Appendix C: Desktop Study Mid-Atlantic Bight Pioneer Array

Desktop Study

Mid-Atlantic Bight Pioneer Array

December 2022

Prepared for

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Table of Contents

1.0 INTRODUCTION 1-1

2.0 STUDY METHODOLOGY 2-1

3.0 ENVIRONMENTAL RESOURCES 3-1

3.1 Biological Resources 3-1

3.1.1 Benthic and Fisheries Resources 3-1

3.1.2 Marine Mammals and Sea Turtles 3-7

3.1.3 Avian and Bat Species 3-16

3.1.4 Protected Habitats 3-20

3.2 Physical Resources 3-23

3.2.1 Underwater Noise 3-23

3.2.2 Geologic Conditions 3-26

3.2.3 Sediment and Water Quality 3-31

3.2.4 Electric and Magnetic Fields 3-33

3.2.5 Air Quality 3-34

3.3 Anthropogenic Resources 3-35

3.3.1 Cultural Resources 3-35

3.3.2 Marine Transportation and Navigation 3-38

3.3.3 Military Operations 3-43

3.3.4 Aviation and Radar 3-45

3.3.5 Hazards and Obstructions 3-45

3.3.6 Tourism and Recreation 3-49

3.3.7 Visual and Aesthetic 3-52

4.0 SUMMARY AND RECOMMENDATIONS 4-1

5.0 REFERENCES 1

List of Tables

Table 3-1. Managed Species with Designated EFH in the Study Area 3-5
Table 3-2. Marine Mammals Known to Occur in the Marine Waters in Coastal Offshore North Carolina 3-8
Table 3-3. Sea Turtles Known to Occur in the Marine Waters in Coastal Offshore North Carolina 3-13
Table 3-4. Sea Turtle Nests in North Carolina (January 1, 2022 – August 8, 2022) 3-15
Table 3-5. Bird Species Likely to Occur Within the Study Area 3-17
Table 3-6. Bat Species Likely to Occur in the Study Area 3-19

List of Figures

Figure 1-1. Study Area 1-2
Figure 1-2. Pioneer Array on NOAA Chart 1-3
Figure 3-1. Biological Resources 3-4
Figure 3-2. Seafloor Sediments 3-29
Figure 3-3. Cultural Resources and Restricted Land Use 3-37
Figure 3-4. Navigation 3-40
Figure 3-5. AIS Data for 2020 3-41
Figure 3-6. AIS Data for 2019 3-42
Figure 3-7. Military Areas 3-44
Figure 3-8. Ocean Uses. 3-47
Figure 3-9. Recreational Fishing 3-51

Acronyms and Abbreviations

°C	degree Celsius
µPa	micropascal
ACPARS	Atlantic Coast Port Access Route Study
AIS	Automatic Identification System
AMAPPS	Atlantic Marine Assessment Program for Protected Species
ASMFC	Atlantic States Marine Fisheries Commission
AUV	autonomous underwater vehicle
AWOIS	Automated Wreck and Obstruction Information System
BMP	Best Management Practice
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
CGSN	Coastal and Global Scale Nodes
CWA	Clean Water Act
dB	decibels
DoD	Department of Defense
DPS	distinct population segment
EFH	essential fish habitat
EMF	electromagnetic fields
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FMC	Fishery Management Council
FMP	Fishery Management Plan
FR	Federal Register
GIS	geographic information system
GMFMC	Gulf of Mexico Fishery Management Council
GPS	Global Positioning System
HAPC	Habitat Areas of Particular Concern
HRG	high-resolution geophysical
Hz	hertz
IBA	Important Bird Area

kHz	kilohertz
km	kilometer
kV	kilovolts
L_{PK}	peak sound pressure levels
m	meter
m^2	square meter
MAFMC	Mid-Atlantic Fishery Management Council
mm	millimeter
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NAAQS	National Ambient Air Quality Standards
NCDENR	North Carolina Department of Environment and Natural Resources
NCDEQ	North Carolina Department of Environmental Quality
NCDMF	North Carolina Division of Marine Fisheries
NCWRC	North Carolina Wildlife Resources Commission
nm	nautical mile
NOAA Fisheries	NOAA National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRHP	National Register of Historic Places
NSF	National Science Foundation
NWP	Nationwide Permit
OCS	Outer Continental Shelf
OOI	Ocean Observatories Initiative
OPAREA	at-sea Operating Area
PARS	Port Access Route Study
Project	the Pioneer Array coastal array currently located on the New England Shelf and proposed to be relocated to the Outer Continental Shelf off the coast of North Carolina in 2024
PTS	permanent threshold shift
RMS	root mean square
SAFMC	South Atlantic Fishery Management Council
SAV	submerged aquatic vegetation

SEL_{cum}	cumulative sound exposure levels
SMA	Seasonal Management Area
SPL RMS	root mean squared sound pressure level
Study Area	federal waters 13 nm to 45 nm offshore off the coast of Nags Head, North Carolina
Tetra Tech	Tetra Tech, Inc.
TTS	temporary threshold shift
U.S. Navy	U.S. Department of the Navy
U.S.C.	United States Code
UME	Unusual Mortality Event
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UXO	unexploded ordinances
WHOI	Woods Hole Oceanographic Institution

1.0 INTRODUCTION

Woods Hole Oceanographic Institution (WHOI) was selected by the National Science Foundation (NSF) to support the development, installation, and operation of the coastal and global components of the NSF's Ocean Observatories Initiative (OOI). The OOI consists of a globally distributed and integrated network of marine observation systems that provide the ocean sciences research community with an advanced research infrastructure to support sustained, long-term, and adaptive measurements of the oceans across global, regional, and coastal scales.

WHOI is currently responsible for the implementation and operation of one coastal scale array and two global scale arrays collectively referred to as the Coastal and Global Scale Nodes (CGSN) portion of the OOI program. The CGSN includes a coastal array called the Pioneer Array currently located in the federal waters of the Mid-Atlantic Bight off the coast of New England. In 2021, The NSF announced the relocation of the Pioneer Array from the New England Shelf to the Outer Continental Shelf (OCS) off the coast of North Carolina in the southern Mid-Atlantic Bight. The Pioneer Array is also referred to in this desktop study report as the Project.

The Pioneer Array is proposed to be relocated in the spring of 2024 to the shelf and slope offshore of the coast of Nags Head in North Carolina. The preliminary plan is for the moored array to be constituted in a sideways "T" shape, with seven mooring sites between about 13 nautical miles (nm) and 45 nm offshore, outside of state waters (**Figure 1-1 and Figure 1-2**).

The Pioneer Array will consist of:

- Three surface moorings (identified in Figure 1-1 as NSM, CSM, and SSM) with local power generation (wind turbines and solar panels), satellite communications capabilities, and benthic nodes;
- Five profiler moorings (identified in Figure 1-1 as NPM, NOPM, CPM, SOPM, and SPM) that would be internally powered (with primary and/or rechargeable batteries), three of the five would be located at the same site (within a few hundred meters) as a surface mooring;
- Two shallow-water moorings (identified in Figure 1-1 as SMW and SME) of a design similar to the surface moorings;
- Two autonomous underwater vehicles (AUVs) operated in campaign mode from ships; and
- Four to six buoyancy-driven ocean gliders.

The purpose of the desktop assessment is to document the existing conditions in the Study Area. This document will provide the existing conditions information for the Nationwide Permit (NWP) needed for the U.S. Army Corps of Engineers (USACE) NWP 5.

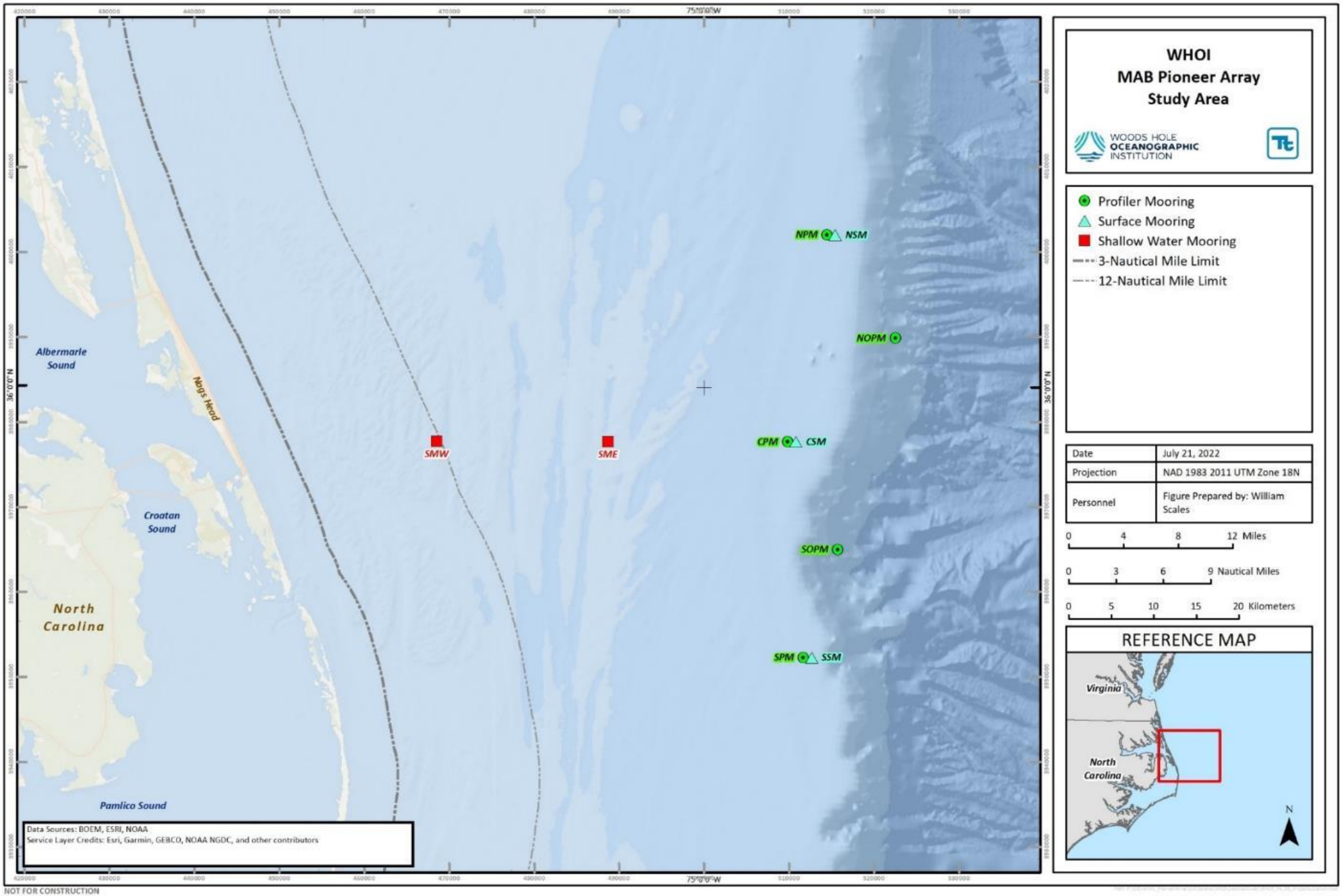

Figure 1-1. Study Area

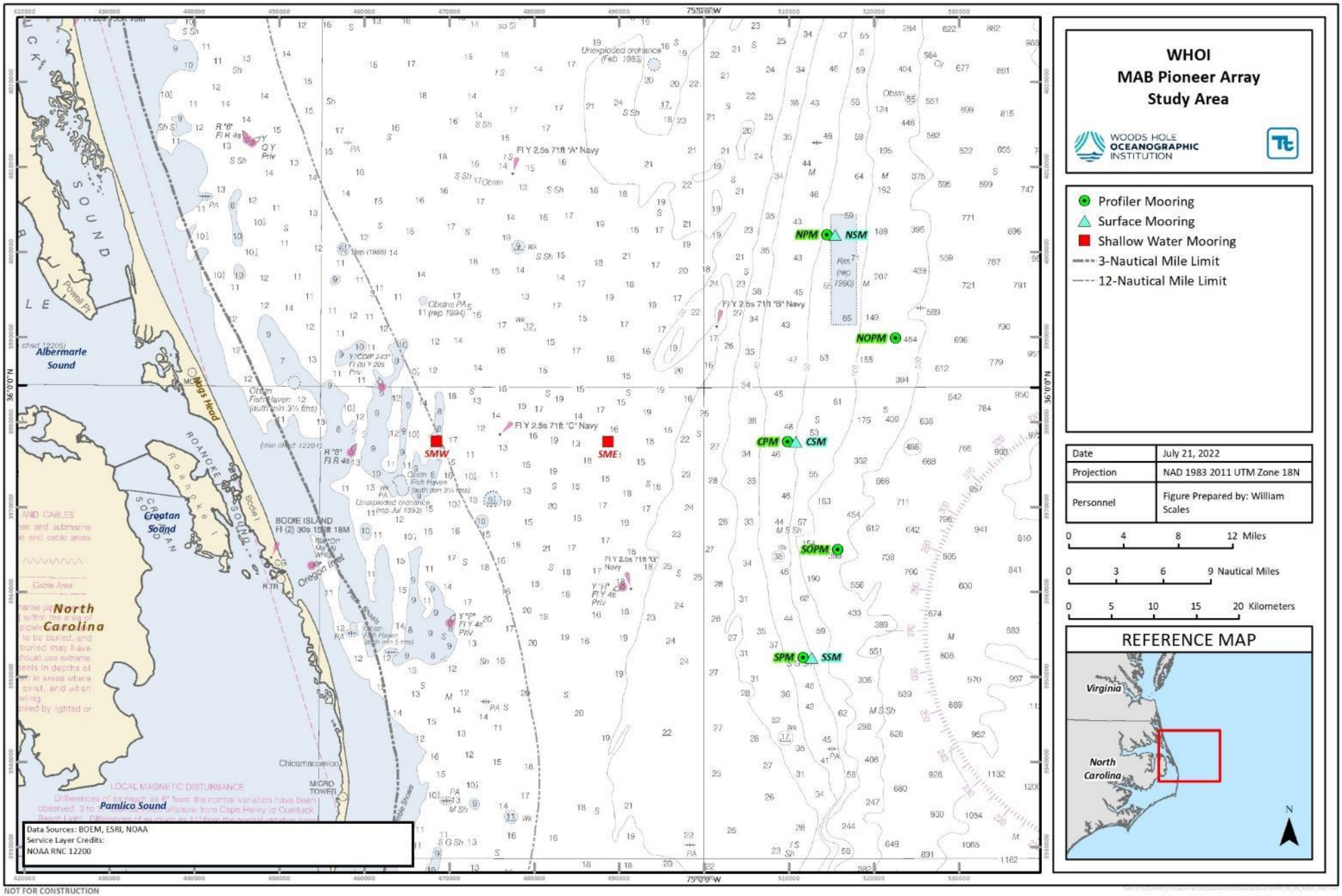

Figure 1-2. Pioneer Array on NOAA Chart

2.0 STUDY METHODOLOGY

Tetra Tech understands that WHOI is planning to relocate the Pioneer Array in the spring of 2024 between about 13 nm and 45 nm offshore off the coast of Nags Head, North Carolina (Study Area). Tetra Tech has evaluated this Study Area for the environmental resources and constraints based on publicly available data on topics and areas of concern. The purpose of the desktop environmental assessment is to document the existing conditions in the Study Area. This document will provide the existing conditions information for the USACE NWP 5 using desktop data, to be followed by a field study prior to deployment to confirm desktop findings. The following resources were used for the desktop study. Sources marked with ** were included in the figure setup but were not present in the data frame and were therefore left out of the map legend.

Biological:

- Artificial Reefs (NCDMF 2022a)
- Shell Bottom Habitat (NC OneMap)
- Submerged Aquatic Vegetation/Seagrass (Marine Cadastre (2019)
- Biologically Important Areas for Cetaceans (NOAA/Marine Cadastre 2015)
- Right Whale Seasonal Management Area (SMA) (NOAA/Marine Cadastre 2021)
- Critical Habitat (NOAA/ U.S. Fish and Wildlife Service [USFWS]/Marine Cadastre 2018)
- NAS/Important Bird Areas (National Audubon Society 2021)
- Coastal Critical Habitat (USFWS/Marine Cadastre 2018)**
- Wreck Diving Location (NC Wreck Diving)**

Military:

- Airports (BTS 2015) (includes Heliports)
- Danger Zones/Areas (NOAA/Marine Cadastre 2017)
- Operations Areas (U.S. Navy/Marine Cadastre 2019)
- Military Range Complex (Northeast Ocean Data 2016)
- Warning Area (Northeast Ocean Data 2016)
- Unexploded Ordinances (UXOs) (NOAA/Marine Cadastre 2018)
- Military Special Use Airspace (U.S. Navy/Marine Cadastre 2017)
- Military Coordinate Grid Area: Atlantic / Gulf of Mexico (U.S. Navy/Marine Cadastre 2017)
- Military Regulated Airspace (U.S. Navy/Marine Cadastre 2017)
- Unexploded Ordnance (FUDS) (NOAA/Marine Cadastre 2018)
- Department of Defense Exclusion Zone
- Submarine Transit Lane (U.S. Navy/Marine Cadastre 2018)**
- Radar Vector Area/Training Route Area/USMC Firing Area (NC Chapel Hill Study)**

Navigation:

- Ferry Routes (BTS 2022)
- Anchorage Area (NOAA/Marine Cadastre 2017)
- Maintained Channel (USACE/Marine Cadastre 2021)
- ACPARS Fairways (USCG 2022)
- Traffic Separation Schemes (TSS) (NOAA/Marine Cadastre 2015)**

Ocean Use:

- Ocean Disposal Sites (NOAA/Marine Cadastre 2022)
- Sand Borrow Areas/Sand Resources (USACE, BOEM, Florida Department of Environmental Protection's Regional Offshore Sand Source Inventory (ROSSI) 2021)
- BOEM Sand Lease Areas (BOEM 2021)
- Sand Resource Aliquots (BOEM 2021)
- Unexploded Ordnance Locations (NOAA/Marine Cadastre 2020)
- Unexploded Ordnance Areas (NOAA/Marine Cadastre 2020)**
- Anchorage Area (NOAA/Marine Cadastre 2017)**

Cultural Resources:

- Shipwrecks (Automated Wreck and Obstruction Information System [AWOIS]/Marine Cadastre 2009)
- Beach Access (NC DCM 2021) (Labeled “Beach” in map legend)
- Protected Areas Database of the United States (PAD-US 2.1 Data; USGS 2020)
- Historic Site (NCHPO 2021) (Labeled “Historic Resource” in map legend)
- Lighthouse (NCDCR 2021)
- NCHPO NR SL DOE Boundaries (NCHPO 2021)
- Wreck Diving Location (NC Wreck Diving)**
- Historic District (NCHPO 2021)**

Seafloor Sediment:

- USGS Seafloor Sediment (USGS 2005)
- US Submarine Canyons (BOEM 2019)
- World Seafloor Geomorphology (GRID Arendal 2015)
- Inlet Hazard Area (NC DCM 2019)**

Recreational Fishing:

- Artificial Reefs (NCDMF 2022a)
- Vessel Data (Northeast Ocean Data 2020)
- Fishing Pier (NCWRC 2021)**
- Wreck Diving Location (NC Wreck Diving)**

3.0 ENVIRONMENTAL RESOURCES

A summary of impacts to biological, physical, and human resources is provided below and includes a preliminary characterization of the resource within the Study Area.

3.1 Biological Resources

The following subsections provide an overview of the potential biological resources in the Study Area.

3.1.1 Benthic and Fisheries Resources

The benthic and fisheries resources discussion below includes, in some respects, commercial and recreational fisheries; however, desktop information is limited, and outreach to commercial and recreational fisheries entities has not been completed as part of this review. Some additional information regarding recreational fishing activities is also discussed in Section 3.3.6 Tourism and Recreation.

3.1.1.1 Preliminary Resource Characterization

The Study Area is located near the fluid boundary of the Mid-Atlantic Bight and the South Atlantic Bight at Cape Hatteras, North Carolina. The South Atlantic Bight extends from the Outer Banks of North Carolina south to the Florida Keys. The Mid-Atlantic Bight extends northward to Massachusetts. Benthic and fisheries species representative of both large ecosystem areas occur in the Project vicinity (Love and Chase 2007). Bottom habitat along the continental shelf is consistent with the Albemarle Self Valley Complex, with fine sand and mud overlaid with coarse sand that form surficial sand waves up to 3 meters (m) high (Swift et al. 1978). Depths along the Mid-Atlantic shelf averages approximately 25 m, becoming deeper eastward across the shelf to approximately 100 m before dropping dramatically across the slope break (Conley et al. 2017). The shelf is typically covered by a sheet of medium- to coarse-grained sands with occasional pockets of sand-shell and sand-gravel sediments (Wigley and Theroux 1981). Additional details on sediments are provided in Section 3.2.2, Geologic Conditions.

The softbottom macroinfaunal communities that dominate the Study Area have high species diversity but low densities because of unstable sediments, wide temperature fluctuations, and low nutrient and organic inputs. Many resident invertebrates are surface deposit or filter feeders with rapid generation times and high tolerances for intermittent and patchy nutrient inputs (BOEM 2014). Hardbottom substrates are heavily encrusted with sessile species (e.g., algae, barnacles, sponges, hydroids, anemones, bryozoans, bivalves, and tunicates) that provide structurally complex secondary habitat for resident invertebrate and finfish communities (BOEM 2014). Seagrass and shell bottom habitat, located well inshore of the Study Area, are shown in **Figure 3-1**. Details of artificial reefs are included in Section 3.1.4 Protected Habitats.

Across the North Carolina shelf, bottom water temperatures generally increase with depth, in contrast to the warm offshore waters that are influenced by the Gulf Stream. The maximum temperature gradient occurs from January to March when air temperatures are at their lowest. Water temperature throughout the North Carolina continental shelf are relatively uniform in the summer (Whitfield et al.

