequently and are not expected to have adverse effects on EFH of managed species or life stages.

Seafloor disturbance, as described above, may result from biological sampling in inshore waters (transmission cable routes) and may also affect EFH for managed species, especially egg and juvenile stages. Potentially vulnerable HAPCs (**Figure E-2**) are also present in inshore waters. These include summer flounder SAV (all areas), sand tiger shark (Delaware Bay) and sandbar shark (Delaware Bay and Chesapeake Bay) nursery areas, and tilefish nursery area (Norfolk Canyon).

HRG Surveys

HRG survey data provides information on seafloor and sub-surface conditions as they pertain to the project siting and design. This includes shallow geologic and anthropogenic hazards, like the presence or absence of archaeological resources. HRG data acquisition instrumentation used during surveys could add noise to the underwater environment (**Table E-2**). These surveys may affect sand tiger, sandbar shark, and tilefish HAPCs illustrated in **Figure E-2**. Effects of HRG surveys on soft bottom species, EFH, or HAPCs are not expected to be significant and are considered in more detail under **Section E.4.3, Pelagic Habitat**.

Geotechnical Surveys

Geotechnical surveys may involve vibracores, piston cores, deep borings, cone penetrometers, sediment profile imagers, and other forms of bottom-sampling gear (**Table E-3**). These methods would disturb soft bottom seafloor habitats by creating holes and pits. Epifauna and infauna resources important to bottom feeding fishes may be lost under and around areas where gear contacts the bottom. Average bottom coverage expected for vibracore, piston core, and deep boring samples is 1 m^2. These sampling methods would generate noise up to 150 decibels (dB) for deep borings (see **Table E-3**). This level is below the threshold considered detrimental to fish physiology and behavior (Popper et al. 2014). For most of these methods, survey vessels require anchoring for brief periods using small anchors; however, approximately 50% of deployments for this sampling work could involve a boat having dynamic positioning capability (i.e., no seafloor anchoring impacts) (BOEM 2014).

Meteorological Buoy Deployment

Met buoys are towed or carried aboard a vessel to the installation location and either lowered to the surface from the deck of the vessel or placed over the final location where the mooring anchor is dropped (BOEM 2014). Based on previous proposals, anchors for boat-shaped or discus-shaped buoys would each weigh about 2,721 to 4,536 kilograms (kg) and have a footprint of about 0.5 m^2 and an anchor sweep of about 34,398 m^2. The maximum number of buoys expected for the project is eight, resulting in a potential impact on soft bottom habitat from anchors of 4 m^2; impacts from anchor chain sweep would be 68 acres. The types of impacts likely to occur are similar to the ones previously described for seafloor disturbance from benthic sampling.

Summary

Soft bottom habitats disturbed by these activities (with the exception of the buoy anchors) are expected to recover physically and biologically over time. Physical recovery by infilling of sediment would proceed rapidly in areas with higher waves and stronger currents and less rapidly in low energy environments. Because the sedimentary regime is generally uniform, recolonization of surficial sediments likely would proceed rapidly through larval settlement and immigration of motile individuals from adjacent undisturbed areas (Newell et al. 1998). Because these actions affect small portions of the survey areas, an adequate supply of motile taxa would be available for rapid migration into impacted areas. Although community composition may differ for a period of time after the disturbance, the infaunal assemblage type that exists in affected areas is expected to be broadly similar, taxonomically and functionally, to naturally occurring assemblages in the study area over time. Based on previous observations of infaunal re-establishment in areas damaged by dredges, the infauna assemblage most likely would become reestablished within approximately 2 years, exhibiting levels of infauna abundance, diversity, and composition comparable to nearby non-impacted areas (Brooks et al. 2006).

Injury to relatively immobile Atlantic scallops, ocean quahogs, and surfclams would be limited due to the patchy nature of their distributions across the shelf (Stokesbury and Himmelman 1993). Bottom feeding fishes may be temporarily displaced from feeding areas. Other demersal species would actively avoid bottom-disturbing sampling activities.

