New York State Offshore Wind Master Plan

Fish and Fisheries Study

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NYSERDA Report 17-25j

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New York State Offshore Wind Master Plan
Fish and Fisheries Study

Final Report

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New York State Energy Research and Development Authority

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Notice

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Acronyms and Abbreviations

μPa	microPascal
μT	microtesla
μV/m	microvolts per meter
AIS	automatic identification system
AoA	Area of Analysis
ASMFC	Atlantic States Marine Fisheries Commission
AUV	autonomous underwater vehicles
BMP	best management practice
BO	Biological Opinion
BOEM	Bureau of Ocean Energy Management
CEFAS	Centre for Environment Fisheries and Aquaculture Science
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CITES	Convention on International Trade in Endangered Species
cm	centimeter
COWRIE	Collaborative Offshore Wind Research into the Environment
CZMA	Coastal Zone Management Act
dB	decibels
DE WEA	Delaware Wind Energy Area
DEC	New York State Department of Environmental Conservation
DO	dissolved oxygen
DOS	New York State Department of State
DPS	distinct population segment
EA	environmental assessment
EFH	Essential Fish Habitat
EIS	environmental impact statement
EMF	electromagnetic field
ESA	Endangered Species Act
FLOWW	Fishing Liaison with Offshore Wind and Wet Renewables Group
FONSI	finding of no significant impact
FR	Federal Register
GARFO	Greater Atlantic Region Fisheries Office
HabCam	habitat camera
HUDS	Human Use Data Synthesis
Hz	hertz
ITS	Incidental Take Statement
km	kilometer

m	meter
m/s^2	meters per second squared
MAFMC	Mid-Atlantic Fishery Management Council
MARCO	Mid-Atlantic Regional Council on the Ocean
Master Plan	New York State Offshore Wind Master Plan
MDAT	Marine-life Data & Analysis Team
MMS	Minerals Management Service
MRAC	Marine Resources Advisory Council
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MW	megawatts
NEAMAP	Northeast Areas Monitoring and Assessment Program
NEFMC	New England Fishery Management Council
NEFOP	Northeast Fishery Observer Program Database
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
New Jersey OSA	New Jersey Ocean Stock Assessment
NJDEP DFW	New Jersey Department of Environmental Protection, Division of Fish and Wildlife
NJDEP	New Jersey Department of Environmental Protection
NJMFC	New Jersey Marine Fisheries Council
NMFS	National Marine Fisheries Service
NOAA Fisheries	NOAA Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NROC	Northeast Regional Council on the Ocean
NYCRR	New York Codes, Rules and Regulations
NYEPI	New York Energy Policy Institute
NYSERDA	New York State Energy Research and Development Authority
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OGS	New York State Office of General Services
OSA	offshore study area
PTS	permanent threshold shift
RI Ocean SAMP	Rhode Island Ocean Special Area Management Plan
RI/MA WEA	Rhode Island/Massachusetts Wind Energy Area
RIDEM	Rhode Island Department of Environmental Management
RSA	Research Set-Aside
SAMS	Scottish Association for Marine Science
SEL_{cum}	sound exposure level (cumulative)
SNE/MA	Southern New England and Mid-Atlantic

SPL	sound pressure level
Study	Fish and Fisheries Study
TTS	temporary threshold shifts
U.S.C.	U.S. Code
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
V/m	volts per meter
VCZMP	Virginia Coastal Zone Management Program
VHF	very high frequency
VIMS	Virginia Institute of Marine Science
VMS	Vessel Monitoring System
VTR	Vessel Trip Report
WEA	wind energy area
WTG	wind turbine generator
WWF	World Wildlife Fund

Summary

This Fish and Fisheries Study (Study) is one of a collection of studies being prepared on behalf of the State of New York to provide information related to a variety of environmental, social, economic, regulatory, and infrastructure-related issues implicated in planning for future offshore wind energy development off the coast of New York State. In embarking on these studies, the State initially focused on a 16,740-square-mile area of the ocean extending from the south shore of Long Island and New York City to the continental shelf break, slope, and into oceanic waters to an approximate maximum depth of 2,500 meters that had been identified by the New York State Department of State (DOS) as part of its two-year Offshore Atlantic Ocean study (the "offshore study area [OSA]") (DOS 2013).