2014). Seasonal variations span up to 20 degrees Celsius (°C) at the surface and 12°C at the bottom of the water column (Guida et al. 2017). Thermal stratification begins in April, as ambient temperatures raise surface water temperatures, and increases until a maximum surface-to-bottom thermal gradient of up to 12°C is achieved in August (Guida et al. 2017). These fluctuations can trigger physiological and behavioral responses, such as inducing migratory behavior and gonadal development. As ocean temperatures increase, warm temperate species move in from the south. When water temperatures drop during winter, warm temperate species migrate southward and cold temperate species move northward (BOEM 2014).

Most marine organisms are neither wholly benthic nor wholly pelagic, but instead rely on the habitat continuum to support them throughout their lives. For example, Atlantic sea scallop eggs are fertilized in benthic habitats on the seafloor, then transform into planktonic larvae suspended in pelagic habitats. After drifting for 5 to 6 weeks and maturing from planktonic larvae into juveniles, these scallops settle back on benthic substrate to filter-feed on plankton, enrich the sediment with their waste, and release a new generation to repeat this cycle (Munroe et al. 2018). Together, benthic substrates and overlying pelagic waters provide supportive habitat for demersal and pelagic fish and invertebrates. These marine communities are supported by phytoplankton that thrive in the photic zone where nutrients are abundant. The coast of North Carolina is known for abundant phytoplankton sustained by nutrients drained into the region from river flow, tides, and currents, and carried to the surface by upwelling during seasonal turnover (Boicourt et al. 1987).

The demersal and pelagic habitats of North Carolina support approximately 600 fish species (BOEM 2014). BOEM and NOAA National Marine Fisheries Service (NOAA Fisheries) characterized fisheries resources within the Study Area as having few to no structure-forming fauna, notable differences in species assemblages and relative abundances between warm and cold seasons, and a relatively taxa-rich system (Guida et al. 2017). Dominant temperate reef fishes in this area include triggerfishes, jacks, grunts, wrasses, snapper/grouper, angelfishes, sea basses, porgies, and puffers (Bacheler et al. 2019).

Common fish families contributing to the demersal assemblages in the Mid-Atlantic Bight include drums, flounders, hakes, porgies, searobins, and skates. In the Study Area, managed demersal invertebrates and fish include the Atlantic surfclam, as well as the Atlantic croaker, black sea bass, flounders, hakes, searobins, scup, skates, smooth and spiny dogfish, and striped bass (NOAA Fisheries 2020a; Guida et al. 2017; BOEM 2014). Species aggregations form a gradient with respect to proximity to the coastline within the review area. Red and silver hakes, northern searobins, and summer and windowpane flounders may aggregate on the inner shelf (18 to 30 m); clearnose skates, little skates, and fourspot flounders may occur in intermediate shelf waters (30 to 50 m); and eels, hagfish, and pouts will likely be found on the outer shelf (50 to 100 m) (BOEM 2014; Love and Chase 2007).

Many coastal pelagic species in the Study Area (e.g., anchovies, bluefish, cobia, mullets, scup) are associated with structured bottom habitats but migrate in response to water column features (e.g., temperature, salinity, dissolved oxygen) and circulation. Atlantic menhaden, Atlantic mackerel, and small herrings are the dominant coastal pelagic forage species; these small shiny schooling fish tend to be short-lived, fast-maturing, and highly fecund, exhibiting wide variations in abundance (MAFMC 2017). Their species abundances may rise and fall asynchronously, and interannual variability in species recruitment can drive peaks in abundance for a given species unrelated to standing stock

(Bethony et al. 2016). Many species, including squid and butterfish, function as forage species while juveniles and as predators as adults.

Small coastal pelagic forage fish serve as an intermediate step to transfer energy from zooplankton to larger epipelagic predatory fish (e.g., jacks, sharks, swordfish, and tunas), which tend to be highly migratory (NOAA Fisheries 2017; BOEM 2014). These opportunistic predators are known to associate with natural and artificial flotsam, which provides foraging and nursery habitat. Yellowfin, blackfin, and skipjack tunas, for example, feed upon small fish attracted to *Sargassum* floats (Rudershausen et al. 2010; Casazza and Ross 2008; Moser et al. 1998). As many as 80 fish species, as well numerous invertebrates, are closely associated with floating *Sargassum* at some point in their life cycle. Floating *Sargassum* is designated as EFH for snappers, groupers, and coastal migratory pelagic species (68 Federal Register [FR] 192).

The Magnuson-Stevens Fishery Conservation Act (MSA) (16 U.S.C. §§ 1801-1882) established regional fishery management councils and mandated that Fishery Management Plan's (FMP) be developed to responsibly manage exploited fish and invertebrate species in U.S. federal waters. In the review area, species and stocks are managed by the North Carolina Marine Fisheries Commission, Atlantic States Marine Fisheries Commission (ASMFC), the South Atlantic Fishery Management Council (SAFMC), and the Mid-Atlantic Fishery Management Council (MAFMC). NOAA Fisheries' Highly Migratory Species Division is responsible for tunas, sharks, swordfish, and billfish (NOAA Fisheries 2017). Similarly, the SAFMC and the Gulf of Mexico Fishery Management Council (GMFMC) are responsible for coastal migratory pelagic species (e.g., king mackerel and Spanish mackerel).

Under the Sustainable Fisheries Act of 1996, Congress charged NOAA Fisheries with designating and conserving EFH for species managed under existing FMPs to minimize adverse effects and encourage conservation and enhancement of habitat caused by fishing or non-fishing activities (BOEM 2014). EFH may be defined as the waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity (16 U.S.C. § 1801(10)), where the term "necessary" indicates habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. Within the review area, EFH may be broadly typified as benthic habitat, including both seafloor habitats and the sediment-water interface, and pelagic habitat (NOAA Fisheries 2017; SAFMC 1998). In assigning specific substrate types, water depths, and foraging habitat as essential to managed species, EFH designations explicitly recognize the joint contributions of benthic and pelagic habitats.

Managed fish with designated EFH in the Study Area were identified using the online EFH Mapper (NOAA Fisheries 2022a). The 36 managed species that may occur seasonally or year-round in the review area are listed in **Table 3-1**.

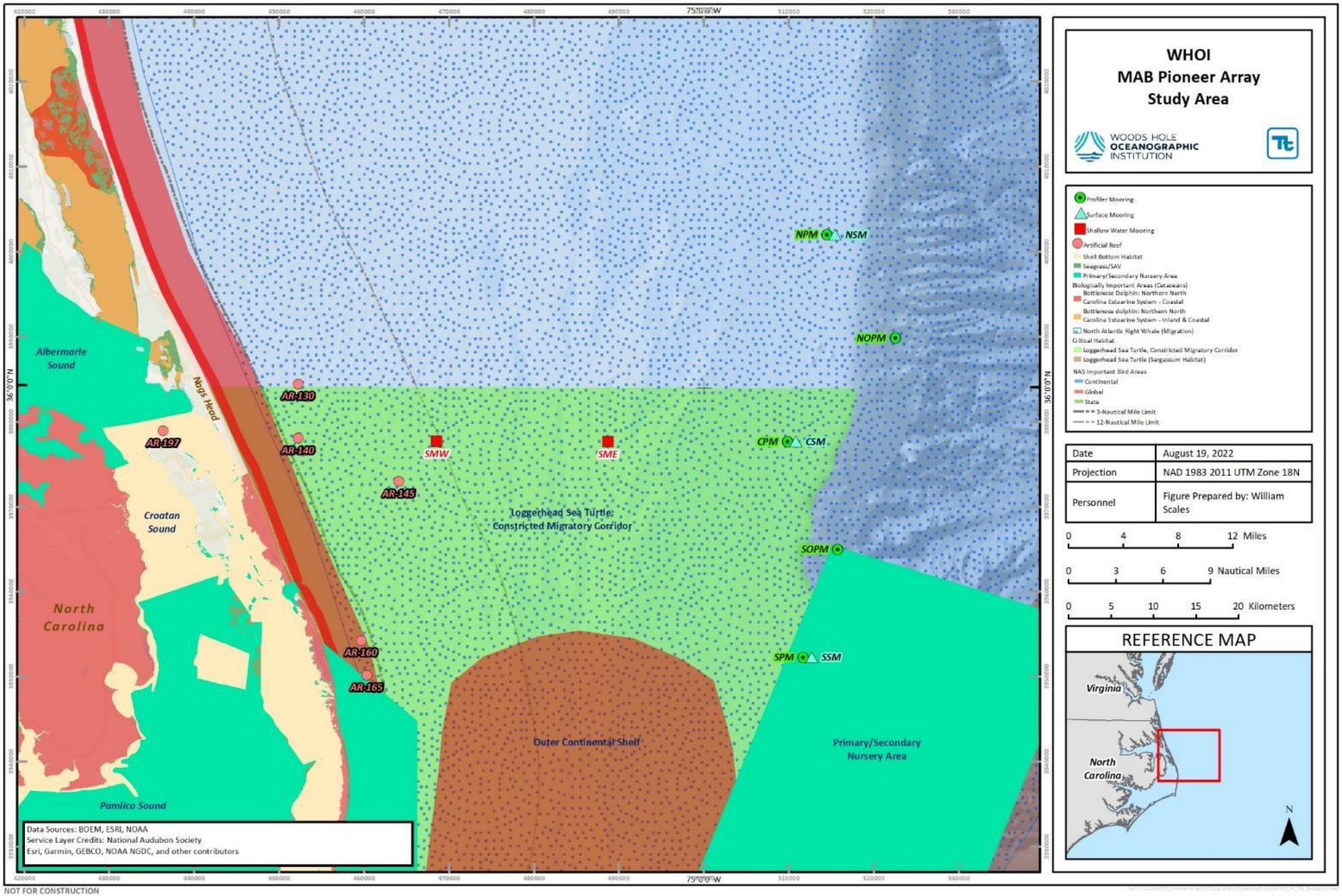

Figure 3-1. Biological Resources

Table 3-1. Managed Species with Designated EFH in the Study Area

Common Name	Scientific Name	Managing Fisheries Management Council	Lifestage(s) Found
Albacore Tuna	*Thunnus alalunga*	NOAA HMS	Adult, Juvenile
Atlantic Angel Shark	*Squatina dumeril*	NOAA HMS	All
Atlantic Butterfish	*Peprilus triacanthus*	MAFMC	Eggs, Adult, Juvenile
Atlantic Cod	*Gadus morhua*	NEFMC	Eggs, Larvae
Atlantic Mackerel	*Scomber scombrus*	MAFMC	Adult, Juvenile
Atlantic Sea Scallop	*Placopecten magellanicus*	NEFMC	All
Atlantic Sharpnose Shark	*Rhizoprionodon terraenovae*	NOAA HMS	Adult
Atlantic Surfclam	*Spisula solidissima*	MAFMC	Adult, Juvenile
Black Sea Bass	*Centropristis striata*	MAFMC	Adult, Juvenile, Larvae
Blue Shark	*Prionace glauca*	NOAA HMS	Adult, Juvenile
Bluefin Tuna	*Thunnus thynnus*	NOAA HMS	Adult, Juvenile, Spawning, Eggs, Larvae
Bluefish	*Pomatomus saltatrix*	MAFMC	Larvae
Clearnose Skate	*Raja eglanteria*	NEFMC	Juvenile
Common Thresher Shark	*Alopias vulpinus*	NOAA HMS	ALL
Dusky Shark	*Carcharhinus obscurus*	NOAA HMS	Adult, Juvenile
Longfin Inshore Squid	*Doryteuthis (Amerigo) pealeii*	MAFMC	Adult, Juvenile
Monkfish	*Lophius americanus*	NEFMC	Eggs/Larvae
Night Shark	*Carcharhinus signatus*	NOAA HMS	All
Northern Shortfin Squid	*Illex illecebrosus*	MAFMC	Adult, Juvenile
Sailfish	*Istiophorus albicans*	NOAA HMS	Adult, Juvenile
Sand Tiger Shark	*Carcharhinus taurus*	NOAA HMS	Adult
Sandbar Shark	*Carcharhinus plumbeus*	NOAA HMS	Adult, Juvenile, Neonate
Scalloped Hammerhead Shark	*Sphyrna lewini*	NOAA HMS	Adult, Juvenile
Scup	*Stenotomus chrysops*	MAFMC	Adult, Juvenile
Silky Shark	*Carcharhinus falciformis*	NOAA HMS	All
Skipjack Tuna	*Katsuwonus pelamis*	NOAA HMS	Adult, Juvenile
Smoothhound Shark Complex / Smooth Dogfish	*Mustelus canis*	NOAA HMS	All
Snapper Grouper	*Epinephelidae; Lutjanidae*	SAFMC	All
Spiny Dogfish	*Squalus acanthias*	MAFMC	Sub-Adult Female, Adult
Spiny Lobster	*Palinuridae*	SAFMC	All
Summer Flounder	*Paralichthys dentatus*	MAFMC	Adult, Juvenile
Tiger Shark	*Galeocerdo cuvier*	NOAA HMS	Adult, Juvenile, Neonate
Windowpane Flounder	*Scophthalmus aquosus*	NEFMC	All
Witch Flounder	*Glyptocephalus cynoglossus*	NEFMC	Larvae
Yellowfin Tuna	*Thunnus albacares*	NOAA HMS	Adult, Juvenile
Yellowtail Flounder	*Limanda ferruginea*	NEFMC	Larvae

The North Carolina Marine Fisheries Commission and the North Carolina Department of Environmental Quality (NCDEQ) Division of Marine Fisheries jointly manage fish and invertebrates within state waters, including shrimp and bay scallop. The North Carolina Fisheries Reform Act of 1997 requires the NCDEQ Division of Marine Fisheries to prepare FMPs for adoption by the North Carolina Marine Fisheries Commission for all marine and estuarine commercially and recreationally significant species. FMPs have been created for the bay scallop, blue crab, eastern oyster, estuarine striped bass, hard clam, kingfishes, red drum, river herring, sheepshead, shrimp, southern flounder, spotted sea trout, and striped mullet (NCDMF 2022b). No proposed Project structures are planned in state waters.

NOAA Fisheries has jurisdiction over two anadromous and three pelagic species federally protected under the Endangered Species Act (ESA) that may occur, but with no designated Critical Habitat, in the Study Area. The anadromous Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is listed under the ESA as five distinct population segments (DPSs; one listed as threatened, the remaining four listed as endangered) (77 FR 24). Given its affinity for North Carolina waters, the Atlantic sturgeon is assumed to be present in the Study Area. Individuals from all DPSs migrate along the U.S. Atlantic Coast; therefore, all Atlantic sturgeon encountered in the Study Area are considered endangered. The anadromous shortnose sturgeon (*Acipenser brevirostrum*) is listed as endangered under the ESA (32 FR 48:4001). Since it rarely enters coastal waters beyond estuarine habitats, the shortnose sturgeon is not expected to occur in the Study Area. The pelagic giant manta ray (*Manta birostris*), oceanic whitetip shark (*Carcharhinus longimanus*), and Central and Southwest Atlantic DPSs of the scalloped hammerhead shark (*Sphyrna lewini*) are listed as threatened under the ESA (79 FR 128:38214-38242; 83 FR 14:2916-2931; 83 FR 20:4153-4165). While there is a low likelihood of these species transiting through the Study Area, it is virtually impossible to demonstrate absence of rare species within their historical ranges; therefore, these three species are assumed present in the Study Area.

3.1.1.2 Mitigation

As described above, the baseline characterization and assessment of potential impacts to benthic and finfish resources from installation and operation of a project in the Study Area may need to satisfy various federal requirements. No proposed Project structures are planned in state waters.

Existing and publicly available data sources do not provide sufficient site-specific coverage to adequately characterize baseline benthic, invertebrate, and finfish resources in the Study Area. Subsequent agency outreach and informal consultation is recommended to determine the need for site-specific benthic characterization surveys to identify sensitive habitats and fisheries resources in the Study Area in support of an Environmental Assessment. Tetra Tech recommends the following actions:

- Agency outreach via informal consultation with USFWS and NOAA Fisheries to establish formal written concurrence that Project activities will incur minimal to no adverse impacts to benthic and fisheries resources or habitats, and thus, the Project will not require more detailed site or species-specific studies or require agency consultation.
- Conduct communication and outreach with fishermen prior to siting as a courtesy in addition to the Local Notice to Mariners.

In addition to the above mitigations, resource agencies have established moratoria to protect species during critical life stages. These moratoria are from sampling data, known fish distribution, and known impacts to a fish or habitat from exposure to turbidity or sedimentation. NCDMF has regional moratoria for work in designated Primary Nursery Areas, or anadromous fish spawning and nursery areas. Similarly, the North Carolina Wildlife Resources Commission (NCWRC) has moratoria related to protected species like nesting sea turtles, and NOAA Fisheries has moratoria for anadromous fish. However, these do not apply as no Project moorings are located within state waters.

3.1.2 Marine Mammals and Sea Turtles

The following sections identify the resources present in the Study Area and mitigation needed to avoid and/or minimize impacts.

3.1.2.1 Preliminary Resource Characterization

The U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessment Reports (Hayes et al. 2021, 2022) provide a number of Atlantic species of marine mammals (whales, dolphins, porpoise, manatee, and seals) that may occur off the North Carolina coast. There are 36 species of marine mammals (7 large whales, 18 dolphins [including larger oceanic dolphin species], 1 porpoise, 5 beaked whales, 4 seals, and 1 manatee) that occur in the Southeast Atlantic OCS region, and all are protected by the Marine Mammal Protection Act (MMPA). Six of these species are additionally listed under the ESA as threatened or endangered and are known to be present, at least seasonally, in the Study Area.

NOAA Fisheries uses Marine Species Density Data Gap Assessments, developed by Roberts et al. (2021) and Duke/EC (2022), which built upon models originally developed by the U.S. Department of the Navy (U.S. Navy), to estimate marine mammal abundance (U.S. Navy 2007). The current estimates provided by Roberts et al. (2021) and Duke/EC (2022) are supplemented by data derived from several sources and independent studies and are used where feasible to update the species Stock Assessment Reports (Hayes et al. 2021, 2022). The Roberts et al. (2021) and Duke/EC (2022) data suggests that marine mammal density in the Mid-Atlantic region is patchy and seasonally variable. Currently, there are a number of Unusual Mortality Events (UMEs) that NOAA Fisheries has evaluated and declared (NOAA Fisheries 2022b). Under the MMPA, a UME is defined as “a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response.” Current UMEs include several of the species found in North Carolina including the North Atlantic right whale [right whale], humpback whale (*Megaptera novaeangliae)* minke whale (*Balaenoptera acutorostrata)*, harbor (*Phoca vitulina)* or gray seals (*Halichoerus grypus)* [nonactive, closure pending]) and West Indian manatee (*Trichechus manatus)*. Of these, the most relevant for this Study Area are UMEs affecting the right whale, minke whale, and humpback whale.

All 36 marine mammal species identified in **Table 3-2** are protected by the MMPA and some are also listed under the ESA. The six ESA-listed marine mammal species known to be present year-round or seasonally in the waters of the Mid-Atlantic are the right whale (*Eubalaena glacialis)*, fin whale (*Balaenoptera physalus),* sei whale (*Balaenoptera borealis*), blue whale (*Balaenoptera musculus)*, sperm whale (*Physeter macrocephalus)*, and the West Indian manatee. Four of the six ESA-listed species, the right, fin, sei, and sperm whale, have the likely potential to occur within the Study Area,

Table 3-2. Marine Mammals Known to Occur in the Marine Waters in Coastal Offshore North Carolina

Common Name	Scientific Name	Federal Status a/	Estimated Population	Stock	Likelihood of Occurrence/ Seasonality
Mysticetes (Baleen Whales)					
Balaenidae (Right and Bowhead Whales)					
North Atlantic Right Whale	*Eubalaena glacialis*	MMPA: Strategic ESA: Endangered	368	W. North Atlantic	Common/ Year-round
Humpback Whale	*Megaptera novaeangliae*	MMPA: Non-Strategic	1,396	Gulf of Maine	Common/ Year-round
Fin Whale	*Balaenoptera physalus*	MMPA: Strategic ESA: Endangered	6,802	W. North Atlantic	Common/ Year-round
Sei Whale	*Balaenoptera borealis*	MMPA: Strategic ESA: Endangered	6,292	Nova Scotia	Uncommon/ Winter/Spring/ Summer
Minke Whale	*Balaenoptera acutorostrata*	MMPA: Non-Strategic	21,968	Canadian East Coast	Common/ Year-round
Blue Whale	*Balaenoptera musculus*	MMPA: Strategic ESA: Endangered	Unknown	W. North Atlantic	Uncommon/ Year-round
Bryde's Whale	*Balaenoptera edeni*	MMPA Protected	Unknown	W. North Atlantic	Unknown
Odontocetes (Toothed Whales)					
Delphinidae (Dolphins)					
Atlantic Spotted Dolphin	*Stenella frontalis*	MMPA: Non-Strategic	39,921	W. North Atlantic	Common/ Year-round
Risso's Dolphin	*Grampus griseus*	MMPA: Non-Strategic	35,215	W. North Atlantic	Common/ Year-round
Long-Finned Pilot Whale	*Globicephala melas*	MMPA: Non-Strategic	39,215	W. North Atlantic	Common/ Year-round
Short-Finned Pilot Whale	*Globicephala macrorhynchus*	MMPA: Non-Strategic	28,924	W. North Atlantic	Common/ Year-round
White-Sided Dolphin	*Lagenorhynchus acutus*	MMPA: Non-Strategic	93,233	W. North Atlantic	Uncommon/ Fall/Winter/Spring
White-Beaked Dolphin	*Lagenorhynchus albirostris*	MMPA: Non-strategic	536,016	W. North Atlantic	Uncommon/ Variable
Short- beaked Common Dolphin	*Delphinus delphis*	MMPA: Non-Strategic	172,974	W. North Atlantic	Common/ Year-round
Bottlenose Dolphin	*Tursiops truncatus*	MMPA: Non-Strategic	3,751	W. North Atlantic, Southern Migratory Coastal	Common/ Year-round
			62,851 b/	W. North Atlantic Offshore	Common/ Year-round
			823	N. North Carolina Estuarine System	Common/ Year-round
			Unknown	S. North Carolina Estuarine System Stock	Common/ Year-round
Clymene Dolphin	*Stenella clymene*	MMPA: Non-Strategic	4,237	W. North Atlantic	Extralimital/ Summer
Pan-Tropical Spotted Dolphin	*Stenella attenuata*	MMPA: Non-Strategic	6,593	W. North Atlantic	Uncommon/ Summer
Striped Dolphin	*Stenella coeruleoalba*	MMPA: Non-Strategic	67,036	W. North Atlantic	Uncommon/ Year-round