Inshore EFH may be directly affected by site characterization activity. Much of the inshore habitat such as SAV, salt marshes, and soft bottom is important for supporting early life stages of bluefish, weakfish, striped bass, scup, black seabass, and summer flounder. HAPCs for summer flounder, sand tiger shark, sandbar shark, and tilefish cover much of the inshore waters of the project area. Surveying of inshore soft bottom habitats may potentially affect EFH or HAPCs, but due to wide spatial coverage (kilometers) and limited temporal exposure (days to weeks), adverse effects are not expected.

Therefore, the effects from bottom sampling, geophysical and geotechnical sampling, and met buoy deployment are not expected to significantly adversely affect the EFH of federally managed species or associated prey and HAPCs.

E.4.2 Hardbottom Benthic Habitat

Fish species such as black seabass (*Centropristis striatus*), scup (*Stenotomus chrysops*), cunner (*Tautogolabrus adspersus*), tautog (*Tautoga onitis*), sheepshead (*Archosargus probatocephalus*), Atlantic striped bass, Atlantic cod, and conger eel (*Conger oceanicus*) associate with artificial or natural hardbottom habitats. A Hardbottom habitat is defined by the Coastal and Marine Ecological Classification System (CMECS) as habitat that includes Substrate Class Rock Substrate, and Gravels, Gravel Mixes, Gravelly, and Shell substrate classes (NMFS 2021b). Natural and artificial hardbottom habitats occur in inshore waters of the region and include rocky outcrops, oyster reefs, and blue mussel beds. Artificial hardbottom consists of construction-derived structures (breakwaters, pilings, piers, riprap shorelines, etc.) as well as planned artificial reefs (Steimle and Zeitlin 2000). Artificial reefs are human-made underwater structures that are developed intentionally or from remnants of objects built for other purposes, such as shipwrecks (Steimle and Zeitlin 2000). According to the Marine Cadastre Ocean Reports data portal most of the artificial reefs in this region are close to shore and outside of the lease areas (BOEM and NOAA 2024).

Data collected during initial remote geophysical surveys would identify possible locations for hardbottom habitat communities. Met buoys would only be installed in the proposed lease areas, and BOEM would require the lessee to develop and implement avoidance measures near these resources before authorizing activities that would disturb hardbottom habitats.

Effects on Managed and Associated Species

Managed species such as black seabass may be attracted to moored buoys and their anchors due to the shelter and feeding potential associated with hard structures (Fabrizio et al. 2013). Although pelagic species, squids attach demersal egg clusters (“mops”) to hard substrata such as shells, lobster pots, piers, fishing traps, boulders, and rocks (Jacobson 2005). Moored buoys and anchors may provide a similar ecological function. In this case, the effect on managed species has the potential to be positive, as the buoys provides additional habitat. However, with a maximum of eight met buoys expected for the entire project, such an artificial reef effect is expected to be negligible. In inshore and offshore hardbottom habitats, the Atlantic sea scallop uses any hard surface for pelagic larvae to settle (Table E-5). This habitat has the potential to be disturbed during geophysical surveys.

Effects on Hardbottom Habitat

No significant effects on benthic hardbottom habitats are expected due to the relatively low occurrence of these habitats in each WEA. Hardbottom habitats may exist in small, isolated patches along the transmission cable routes to shore, but data collected during initial geophysical surveys could identify alternate locations to allow for avoidance of these habitats. Therefore, no impacts on hardbottom habitat or on managed or associated EFH species is expected.

Summary

Due to the scarcity of hardbottom habitat in the WEAs and surrounding area, and the avoidance measures that would be implemented, hardbottom habitats are unlikely to be affected by activities conducted under the Proposed Action. Therefore, the effects from bottom sampling, geophysical and geotechnical sampling, and met buoy deployment are not expected to adversely affect the EFH of federally managed species, associated prey, or HAPCs. An artificial reef effect may occur for species that are affiliated with hardbottom habitats, such as black seabass and pelagic squids, but that effect is expected to be beneficial and negligible.