The Area of Analysis (AoA) is the geographic scope of analysis for this study. The AoA for this Study is the area within the OSA that was identified to reflect a shoreward boundary that begins 15 nautical miles from the coast, and certain areas outside of the OSA that were recommended by stakeholders for consideration.

This Study synthesizes existing data on fish populations, habitats, and fisheries in the AoA and examines the relative sensitivity of fish, habitats, and fishers to potential offshore wind energy development. The Study also presents a review of federal and state statutes, regulations, and policies that are pertinent to the future development of offshore wind farms in the AoA, specifically, those statutes that are relevant with respect to the protection of fish and fisheries. The Study reviews the presence, distribution, and use patterns of fish and fisheries in the OSA using sources from state and federal agencies, regional fisheries councils and commissions, academic institutions, and non-governmental organizations. Data sources developed from multi-agency programs such as the Mid-Atlantic Regional Council on the Ocean and Northeast Regional Ocean Council were also included in the review.

The Study examines existing biological data on fishery populations, essential fish habitat (EFH), and sensitive species and habitats in the AoA. The Study describes eight fishery-dependent surveys, three research set-aside programs, and one aerial survey that overlap with the AoA.

The Study also determined that the AoA lies within designated offshore EFH for 52 species in the Atlantic Ocean. Additionally, within the AoA, there is one fish species that is protected under the Endangered Species Act (ESA), one that is a candidate for listing, and two that are proposed for listing under the ESA. There are also ten species of special concern listed by National Oceanic and Atmospheric Administration Marine Fisheries Service (NOAA Fisheries). There are no sensitive habitats within the AoA, as it does not encompass any seagrass beds, coral reefs, nurseries, sanctuaries, national marine sanctuaries, or national estuarine research reserves.

Available commercial, recreational, and for-hire fishery information was reviewed to determine what is known about the fisheries in the AoA, including the spatial use of the area, the species fished, the common vessel and gear types, and a general understanding of the fishing industry dynamics and the relative revenue it generates in the region. The AoA contains fishing grounds for fishing boats landing in New York, New Jersey, Rhode Island, Massachusetts, and elsewhere, including major fishing ports such as Cape May, New Jersey, Point Judith, Rhode Island, and New Bedford, Massachusetts. These vessels target a variety of species, such as scallops, squid, flounders, skates, herring, and clams, and use a variety of fishing gear, including rod and reel, longlines, gillnets, seines, beam trawls, otter trawls, paired midwater and bottom trawls, spears, pots and traps, and dredges. Additionally, over 50 publicly available maps were reviewed to help determine how different fisheries and fishing gear types are utilized the AoA and how these data can best be interpreted for preliminary master planning efforts.

Existing literature and case studies on potential risk and sensitivities of fish and fisheries to offshore wind energy development were reviewed and the findings were categorized into pre-construction, construction, and post-construction stages. These include potential risks such as sensory disturbances to fish, habitat impacts, and changes to local fishing practices. The study also includes an appendix that reviews monitoring reports and other population structure and distribution studies from existing offshore wind projects. Additionally, potential benefits of offshore wind are presented, including examples documented from existing projects in the United States and Europe.

This Study includes details of feedback from fisheries stakeholders such as active fishers, industry representatives, and regulatory agencies. This feedback provided information on fish and fisheries data, siting, wind farm layouts, and other information and concerns to improve the ability for offshore wind and fisheries to co-exist. Direct feedback was provided through phone and email correspondence, attendance at local and regional fisheries meetings, site visits to fishing docks, and public meetings. Stakeholder outreach and feedback were facilitated through the stakeholder engagement process, which included the use of a fisheries liaison. A summary of these interactions and their outcomes is included in the study. The Study also presents guidelines and best management practices (BMPs) synthesized from other offshore wind studies and reports, information gathered in this study, and stakeholder outreach.