Common Name	Scientific Name	Federal Status a/	Estimated Population	Stock	Likelihood of Occurrence/ Seasonality
Spinner Dolphin	*Stenella longirostris*	MMPA: Non-Strategic	4,102	W. North Atlantic	Uncommon/ Year-round
Killer Whale	*Orcinus orca*	MMPA: Non-Strategic	Unknown	W. North Atlantic	Uncommon/ Year-round
False Killer Whale	*Pseudorca crassidens*	MMPA: Strategic	1,791	W. North Atlantic	Uncommon/ Variable
Melon-Headed whale	*Peponocephala electra*	MMPA: Non-Strategic	Unknown	W. North Atlantic	Uncommon/ Variable
Sperm Whale	*Physeter macrocephalus*	MMPA: Strategic ESA: Endangered	4,349	North Atlantic	Uncommon/ Year-round
Dwarf Sperm Whale	*Kogia sima*	MMPA: Non-Strategic	7,750 c/	W. North Atlantic	Uncommon/ Variable
Pygmy Sperm Whale	*Kogia breviceps*	MMPA: Non-Strategic	7,750 c/	W. North Atlantic	Uncommon/ Variable
Phocoenidae (Porpoises)					
Harbor Porpoise	*Phocoena phocoena*	MMPA: Non-Strategic	95,543	Gulf of Main/Bay of Fundy	Common/ Winter
Ziphiidae (Beaked Whales)					
Blainville's Beaked Whale	*Mesoplodon densirostris*	MMPA: Non-Strategic	10,107 d/	W. North Atlantic	Uncommon/ Spring/Summer
True's Beaked Whale	*Mesoplodon mirus*	MMPA: Non-Strategic	10,107 d/	W. North Atlantic	Uncommon/ Spring/Summer
Gervais' Beaked Whale	*Mesoplodon europaeus*	MMPA: Non-Strategic	10,107 d/	W. North Atlantic	Uncommon/ Spring/Summer
Cuvier's Beaked Whale	*Ziphius cavirostris*	MMPA: Non-Strategic	5,744	W. North Atlantic	Uncommon/ Spring/Summer
Sowerby's Beaked Whale	*Mesoplodon bidens*	MMPA: Non-Strategic	10,107 d/	W. North Atlantic	Uncommon/ Variable
Pinnipeds (Eared and Earless Seals)					
Phocidae (Earless Seals)					
Harbor Seal	*Phoca vitulina*	MMPA: Non-Strategic	61,336	W. North Atlantic	Common/ Fall/Winter/Spring
Gray Seal	*Halichoerus grypus*	MMPA: Non-Strategic	27,300	W. North Atlantic	Common/ Fall/Winter/Spring
Harp Seal	*Pagophilus groenlandicus*	MMPA: Non-Strategic	7,600,000	W. North Atlantic	Uncommon/ Winter/Spring
Hooded Seal	*Cystophora cristata*	MMPA: Non-Strategic	Unknown	W. North Atlantic	Extralimital/ Summer/Fall
Sirenia (Sea Cows)					
Trichechidae (Manatees)					
West Indian Manatee	*Trichechus manatus*	MMPA: Strategic ESA: Threatened	Unknown	Florida	Extralimital/ Variable

Notes:
a/ A strategic stock is defined as any marine mammal stock: 1) for which the level of direct human-caused mortality exceeds the potential biological removal level, 2) which is declining and likely to be listed as threatened under the ESA, or 3) which is listed as threatened or endangered under the ESA or as depleted under the MMPA (NOAA Fisheries 2019a).
b/ Estimates may include sightings of the coastal form.
c/ This estimate includes both the dwarf and pygmy sperm whales.
d/ This estimate includes Gervais' beaked whales and Blainville's beaked whales for the Gulf of Mexico stocks and all species of Mesoplodon in the Atlantic.
Sources: Hayes et al. 2021, 2022 (Draft NOAA Fisheries 2021 Stock Assessment Report (SAR); NOAA Fisheries 2022c, Pace et al. 2017, USFWS 2022b

based on the current knowledge of these species' occurrences and the overlap of project profiler and surface moorings within established Biologically Important Areas for cetaceans, **Figure 3-1**. The humpback whale is designated as non-strategic under the MMPA. The stock that inhabits the Mid-Atlantic region, which may occur year-round, was recently delisted as an endangered species (Hayes et al. 2021). Generally, many of these species are migratory, and as such, were historically thought to be present seasonally. However, they are increasingly seen foraging throughout the summer and fall months and in the winter during their migrations to warmer waters. Additionally, some individuals from the larger whale species (including right whales) are known to remain year-round (Hodge et al. 2015). Dolphins, especially bottlenose (*Tursiops truncatus)*, are known to be residents in estuarine regions (NOAA Fisheries 2014).

The Bryde's whale (*Balaenoptera edeni*) is not currently ESA-listed, and there is not enough information to estimate population trends for the Bryde's whale species as a whole. This species is designated as protected under the MMPA (Hayes et al. 2021). Other than a single stranding event in 2003, there are no confirmed NOAA Fisheries sightings of any type of Bryde's whale along the U.S. eastern seaboard between 1992 and 2019 (Rosel et al. 2021). Bryde's whales primarily have a restricted distribution with the majority of species sightings having occurred within the northeastern Gulf of Mexico (Waring et al. 2016). The West Indian manatee is listed as endangered under the ESA and is designated as strategic under the MMPA (Hayes et al. 2021). This manatee species has been sighted in North Carolina waters. However, such events are infrequent as this species cannot tolerate temperatures below 20°C for extended periods of time (USFWS 2022a), The potential for the Bryde's whale and West Indian manatee to occur within the Study Area is unlikely, therefore these species will not be described further in this analysis.

The offshore waters of North Carolina, including the Study Area, are primarily used as a migration corridor for many cetacean species, particularly by right whales, during seasonal movements north or south between important feeding and breeding grounds (Firestone et al. 2008; Knowlton et al. 2002). The right whale is considered one of the most critically endangered populations of large whales in the world and is listed as federally endangered under the ESA. The Western North Atlantic stock is considered strategic under the MMPA (Hayes et al. 2021). Right whales have been observed in coastal Atlantic waters year-round and have been acoustically detected off Georgia and North Carolina in 7 of 11 months monitored (Hodge et al. 2015). This species moves annually between high-latitude feeding grounds and low-latitude calving and breeding grounds. The current range of the western Atlantic right whale population includes two areas designated as Critical Habitat which are connected by a migratory corridor. As of January 26, 2016, NOAA Fisheries expanded the North Atlantic Right Whale Critical Habitat Southeastern U.S. Calving Area from below Cape Canaveral, Florida northward to Cape Fear, North Carolina; this Critical Habitat is utilized for wintering and calving (NOAA Fisheries 2019b, 2022d). The Critical Habitat Northeastern U.S. Foraging Area defines summer feeding and nursery grounds and is located between New England, the Bay of Fundy, and the Gulf of St. Lawrence (Kenney 2009; Hayes et al. 2021, NOAA Fisheries 2019b). The right whale migratory corridor connects the southern and northern Critical Habitat areas and there are additional zones along the coast that are designated as Seasonal Management Areas (SMAs) (NOAA Fisheries 2021). The Mid-Atlantic SMAs and designated Critical Habitat areas for right whales do not overlap with the Study Area. However, the

offshore waters of North Carolina, including waters within the Study Area, are utilized by right whales, and are considered Biologically Important Areas for migration. Biologically Important Areas are designated by NOAA Fisheries with the input of specialists in order to identify areas where cetacean species or populations are known to concentrate for specific behaviors (NOAA Fisheries 2005; Hayes et al. 2021).

The fin whale is listed as endangered under the ESA and the Western North Atlantic stock is designated as strategic under the MMPA (Hayes et al. 2021). This species is the most commonly sighted large whale in continental shelf waters from the mid-Atlantic coast of the United States to Nova Scotia, principally from Cape Hatteras northward (NOAA Fisheries 2011). Fin whales are present in the Mid-Atlantic OCS region during all four seasons, although sighting data indicate that they are more prevalent during winter, spring, and summer (Hayes et al. 2021).

The sei whale is listed as endangered under the ESA, and the Nova Scotia stock is designated as strategic under the MMPA (Hayes et al. 2021). Sei whales occur in deep water characteristic of the continental shelf edge throughout their range (NOAA Fisheries 2012; Hayes et al. 2021). The sei whales' range is widespread encompassing the world's temperate, subpolar, subtropical, and tropical marine waters. NOAA Fisheries considers sei whales occurring from the U.S. East Coast to Cape Breton, Nova Scotia, and east to 42°W, as belonging to the "Nova Scotia stock" of sei whales (Hayes et al. 2021). Sei whales have been observed along the continental shelf and shelf edge waters around Cape Hatteras, North Carolina (NOAA Fisheries 2012).

The minke whale is not ESA-listed and the Canadian East Coast stock is listed by NOAA Fisheries as non-strategic under the MMPA (Hayes et al. 2021) Minke whales occur in the North Atlantic and North Pacific, from tropical to polar waters (Risch et al. 2019). Generally, they inhabit warmer waters during winter and travel north to colder regions in summer, while some animals migrate as far as the ice edge. They are frequently observed in coastal or shelf waters off the U.S. East Coast. Strandings of this species have been reported along the Cape Hatteras National Seashore (NOAA Fisheries 2022e).

The false killer whale (*Pseudorca crassidens*) is not ESA-listed and the Western North Atlantic stock is considered strategic under the MMPA (Hayes et al. 2021). False killer whales generally prefer offshore tropical to subtropical waters that are deeper than 3,300 feet. False killer whales have been sighted in U.S. Atlantic waters from southern Florida to Maine; however, these sightings are uncommon (NOAA Fisheries 2020b).

The Blainville's beaked whale (*Mesoplodon densirostris)*, True's beaked whale (*Mesoplodon mirus*), Gervais' beaked whale (*Mesoplodon europaeus)*, Cuvier's beaked whale (*Ziphius cavirostris)* and Sowerby's beaked whale (*Mesoplodon bidens)* are not ESA-listed and their Western North Atlantic stocks are designated as non-strategic under the MMPA (Hayes et al. 2021). For the relevant species of the *Mesoplodon* genus, sightings off the U.S. Atlantic coast have principally occurred along the shelf-edge and deeper oceanic waters including the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (NOAA Fisheries 2004). The singular species of the *Ziphius* genus relevant to the Study Area is found worldwide in deep waters and have been sighted near the continental slope off the North Carolina coast. Particularly along the Gulf Stream area off Cape Hatteras which may potentially be year-round habitat for this genus (McLellan et al. 2018).

The blue whale is listed as endangered under the ESA and is designated as protected under the MMPA. Blue whales are considered an occasional visitor in U.S. Atlantic Exclusive Economic Zone waters, being generally more pelagic than most other whales (Hayes et al. 2021). A juvenile blue whale sighting from a survey vessel was the first photographic record of this species in the nearshore area (U.S. Navy Marine Species Monitoring 2018). It may be that prey availability, changing habitat from climate change, or other factors that are adjusting known distributions, are refining previous findings.

Sperm whales are listed as ESA endangered and the North Atlantic stock is designated as strategic by the MMPA. Sperm whales, including pygmy and dwarf species, are considered deep-water species. In the Northern Hemisphere, the peak breeding season occurs between March and June (NOAA Fisheries 2020c). Sperm whale distribution is typically associated with waters over the continental shelf break, the continental slope, and farther offshore, with higher concentrations near drop-offs and areas with strong currents and steep topography regardless of season (Whitehead et al. 1992; Jefferson et al. 2015; Hayes et al. 2021) Sperm whales have been known to concentrate off the North Carolina coast during winter months where calving grounds are believed to exist south of the Study Area around Cape Hatteras (NOAA Fisheries 2020c).

The harbor seal is not ESA-listed, and NOAA Fisheries considers the Western North Atlantic stock as non-strategic under the MMPA. Harbor seals are the most abundant seals in the waters of the eastern United States and are commonly found in all nearshore waters of the Atlantic Ocean from Newfoundland, Canada, southward to northern Florida. Winter haul-out sites for harbor seals have been identified within the Chesapeake Bay region and Outer Banks beaches; however, these seals are only occasionally sited as far south as the Carolinas (Hayes et al. 2021). The gray seal is not ESA-listed, and NOAA Fisheries considers the Western North Atlantic stock as non-strategic under the MMPA (Hayes et al. 2021). Until recently, coastal Virginia was thought to represent the southern extent of the habitat range for gray seals; however, rare sightings of gray seals have occurred along North Carolina beaches (Waring et al. 2016). Previously, data indicated that both harbor and gray seals prefer colder, northern waters; however, similar to shifts in cetacean occurrence, prey availability, or changing habitat from climate change or other factors could be driving changes in distribution of seals. More focused survey efforts for seals, such as the one presented in Jones and Dees (2020), are anticipated and may help refine and update previous findings. Both the harp and hooded seal are not ESA-listed, and NOAA Fisheries considers their Western North Atlantic stock as non-strategic under the MMPA. This stock of harp seal is generally found in more northern waters along the U.S. Atlantic coast; however, data suggests that abnormal environmental conditions likely account for the increase of sightings off North Carolina. The Western North Atlantic stock of hooded seals prefer deeper water and typically occurs farther offshore than harp seals with only extralimital strandings of this species reported off the southeast United States (Hayes et al. 2021).

The relevant stocks of harbor porpoises (*Phocoena phocoena*), Atlantic spotted dolphin (*Stenella frontalis)*, Risso's dolphin (*Grampus griseus*), long and short-finned pilot whale (*Globicephala spp.),* white-sided dolphin (*Lagenorhynchus acutus),* white-beaked dolphin (*Lagenorhynchus albirostris),* short-beaked common dolphin (*Delphinus delphis),* bottlenose dolphin, Clymene dolphin (*Stenella clymene)*, pan-tropical spotted dolphin (*Stenella attenuata),* striped dolphin (*Stenella coeruleoalba),* spinner dolphin (*Stenella longirostris),*killer whale (*Orcinus orca)* and melon-headed whale

(*Peponocephala electra)* are all non-ESA listed species with a non-strategic MMPA designation (Hayes et al. 2021).

The five species of sea turtle that have historically been reported to occur in Mid-Atlantic waters off the coast of North Carolina include the Atlantic hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and loggerhead sea turtle (*Caretta caretta*). **Table 3-3** provides the known distributions within coastal North Carolina and the Study Area and a summary of key information for each species, all of which are listed as threatened or endangered under the ESA. Hawksbill sightings across North Carolina are rare, and since they are strongly affiliated with tropical environments, any occurrences in North Carolina should be considered extralimital (Finn et al. 2016; Sea Turtle.org 2022; STSSN 2022). Green, loggerhead, and Kemp's ridley turtles are the most abundant species to occur in North Carolina, while leatherbacks are observed annually in fewer numbers (Epperly et al. 1995; STSSN 2022). In 2014, NOAA Fisheries designated occupied marine areas within the Atlantic Ocean and the Gulf of Mexico as critical habitat for the Northwest Atlantic DPS of loggerhead turtle (**Figure 3-1**; 79 FR 128:38214-38242).

Table 3-3. Sea Turtles Known to Occur in the Marine Waters in Coastal Offshore North Carolina

Common Name	Scientific Name	Federal Status	Abundance a/	Known Distribution	Likelihood of Occurrence b/
Cheloniidae (Sea Turtles)					
Dermochelyidae (Leatherback Sea Turtles)					
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	34,00 – 94,000	Offshore, continental shelf and deeper	Uncommon/ Year-round
Cheloniidae (Hard-shelled Sea Turtles)					
Atlantic Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered	19,000	N/A	Extralimital/ Year-round
Green Sea Turtle (North Atlantic DPS)	*Chelonia mydas*	Threatened	215,000	Coastal, bays, estuaries, and inlets	Uncommon/ Year-round
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Endangered	248,300	Coastal, bays, estuaries, and inlets	Common/ Year-round
Loggerhead Sea Turtle (Northwest Atlantic DPS)	*Caretta caretta*	Threatened	588,000	Throughout: offshore, continental shelf and deeper; coastal, bays, estuaries, and inlets	Common/ Year-round

Sources: NOAA Fisheries 2015, 2019a, 2019c; NOAA Fisheries and USFWS 2009, 2013a, 2013b, 2015; TEWG 2007
Notes:
a/ Abundance estimates based on current nesting female and sex ratio estimates.
b/ Occurrence defined as: Common: occurrences are regularly documented, and the Study Area is generally considered within the typical range of the species.
Uncommon: occurrences are occasionally documented, and the Study Area is generally considered within the typical range of the species.
Extralimital: few occurrences have been documented and the Study Area is generally considered outside the typical range of the species; any occurrences would likely be of incidental individuals.

In North Carolina, sea turtles generally appear in late spring when water temperatures approach 20°C and leave in fall as water temperatures drop below 18°C (Barco and Lockhart 2016; Mansfield 2006). The Gulf Stream acts as a transportation vector for hatchlings that have departed their nesting beaches along the U.S. southeast coast (Putman et al. 2010). Juveniles use the Gulf Stream as overwintering habitat but may also occur nearshore in pursuit of macroalgae or submerged aquatic vegetation (SAV) and seagrass, as identified in **Figure 3-1**. North Carolina coastal and estuarine waters serve as important transitional foraging habitat for juvenile sea turtles in their migrations north to

coastal developmental habitats or south to warmer water (Morreale and Standora 2005). The U.S. Mid-Atlantic Bight is prime foraging habitat for loggerhead sea turtles, one of North Carolina's most common sea turtle species, during the late-spring to summer months (NOAA Fisheries 2019c). The Study Area does not overlap with the loggerhead sea turtle Coastal Critical Habitat Designation (sargassum habitat), however, it does overlap with the loggerhead sea turtle Constricted Migratory Corridor encompassing profiler moorings CMP and SPM, surface moorings SSM and CSM and shallow-water moorings SME and SWM, as shown in **Figure 3-1**.

Sea turtles are found globally in tropical, sub-tropical, and temperate waters. They are long-lived, slow-growing reptiles that spend their lives in the ocean in two distinct life stages: a pelagic (offshore) stage and a neritic (nearshore to the continental shelf break) stage (Barco and Swingle 2014). Hatchlings begin their pelagic stage by drifting in convergence zones or sargassum rafts offshore and feeding on pelagic invertebrates (Witherington et al. 2012). As they mature into juveniles, they enter their neritic (relatively shallow, coastal waters) stage and transition from surface to benthic feeding and forage for crustaceans, mollusks, sponges, coelenterates, fish, and seagrasses. Adults migrate thousands of kilometers between nesting beaches, mating areas, nursery habitats, and feeding grounds to satisfy reproductive and foraging needs (Lohmann and Lohmann 2010). Cheloniid sea turtle (hard-shelled species that exclude leatherbacks) migrations are influenced by changes in ocean currents, food availability, reproductive requirements, and water temperatures (Musick and Limpus 1997). Water temperatures play a crucial role in dictating seasonal movements, since these species often become lethargic at temperatures below 10°C and risk becoming cold-stunned. Leatherbacks exhibit a wider geographic range and more variable movements due to their ability to maintain warm body temperatures in temperate waters and cool body temperatures in tropical waters (Barco and Swingle 2014).

Based on the known areas of occurrence, sea turtles are likely to occur in the offshore Study Area, but given the absence of terrestrial project parameters, no onshore impacts are expected for sea turtles. However, onshore strandings, particularly those associated with cold stunning, are initiated in offshore waters. Annual sea turtle strandings across North Carolina may number in the hundreds (Niemuth et al. 2020; STSSN 2022). Strandings are defined as events in which sea turtles wash ashore entangled, sick, injured, or dead; records of such events may be used to indicate seasonal trends in presence (NCWRC 2022a,b). Sea turtles may also strand due to cold stunning in winter months. Cold stunning is a hypothermic reaction that occurs in response to prolonged cold-water temperatures (typically under 10°C) and may manifest as decreased heart rate, decreased circulation, lethargy, shock, pneumonia, and possibly death. Juvenile loggerheads and Kemp's ridley turtles are most likely to suffer from such events in the Study Area (Barco and Lockhart 2016; Niemuth et al. 2020). Based on multi-decadal stranding data, green and Kemp's ridley turtles may be observed year-round in North Carolina. Loggerheads are present from May through October, while leatherbacks peak from May to July (STSSN 2022; NCWRC 2022a).

In North Carolina, loggerhead, green, leatherback, and Kemp's ridley sea turtle nest recordings are ongoing for 2022, with loggerhead nests being the most common (**.**

Table 3-4). Two nests were also laid by a hawksbill sea turtle in 2015 (Sea Turtle.org 2022; Finn et al. 2016). The two hawksbill sea turtle nests are unusual in that they are the only ones documented this far north.