E.4.3 Pelagic Habitat

The offshore pelagic environment of the project area experiences large seasonal temperature changes at the surface and bottom. In winter months (October to April) water temperatures drop to just above 1°C. During this time, the water column is not thermally stratified. As waters warm (15 to 20°C) in mid to late April, the water column stratifies (Guida et al. 2017). Large scale circulation in the Mid-Atlantic Bight (and the NY Bight) involves a mass of cold bottom water (the cold pool) that moves from Georges Bank southward into the project area in the warm season. The cold pool holds nutrients over the shelf during the spring and summer, which in turn promotes phytoplankton productivity and affects fish distributions and behavior (Lentz 2017; Nye et al. 2009). None of the activities described for the Proposed Action are expected to have any effect on the water column environment. Currents over the shelf tend to follow major isobaths and generally increase with increasing water depth (Guida et al. 2017).

Effects on Managed and Associated Species

The primary pelagic invertebrates with EFH in the WEA are longfin inshore squid and northern shortfin squids. Common pelagic fishes inhabiting the project area include Atlantic mackerel, bluefish, butterfish, yellowfin tuna, albacore tuna, skipjack tuna, weakfish, and striped bass. Sharks found in the water column include sandbar shark, dusky shark, blue shark, and spiny dogfish. Other pelagic species such as alewife (*Alosa psuedoharengus*), American shad (*Alosa sapidissima*), Atlantic herring, and Atlantic menhaden (*Brevoortia tyrannus*) also occur in the area. In addition, several demersal species have pelagic larvae whose EFH overlaps the WEAs (**Table E-7**). These species move mostly in response to seasonal water temperature changes. Movements may be across the shelf or north and south, depending on the species.

The potential impacts of renewable energy site characterization on pelagic resources and EFH have been analyzed in the previous Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic OCS Offshore New Jersey, Delaware, Maryland, and Virgnia EA (BOEM 2012), which is incorporated herein by reference. Key impact-producing factors for the pelagic environment are sediment suspension (elevated turbidity) and noise generated by biological, geological, and geotechnical surveying. Elevated turbidity can cause avoidance and attraction movements, impair feeding, and lead to physiological changes in adult pelagic fishes. Gill cavities can be clogged by suspended sediment, which can mechanically affect food gathering in planktivorous species. High levels of suspended sediment can clog gill cavities and erode gill lamellae (Wenger et al. 2017), preventing or interfering with normal gill respiration. Motile species such as squids, summer flounder, striped bass, Atlantic herring, Atlantic mackerel, bluefish, and butterfish could avoid turbid areas and escape most of those impacts. In contrast, less motile organisms—including pelagic larvae of sea scallops, ocean quahogs, Atlantic surfclams, and many species of fishes—would temporarily experience impaired sensory abilities.

Medium and shallow seabed profilers are the only HRG sound sources expected to produce sounds within finfish and invertebrate hearing ranges. Sound exposure levels are expected to be below the hearing damage thresholds for fishes and invertebrates (Popper and Hawkins 2018). Fishes can also detect particle motion at frequencies produced during HRG surveys, but understanding of the potential effects of particle motion on fish and invertebrates is limited and suggests that impacts are similar to pressure waves unless animals are close to the sound source (Popper and Hawkins 2018; Weilgart 2018). Acoustic impacts would result in temporary and spatially limited changes in behavior and displacement, particularly to those species capable of hearing in the high-frequency range, such as herrings, although these species are expected to avoid such sounds. Ichthyoplankton (eggs and larvae) and other organisms inhabiting the water column or near the water surface are unlikely to be affected by noise unless they are within a few meters of the activities (Popper et al. 2014). Therefore, only a small percentage of the ichthyoplankton and overall plankton assemblage populations would be affected.