The Fish and Fisheries Study presents a review and summary of available biological and fishery information for the AoA. The material synthesized in this report can be used to identify the relative potential impact of future offshore wind energy development on fish and fisheries. This information can also be used to assist in the preliminary identification of areas that New York State believes should be considered by the Bureau of Ocean Energy Management (BOEM) for future offshore wind energy projects.

1 Introduction

This Fish and Fisheries Study (Study) is one of a collection of studies prepared on behalf of New York State in support of the New York State Offshore Wind Master Plan (Master Plan). These studies provide information on a variety of potential environmental, social, economic, regulatory, and infrastructure-related issues associated with the planning for future offshore wind energy development off the coast of the State. When the State embarked on these studies, it began by looking at a study area identified by the New York State Department of State (DOS) in its two-year Offshore Atlantic Ocean Study (DOS 2013). This study area, referred to as the "offshore study area (OSA)," is a 16,740-square-mile (43,356-square-kilometer) area of the Atlantic Ocean extending from New York City and the south shore of Long Island to beyond the continental shelf break and slope into oceanic waters to an approximate maximum depth of 2,500 meters (Figure 1). The OSA was a starting point for examining where turbines may best be located, and the area potentially impacted. Each of the State's individual studies ultimately focused on a geographic Area of Analysis (AoA) that was unique to that respective study. The AoA for this study is described below in Section 1.1.

The State envisions that its collection of studies will form a knowledge base for the area off the coast of New York that will serve a number of purposes, including: (1) informing the preliminary identification of an area for the potential locating of offshore wind energy areas (WEAs) that was submitted to the Bureau of Ocean Energy Management (BOEM) on October 2, 2017 for consideration and further analysis; (2) providing current information about potential environmental and social sensitivities, economic and practical considerations, and regulatory requirements associated with any future offshore wind energy development; (3) identifying measures that could be considered or implemented with offshore wind projects to avoid or mitigate potential risks involving other uses and/or resources; and (4) informing the preparation of a Master Plan to articulate New York State's vision of future offshore wind energy development. The Master Plan identifies the potential future WEAs that have been submitted for BOEM's consideration, discusses the State's goal of encouraging the development of 2,400 megawatts (MW) of wind energy off the New York coast by 2030, and sets forth suggested guidelines and best management practices (BMPs) that the State will encourage to be incorporated into future offshore wind energy development.

Each of the studies was prepared in support of the larger effort and was shared for comment with federal and State agencies, indigenous nations, and relevant stakeholders, including non-governmental organizations and commercial entities, as appropriate. The State addressed comments and incorporated feedback received into the studies. Feedback from these entities helped to strengthen the quality of the studies, and also helped to ensure that these work products will be of assistance to developers of proposed offshore wind projects in the future. A summary of the comments and issues identified by these external parties is included in the *Outreach Engagement Summary*, which is appended to the Master Plan.

The Energy Policy Act of 2005 amended Section 8 of the Outer Continental Shelf Lands Act (OCSLA) to give BOEM the authority to identify offshore wind energy development sites within the Outer Continental Shelf (OCS) and to issue leases on the OCS for activities that are not otherwise authorized by the OCSLA, including wind farms. The State recognizes that all development in the OCS is subject to review processes and decision-making by BOEM and other federal and State agencies. Neither this collection of studies nor the State's Master Plan commit the State or any other agency or entity to any specific course of action with respect to offshore wind energy development. Rather, the State's intent is to facilitate the principled planning of future offshore development off the New York coast, provide a resource for the various stakeholders, and encourage the achievement of the State's offshore wind energy goals.

1.1 Scope of Study

This Study summarizes and synthesizes the best available fish and fisheries data on the presence, distribution, and use-patterns of fish and fisheries in the AoA. The AoA for this Study is a 14,980-square-mile area of the ocean extending from 15 nautical miles from the coast of Long Island and New York City to the continental shelf break, slope, and into oceanic waters to an approximate maximum depth of 2,500 meters (Figure 1).