Table 3-4. Sea Turtle Nests in North Carolina (January 1, 2022 – August 8, 2022)

Beach	Loggerhead	Green	Leatherback	Kemp's Ridley	Total
Atlantic Beach	4	1	0	0	**5**
Bald Head Island	132	0	0	0	**132**
Cape Hatteras National Seashore	334	10	1	1	**346**
Cape Lookout National Seashore	406	5	1	3	**415**
Carolina Beach	11	0	0	0	**11**
Caswell Beach	92	1	1	0	**94**
Emerald Isle	29	0	0	1	**30**
Figure 8 Island	9	0	0	0	**9**
Fort Fisher State Recreation Area	127	1	0	0	**128**
Fort Macon State Park	5	0	0	0	**5**
Hammocks Beach State Park	19	0	0	0	**19**
Holden Beach	62	0	0	0	**62**
Indiana Beach/Salter Path	9	0	0	0	**9**
Kure Beach	5	0	0	0	**5**
Lea-Hutaff Island	14	0	0	0	**14**
Masonboro	68	5	0	0	**73**
Northern Outer Banks	34	2	0	2	**38**
Oak Island	134	0	1	0	**135**
Ocean Isle Beach	36	0	0	0	**36**
Onslow Beach	87	0	0	0	**87**
Pea Island National Wildlife Refuge	46	2	0	0	**48**
Pine Knoll Shores	12	0	0	0	**12**
Sunset Beach plus Bird Island	20	0	0	0	**20**
Topsail Island	106	2	0	0	**108**
Wrightsville Beach	2	0	0	0	**2**
Total	**1,803**	**29**	**4**	**7**	**1843**

3.1.2.2 Mitigation

The potential impacts to marine mammal and sea turtle species from installation and operation of a project in the Study Area must fulfill federal requirements. Based on Tetra Tech's Pioneer Array Regulation Study (June 2022), consultation with the USACE determined that the Project is subject to NWP 5 for Scientific Measurement Devices. Authorization of the NWP 5 additionally satisfies NOAA consultation requirements including those outlined by NOAA Fisheries for living marine resources within the Exclusive Economic Zone. As such, no Incidental Harassment Authorization or Letter of Authorization is required for the anchoring and operating of the Pioneer Array (Laws 2022).

USFWS activities include the identification of threatened and endangered species and issuance of permits for activities affecting protected species and their habitats (50 CFR 1 through 100). The USFWS manages land and freshwater species, while NOAA Fisheries manages marine species; however, the USFWS has responsibility for some marine animals such as nesting sea turtles and manatees.

Based on this desktop study of publicly available data, there is potential for ESA-protected marine mammal and sea turtle species to occupy or navigate the waters and aquatic habitats surrounding the Study Area. Due to the small scale and temporary nature of the proposed Project activities, the limited use and speed (1 to 2 knots for mooring deployment) of vessels for array anchoring and maintenance (vessel strikes), the rigidity of the mooring cables (entanglement), and the slow speeds of the associated gliders (about 0.5 knot) and AUVs (about 3.5 knots), the proposed Project activities are not likely to adversely affect relevant marine mammal or turtle species.

A protected species habitat assessment or survey may be recommended by USFWS or NOAA Fisheries to further support the desktop study findings of marine mammals and sea turtles in the Study Area. Six of the Project's moorings are sited within the loggerhead sea turtle Constricted Migratory Corridor. NWP 5 does not authorize any activity that may directly or indirectly jeopardize the continued existence of an ESA threatened or endangered species or their habitat, or any activities that may affect a listed species or its critical habitat without Section 7 consultation. In order to comply with USFWS consultation under Section 7 of the ESA, Tetra Tech recommends subsequent agency outreach via informal consultation with USFWS and NOAA Fisheries to establish written concurrence that Project activities will incur minimal to no adverse impacts to protected marine species or their habitat, and thus, the Project will not require a more detailed protected species habitat assessment/survey or require formal agency consultation.

Furthermore, it is Tetra Tech's understanding that moorings, gliders, and AUVs employed by the Project pose little risk for entanglement or vessel strikes concerns to both marine mammals and sea turtles. Vessel transiting to and from the Study Area are responsible for adhering to the published NOAA Fisheries procedures outlined by the NOAA Vessel Strike Avoidance Guidelines.

3.1.3 Avian and Bat Species

The following sections identify the resource present in the Study Area and mitigation needed to avoid impacts.

3.1.3.1 Preliminary Resource Characterization

The Study Area is located along the Atlantic Coast of North Carolina and within the Marine Bird Conservation Region M19 (USFWS 2021a) where associated OCS waters support a large diversity of birds, including waterfowl, pelagic seabirds, shorebirds, wading birds, and raptors (**Table 3-5**).

The Study Area is located within the Atlantic Flyway, one of four major North American north-south migration routes for many species of seabirds, shorebirds, waterfowl, raptors, and songbirds (Audubon 2022a). The Atlantic Flyway essentially runs along the Atlantic Coast of North America and includes U.S. states and Canadian provinces that span the route from Canada to Central America, South America, and the Caribbean. Coastal and marine environments along the Atlantic Flyway

provide important habitat and food resources for hundreds of avian species at stop-over sites, breeding locations, and wintering areas (Menza et al. 2012). Coastal habitats provide nesting and foraging habitats for seasonal and year-round residents. Some birds, such as shorebirds, are generally restricted to coastline margins except when migrating. Coastal and adjacent inland wetlands may

Table 3-5. Bird Species Likely to Occur Within the Study Area

Common Name	Scientific Name	Federal Status a/	State Status a/	Species-Habitat Associations b/	Likelihood of Occurrence c/
Dabblers, Geese, and Swans					
Blue-winged teal	*Anas discors*	MBTA	--	Coastal waters and freshwater wetlands	Unlikely
Grebes					
Pied-billed grebe		--	--	Coastal and freshwater wetlands	Unlikely
Rails					
King rail	*Rallus elegans*	BCC	--	Marshlands	Unlikely
Virginia rail	*Rallus limicola*	--	--	Marshlands	Unlikely
Black rail	*Laterallus jamaicensis*	T	SC	Marshlands	Unlikely
Shorebirds					
American oystercatcher	*Haematopus palliatus*	BCC, MBTA	SC	Coastal beaches, dunes, and saltwater marshlands	Unlikely
Wilson's plover	*Charadrius wilsonia*	BCC, MBTA	SC	Coastal beaches, dunes, and saltwater marshlands	Unlikely
Piping plover	*Charadrius melodus*	T, MBTA	E	Coastal beaches, dunes, and saltwater marshlands	Unlikely
Red knot	*Calidris canutus*	T, MBTA	ST	Migrant and rare winter resident; Coastal beaches, dunes, and saltwater marshlands	Unlikely
Auks					
Razorbill	*Alca torda*	--	--	Coastal and pelagic waters	Low
Terns					
Black skimmer	*Rynchops niger*	BCC	SC	Coastal waters and beaches	Moderate
Least tern	*Sternula antillarum*	BCC	SGCN, SC	Coastal waters and beaches	Moderate
Black tern	*Chlidonias niger*	--	--	Coastal and inlet bays; saltwater marshlands	Moderate
Sooty tern	*Onychoprion fuscatus*	--	--	Coastal waters and beaches	Moderate
Roseate tern	*Sterna dougallii*	E, MBTA	E	Coastal waters and beaches	Moderate
Common tern	*Sterna hirundo*	--	SGCN	Coastal waters and beaches	Moderate
Forster's tern	*Sterna forsteri*	--	SGCN	Coastal waters and beaches	Moderate
Gull-billed tern	*Gelochelidon nilotica*	BCC	T	Coastal waters and beaches	Moderate
Royal tern	*Thalasseus maximus*	--	SGCN	Coastal waters and beaches	Low

Common Name	Scientific Name	Federal Status a/	State Status a/	Species-Habitat Associations b/	Likelihood of Occurrence c/
Caspian tern	*Hydroprogne caspia*	--	--	Coastal waters and beaches	Low
Loons					
Red-throated loon	*Gavia stellata*	BCC	SGCN	Coastal and pelagic waters	Low
Common loon	*Gavia immer*	--	--	Coastal and pelagic waters	Low
Fulmars, Shearwaters, and Petrels					
Cory's shearwater	*Calonectris diomedea*	BCC	--	Coastal and pelagic waters	High
Manx shearwater	*Puffinus*	BCC	--	Pelagic waters	High
Audubon's shearwater	*Puffinus lherminieri*	BCC	--	Pelagic waters	High
Black-capped petrel	*Pterodroma hasitata*	BCC	--	Pelagic waters	High
Fea's petrel	*Pterodroma feae*	BCC	--	Pelagic waters	High
Storm-petrels					
Wilson's storm-petrel	*Oceanites oceanicus*	--	--	Pelagic waters	High
Band-rumped storm-petrel	*Oceanodroma castro*	BCC	--	Pelagic waters	High
Pelicans					
Brown pelican	*Pelecanus occidentalis*	--	--	Coastal waters	High
Raptors					
Bald eagle	*Haliaeetus leucocephalus*	BGEPA, MBTA	T, SGCN	Any saltwater and freshwater; woodland edges	Low

Sources: USFWS 2021a,b, 2022c, NCWRC 2015, 2020, NCNHP 2022
a/ E = Endangered; T = Threatened; SC = Special Concern, SGCN = Species of Greatest Conservation Need, BCC = Bird of Conservation Concern, BGEPA = Bad and Golden Eagle Protection Act, MBTA = Migratory Bird Treaty Act
b/ Habitat Association based on general species habitat preference for breeding and migration (NCWRC 2015).
c/ Likelihood of Occurrence: Unlikely– no species range overlap with Study Area or unsuitable habitat in Study Area or rare observation during migration; **Low**– species range overlaps with Study Area and marginally suitable habitat in PSN Area; Moderate– species range overlaps with Study Area and suitable habitat present in Study Area, or species known to occur in habitat similar to Study Area; High–highly suitable habitat present in Study Area, or known populations exist in Study Area.

serve as important habitats for overwintering, and as temporary feeding and resting habitats for migrating birds.

There are 17 species of bats known to occur in North Carolina, where 4 of those species are federally listed and 7 are state listed (**Table 3-6**). These species can be divided into two major groups based on their wintering strategy: cave-hibernating bats and migratory tree bats (Fleming 2019). Both groups of bats are nocturnal insectivores that use a variety of forested and open habitats for foraging during the summer (Barbour and Davis 1969). Cave-hibernating bats are generally not observed offshore (Dowling and O'Dell 2018); in the fall, these bats migrate from summer habitat to winter hibernacula in the mountain and foothill regions of the state (LeGrand et al. 2020). In contrast, migratory tree bats generally fly to southern parts of the United States to overwinter (Cryan 2003), with some present year-round in North Carolina (LeGrand et al. 2020, Timpone et al. 2011), and sightings have been documented offshore in the vicinity of the proposed project (Solick and Newman 2021; Peterson et al. 2016). Bat migration over the ocean has been documented to occur typically in the autumn months, with most sightings occurring during the day and where the migration route is observed to occur over a relatively wide area (Solick and Newman 2021; Peterson et al. 2016). There are records of migratory tree bats being observed offshore, and results of acoustic bat surveys completed near Bodie Island, North Carolina, and within proximity to the Study Area (Peterson et al. 2016), identified the presence of eastern red bats, tricolored bats, hoary bats, and silver-haired bats within 7.8 nm of the coast.

Table 3-6. Bat Species Likely to Occur in the Study Area

Common Name	Scientific Name	Federal Status a/	State Status a/	Species-Habitat Associations b/	Likelihood of Occurrence c/
Cave-Hibernating Bats					
Eastern small-footed bat	*Myotis leibii*	--	SC	Woodlands and forests	Unlikely
Little brown bat	*Myotis lucifugus*	--	--	Woodland and urban environments	Unlikely
Northern long-eared bat	*Myotis septentrionalis*	T	T	Woodlands and forest	Unlikely
Indiana bat	*Myotis sodalis*	E	E	Woodlands and forests	Unlikely
Gray bat	*Myotis grisescens*	E	E	Woodlands and forests	Unlikely
Southeastern myotis	*Myotis austroriparius*	--	SC	Woodlands and forests	Unlikely
Tri-colored bat	*Perimyotis subflavus*	--	--	Woodlands and forests	Unlikely
Big brown bat	*Eptesicus fuscus*	--	--	Woodland and urban environments	Unlikely
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	--	--	Woodland and urban environments	Unlikely
Virginia big-eared bat	*Corynorhinus townsendii virginianus*	E	E	Woodland and urban environments	Unlikely
Brazilian free-tailed bat	*Tadarida brasiliensis*	--	--	Woodland and urban environments	Unlikely
Migratory Tree Bats					
Evening bat	*Nycticeius humeralis*	--	--	Woodlands and forests	Unlikely
Eastern red bat	*Lasiurus borealis*	--	--	Woodlands and forests	Low
Seminole bat	*Lasiurus seminolus*	--	--	Woodlands and forests	Unlikely

Common Name	Scientific Name	Federal Status a/	State Status a/	Species-Habitat Associations b/	Likelihood of Occurrence c/
Hoary bat	*Lasiurus cinereus*	--	--	Woodlands and forests	Low
Silver-haired bat	*Lasionycteris noctivigans*	--	--	Coniferous woodlands and forests	Low
Northern yellow bat	*Lasiurus intermedius*	--	SC	Woodlands and forests	Unlikely

Sources: NCWRC 2015, 2020; LeGrand et al. 2020; USFWS 2021a
a/ E = Endangered; T = Threatened; SC = Special Concern
b/ Habitat Association based on general species habitat preference for breeding and migration (NCWRC 2015).
c/ Likelihood of Occurrence: Unlikely– no species range overlap with Study Area or unsuitable habitat in Study Area; Low– species range overlaps with Study Area and marginally suitable habitat in Study Area; Moderate– species range overlaps with Project area and suitable habitat present in Study Area, or species known to occur in habitat similar to Study Area; High–highly suitable habitat present in Study Area, or known populations exist in Study Area.

3.1.3.2 Mitigation

The Project is not anticipated to significantly affect avian and bat populations. Surface buoys will consist of buoyant, non-compressible materials with metal platforms to support sensors and satellite/radio transmitters that may provide roosting or stopover habitat for avian or bat species migrating through the area but are expected to pose little to no risks to the species, as compared to other large off-shore projects that have been documented to affect migratory birds and bats through noise and artificial lighting stressors, habitat alteration, displacement, and collisions (USFWS 2022d). The buoys will consist of a low profile on the water's surface with little to no noise emissions and will be constructed and operated in compliance with USCG requirements for lighting, while using lighting technology that minimizes impacts on avian and bat species to the extent practicable. Any dead or injured birds or bats found on or near the Project during array deployment operations or routine maintenance should be reported to the USFWS. Any birds found with federal bands should be reported to the United States Geological Survey (USGS) Bird Band Laboratory.

3.1.4 Protected Habitats

Protected coastal and marine habitats provide refuge for resident and transient species of fishes, invertebrates, marine mammals, sea turtles, and birds in North Carolina. The protected habitats identified in this section occur from the intertidal zone to open ocean and include marshes, estuaries, complex nearshore habitats, and offshore benthic and pelagic habitats within and in the vicinity of the Study Area.

Coastal protected habitats in tidal and state waters within 3 nm (5.6 kilometers [km]) of shore are under the jurisdiction of the State of North Carolina. NCDEQ manages coastal habitats such as wetlands and administers the Coastal Area Management Act under the Clean Water Act (CWA) (15A NCAC 07H .0100). NCDMF regulates fishing practices in coastal waters, including management of SAV (15A NCAC 03I .0101), artificial reefs (15A NCAC 03I .0109), and Fishery Nursery Areas (15A NCAC 03N .0104). NCDMF and the NCWRC jointly manage anadromous fish spawning (15A NCAC 10C .0603) and management areas (15A NCAC 03R .0201). The North Carolina Department of Environment and Natural Resources (NCDENR) manages Marine Protected Areas (MPAs) and may co-manage certain MPAs with NOAA Fisheries (MPA Executive Order 13158). However, no proposed Project structures are planned to be located in state waters.

At the federal level, impacts to protected habitats are regulated under various federal laws. Regional Fisheries Management Councils (FMCs) designate Habitat Areas of Particular Concern (HAPC) as sub-categories of EFH under the MSA. NOAA Fisheries establishes North Atlantic right whale SMAs and administers them under the ESA and MMPA. The National Audubon Society establishes and protects Important Bird Areas (IBAs) for species listed as threatened or endangered under the ESA.

The following sections identify the resource present in the Study Area and mitigation needed to avoid impacts.

3.1.4.1 Preliminary Resource Characterization

Artificial Reefs. Hard bottom is defined as exposed areas of rock or consolidated sediments, distinguished from surrounding unconsolidated sediments, which may or may not be characterized by a thin veneer of live or dead biota (NCDEQ 2016). In addition to areas of natural hard bottom, man-made structures, including artificial reefs and shipwrecks, provide substrata for the development of hard bottom communities. Artificial reef habitats are considered crucial spawning and foraging habitat for the state's commercially and recreationally important fisheries. NCDMF maintains 43 offshore and 25 estuarine artificial reefs. Due to their high habitat value, NCDMF may prohibit or restrict the use of any equipment in and around any artificial reef (15A NCAC 03I .0109; NCOAH 2022). Several artificial reefs are in the vicinity of the Study Area, including AR-130, -140, -145, -160, and -165 (**Figure 3-1;** NCDMF 2022a). Artificial reef AR-197 is located within Croatan Sound, where no Project structures will be located (NCDMF 2022a).

Fishery Nursery Areas. NCDMF administers the Fishery Nursery Area Program (15A NCAC 03N .0104; NCOAH 2022). Fishery Nursery Areas are defined as areas in which young finfish and crustaceans spend a major portion of their first growing season. Compared to other coastal habitats, Fishery Nursery Areas support greater contributions of juveniles to adult recruitment because they provide protection, foraging opportunities, and suitable environmental conditions for growth, development, and survival during early life history (NOAA Fisheries 2019d). Primary Nursery Areas are those areas in the estuarine system where initial post-larval development takes place. These are areas where populations are uniformly early juveniles. Secondary Nursery Areas are those areas in the estuarine system where later juvenile development takes place. Populations are composed of developing sub-adults of similar size that have migrated from upstream Primary Nursery Areas. The southern mooring locations for SOPM, SPM and SSM are sited within a Primary/Secondary Nursery Habitat east of Oregon Inlet (**Figure 3-1**). To protect sensitive life stages, NCDMF has established moratoria for coastal alteration projects in Nursery Areas. No excavation or filling activities are permitted between April 1 and September 30 within any designated Fishery Nursery Area, however, as no excavation or fill activities are associated with the Project, this restriction is not applicable.

Critical Habitat. Under 50 CFR § 226.223, Critical habitat has been established for the Northwest Atlantic Ocean DPS of the loggerhead sea turtle. Critical habitat is designated by the Secretary of Commerce, under Section 4 of the ESA, for endangered and threatened species. Critical habitat designations do not create preserves or refuges or affect land ownership, and only result in restrictions on human activities in situations where federal actions, funding or permitting are involved. In those cases, the federal agency concerned works with NOAA Fisheries or USFWS to avoid,

reduce or mitigate potential impacts to the species' habitat. Critical habitat is only designated within U.S. jurisdiction. **Figure 3-1** identifies the loggerhead sea turtle Constricted Migratory Corridor, defined as a high use migratory corridor that is constricted (limited in width) by land on one side and the edge of the continental shelf and Gulf Stream on the other side (79 FR 39855). In addition, the area identifies conditions to allow for migration to and from nesting, breeding, and/or foraging areas. Six moorings, including profiler moorings CMP and SPM, surface moorings SSM and CSM and shallow-water moorings SME and SWM are sited within the loggerhead sea turtle Constricted Migratory Corridor. Loggerhead sea turtle Sargassum habitat is also identified in **Figure 3-1**, which is critical as developmental and foraging habitat for young loggerheads where surface waters form accumulations of floating material, especially Sargassum. Sargassum critical habitat is located east of the Constricted Migratory Corridor along the shelf break and out to the boundary of the Exclusive Economic Zone. The proposed Project activities are not likely to adversely affect relevant turtle species or their habitat. However, actions that may affect designated critical habitat or adversely modify or destroy proposed critical habitat are subject to the ESA section 7 consultation process and include Federal activities and non-Federal activities requiring a permit from a federal agency (e.g., a Clean Water Act, Section 404 dredge or fill permit from the USACE) or some other federal action, including funding (e.g., Federal Highway Administration funding for transportation projects). ESA section 7 consultation would not be required for federal actions that do not affect listed species or critical habitat and for non-federal activities or activities on non-federal and private lands that are not federally funded, authorized, or carried out.

Habitat Areas of Particular Concern. Under the MSA, HAPCs are defined as subsets of EFH that exhibit one or more of the following traits: rare, stressed by development, provide important ecological functions for federally managed species, or are especially vulnerable to anthropogenic degradation. While not relevant to project facilities, HAPCs are designated by regional FMCs, and while they do not convey additional restrictions or protections on an area, FMCs may include actions to restrict the use or possession of fishing gear or fishing equipment types within HAPCs. The Study Area intersects a joint Snapper-Grouper, Coral Reefs and Hardbottom, and Dolphin/Wahoo HAPC designated by the SAFMC, also coincident within the Primary/Secondary Nursery Area (sited east of Oregon Inlet [**Figure 3-1**]).

Important Bird Areas. IBAs are sites administered by the National Audubon Society that provide essential habitat to one or more species of birds during some portion of the year, including nesting, crucial migratory stop-over sites, or wintering grounds. Criteria for IBA designation includes occurrence of threatened and endangered species or species of conservation concern, and/or sites with substantial concentrations of birds or high species diversity. The Pioneer Array project will have no impact on IBAs, the existence of local IBAs is provided for inclusion purposes only as to fully evaluate protected habitats. The Outer Continental Shelf IBA is located in the vicinity of the Study Area eastward of the Oregon Inlet. This IBA is unique in that it is the open ocean of the Atlantic. This is a site where two major Atlantic currents mix, forming a very rich marine environment. Large mats of Sargassum form surface reefs and concentrate rare and endangered seabirds, marine mammals, marine turtles, and fish (Audubon 2022b). The site is an important commercial and sport fishing area, as well as an important commercial birdwatching area. The Outer Continental Shelf IBA has the

greatest diversity of seabirds and marine mammals in the southeastern United States. For tropical species, the site probably has the greatest density of seabirds in the southeastern United States (Audubon 2022b). Bird species common in this area include the Atlantic puffin, Audubon's shearwater, band-rumped storm-petrel, black-capped petrel, black-legged kittiwake, sooty shearwater, South Polar skua, and Wilson's storm-petrel. (Audubon 2022b). This IBA is currently afforded no formal protection.