Effects on Pelagic Habitat

Biological Sampling

Installation of clump anchors associated with met buoys, vibracoring, bottom sampling (trawling or bottom grabs), or deep borings may cause an increase in local suspended sediments. These impacts would be limited to the immediate area surrounding the anchors and of short duration. Suspended sediments could elevate ambient turbidity of the water column, which would be a localized, transient effect.

In general, biotic assemblages of the Mid-Atlantic Bight inner shelf are regularly subjected to periodic reworking of surficial sediments caused by storm events and are unlikely to experience adverse effects that are greater than those due to the normal dynamic environment. Effects from proposed activities would be limited to within hundreds of meters of anchoring and other bottom-disturbing activities and would persist for a matter of hours after the activity ceases. The sweep of anchor chains across the sedimentary seafloor is expected to elevate turbidity in small areas adjacent to the met buoys. Anchor sweep is expected to be a limited but continuous process. Biological, geological, and geotechnical sampling would temporarily elevate turbidity, but there would be no lasting adverse effect on the water column habitat from this disruption.

HRG Surveys

HRG surveys acquire geophysical shallow hazards information, and their primary impact is likely to be increasing noise. Noise characteristics of equipment used during HRG surveys are provided in **Table E-2**. Increased vessel presence and traffic during HRG surveys could result in several impact-producing factors, including noise, routine vessel discharges, and lighting from vessels. Survey of inshore transmission cable routes could interact with HAPCs for summer flounder (SAV), sand tiger shark, sandbar shark, and tilefish (**Figure E-2**). None of these factors are expected to adversely affect managed species, EFH, or HAPCs as they would be short in duration (weeks) and conducted from moving vessels.

Impacts from acoustic sound sources from HRG survey methods such as side-scan sonar, multibeam sonar, and seabed profilers are not expected. Medium and shallow seabed profilers (such as a boomer plate) are the only sound source expected to produce sounds within finfish and invertebrate hearing ranges. Fish are not expected to be exposed to sound pressure levels that could cause hearing damage (Popper et al. 2014). While fishes can also detect particle motion at frequencies produced during HRG surveys, there is currently limited understanding of the potential effects of particle motion on fish and invertebrates (Popper and Hawkins 2018). In general, particle motion is most relevant to frequencies below 1,000 hertz (Hz) and within close ranges to the source (within tens of meters), although some information suggests that fish and invertebrates may perceive this at greater distances. At longer ranges from the source, it is expected that particle motion associated with impulsive noise sources (e.g., medium seabed profilers) will have similar effects to pressure waves in fish and invertebrate species (Weilgart 2018). Additionally, because there are no accepted thresholds for particle motion from which the potential for impact may be assessed, particle motion impacts were not evaluated separately from sound pressure impacts. Sound exposure levels would also be below harmful thresholds for fishes and invertebrates. Impacts would result in temporary and spatially limited changes in behavior and displacement, particularly to those species capable of hearing in the high-frequency range, such as herrings. Impulsive seismic sounds may affect squid behavior and physiology by damaging statoliths used for balance (André et al. 2011). Such effects may prevent squids from detecting predators, locating food, or finding mates. Other prey species sensitive to sounds (e.g., shads, menhaden, Atlantic herring, anchovies) may temporarily move from a project area during acoustic surveys, affecting some predators. General effects of acoustic survey devices on EFH for managed species in the area are also detailed in BOEM 2014.

Placement of moored metocean buoys is expected to only affect currents around the mooring lines of the structure, creating minor turbulence at that point. Based on the limited extent of water column effects, no adverse effects on pelagic biota or habitat associated with persistent remnant wintertime bottom water (cold pool; an important feature of the water column in the Mid-Atlantic Bight) are expected. The hydrodynamic environment of the project area likely would not be adversely affected by the small water column footprint of met buoys.