The offshore waters of the AoA serve as habitat for a diverse array of fish species and support commercial, recreational, and for-hire fisheries from throughout the East Coast of the United States. Reviewing existing data available for the species and fisheries within the AoA is an important step in characterizing potentially affected fish species, fish habitat, and fisheries. This information can then be used to assess ways to reduce potential risks to those marine resources and provide BMPs for offshore wind within the AoA. This Study is also intended to be a resource for future offshore wind energy developers completing site characterization studies and evaluating potential impacts on fish and fisheries.

This Study includes a detailed discussion of data that were publicly available at the time the Study was developed. Any information and studies included herein may be updated over time; therefore, the information presented in this Study may be used as a baseline by offshore wind energy developers investigating future site-specific areas, but a review of any new studies may also be needed.

Section 1 introduces the scope, regulatory framework, and objectives of the Study. Section 2 presents the data and literature review, including spatial and socioeconomic data for fisheries within the AoA, fisheries population data based on a variety of existing population studies, and data on essential fish habitat (EFH), threatened and endangered fish species, and other sensitive fish habitats or fisheries species present within the AoA. Section 3 presents potential risks to species, habitats, and fishing industries, as well as resource sensitivities to be considered in planning wind energy projects. Section 4 describes potential benefits of wind farms for fish and fisheries. Section 5 presents a discussion of the stakeholder outreach process and the feedback through the stakeholder engagement process. Finally, Section 6 presents potential guidelines and BMPs based on information drawn from Sections 1 through 5, and provides a review of existing BMP literature related to offshore wind and fish and fisheries and information gained in the stakeholder process.

1.1.1 Study Objectives

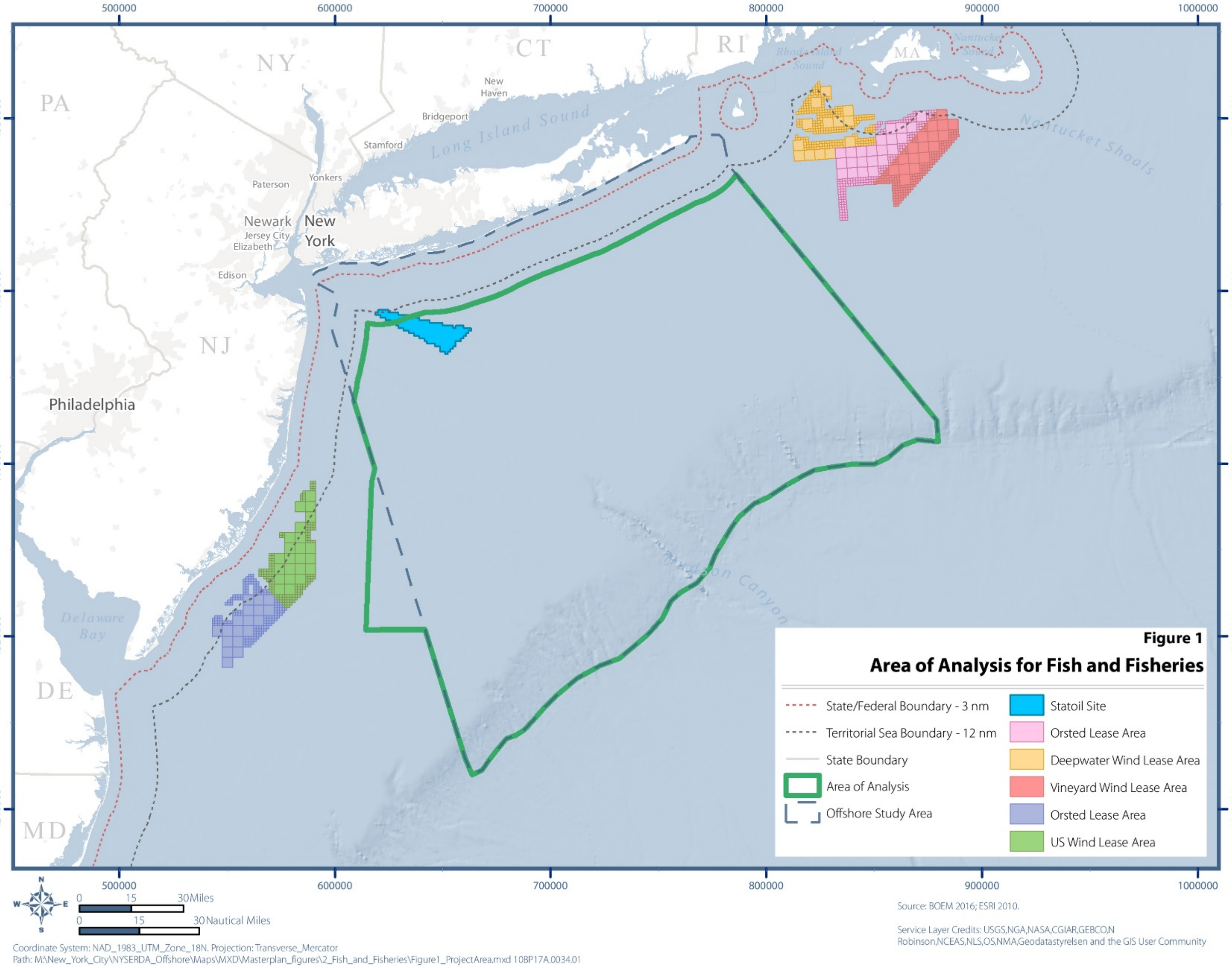
An understanding of existing information available for fish and fisheries in the AoA, including feedback from fisheries stakeholders, can inform future project siting. The aim of this Study is to provide information useful for the identification of areas of importance for fish species and fisheries stakeholders in order to minimize and avoid conflicts due to future offshore wind energy development.