North Atlantic Right Whale Seasonal Management Areas. North Atlantic right whales (right whales) are protected under the ESA and MMPA. SMAs are established to reduce the likelihood of right whale deaths and serious injuries that could result from vessel collisions. Regulations implement speed restrictions of 10 knots or less on all vessels 19.8 m (65 feet) or longer transiting through any given SMA. Project installation and service vessels should be aware of the existence of SMAs for the Ports of Norfolk, Virginia, and Morehead City, North Carolina, depending on port of departure for Project activities (NOAA Fisheries 2022f).

3.1.4.2 Mitigation

The proximity of protected habitats does not preclude future development of the Study Area; however, these habitats should be considered refuges for certain protected species. A site-specific survey may be recommended by USFWS or NOAA Fisheries to ensure avoidance of any protected habitat.

- Delineate and avoid any artificial reefs.
- Observe any construction moratoria established in Fishery Nursery Areas, if applicable.
- In order to comply with USFWS consultation under Section 7 of the ESA, Tetra Tech recommends subsequent agency outreach via informal consultation with USFWS and NOAA Fisheries to establish written concurrence that Project activities will incur minimal to no adverse impacts to protected marine species, critical habitats, and HAPCs.

3.2 Physical Resources

Physical resources such as noise, geologic conditions, sediment and water quality, electromagnetic fields (EMF), and air quality require analysis in support of federal and state regulations. The following sections provide the preliminary resource characterization, and next steps.

3.2.1 Underwater Noise

The MMPA provides for the protection of all marine mammals and additionally regulates and provides protection for marine mammals sensitive to underwater noise. The MMPA prohibits, with certain exceptions, the "take" of marine mammals (NOAA Fisheries 2019a). NOAA Fisheries has jurisdiction for overseeing the MMPA regulations as they pertain to most marine mammals and sea turtles, while the USFWS has jurisdiction over a select group of marine mammals, including manatees.

Generally, NOAA Fisheries is responsible for issuing take permits under the MMPA, upon a request, for authorization of incidental but not intentional "taking" of small numbers of marine mammals by U.S. citizens or agencies who engage in a specified activity (other than commercial fishing) within a

specified geographical region. The USFWS would issue a take permit for manatees, but the criteria for evaluating the potential acoustic impacts to manatees has not yet been developed by the agency. The term "take," as defined pursuant to the MMPA (16 U.S.C. § 1362[13]), means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The term "harass" was then further defined in the 1994 amendments to the MMPA, with the designation of two levels of harassment: Level A and Level B.

By definition, Level A harassment is "any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock", while Level B harassment defined as "any act of pursuit, torment, or annoyance which has the potential to disturb (but not injure) a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering." In reference to the underwater acoustic environment, NOAA Fisheries defines the threshold level for Level B harassment at 160 decibels (dB) referenced at 1 micropascal (dB re 1 µPa) sound pressure level for impulsive sound, averaged over the duration of the signal, and at 120 dB re 1 µPa for non-impulsive sound, with no relevant acceptable distance specified.

In July of 2016, NOAA Fisheries finalized the Technical Guidance for Assessing the Effect of Anthropogenic Sound on Marine Mammals – Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. This guidance is reaffirmed in the 2018 Revision to the Technical Guidance (NOAA Fisheries 2016, 2018) NOAA Fisheries provided guidance for assessing the impacts of anthropogenic sound on marine mammals under their regulatory jurisdiction, including whales, dolphins, seals, and sea lions. The updated 2018 guidance (NOAA Fisheries 2018) specifically defines marine mammal hearing groups, develops auditory weighting functions, and identifies the received levels, or acoustic threshold levels, above which individual marine mammals are predicted to experience changes in their hearing sensitivity (permanent threshold shift [PTS] or temporary threshold shift [TTS]) for acute, incidental exposure to underwater sound. Under this guidance, any occurrence of PTS constitutes a Level A, or injury, "take". The sound emitted by man-made sources may induce TTS or PTS in an animal in two ways: 1) peak sound pressure levels (L_{PK}) expressed in dB re 1 µPa may cause damage to the inner ear, and 2) the accumulated sound energy that the animal is exposed to (cumulative sound exposure levels [SEL_{cum}], expressed in dB re 1 $\mu Pa^2 \cdot s$) over the entire duration of a discrete or repeated noise exposure has the potential to induce auditory damage if it exceeds the relevant threshold levels.

Research has demonstrated that the frequency content of the sound plays a role in causing damage. In other words, sounds that are outside of the hearing range of the animal would unlikely affect its hearing, while the sound energy within the hearing range could be harmful. Under the NOAA Fisheries 2018 guidance, recognizing that marine mammal species do not have equal hearing capabilities, five hearing groups of marine mammals are defined as follows: low-frequency, mid-frequency, high-frequency, phocid seals, and otariid seals.

For sea turtles, NOAA Fisheries has considered injury onset beginning at a root mean squared sound pressure level (SPL RMS) of 180 dB re 1 µPa to prevent mortalities, injuries, and most auditory impacts as well as behavioral responses from impulsive sources at 175 dB re 1 µPa SPL RMS, which has elicited avoidance behavior of sea turtles in the past (Blackstock et al. 2018). There is currently limited

information available on the effects of noise on sea turtles and the hearing capabilities of sea turtles are still poorly understood. In a cooperative effort between federal and state agencies, interim criteria were developed to assess the potential for injury from elevated anthropogenic underwater noise to fish and sea turtles. These noise thresholds were established by the Fisheries Hydroacoustic Working Group, assembled by NOAA Fisheries and these thresholds have subsequently been adopted by NOAA Fisheries. Additionally, the Fisheries Hydroacoustic Working Group, under the American National Standards Institute, developed sound exposure guidelines for fish and sea turtles (Popper et al. 2014). They identified three types of fish according to how they could potentially be affected by underwater sound. These categories include fish with no swim bladder or other gas chamber (e.g., dab and other flatfish), fish with swim bladders in which hearing does not involve the swim bladder or other gas volume (e.g., salmonids), and fish with a swim bladder that is involved in hearing (e.g., channel catfish).

3.2.1.1 Preliminary Resource Characterization

Noise in the ocean associated with natural sources is generated by physical and biological processes as well as anthropogenic sources such as shipping. Examples of physical noise sources are tectonic seismic activity, wind, and waves; examples of biological noise sources are the vocalizations of marine mammals and fish. There can be a strong minute-to-minute, hour-to-hour, or seasonal variability in sounds from biological sources. The ambient noise for frequencies above one kilohertz (kHz) is due largely to waves, wind, and heavy precipitation (Simmonds et al. 2004). Surface wave interaction and breaking waves with spray have been identified as significant sources of noise. Wind-induced bubble oscillations and cavitation are also near-surface noise sources. At areas within distances of 8 to 10 km (4.3 to 5.4 nm) of the shoreline, surf noise will be prominent in the frequencies ranging up to a few hundred hertz (Hz) (Richardson et al. 2013).

A considerable amount of background noise may also be caused by biological activities. Aquatic animals generate sounds for communication, echolocation, prey manipulation, and as byproducts of other activities such as feeding and breeding. Biological sound production usually follows seasonal and diurnal patterns, dictated by variations in the activities and abundance of the vocal animals. The frequency content of underwater biological sounds ranges from less than 10 Hz to beyond 150 kHz. Source levels show a great variation, ranging from below 50 dB to more than 230 dB SPL RMS re 1 µPa at 1 m. Likewise, there is a significant variation in other source characteristics such as the duration, temporal amplitude, frequency patterns, and the rate at which sounds are repeated (Wahlberg 2012). Typical underwater noise levels show a frequency dependency in relation to different noise sources; the classic curves are given in Wenz (1962).

Anthropogenic noise sources can consist of contributions related to industrial development, offshore oil industry activities, naval or other military operations, and marine research. A predominant contributing anthropogenic noise source is generated by commercial ships and recreational watercraft. Noise from these vessels dominates coastal waters and emanates from the ships' propellers and other dynamic positioning propulsion devices such as thrusters. The sound generated from main engines, gearboxes, and generators transmitted through the hull of the vessel into the water column is considered a secondary sound source to that of vessel propulsion systems, as is the

use of sonar and depth sounders, which occur at generally high frequencies and attenuate rapidly. Typically, shipping vessels produce frequencies below one kHz, although smaller vessels such as fishing, recreational, and leisure craft may generate sound at somewhat higher frequencies (Simmonds et al. 2004).

3.2.1.2 Mitigation

Measures are typically put in place to minimize and avoid exposure of marine mammals and sea turtles to potentially impactful noise levels. The anticipated underwater noise impacts associated with Project activities were evaluated against the criteria prescribed in the revised NOAA Fisheries (2018) Technical Guidance which establishes specific hearing criteria thresholds for each functional hearing group. Active acoustic sources for the Pioneer Array generally operate at frequencies higher than the auditory range of fish and marine mammals (greater than 180 kHz) with most equipment operating at greater than 200 kHz. Instruments operating at frequencies between 2 and 1200 kHz include acoustic dopplers, bioacoustics profilers, altimeters, acoustic modems and tracking pingers. However, these acoustic sources are limited in use due to the infrequent sampling method. Therefore, the generated underwater noise associated with Project activities, including the anchoring of the Pioneer Array and deployment of AUVs and gliders, would result in no significant impact to marine fauna. Consultation with NOAA Fisheries confirmed that neither a Letter of Authorization nor Incidental Harassment Authorization would be required due to the acoustic dopplers, single point velocity, bio-acoustic sonar and passive hydrophone equipment (Laws 2022). For an overview of general marine mammal and sea turtle mitigation measures, see Section 3.1.2.

3.2.2 Geologic Conditions

Understanding the geologic conditions, including bathymetry and seabed morphology, sediment type and distribution, and existence of natural hazards, is a key element of characterizing and evaluating important environmental resources and constraints in the Study Area. These factors have a direct impact on the siting of the project and inform other critical issues, such as benthic habitats, protected species, and the potential for cultural resources.

3.2.2.1 Preliminary Resource Characterization

The Pioneer Array is to be relocated on the Atlantic Outer Continental Shelf and Slope, off the coast of North Carolina's Outer Banks. The relevant stretch of continental shelf is commonly referred to as the Mid-Atlantic Bight. The Mid-Atlantic shelf averages 25 m in depth, growing deeper eastward until it reaches 100 m at the shelf edge and then drops to 1,000 m at the steep escarpment and deep canyons of the slope break. The topography of the Mid-Atlantic shelf is mostly flat, with low-relief features such as sandy shoals and swales, sand wedges and waves, and relict coastal features (Conley et al. 2017).

The Mid-Atlantic shelf is overlain by a mantle of sand approximately zero to 20 m thick along the OCS shelf off North Carolina. Linear sand ridges are also characteristic of the continental shelf in this region. In places where the sand cover is absent, the substrate is harder, consisting of exposures of cemented sand that can range from smooth outcrops to rough bottoms with relief up to 15 m (50 feet).

The Study Area located along the shelf is located at the southernmost part of the Baltimore Canyon Trough, a geological feature that extends along the Atlantic continental shelf from Cape Hatteras in the south up to Georges Bank in the north (Poag 1978). Off the coast of North Carolina, the Quaternary sediments are expected to be predominantly Quaternary fluviatile sands and silts, perhaps generally decreasing in grain size with increasing distance from the shore.

The seabed within the Study Area is predominantly composed of unconsolidated sediment. However, some areas of harder substrates are exposed at the seabed and within the shallow subsurface. Softbottom sediments in the Study Area are characteristic of Mid Atlantic Bight sediments and range from very fine to fine sands (0.065 to 0.25 millimeters [mm]), medium sands (0.25 to 0.5 mm), and coarse to very coarse sands (0.5 to 2 mm) (**Figure 3-2**; Conley et al. 2017).

There is also potential for sediment to be significantly thicker or absent in some locations. In general, the present-day continental shelf is starved of sediment due to sediment accumulation in coastal estuaries. Typically, seabed sands originating from the Appalachian Mountains have been transported by major rivers, deposited in coastal plains in the nearshore zone and subsequently reworked during the Holocene transgression (sea level rise).

The continental slope here is highly dissected by deep canyons and valleys. The canyons vary in size, shape, and morphological complexity; some were scoured by the flow of rivers during past low sea level periods, but most formed via other erosional processes, such as mudslides, debris flows, and turbidity currents. Sediments on the slope are highly variable but consist mainly of sandy silts on the upper slope and silts and clays on the lower slope (McGregor 1983).

Seabed Mobility Risk

The seabed along northeastern North Carolina is one of the more dynamic along the U.S. East Coast in terms of current-driven sedimentation patterns. The interplay between the northward flow of the Gulf Stream and seasonal wind and wave activity are overlaid with the impacts of extra-tropical and tropical storms, which can mobilize large amounts of sediments on the shallow shelf. Frying Pan Shoals off Cape Fear, Lookout Shoals off Cape Lookout, and Diamond Shoals off of Cape Hatteras are the most striking examples in terms of the scale of the area impacted, the size of the features, and the timeline of feature mobility.

This is supported by the data provided by the USGS in their Sea Floor Stress and Sediment Mobility Database for the South Atlantic Bight. This dataset spatially and temporally resolves seabed bottom stress and sediment movement recurrence intervals, using modelled currents and waves acting on measured seabed core data for sediment texture and grain size. The result is a gridded dataset with yearly and seasonal values for bed shear stress and seabed mobility event frequency and recurrence intervals for approximately 5-km cell size grids across the area.

Where available, the datasets indicate that the mooring locations avoid the regions of the very highest average annual seabed shear stress and the shortest mobility event recurrence interval; however, the values at the SMW location are higher due to the shallow depth at this location and its proximity to the coast. Recurrence intervals for seabed mobility events are on the order of days to weeks, indicative of a high potential for mobile seabed and seabed scour. The addition of structures on the seabed or

changes to the seabed due to cable burial or cable protection may locally alter currents and enhance the risks of scour and mobility.

While the dataset does not extend further offshore to show seabed mobility recurrence intervals or average shear stress along the continental slope, the geomorphologic nature of the slope (e.g., escarpments, sediment gravity flow deposits) and the presence of mapped submarine canyons (The Point and Keller) indicate that seabed mobility may be a concern for the mooring locations (SOPM and NOPM) along and across the continental slope.

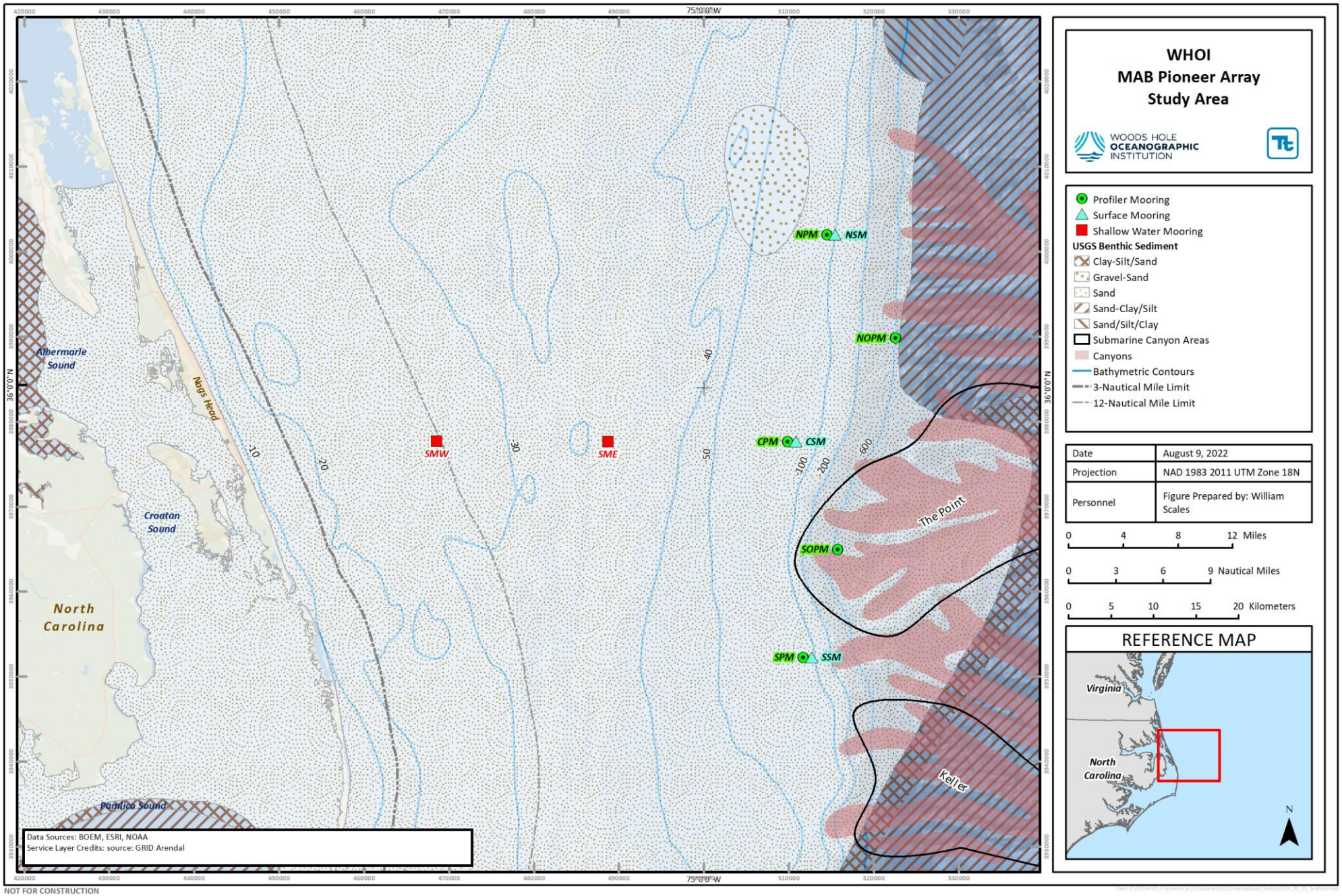

Figure 3-2. Seafloor Sediments

Seabed Character and Seafloor Sediments

The nature of the seafloor sediment will directly impact the suitability of offshore mooring locations. Generally, seabed sediments are coarse, composed of fine to coarse sands, with some areas of older, harder strata potentially exposed at the seabed, or encrusted with marine biota.

Areas of hardbottom can be outcropping rockier or harder seabed, or naturally occurring due to the presence of encrusting organism that colonize existing harder seabed or very coarse materials. These areas represent potential sensitive habitat to be avoided (see Section 3.1, Biological Resources). These areas are likely to be encountered within a particular mooring siting area, and special attention should be given to mapping and understanding potential hardground features during any reconnaissance survey to facilitate micrositing for avoidance and evaluation of other potential mitigations, if needed.

Exposed hard substrata are common in canyons and are generally found on the upper rims, where currents are elevated, and sometimes in the base of the axis, where boulders have been deposited. They may also occur on outcrops or relict shorelines along canyon walls, where currents keep substrata clear of sediment.

Submarine Canyons

Canyons vary in physical structure, hydrography and geological activity, and this variation creates complex patterns in oxygen, temperature, food, sedimentation, and substrata. Exposed hard substrata are common in canyons and are generally found on the upper rims, where currents are elevated, and sometimes in the base of the axis, where boulders have been deposited. They may also occur on outcrops or relict shorelines along canyon walls, where currents keep substrata clear of sediment (Ross and Brooke 2012).

The North Carolina canyons may be unique relative to those further north due to their location where strong current systems collide. The cold Labrador Current from the north meets the warm Gulf Stream and Virginia Currents from the south, where the latter currents are deflected offshore at Cape Hatteras. The colliding currents create a dynamic exchange of inshore and offshore waters as well as one of the sharpest thermal boundaries known in the world's coastal oceans. Regional differences in fishes, invertebrates, and deep-sea corals have been documented north and south of Cape Hatteras, with origins likely related to the barrier created by steep temperature gradients and tolerances of organisms (Morrison 2019).

Two mooring sites are located along the continental slope off the coast of North Carolina, NOPM and SOPM. The most southerly of these sites, SOPM, occur in an extremely dynamic and productive area known as The Point. The Point has been characterized as one of the most productive fishing spots on the East Coast, apparently fueled by upwelling generated by the collision of several major currents over complex bottom topography (e.g., escarpment) (Ross and Brook 2012).

Sites SSM and SPM are located on the outer shelf, to the Northwest of Keller Canyon. Keller Canyon is the only one of the Carolina canyons that incises the shelf, but less so than the canyons further to the north.

3.2.2.2 Mitigation

The placement of the Pioneer Array anchors and sensors would result in short-term insignificant impacts to surface sediments in the immediate vicinity of the proposed Pioneer Array assets. The primary mitigations an offshore project can take regarding geologic conditions are 1) identification, delineation, and avoidance of sensitive or challenging conditions during project siting; and 2) survey the area to ensure the anchor locations minimize impacts and withstand potential geologic hazards.

A high-resolution geophysical (HRG) survey designed to understand site conditions at the proposed mooring anchor sites and respective surrounding areas of possible seabed disturbance, is considered the best practice to ensure geological conditions and hazards are adequately identified and evaluated, and to inform project siting. As a guide for siting studies within the OCS for renewable energy projects, BOEM has published documents capturing the recommended approaches for characterizing geological conditions and hazards through the collection of geophysical and geotechnical datasets in the document *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585* (BOEM2020a).

Currently, there are no specific survey requirements for the deployment and operation of scientific buoys, however the guidelines for HRG survey activities detail the recommended equipment and specifications inclusive of the following:

- Navigation and positioning
- Bathymetry
- Magnetometer
- Side-scan sonar
- Sub-bottom profiler
- Seabed imagery and/or sampling

Prior to installation of the Pioneer Array, HRG surveys are suggested at each location along a series of regularly-spaced parallel track lines to allow for adequate seabed evaluation and facility micrositing if necessary to avoid identified hazards or other features. Survey of approximately 200 m x 200 m area of seabed is anticipated to be adequate for each mooring site and can be adjusted for site-specific conditions and planned mooring geometry. Survey specifications and line spacing is dependent on a variety of factors such as water depth, equipment deployed and desired resolution, and different minimum line spacing based on the area and goals of the survey.