Summary

Pelagic habitats disturbed by site characterization activities are expected to recover from elevated turbidity and altered noise regimes in a short time (hours to days). Suspended sediments would dissipate within hours of suspension. Much of the sediment in offshore areas is sandy and is expected to settle out rapidly. Fishes and squids can actively avoid clouds of elevated turbidity created by bottom-sampling gear. Passively drifting larvae of managed species and their prey may experience reduced sensory capabilities and other physiological effects while entrained in suspended sediment plumes. Due to the patchy distribution of larvae at small scales and the small volumes of suspended sediment expected, effects on larval stages should be negligible. Because of relatively finer grained sediments found in nearshore waters, the extent and duration of equipment-caused turbidity is expected to be higher for surveys of transmission cable routes than for the WEAs. However, because of relatively small footprints expected for these corridors, adverse effects on EFH of managed species life stages or prey are not expected.

Noise from HRG surveys is expected to be below the levels considered detrimental to fish physiology and behavior (Popper et al. 2014). Most of the managed fish species—such as sharks, skates, tunas, Atlantic mackerel, and bluefish—found in shelf waters or species occurring within nearshore transmission corridors would not be adversely affected by the expected sound levels produced by HRG surveys.

Elevated turbidity and noise generated by bottom sampling, geophysical and geotechnical sampling, and met buoy deployment are not expected to noticeably adversely affect the EFH, associated prey, or HAPCs of federally managed pelagic species or their life stages. The same conclusion would apply to other NOAA Trust Resources, including weakfish, striped bass, Atlantic menhaden, and river herrings.

E.5 Standard Operating Conditions

Standard Operating Conditions for the Proposed Action are described in **Section 4** of the EA. BOEM's primary mitigation strategy has and will continue to be avoidance. For example, the exact location of met buoys would be adjusted to avoid adverse effects on biologically sensitive habitats, if present. Overall impacts on finfish and invertebrates from biological surveys are anticipated to be **negligible**, but BOEM recognizes that some fishery surveys could impact ESA-listed species. Thus, BOEM is proposing to prohibit fisheries surveys until all required ESA consultations are concluded.

E.6 Conclusions

Based on the analysis in the preceding sections, the Proposed Action is not expected to have lasting adverse effects on EFH, federally managed species, associated prey, or HAPCs at or around the WEAs. Impacts on the water column habitat would be localized and transient, with no significant adverse effect on EFH for any pelagic species. Minor disturbance of soft bottom areas may occur, but no significant adverse effects on soft bottom benthic habitats are expected due to the small area of seafloor disturbance relative to the available habitat, and any disturbed habitat would be expected to recover in short time frames. Hardbottom habitats would be avoided during met buoy placement; thus, no adverse effects are anticipated.

E.7 References

Able K, Fahy M. 2008. The first year in the life of estuarine fishes in the Middle Atlantic Bight. New Brunswick (NJ): Rutgers University Press. 342 p.

Able K, Fahy M. 2010. Ecology of estuarine fishes: temperate waters of the Western Atlantic. Baltimore (MD): Johns Hopkins University Press. 584 p.

André M, Solé M, Lenoir M, Durfort M, Quero C, Mas A, Lombarte A, van der Schaar M, López-Bejar M, Morell M, et al. 2011. Low-frequency sounds induce acoustic trauma in cephalopods. Frontiers in Ecology and the Environment. 9(9):489-493. doi:10.1890/100124.

Atlantic Renewable Energy Corporation, AWS Scientific Inc. 2004. New Jersey offshore wind energy: feasibility study. Final version. Trenton (NJ): New Jersey Board of Public Utilities. 217 p.

Auster PJ, Malatesta RJ, Donaldson CLS. 1997. Distributional responses to small-scale habitat variability by early juvenile silver hake, *Merluccius bilinearis*. Environmental Biology of Fishes. 50(2):195-200. doi:10.1023/A:1007305628035.

Baker K, Howson U. 2021. Data collection and site survey activities for renewable energy on the Atlantic Outer Continental Shelf. Biological assessment. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 152 p.

BOEM. 2014. Atlantic OCS proposed geological and geophysical activities Mid-Atlantic and South Atlantic Planning Areas. Final programmatic environmental impact statement. New Orleans (LA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 3 vols. 2328 p. Report No.: OCS EIS/EA BOEM 2014-001.

BOEM. 2016. Commercial wind lease issuance and site assessment activities on the Atlantic Outer Continental Shelf offshore New York. Revised environmental assessment. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 449 p. Report No.: OCS EIS/EA BOEM 2016-070.

BOEM. 2019a. Guidelines for providing benthic habitat survey information for renewable energy development on the Atlantic Outer Continental Shelf pursuant to 30 CFR Part 585, Subpart F. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 9 p.

BOEM. 2019b. Guidelines for providing information on fisheries for renewable energy development on the Atlantic Outer Continental Shelf pursuant to 30 CFR Part 585. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 14 p.

BOEM. 2019c. Guidelines for providing information on marine mammals and sea turtles for renewable energy development on the Atlantic Outer Continental Shelf pursuant to 30 CFR Part 585. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 15 p.

BOEM. 2020a. Guidelines for providing avian habitat survey information for renewable energy development on the Atlantic Outer Continental Shelf pursuant to 30 CFR Part 585. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 17 p.

BOEM. 2020b. Guidelines for providing geophysical, geotechnical, and geohazard information pursuant to 30 CFR Part 585. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 32 p.

BOEM. 2021. Memorandum. New York Bight area identification memorandum pursuant to 30 CFR § 585.211(b). Washington (DC): U.S. Department of the Interior, Bureau of Ocean Energy Management. 39 p.

BOEM and NOAA. 2024. Marine Cadastre, Ocean Reports [web application]. https://marinecadastre.gov/oceanreports

Bolam, SG and Rees, HL. 2003. Minimizing impacts of maintenance dredged material disposal in the coastal environment. A habitat approach. Environmental Management. 32, 171-188.

Brooks RA, Purdy CN, Bell SS, Sulak KJ. 2006. The benthic community of the eastern U.S. Continental Shelf: a literature synopsis of benthic faunal resources. Continental Shelf Research. 26(6):804–818. doi:10.1016/j.csr.2006.02.005.

Collie JS, Escanero GA, Valentine PC. 1997. Effects of bottom fishing on the benthic megafauna of Georges Bank. Marine Ecology Progress Series. 155:159–172.

Collie JS, Hall SJ, Kaiser MJ, Poiner IR. 2000. A quantitative analysis of fishing impacts on sea-shelf benthos. Journal of Animal Ecology. 69:785–798.

Continental Shelf Associates Inc. 2004. Geological and geophysical exploration for mineral resources on the Gulf of Mexico Outer Continental Shelf, final programmatic environmental assessment. New Orleans (LA): U.S. Department of the Interior, Minerals Management Service. 487 p. Report No.: OCS EIS/EA MMS 2004-054.

Dalhberg M. 1979. A review of survival rates of fish eggs and larvae in relation to impact assessments. Marine Fisheries Review 41 (3) 1-12.

Diaz R, Cutter G, Able K. 2003. The importance of physical and biogenic structure to juvenile fishes on the shallow inner continental shelf. Estuaries and Coasts. 26:12–20.

Dragesund O, Nakken O. 1973. Relationship of parent stock size and year class strength in Norwegian spring spawing herring. Fish Stocks and Recruitment. 15-29 pp.

Erbe C, McPherson C. 2017. Underwater noise from geotechnical drilling and standard penetration testing. The Journal of the Acoustical Society of America. 142(3):EL281–EL285. doi:10.1121/1.5003328.

Fabrizio MC, Manderson JP, Pessutti JP. 2013. Habitat associations and dispersal of black sea bass from a Mid-Atlantic Bight reef. Marine Ecology Progress Series. 482:241–253.

Guida V, Drohan A, Welch H, McHenry J, Johnson D, Kentner V, Brink J, Timmons D, Estela-Gomez E. 2017. Habitat mapping and assessment of northeast wind energy areas. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 312 p. Report No.: OCS Study BOEM 2017-088.