3.2.3 Sediment and Water Quality

Impacts to sediment and water quality are regulated under various federal and state laws including the CWA, National Environmental Policy Act, and North Carolina's Coastal Management Program under the Coastal Zone Management Act. State regulations apply to state waters including the waters of the Atlantic Ocean within 3 nm (5.6 km) from the coastline and all other tidal waters within the State of North Carolina. As the arrays will be deployed in OCS outside of the 3 nm limit and outside of state waters, the Project is not anticipated to be subject to state water quality standards.

3.2.3.1 Preliminary Resource Characterization

The Study Area is located in the Mid-Atlantic Bight where the topography is mostly flat with low-relief features such as sandy shoals and swales, sand wedges and waves, and relict coastal features (Conley et al. 2017). Sediments within the area consist of sand and sand-clay/silts with an approximate

thickness of 20m (65 ft). In places where the sand cover is absent, the substrate is harder and consists of cemented sand that can range from smooth outcrops to rough bottoms with relief up to 15 m (50 ft). The disturbance of sediments during Project activities including surveys mooring deployment and placement on the sea floor, and potential adjustments to the mooring placement during routine maintenance has the potential to affect water quality and increase total suspended solids in the water column as well as release of contaminants that could affect surrounding marine habitat and aquatic life through dispersal, resuspension, and subsequent sedimentation. These impacts are typically short-term, and the disturbance area is often limited to the immediate vicinity of the moored array, although exact impacts are dependent on sediment type, extent of disturbance, and installation method. Accidental spills associated directly with the arrays are not anticipated as chemicals and petroleum products are not used on site in the marine environment to maintain the equipment. Impacts from accidental spills associated with marine vessels used during Project deployment and routine maintenance are expected to be negligible as they are of low probability and low magnitude, and appropriate spill control and response procedures will be developed based on industry best management practices (BMPs) to minimize potential impacts.

Transport of suspended sediment will be driven by existing currents throughout the Study Area. Ocean currents in the Study Area are dependent on the ocean floor currents, wind-generated near-surface currents, swell and surf-generated longshore currents, swell and surf-generated rip currents, and tidal currents.

Recent water quality data have not been collected in the Study Area. Review of the Environmental Protection Agency's (EPA) most recent National Coastal Condition Report IV (EPA 2012) summarizing coastal monitoring data collected between 2003-2006 identified the Project to be located within the South Atlantic Bight of the Southeast Coast Region assessment area with an overall ecological health rating of fair. The overall ecological health rating is determined based on the assessment of the following factors: water quality index, sediment quality index, benthic index, coastal habitat index, and fish tissue contaminants index. Data collected at several monitoring locations within the vicinity of the Study Area characterized water quality as fair to good and sediments were characterized as good (EPA 2012).

The National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management monitors water quality through the Integrated Ocean Observing System. However, there are no data available in the vicinity of the Study Area. The USGS, NOAA, and NCDEQ do not have surface water monitoring locations near the landfall areas, therefore, water quality data are not available for the Study Area.

The majority of pollutants to marine waters are sourced from shore-based activities. There are no federal Superfund sites or wastewater outfalls in the OCS within the vicinity of the Project that would contribute to contaminated sediments (Marine Cadastre National Viewer 2022). No oil and gas wells are off the coast of North Carolina. In the event of a spill, spills from vessels would be localized.

3.2.3.2 Mitigation

Potential but unlikely impacts on water quality would result from mooring deployment and placement on the sea floor, potential adjustments to the mooring placement during routine maintenance, and accidental spills associated with marine vessels. BMPs would be used to minimize impacts.

The deployment and anchoring of the array moorings would require use of USACE Nationwide Permit (NWP) 5 Scientific Measuring Devices (USACE 2022). Based on previous discussions with the USACE Wilmington District on March 17, 2022, submittal of a Pre-Construction Notification for the Project will not be required for authorized use of NWP 5. Projects that require a federal permit or involve dredging or fill activities that may result in a discharge to U.S. surface waters and/or waters of the U.S. are required to obtain a CWA Section 401 Water Quality Certification to verify that the project activities would comply with state water quality standards. Although the Project would require a federal permit, given the location of the Project several miles outside of state territorial waters, the Project is not likely to affect state water quality. As Section 401 Water Quality Certifications are automatically associated with NWPs, a separate authorization application and approval will not be required.

Based on these conditions, Tetra Tech recommends developing appropriate spill control and response plans in accordance with industry BMPs and agency recommendations.

3.2.4 Electric and Magnetic Fields

There are no federal regulations that limit human or environmental exposure to EMF. North Carolina does not have EMF threshold regulations listed by the North Carolina Utilities Commission and NCDEQ.

3.2.4.1 Preliminary Resource Characterization

There are three primary, natural sources of EMF in the marine environment: earth's geomagnetic field, electric fields induced by the movement of charged objects (e.g., marine currents and organisms) through this geomagnetic field, and bioelectric fields produced by marine organisms (Normandeau et al. 2011). Anthropogenic sources of magnetic and induced electric fields such as exhibited in some marine cabling, may generate additional EMF sources. The intensity of EMF depends on a combination of various factors which may include the type of current (alternating or direct), cable characteristics (if applicable), transmitted power, and ambient marine conditions (Gill and Desender 2020).

Elasmobranchs (rays, sharks, and skates), finfishes, invertebrates, marine mammals, and turtles are reported to exhibit sensitivity to EMF (Taormina et al. 2018). Sensitive taxa exhibit varying degrees of magnetosensitivity, electrosensitivity, or a combination of both. Magnetosensitive species use naturally occurring EMF for migration and foraging purposes. Electrosensitive species have specialized sensory organs called ampullae of Lorenzini that use ambient electric fields to locate prey or avoid predators; however, the range over which these species can detect electric fields is limited to centimeters (Snyder et al. 2019). Studies in the literature indicate the potential for anthropogenic EMF to interfere with ambient EMF and impact predator-prey interactions, orientation and migration behaviors, or physiological development of fishes (e.g., eels, elasmobranchs, salmonids),

invertebrates (e.g., bivalves, crabs, lobsters, shrimp), marine mammals, and sea turtles (Taormina et al. 2018).

The Pioneer array consists of 10 uncabled moorings that are powered through surface buoys as well as internal battery packs, thus EMF impacts related to marine life are unlikely. Each surface mooring can contain multiple "nodes" that provide power and connectivity. Non-cabled nodes contain one or more computers and power converters, powered by batteries, wind or solar. Cabled instruments are plugged into the powered cable and their data are collected and transmitted to shore. These nodes also serve as distribution centers for extension cables that provide power and communication to sensors, instrument platforms, and moorings. Continuous, real-time flow of data allows interactive science experiments to be conducted at the seafloor and throughout the water column.

3.2.4.2 Mitigation

The potential EMF impacts to marine life for the Pioneer array are considered negligible due to the restricted potential of EMF output from the proposed Project equipment.

Project components including those associated with deployment of the proposed monitoring buoys, inductive mooring cables, or associated data collection instrumentation generate minimal EMF output there are no impacts, mitigation recommendations or additional analyses related to EMF required.

3.2.5 Air Quality

Impacts to air quality are regulated under various federal laws including the Clean Air Act, Outer Continental Shelf Lands Act, and National Environmental Policy Act, as well as federal regulations including the OCS Air Regulations under 40 CFR Part 55, and the General Conformity Regulations under 40 CFR Part 93.

EPA Region 4 is responsible for implementing and enforcing Clean Air Act requirements for OCS sources offshore the state seaward boundaries of North Carolina. If any air emissions from construction or operation of a project will be produced by equipment that can be considered part of an "OCS source," then they may be subject to submittal and approval of an OCS air permit application. Within state waters and onshore, the NCDEQ regulates air quality with the Department of Air Quality with the Wilmington Regional office covering Dare County. The Air Quality Rules and Regulations identify procedures for permits and approvals if there is a need for air pollution control requirements. The Project would not need a Title V Air Quality permit under Title 15A of the North Carolina Administrative Code because the Project is not located within state waters and there would be no air pollutant emissions during operations.

3.2.5.1 Preliminary Resource Characterization

The geographic area included in a National Ambient Air Quality Standards (NAAQS) designation is limited to areas that are either within a state or territory's actual area, or that are within 3 nm of a state or territory's seaward boundary. Since the entire Study Area is more than 3 nm from the seaward boundary of any state, 40 CFR Part 55 specifies that a Corresponding Onshore Area must be identified

in order to determine what federal and state air quality regulations may apply to a project. In most cases, the Corresponding Onshore Area will be the nearest point of land to a proposed project.

The nearest point of land to the Study Area is Nags Head, in Dare County, North Carolina, located approximately 13 nm west of the nearest proposed mooring. Dare County is part of the "Northern Coastal Plain" Air Quality Control Region (40 CFR 81.149). This region is designated as unclassifiable or attainment for all NAAQS pollutants.

The Project would result in minor temporary emissions from surface vessels used during array installation and annual maintenance and would not represent a substantial increase above existing conditions. To protect human health, the EPA establishes NAAQS under authority of the Clean Air Act that apply for outdoor air throughout the country. For each NAAQS pollutant and averaging period, the EPA may designate a specified geographic area as being in attainment of the standard, as being in nonattainment of the standard, or as being a maintenance area, meaning that an area was previously in nonattainment but has since been re designated to attainment due to ongoing improvements in local air quality. Because the Project will occur in an attainment area, no further conformity analysis would likely be required pursuant to 40 CFR Part 93 for air emissions occurring within 3 nm from shore (and potentially as far as 25 nm from the state seaward boundary), both for construction of a project, and for any operational air emissions that will not be included in an OCS air permit.

3.2.5.2 Mitigation

No mitigation is needed for air quality. The Proposed Action is not located within the jurisdiction of any state. There are no emissions standards for vessels or activities operating beyond 12 nm of shore. Proposed activities would result in minor temporary emissions from surface vessels or surface buoys during installation and operation and maintenance activities of the Pioneer Array. However, these emissions would not represent a substantial increase above existing conditions because only a small number of vessels and surface buoys would be used.

3.3 Anthropogenic Resources

In support of the NWP and other federal and state regulations, the National Historic Preservation Act, and the Ports and Waterways Safety Act, anthropogenic resources including marine cultural resources, transportation and navigation, military operations, aviation and radar, humanmade hazards and obstructions, tourism and recreation, visual and aesthetic resources, and environmental justice require analysis. The following sections provide the preliminary resource characterization and recommendations for next steps.

3.3.1 Cultural Resources

Review of the marine cultural resources is assessed under separate cover (*Marine Cultural Resources Study)*. Review of terrestrial cultural resources present along the shoreline adjacent to the Study Area are included below. Historic properties that have been listed on or are eligible for listing on the National Register of Historic Places (NRHP) are considered significant cultural resources and may include properties of traditional, religious, and cultural importance to Native American Tribes.

3.3.1.1 Preliminary Resource Characterization

A review of recorded terrestrial cultural resources identified NRHP-listed, NRHP-eligible, and unevaluated properties within the Study Area (Figure 5). Although the vast majority of these recorded resources have at least a partial view of the Atlantic Ocean, none are expected to have views of the Pioneer Array given the distance of the array from the shoreline and the array's low height above the waterline (maximum 4.5 m above the water).

Publicly available shipwreck and obstruction data from NOAA Coast Survey's Automated Wreck and Obstruction Information System (AWOIS) was used to identify charted shipwrecks in the Study Area (**Figure 3-3**). Three charted shipwrecks were identified in the vicinity of planned moorings. However, these data are limited; therefore, a detailed desktop assessment was completed by a Qualified Marine Archeologist. It should be noted that uncharted shipwrecks and obstructions are commonly identified during HRS surveys, since full coverage surveys are typically not conducted on a regular basis to update shipwreck databases. An HRG survey will likely identify additional wrecks and obstructions. Note, however, that not all wrecks and obstructions identified in the Study Area will require a cultural avoidance buffer. If the wreck or obstruction is not identified as having cultural significance, there is potential for it to be removed from the Study Area.

3.3.1.2 Mitigation

With regard to terrestrial cultural resources, mitigation measures will not be required since adverse effects to these resources are not anticipated to occur.

It is recommended that an HRG survey of the mooring sites be completed. All wrecks, debris, obstructions, and potential paleolandscapes identified in HRG survey data will be reviewed for potential cultural significance. A project Qualified Marine Archeologist would evaluate this data and develop a Marine Archaeological Resources Assessment whereby shipwrecks and other submerged cultural resources will be identified and delineated. If site-specific survey confirms the presence of shipwrecks and/or other submerged cultural resources, avoidance is the preferred mitigation measure. A Qualified Marine Archeologist would make recommendations for avoidance. Avoidance buffers for shipwrecks are typically in the range of 50 m applied to the extent of identified acoustic targets and/or magnetic anomalies. These avoidance buffers will apply to both shipwrecks and obstructions identified on the seabed, as well as paleolandscapes identified below the seabed. Tetra Tech recommends collaboration and coordination with the North Carolina State Historic Preservation Office and the local tribes during the planning process.

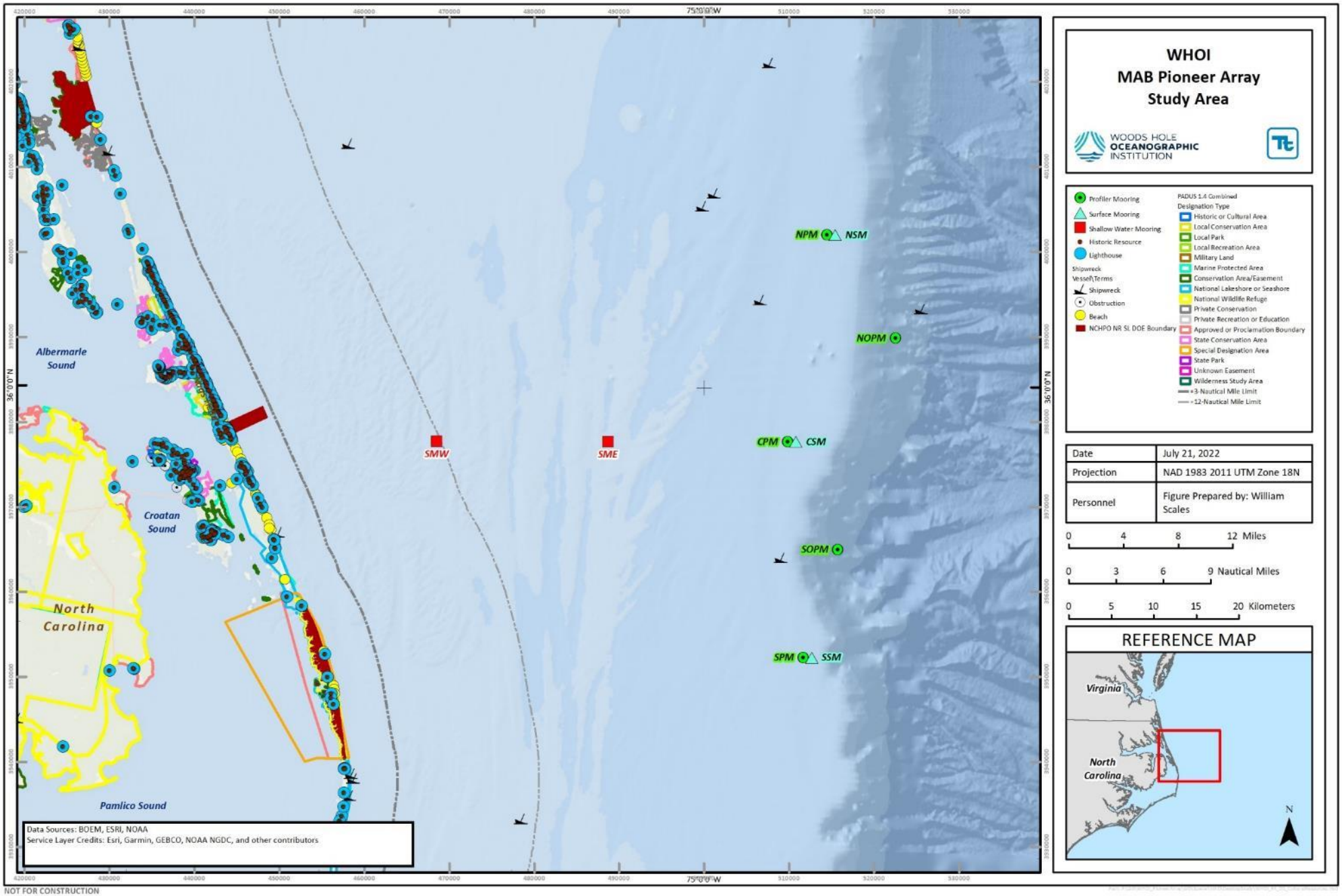

Figure 3-3. Cultural Resources and Restricted Land Use

3.3.2 Marine Transportation and Navigation

In 2011, the USCG began a Port Access Route Study (PARS) for the entire Atlantic Coast in order to develop reasonable routing measures (where required) to provide for the safe transit of vessels near offshore wind energy developments. To accomplish this, the final Atlantic Coast Port Access Route Study (ACPARS) established certain designated safety fairways running north and south along the coast. These fairways are designated as "nearshore" or "offshore" to be used at the preference of the vessel operator. The ACPARS study was published on July 8, 2015 (USCG 2015) and includes responses to comments from maritime stakeholders who were concerned about how the presence of offshore wind facilities may affect vessel navigation (USGS 2015).

The ACPARS study is primarily concerned with vessel traffic along the Atlantic coast that transits in a north-south direction. It was recognized that a study of vessel traffic transiting from these north-south routes to ports on the U.S. East Coast was necessary. On March 18, 2020, the USCG announced a new PARS for the Seacoast of North Carolina Including Offshore Approaches to the Cape Fear River and Beaufort Inlet, North Carolina. Results of this study were published by the USCG in 2021 (USCG 2021a).

In addition to the north and south navigational safety fairways discussed in the ACPARS study, a similar PARS study was conducted just for the Chesapeake Bay. Published in 2021, the study introduced two offshore routes for vessels transiting in the east-west to and from Chesapeake Bay. These new proposed fairways may impact local traffic, however they are located greater than 50 nm from the proposed Pioneer Array moorings and are considered to have no impact (USCG 2021b).

The Pioneer Array will have a total of 10 moorings, both surface moorings and subsurface. It is essential that vessel traffic in the vicinity of the array pass these buoys at a safe distance. Since offshore wind farms are developed along the East Coast in the Kitty Hawk Lease Areas, vessel traffic will also need to ensure that their routes pass offshore wind structures at a safe distance. An analysis of likely routing changes to vessel traffic due to the combined development of offshore wind and the Pioneer Array should be conducted to minimize any "funneling" effects and ensure buoys are not located within either the nearshore or offshore fairways.

Figure 3-4 shows the relative location of the proposed Pioneer Array, the Kitty Hawk lease areas, and the nearby St. Lucie-to-Chesapeake Bay Fairways (offshore and nearshore). The proposed distance from both SMW and SME has been calculated as less than 0.5 nm.

3.3.2.1 Preliminary Resource Characterization

The largest ports in the vicinity of the project are Norfolk, Virginia, the largest military port in the country to the north, and to the south, Morehead City with breakbulk facilities and Wilmington, with breakbulk and container facilities. Likely changes to vessel traffic patterns have been considered in the above-mentioned PARS studies, providing valuable background information for the placement of the Pioneer Array moorings.

The primary source of commercial vessel traffic data is AIS, which is required for most commercial vessels. AIS data received from vessels in the Study Area is considered to be at the limit for terrestrial AIS receivers as parts of the Pioneer Area are beyond 30 nm from the shore. AIS data received by

satellite receivers may be used to fill any data gaps that are likely for the eastern extent of the Study Area. **Figure 3-5** and **Figure 3-6** show 1 year of AIS data for all vessel types in 2020 and 2019, respectively. Further examination of vessel traffic of all types may be used to inform the sighting of Pioneer Array elements.

3.3.2.2 Mitigation

USCG-approved Private Aids to Navigation (PATON) and Local Notice to Mariners (LNM) will be required to support the installation and operation of the Pioneer Array.

While all aspects of the array should be monitored to ensure buoys are on-station, extra care should be taken with SMW and SME due to their close proximity to the navigational fairways. The St. Lucie-to-Chesapeake Bay Nearshore Fairway is a designated tug and towing vessel fairway. These vessels are routinely operating with restricted maneuverability and may not be able to avoid collision should SMW become off-station.

It will be important for the Pioneer Array location to be routinely monitored to ensure any off-station buoys do not encroach or impede traffic in the nearby navigational fairways and to keep track of further mitigation measures as they are developed. It is Tetra Techs understanding that the Pioneer Array employs Global Positioning System (GPS) telemetry which monitors buoy location in real-time. The GPS telemetry combined with the Projects scheduled weekly Operations Team meetings are sufficient mitigation for monitoring buoy positioning.

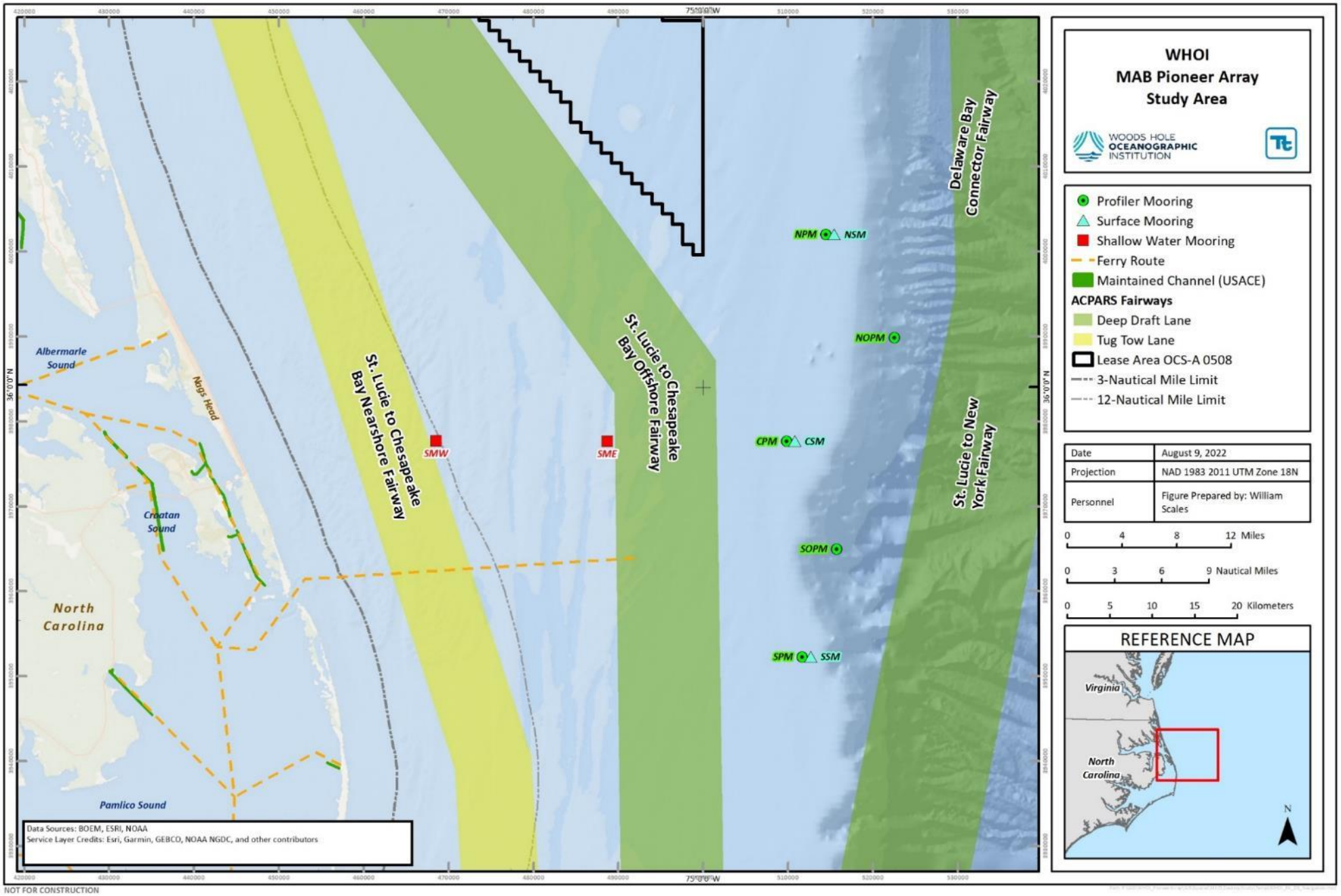

Figure 3-4. Navigation

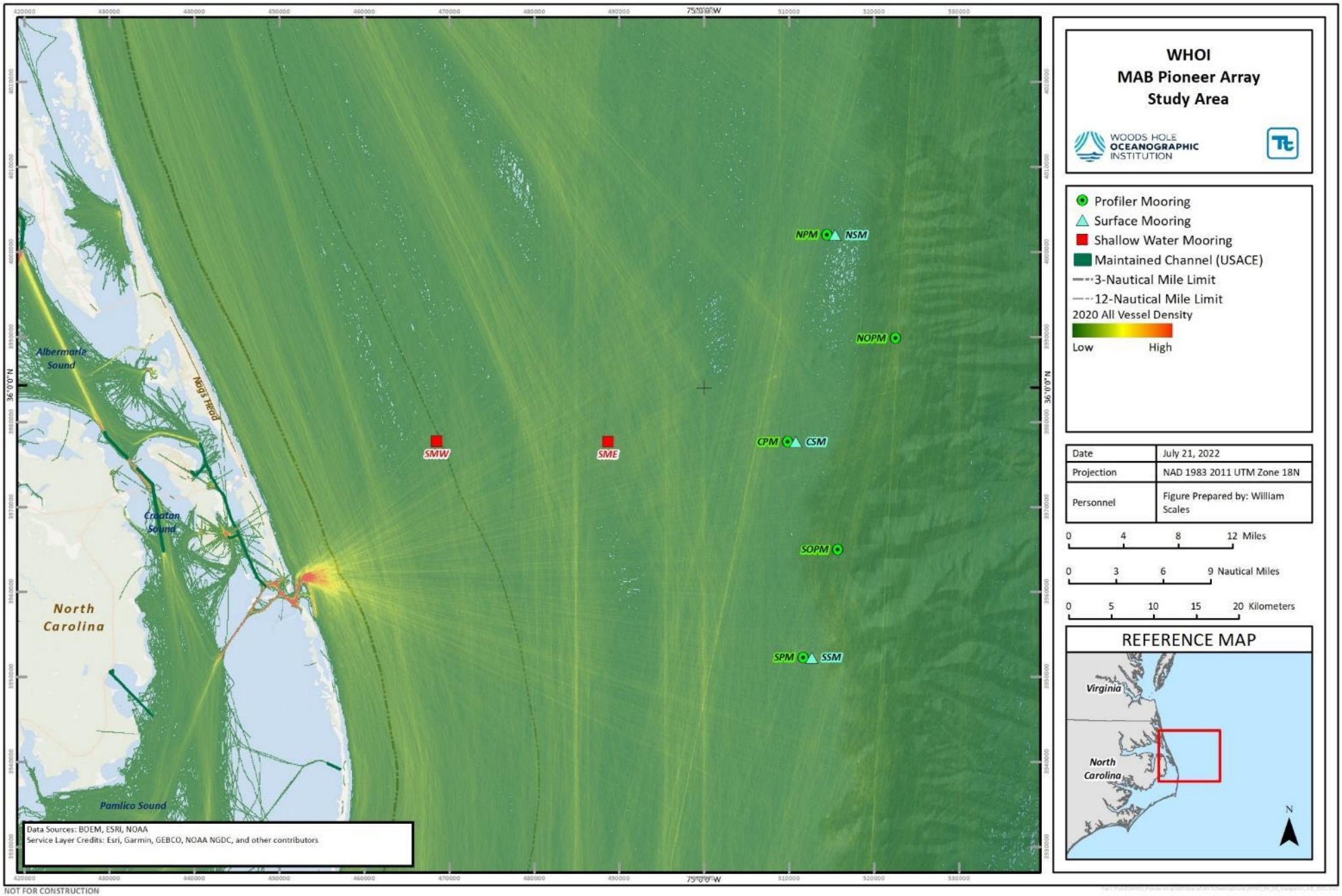

Figure 3-5. AIS Data for 2020

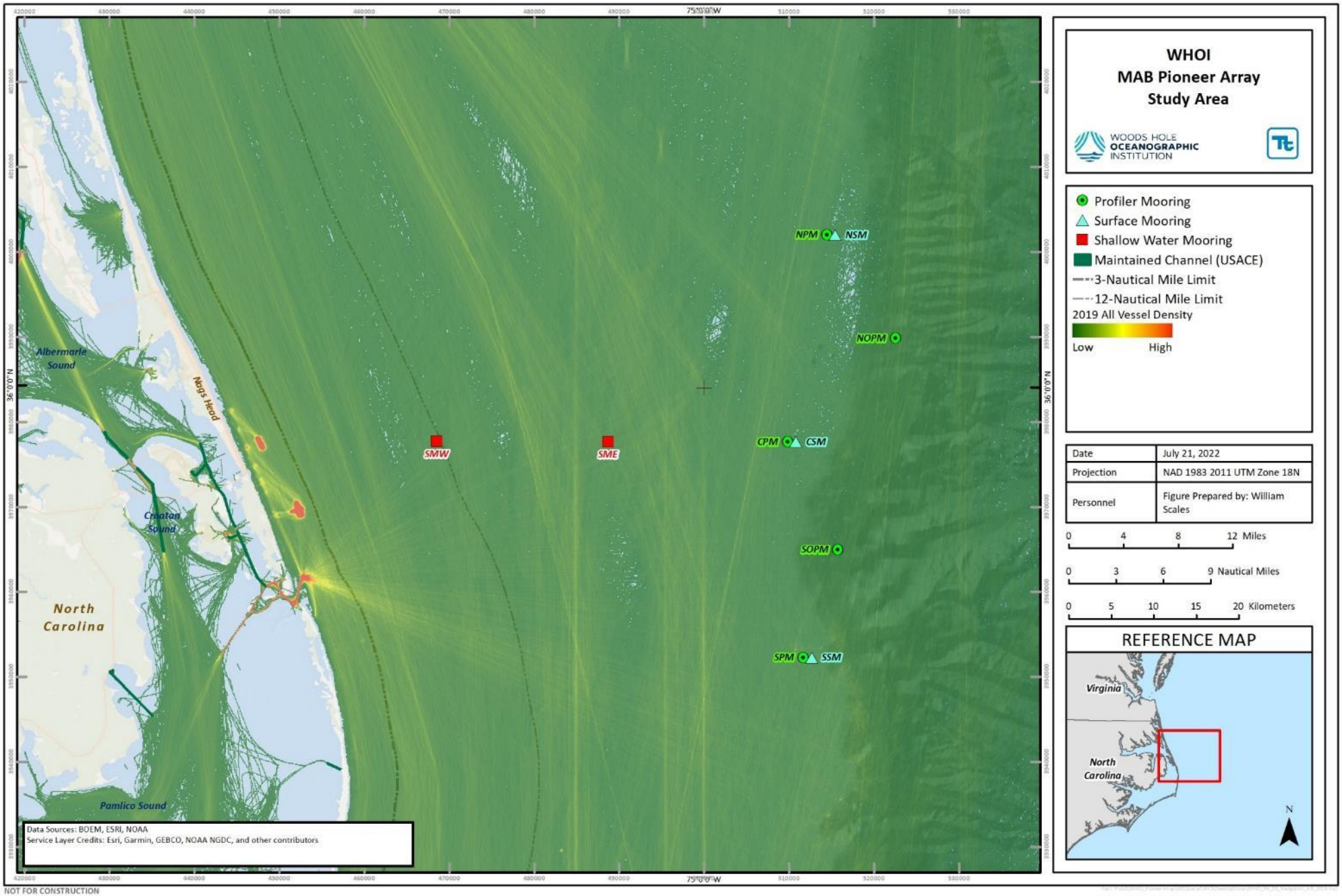

Figure 3-6. AIS Data for 2019

3.3.3 Military Operations

Under 49 U.S.C.§ 44718, the Department of Defense (DoD) was required to study the effects of new construction of obstructions on military installations and operations including radar and wind turbine generator interference and low-level flight operations. The act also established a "Clearinghouse" to provide a coordinated DoD review of renewable energy applications. The stated objective is "To ensure the robust development of renewable energy sources and the increased resiliency of the commercial electrical grid may move forward in the United States, while minimizing or mitigating any adverse impacts on military operations and readiness."

The DoD is authorized under 10 U.S.C. § 2684a to enter into agreements to limit encroachments and other constraints on military training, testing, and operations in order to ensure training range sustainability. The DoD Clearinghouse is an important resource for the determination of impacts to DoD programs by the placement of Pioneer Array elements.

3.3.3.1 Preliminary Resource Characterization

The proposed location of the Pioneer Array is located within the Virginia Capes Range Complex and near the northern border of the Cherry Point Range Complex. A range complex is a designated set of specifically bounded geographic areas and encompasses a water component (above and below the surface), airspace, and may encompass a land component where training and testing of military platforms, tactics, munitions, explosives, and electronic warfare systems occur. Since the Pioneer Array is located near the border of both at-sea Operating Areas (OPAREA), this study references both.

The U.S. Navy Virginia Capes Range Complex has an area of more than 27,000 square nm extending from the Delaware-Maryland border down the coast through Virginia and ends approximately off the coast of Cape Fear, North Carolina. In addition to surface operations, the Virginia Capes Range Complex includes two submarine transit lanes (Whiskey and Echo), Special Use Airspace with designated Warning Areas (U.S. Navy 2018). The proposed location of the Pioneer Array within the VACAPES Range Complex is shown in **Figure 3-7**.

The U.S. Navy Cherry Point Range Complex has an area of more than 18,000 square nm extending from North Carolina to South Carolina. The U.S. Navy Cherry Point Range Complex includes special use airspace with associated warning areas and surface and subsurface sea space of the U.S. Navy Cherry Point. This Range Complex is adjacent to the U.S. Marine Corps Cherry Point and Camp Lejeune Range Complexes associated with U.S. Marine Corps Air Station Cherry Point and U.S, Marine Corps Base Camp Lejeune. (U.S. Navy 2018).

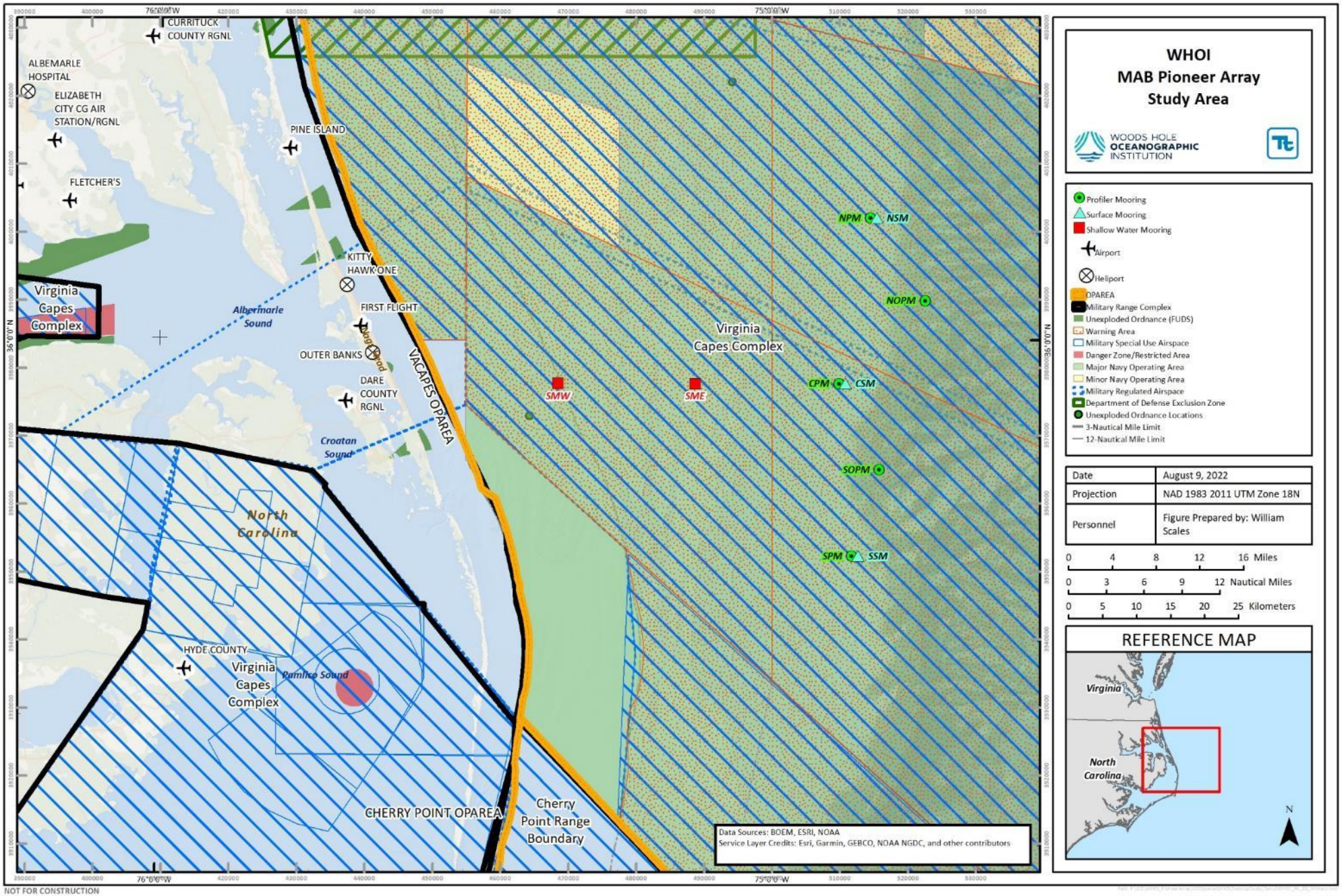

Figure 3-7. Military Areas

3.3.3.2 Mitigation

Consultation and engagement with USCG and DoD will provide further detail regarding ongoing and upcoming military use in the Study Area. To support the assessment of military operations off the coast of North Carolina, South Carolina, and Virginia as it pertains to Project siting and development, the following steps should then be taken:

- Establish communication and outreach with DoD and the USCG to confirm expectations regarding regulatory requirements.
- With the array being located near the border of both Virginia Capes and Cherry Point OPAREAS, engage the DoD Siting Clearinghouse to better understand how both areas are being used and any future area plans. Also determine if there are classified operations that may be impacted by the presence of the Project.

3.3.4 Aviation and Radar

The Federal Aviation Administration (FAA) regulates air safety and use of the navigable airspace (14 CFR Part 77). The FAA must be notified of any construction that may affect the National Airspace System under provisions 14 CFR Part 77. A Notice of Proposed Construction or Alteration (Form 7460-1) must be submitted to the FAA for structures over 200 feet (61 m) tall, or for structures less than 200 feet tall that extend into regulated air space near an airport, or as otherwise required under 14 CFR 77 Subpart B, Section 77.9.

No elements of the Pioneer Array meet this reporting standard so there are no concerns to aviation or land-based radar or mitigation factors.

3.3.5 Hazards and Obstructions

Shipwrecks and other charted obstructions are discussed in Section 3.3.1. Marine cultural resources are assessed under separate cover (*Marine Cultural Resources Study).*

There are currently no charted offshore cables or pipelines in the Study Area; however, due to the proximity of the Kitty Hawk Lease Area, there could be export cables in the vicinity of the Study Area by the time an offshore wind facility is built. In federal waters, the cable owner as well as other federal regulatory authorities should be consulted in the event a seabed use issue arises.

3.3.5.1 Preliminary Resource Characterization

Telecommunications and Power Cables

Subsea cables cross the continental shelf and connect coastal areas. In-Service and Out-of-Service, or retired, telecommunications cables occur across the world's oceans. Modern fiber optic cables carry voice and data, while many of the oldest telegraph cables, some installed more than 150 years ago, still lie on or below the seabed. Power transmission cables may also cross nearer to the shoreline as part of a nation's power infrastructure.

The National Oceanic and Atmospheric Administration (NOAA) Office of Coast Survey is responsible for updating and maintaining the NOAA Nautical Charts of the United States. As such, the relevant

nautical charts have been consulted. On occasion, the USACE may have information regarding seabed assets that are not plotted on nautical charts; therefore, consultation with the USACE regarding seabed assets during the normal course of permitting is advisable.

There are currently no charted submarine cables in the vicinity of the Study Area.

A proposed offshore wind export cable planning effort is underway and includes cable routing options that may impact mooring sites along the OCS. However, the schedule for the Pioneer Array relocation would preclude any offshore wind project export cable installation.

Engineering, installation methodologies, and notification requirements for crossing telecommunications cables have been established by the International Cable Protection Committee (ICPC) and formalized in a series of best-practices guidelines. Additional information on cable location, ownership, and owner contact information may be available from federal and local agencies (e.g., U.S. Navy, USACE, and the North Carolina State Ports Authority), from commercial databases, and from cable maintenance authorities and cable operators. It must be noted that uncharted cables related to DoD activities or facilities may occur within the Study Area.

Additional review of existing and proposed telecommunications and power cables should be considered during mooring siting activities. Specifically, coordination with the Naval Seafloor Cable Protection Office (NSCPO), the North American Submarine Cable Association (NASCA), and International Cable Protection Committee is recommended, in addition to procurement of relevant GIS datasets for the management and analysis of geographically referenced cable data in the Study Area.

Pipelines

Pipelines, generally transporting water or petroleum liquid or gas products, may also cross coastal areas, along with outfall pipes that may be utilized to drain storm water or treated effluent from onshore locations. Charted “Pipeline Areas” are typically identified on NOAA Nautical Charts. More detailed nautical charts may show outfall pipes as these features typically only extend a few hundred feet from the shoreline.

There are currently no charted pipelines in the vicinity of the Study Area.

Sand Resource Areas

The BOEM Marine Minerals Program identifies Atlantic OCS sediment aliquots with sand resource areas identified in a block grid. These OCS blocks represent areas within the OCS protraction grid where sand resources have been identified through reconnaissance and/or design-level OCS studies. Access to and identification of potential OCS sand resources is crucial for the long-term management of coastal restoration, beach nourishment, and habitat reconstruction to mitigate future coastal erosion, land loss, flooding, and storm damage along the U.S. Atlantic Ocean.