Jacobson LD. 2005. Longfin inshore squid, *Loligo pealeii,* life history and habitat characteristics. Second edition. Woods Hole (MA): U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center. 42 p. Report No.: NOAA Technical Memorandum NMFS_NE-193.

Lentz SJ. 2017. Seasonal warming of the Middle Atlantic Bight Cold Pool. Journal of Geophysical Research: Oceans. 122(2):941–954. doi:10.1002/2016JC012201.

MAFMC. 1998a. Amendment 1 to the bluefish fishery management plan. Gloucester (MA): Mid-Atlantic Fishery Management Council, Atlantic States Marine Fisheries Commission, National Marine Fisheries Service, New England Fishery Management Council, South Atlantic Fishery Management Council. 341 p.

MAFMC. 1998b. Amendment 8 to the Atlantic mackerel, squid, and butterfish fishery management plan. Gloucester (MA): Mid-Atlantic Fishery Management Council, Atlantic States Marine Fisheries Commission, National Marine Fisheries Service, New England Fishery Management Council, South Atlantic Fishery Management Council. 351 p.

MAFMC. 1998c. Amendment 12 to the Atlantic surfclam and ocean quahog fishery management plan. Gloucester (MA): Mid-Atlantic Fishery Management Council, National Marine Fisheries Service, New England Fishery Management Council. 340 p.

MAFMC. 1998d. Amendment 12 to the summer flounder, scup, and black sea bass fishery management plan. Gloucester (MA): Mid-Atlantic Fishery Management Council, Atlantic States Marine Fisheries Commission, National Marine Fisheries Service, New England Fishery Management Council, South Atlantic Fishery Management Council. 398 p.

MAFMC. 2011. Amendment 11 to the fishery management plan for Atlantic mackerel, squid, and butterfish. Includes final environmental impact statement (FEIS). Mid-Atlantic Fishery Management Council, National Marine Fisheries Service 625 p.

MAFMC. 2014. Amendment 3 to the spiny dogfish fishery management plan. Dover (DE): Mid-Atlantic Fishery Management Council, National Marine Fisheries Service. 112 p.

Mazor T, Pitcher CR, Rochester W, Kaiser MJ, Hiddink JG, Jennings S, Amoroso R, McConnaughey RA, Rijnsdorp AD, Parma AM, et al. 2021. Trawl fishing impacts on the status of seabed fauna in diverse regions of the globe. Fish and Fisheries. 22(1):72–86. doi:10.1111/faf.12506.

MMS. 2007. Programmatic environmental impact statement for alternative energy development and production and alternate use of facilities on the Outer Continental Shelf. Final environmental impact statement. 4 vols. Herndon (VA): U.S. Department of the Interior, Minerals Management Service. Report No.: OCS EIS/EA MMS 2007-046.

NEFMC, NMFS. 2016. Draft omnibus essential fish habitat amendment 2. Volume 2: EFH and HAPC designation alternatives and environmental impacts amendment 14 to the northeast multispecies FMP; amendment 14 to the Atlantic sea scallop FMP; amendment 4 to the monkfish FMP; amendment 3 to the Atlantic herring FMP; amendment 2 to the red crab FMP; amendment 2 to the skate FMP; and amendment 3 to the Atlantic salmon FMP including a final environmental impact statement. Newburyport (MA) and Gloucester (MA): New England Fishery Management Council, National Marine Fisheries Service. 490 p.

NEFMC, NMFS. 2017. Final omnibus essential fish habitat amendment 2. Volume 2: EFH and HAPC designation alternatives and environmental impacts amendment 14 to the northeast multispecies FMP; amendment 14 to the Atlantic sea scallop FMP; amendment 4 to the monkfish FMP; amendment 3 to the Atlantic herring FMP; amendment 2 to the red crab FMP; amendment 2 to the skate FMP; and amendment 3 to the Atlantic salmon FMP including a final environmental impact statement. Newburyport (MA) and Gloucester (MA): New England Fisheries Management Council, National Marine Fisheries Service. 452 p.

Newell R, Seiderer L, Hitchcock D. 1998. The impact of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. Oceanography and Marine Biology: An Annual Review. 36:127–178.

NMFS. 2021a. EFH mapper. Washington (DC): U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service; [accessed 2021 Jun 29]. https://www.habitat.noaa.gov/protection/efh/efhmapper/index.html.

NMFS 2021b. Updated Recommendations for Mapping Fish Habitat. March 29, 2021. Available: https://media.fisheries.noaa.gov/2021-03/March292021_NMFS_Habitat_Mapping_Recommendations.pdf?null. NOAA Fisheries. 2017. Final amendment 10 to the 2006 consolidated Atlantic highly migratory species fishery management plan: essential fish habitat and environmental assessment. Silver Spring (MD): NOAA Fisheries, Office of Sustainable Fisheries, Atlantic Highly Migratory Species Management Division. 442 p.

Nye JA, Link JS, Hare JA, Overholtz WJ. 2009. Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States Continental Shelf. Marine Ecology Progress Series. 393:111–129.

NYSERDA. 2017. New York State offshore wind master plan; fish and fisheries study. Final report. New York (NY): New York State Energy Research and Development Authority. 202 p. Report No.: NYSERDA Report 17-25j.

Popper A, Hawkins A. 2018. The importance of particle motion to fishes and invertebrates. Journal of the Acoustical Society of America. 143(1):470–488.

Popper AN, Hawkins AD, Fay RR, Mann DA, Bartol S, Carlson TJ, Coombs S, Ellison WT, Gentry RL, Halvorsen MB, et al. 2014. Sound exposure guidelines for fishes and sea turtles: a technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Cham (Switzerland): Acoustical Society of America Press and Springer International Publishing. 76 p.

Raposa KB, Schwartz ML. 2009. An ecological profile of the Narragansett Bay National Estuarine Research Reserve. Narragansett (RI): Rhode Island Sea Grant. 180 p.

Steimle F, Zeitlin C. 2000. Reef habitats in the Middle Atlantic Bight: abundance, distribution, associated biological communities, and fishery resource use. Marine Fisheries Review. 62(2):24–42.

Steves BP, Cowen RK, Malchoff MH. 1999. Settlement and nursery habitats for demersal fishes on the continental shelf of the New York Bight. Fishery Bulletin. 98:167–188.

Stokesbury KDE, Himmelman JH. 1993. Spatial distribution of the giant scallop *Placopecten magellanicus* in unharvested beds in the Baid des Chaleurs, Québec. Marine Ecology Progress Series. 96:159–168.

Sulok, KJ. 1990. Synodontidae. *In* Check-list of the fishes of the eastern tropical Atlantic (CLOFETA), volume 1, 365-370 p.

Thaxter CB, Burton NHK. 2009. High-definition imagery for surveying seabirds and marine mammals: a review of recent trials and development of protocols. Norfolk (UK): British Trust for Ornithology Report Commissioned by Cowrie Ltd. 30 p. [accessed 2021 Jun 16]. https://tethys.pnnl.gov/sites/default/files/publications/Thaxter-Burton-2009.pdf.

USACE. 1987. Confined disposal of dredged material. Washington (DC): U.S. Army Corps of Engineers. 243 p. Report No.: Engineer Manual EM 1110-2-5027.

Vasslides JM, Able W. 2008. Importance of shoreface and sand ridges as habitats for fish off the northeast coast of the United States. Fishery Bulletin. 106(1):93–107.

Weilgart L. 2018. The impact of ocean noise pollution on fish and invertebrates. Wädenswil (Switzerland): OceanCare and Dalhousie University. 34 p.

Wenger AS, Harvey E, Wilson S, Rawson C, Newman SJ, Clarke D, Saunders BJ, Browne N, Travers MJ, Mcilwain JL, et al. 2017. A critical analysis of the direct effects of dredging on fish. Fish and Fisheries. 2017:1–19.