These offshore sand resource areas occur in federal waters within the Study Area (**Figure 3-8**). As storm effects and storm-preparedness efforts have reached critical levels in recent years, identifying these resources has become a priority. BOEM maintains leased sand and gravel borrow areas on the OCS. These polygons define the areas where leaseholders can dredge sand, gravel, or shell material

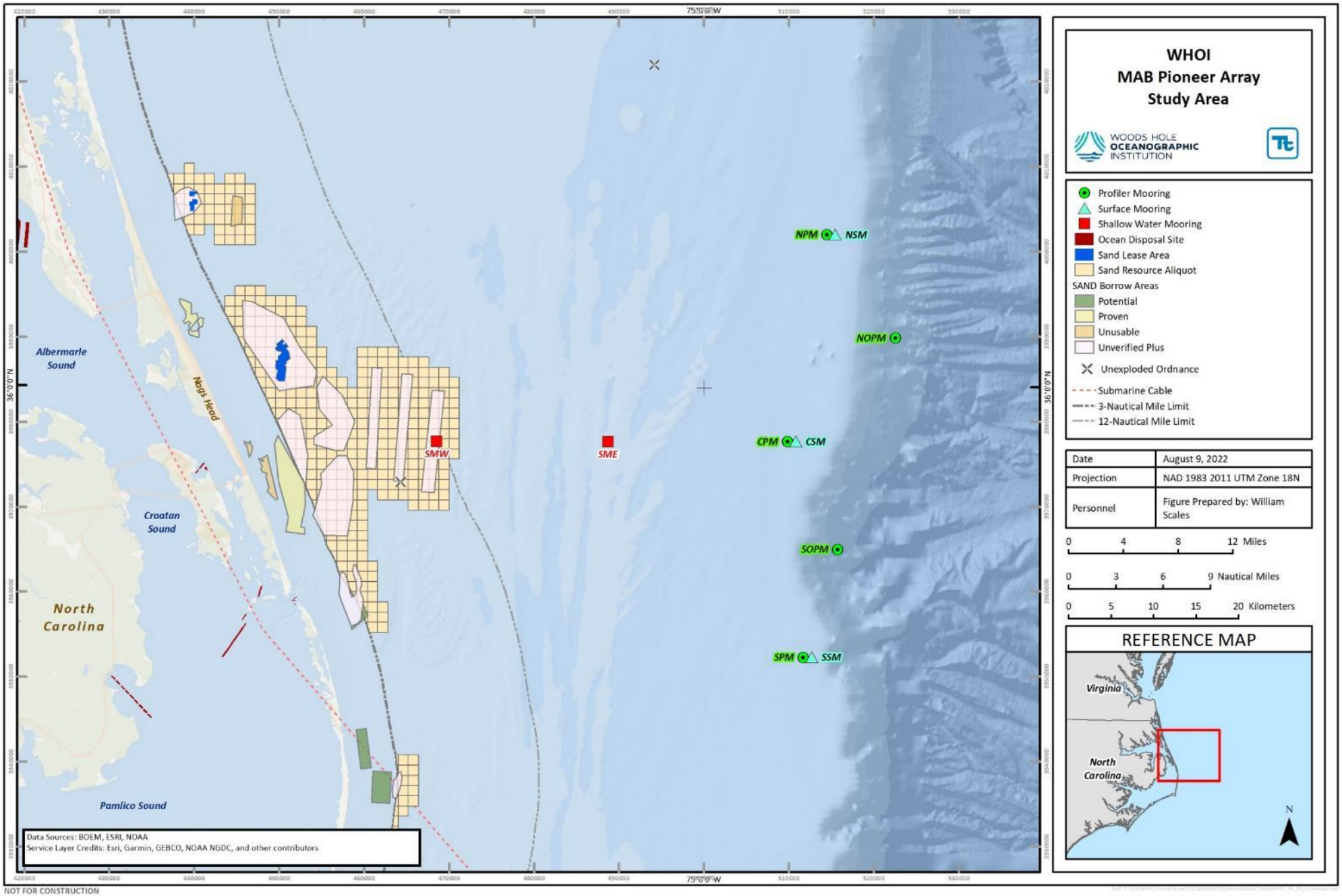

Figure 3-8. Ocean Uses.

from the OCS for use in beach and coastal restoration and protection projects undertaken by the federal government, or in a construction project funded in whole or in part by the federal government and should be carefully considered for avoidance by export cable routing.

Initial assessment indicates that site SMW is located within a sand resource aliquot (MT6014) and Borrow Area (NC_M14AC00009_91). The Borrow Area is classified as Unverified Plus, which are defined as those hypothesized to contain beach-quality sand based on limited geophysical or geotechnical data. Avoidance of these sand borrow areas should be considered.

Obstructions

Various obstructions are charted throughout the Study Area. These obstructions can include artificial reefs (Figure 3-1) and fish havens containing a variety of materials from debris to rocks, or even sunken vessels (Review of the marine cultural resources is assessed under separate cover (*Marine Cultural Resources Study*).

Obstructions, artificial reefs, fish havens, and submerged piles should all be avoided as a hazard to installation. The increased fishing efforts near these features may also pose an additional risk to mooring suitability from potential vessel activity and anchor impacts. Additional items of debris may be encountered during marine surveys and should be evaluated as potential hazards and avoided through micrositing or otherwise mitigated through further investigation, if necessary.

Sites NSM and NPM are located within a charted “rock” area and should be further evaluated during mooring siting activities.

Unexploded Ordinance

Munitions are present in U.S. waters as a result of live-fire testing and training (both ongoing and past); combat operations (acts of war through World War II); sea disposal (conducted through 1970); accidents (periodic); and disposal (e.g., jettisoning) during emergencies (Carton et al. 2017). Unexploded ordnance (UXO), which was either deployed in the marine environment during military activities but failed to initiate, or has been dumped at sea, can present a prospective threat.

The principal issue is that some activities, such as trawling, dredging of the installation, operation and maintenance, or decommissioning of marine infrastructure, may encounter UXO (Cooper and Cooke 2015). The closest location of potential UXO is charted 6.4 km southwest of mooring site SMW.

Areas of the seabed that will be disturbed during installation of oceanographic moorings should be investigated thoroughly prior to installation activities to the extent necessary for both human safety and environmental protection.

Dumping Areas

The EPA is responsible for designating and managing ocean dumping sites under the Marine Protection, Research and Sanctuaries Act. Many of these ocean disposal sites are located offshore of major ports and harbors nationwide. Designated ocean disposal sites are selected to minimize the risk of potentially adverse impacts of the disposed material on human health and the marine environment.

EPA Regional Offices conduct oceanographic surveys to monitor the impacts of regulated dumping at the ocean disposal sites. EPA Regional Offices often conduct site monitoring activities in coordination with the USACE because the vast majority of ocean sites are designated for the disposal of dredged material. Ocean disposal sites are monitored to ensure that dumping will not unreasonably degrade or endanger human health or the environment, to verify that unanticipated adverse effects are not occurring from past or continued use of the site, and to ensure that terms of the ocean dumping permit are met. Individual projects using the ocean disposal sites are also monitored for compliance with EPA site use conditions.

No USACE Ocean Dredged Material Disposal Site areas are located near the Study Area for current dredged material disposal.

3.3.5.2 Mitigation

To support the assessment of manmade hazards and obstructions within the Study Area pertaining to siting and development, the following actions are recommended:

- Project-specific field surveys beyond the geophysical studies necessary to support characterization of geologic and benthic resources are not yet recommended; however, consultation with federal agencies and other stakeholders is recommended as follows:
  - Commercial or Private owners of any utilities that may be identified during field surveys;
  - USACE and US EPA to identify existing and future sediment borrow/dumping areas;
  - Naval Seafloor Cable Protection Office to elucidate potentially unknown constraints and/or DoD assets that are unpublished; and
  - North American Submarine Cable Association and International Cable Protection Committee to advise on the location of the planned moorings and requesting feedback from their respective members as to any concerns of installed or planned cables in the area.

3.3.6 Tourism and Recreation

Review of the recreation and tourism resources within and around the Study Area indicate that recreational boating and fishing, charter fishing, shellfishing, sailboat races, sightseeing, bird and wildlife viewing (including whale watching), surfing, swimming, watersports, visiting beaches, hiking, and other activities are common to this part of coastal North Carolina (Visit North Carolina 2021; Outer Banks Visitors Bureau 2022a).

3.3.6.1 Preliminary Resource Characterization

The main resources associated with and around the Study Area for recreation and tourism include recreational boating and fishing, charter fishing, shellfishing, sailboat races, sightseeing, bird and wildlife viewing (including whale watching), swimming, visiting beaches, and hiking. Most of these activities occur nearshore or onshore in the towns of Nags Head, Kitty Hawk, and Kill Devil Hills, North Carolina, particularly during the summer months when tourism it as its highest. The south end of the Town of Nags Head borders the Cape Hatteras National Seashore, which extends more than 113 km

from South Nags Head to Ocracoke Inlet encompassing 30,000 acres of shoreline (Outer Banks Visitors Bureau 2022b).

In 2021, visitors to North Carolina spent $28.9 billion, or just 1 percent below record 2019 spending levels and 45 percent more than 2020, when travel restrictions tied to the pandemic crippled the state's tourism industry (Visit North Carolina 2021). The towns of Nags Head, Kitty Hawk, and Kill Devil Hills are situated within Dare County, North Carolina. Located on the Outer Banks of North Carolina there are several attractions within the county that draw recreation and tourism activity, including parks, lighthouses, and beaches (Outer Banks Visitors Bureau 2022a). Tourism provides more than 13,880 jobs in Dare County, employing one out of three county residents. Annual Dare County tourism generates more than $130 million ($1,409 per resident) in state and local tax revenue. Visitor spending in Dare County surpassed $1.4 billion in 2020 and ranks the fifth-highest among counties for tourism expenditures in North Carolina, on average (Outer Banks of North Carolina 2022).

Kill Devil Hills is the largest town in Dare County with a population of 7,633 (U.S. Census Bureau 2021) and home of the Wright Brothers National Memorial. Located between Kill Devil Hills and Hatteras Island, Nags Head is an Outer Banks community known for its sand dunes and endless stretches of pristine shoreline. Nags Head is a well-known for its miles of sand dunes. Jockey's Ridge State Park covers 427 acres and includes the tallest active sand dune system in the eastern United States (NCDPR 2022). Given the offshore nature of the Project, no impacts are associated with any land-based recreation or tourism opportunities or nearshore water-based activities.

The recreation and tourism elements most pertinent to Project activities are associated with saltwater fishing as recreational angling is a major tourism activity and a significate contributor to North Carolina's tourism economy (Bumgarner and Hegyi 2006). The waters off the Outer Banks are renowned for the year-round fishing opportunities, particularly for species commonly considered ocean game or trophy fish. Referred to as the "The Billfish Capital of the World", more than 100 fishing tournaments were scheduled in North Carolina in 2020 (Fisherman's Post 2020). Fishing tourism is demonstrated through the use of privately owned vessels, chartered vessels, and head boats in the form of both pleasure and tournament-style fishing (Outer Banks Visitors Bureau 2022c). In 2020, recreational anglers took 16.4 million trips in North Carolina, with the majority shore fishing (5.5 million) followed by private (5.4 million) and manmade boat trips (5.2 million) and charter boats (215,000; NCDMF 2020). Figure

Recreational fishing is mainly associated with targeted fishing grounds and includes HMS species like tuna and sailfish. Due to the likely presence of highly sought-after game fish, the Study Area will be subject to vessels transiting and fishing within proximity. Established artificial reefs providing fish habitat essential to maintaining healthy fish stocks are located east of the Study Area and are maintained by the North Carolina Division of Marine Fisheries. State-wide data on recreational fishing efforts may serve as an indicator for fishing activity and is demonstrated by the density of recreational fishing vessel use in **Figure 3-9**.

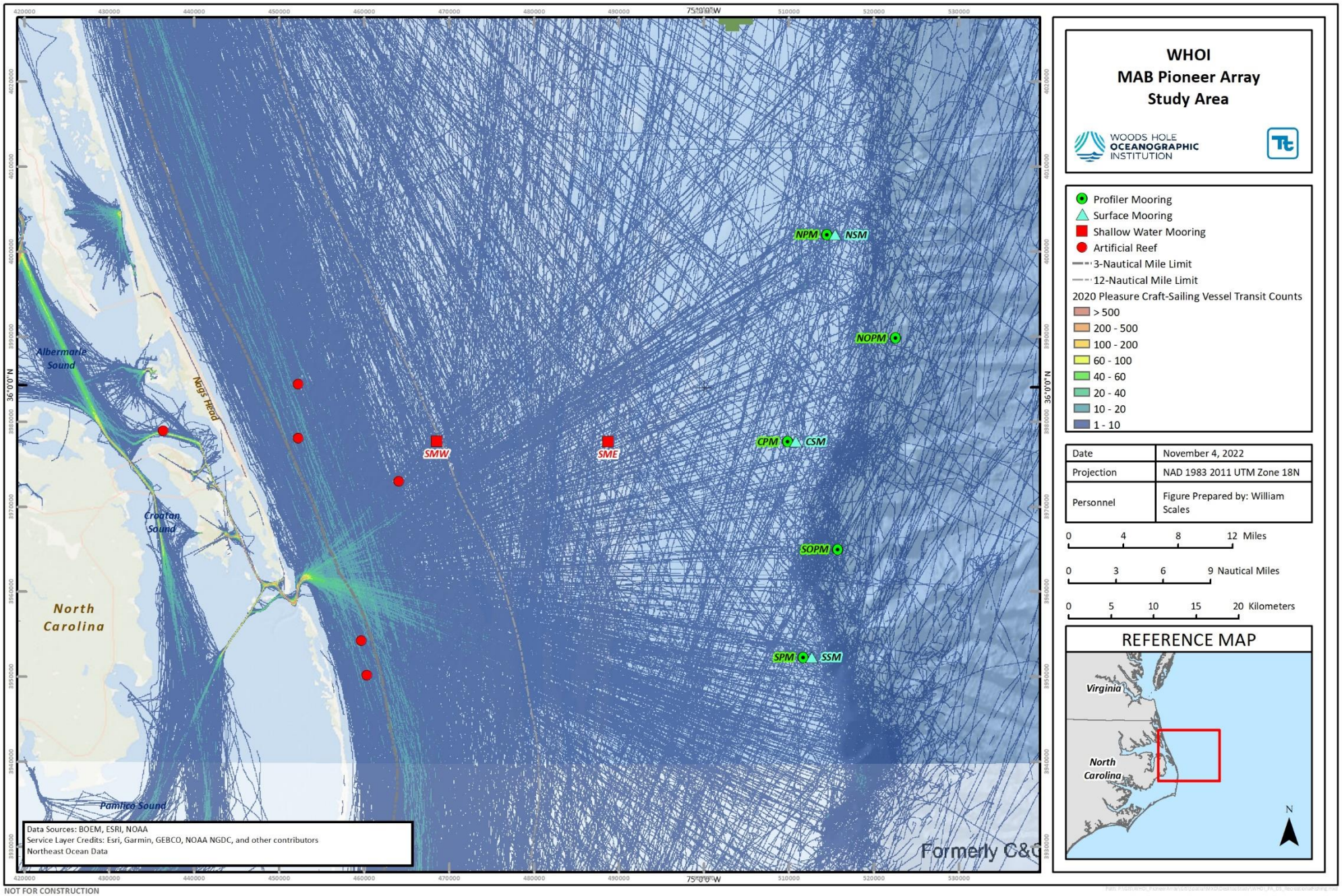

Figure 3-9. Recreational Fishing

Recreation and tourism opportunities associated with the Study Area are subject to minimal displacement due to the localized, short-term, temporary nature of the mooring installation and maintenance periods. Once installed, the micro-siting of the moorings will not significantly reduce access to pelagic fishing grounds; therefore, impacts would be considered discountable.

3.3.6.2 Mitigation

The impacts to recreation and tourism opportunities associated with the Study Area are anticipated to be minimal due to the localized, short-term, temporary nature of the Pioneer Array; no further mitigation is required. However, due to extent of the recreational fishing community, communication with the towns of Nags Head, Kitty Hawk, Kill Devil Hills and Caswell Beach, North Carolina is suggested as a courtesy and best practice above and beyond the Local Notice to Mariners required by the USCG.

3.3.7 Visual and Aesthetic

3.3.7.1 Regulatory Context

BOEM guidelines for assessing impacts to seascape, landscape, and visual resources apply to offshore renewable energy development in federal waters (BOEM 2020b). As such, there are no established visual impact regulatory requirements specific to scientific measurement devices; therefore, in this instance, the BOEM guidelines used comparatively established that the scale of the Pioneer Array Project does not meet the minimum threshold for a Visual Impact Assessment.

State and local plans or policies may additionally protect or manage views from specific publicly accessible areas. For example, the North Carolina Department of Transportation provides guidelines for preserving and protecting valued scenery surrounding designated state scenic byways.

3.3.7.2 Preliminary Resource Characterization

The Study Area is located approximately 13 nm and 45 nm offshore from the eastern shore of Nags Head, North Carolina. The adjacent shorelines and inland areas support a variety of open space, residential, recreational, and cultural uses. In addition to these uses, as noted in the preceding section, tourism associated with beaches and offshore recreational activities (i.e., water sports, sport fishing, etc.) is important to the local economy. The Project description and geographic scope, including the size and scale of changes to the existing visual conditions are critical to evaluating the potential for seascape, landscape, and visual impacts of proposed offshore projects. Applying the BOEM Visual Impact Assessment guidelines to access the Project scale for potential applicable visual impacts requiring regulations, Tetra Tech concluded that the cumulative potential impacts of Project components to the scenic value of the seascape, landscape, and the community are negligible due to the temporary nature of the Pioneer Array installation, the small-scale scope of operation and maintenance procedures, the overall distance from shore, the limited number of moorings, and the low height profile (less than 4.5 m) of the surface buoys. As mandated, the Project must comply with all USCG requirements for lighting; however, the impacts of the compulsory lighting to the scenic value of the seascape, landscape, and the community are also considered negligible.

3.3.7.3 Mitigation

The installed components of the Pioneer Array are primarily subsurface with only small-scale buoy towers extending visibly above the waterline; therefore, the potential impacts of the proposed Study Area's visual and aesthetic resources require no additional mitigation measures.

4.0 SUMMARY AND RECOMMENDATIONS

Based on the evaluated desktop data, the relocation of the Pioneer Array to the OCS off the coast of North Carolina is low risk of impacts to resources, but further site-specific field studies are recommended to comply with federal permitting guidelines.

The items detailed below may require the development of site-specific mitigation strategies:

- **Benthic and Fisheries Resources:** Species and EFH managed by the MAFMC, SAFMC, GMFMC, and NOAA HMS Division occur in the Study Area in federal waters. No proposed Study Area structures are planned to be located in state waters. Mitigation measures include informal consultation with cognizant agencies to determine the need for site-specific benthic characterization surveys to identify sensitive habitats and fisheries resources in the Study Area to avoid impacts due to placement of moorings.
- **Marine Mammals and Sea Turtles:** Marine mammals and sea turtles protected under the ESA are known to occur in the Study Area. Mitigation in the form of informal consultation with USFWS and NOAA Fisheries is recommended to document concurrence that no further steps will be necessary. Site-specific surveys may be conducted to ensure critical habitat is not present in the Study Area. Documentation from USFWS and NOAA Fisheries is required to accompany the NWP 5 certification to document that no formal agency consultation will be necessary, nor species-specific surveys are required.
- **Avian and Bat Species:** Species regulated under ESA, MBTA, and BGEPA are known to occur in the Study Area. From a mitigation standpoint, the Project is required to be constructed and operated in compliance with the USCG requirements for lighting, while using lighting technology that minimize impacts on avian and bat species to the extent practicable.
- **Protected Habitats:** Protected habitats are regulated by the NCDEQ, Coastal Area Management Act, NCDMF, NCWRC, NCDENR, and NOAA Fisheries. Project-specific protected habitats are limited to offshore benthic and pelagic habitats within and in the vicinity of the Study Area. The proximity of protected habitats does not preclude siting buoys; a site-specific survey may be recommended by USFWS or NOAA Fisheries to ensure avoidance of any protected habitat.
- **Underwater Noise:** MMPA regulates and provides protection for marine mammals sensitive to underwater noise, with USFWS having jurisdiction over a select group of marine mammals, and NOAA Fisheries responsible for issuing take permits under the MMPA. Previous consultation with NOAA regarding underwater acoustics outputs for the Pioneer Array confirmed that neither a Letter of Authorization or Incidental Harassment Authorization would be required. No further mitigation is required.
- **Geologic Conditions:** The risk of scour and seabed mobility should be considered in siting buoys. Site-specific HRG surveys are recommended as they are considered the best practice to access geological conditions for project implementation and hazard avoidance.
- **Sediment and Water Quality:** Impacts to sediment and water quality are regulated under the CWA. No existing issues with sediment and water quality were identified. Risk of impacts to

sediment and water quality would be from mooring deployment and operational maintenance of the project. Prior consultation with the USACE Wilmington District confirmed that a Pre-Construction Notification for the Project will not be required for authorized use of NWP 5. The issuance of the NWP 5 automatically authorizes the CWA Section 401 Water Quality Certification, no further mitigation is required.

- **Electric and Magnetic Fields:** Minimal EMF outputs are associated with the deployment of the proposed monitoring buoys, inductive mooring cables, or associated data collection instrumentation; there are no recommendations for additional analyses or mitigation.
- **Air Quality:** Dare County is part of the "Northern Coastal Plain" Air Quality Control Region. This region is designated as unclassifiable or attainment for all NAAQS pollutants. Emissions are restricted to installation and maintenance vessels and thus expected to be both minor and temporary with no air quality mitigation measures needed.
- **Cultural Resources:** Due to the offshore nature of this Project there are no mitigation measures or recommendations related to terrestrial cultural resources. Marine cultural resources are assessed under separate cover.
- **Marine Transportation and Navigation:** The two shallow water moorings are in close proximity to navigational fairways. The St. Lucie-to-Chesapeake Bay Nearshore Fairway is a designated tug and towing vessel fairway. These vessels are routinely operating with restricted maneuverability. Appropriate mitigation measures would include array monitoring to ensure inadvertent events such as off-station buoys do not encroach or impede traffic in the nearby navigational fairways.
- **Military Operations:** Military operations in the vicinity of the Study Area include Virginia Capes and Cherry Point OPAREAS. Mitigation measures in the form of consultation with USCG and DoD will provide further detail regarding ongoing and upcoming military use in the Study Area.
- **Aviation and Radar:** Mitigation measures are not necessary as there are no concerns to aviation or land-based radar systems.
- **Hazards and Obstructions:** There are currently no charted pipelines or USACE Ocean Dredged Material Disposal Sites in the vicinity of the Study Area. Mooring sites NSM and NPM are located within a charted "rock" area and should be further evaluated during mooring siting activities. Areas of the seabed that will be disturbed during installation of oceanographic moorings should be investigated prior to installation activities to the extent necessary for both human safety and environmental protection. Mitigation in the form of consultation with federal agencies is recommended to help identify existing utilities, existing and future sediment borrow/dumping areas and potentially unknown constraints and/or DoD assets.
- **Tourism and Recreation:** The installed components of the Pioneer Array are unlikely to interfere with tourism and recreation; therefore, potential impacts are considered negligible and no further mitigation measures are required. However, consultation with the towns of

Nags Head, Kitty Hawk, Kill Devil Hills and Caswell Beach, North Carolina, would be considered as a courtesy notice/best practice.

- **Visual and Aesthetic:** The installed components of the Pioneer Array are primarily subsurface with only small-scale buoy towers extending visibly above the waterline; impacts to visual and aesthetic resources are therefore considered negligible, and no additional mitigation measures are required.

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