The principal objectives of this Study are the following:

- Create a compendium of existing fish and fisheries occurrence and distribution data, including information on sensitive fish habitats and species in the AoA.
- Review and summarize the known impacts (both positive and negative) of offshore wind construction and operation on fish and fisheries.
- Engage the fishing community to solicit feedback on fish and fisheries data, siting, wind farm layouts, and other issues to improve the ability for fishing and offshore wind energy development to co-exist.
- Provide guidelines and BMPs that offshore wind developers may consider to avoid and minimize potential project impacts on fish and fisheries.

Figure 1. Area of Analysis for Fish and Fisheries

Source: BOEM 2016; ESRI 2010



1.2 Regulatory Framework

This section describes federal and state statutes, regulations, and policies that are pertinent to the future development of offshore wind farms in the AoA, specifically, those statutes that are relevant with respect to the protection of fish and fisheries. These statutes include the Endangered Species Act (ESA), under which consultations and, potentially, Incidental Take Statements (ITS) would be required for ESA-listed fish species at the project development stage; and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), the primary law governing marine fisheries management in U.S. federal waters. In addition, this section provides an overview of state regulations that govern fish and fisheries in New York and New Jersey, and regional fisheries management councils with jurisdiction over waters encompassing the AoA.

1.2.1 Federal Laws and Regulations

1.2.1.1 Endangered Species Act

The ESA of 1973, 16 U.S. Code (U.S.C.) 1531-1544, provides a program for the conservation of threatened and endangered species of animals and plants and the habitats in which they occur. Under the ESA, the U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration Marine Fisheries Service (NOAA Fisheries) may list species as either endangered or threatened depending on the species' biological status and threats to the species' existence. The ESA prohibits the take of any threatened or endangered species except under federal permit. As defined in the ESA, "take" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." Section 7 of the ESA directs federal agencies to consult with the USFWS and/or NOAA Fisheries to ensure that any actions carried out under that agency's jurisdiction will not jeopardize the existence of any listed species or destroy or adversely modify designated critical habitat. To implement the ESA, NOAA Fisheries and the USFWS promulgated regulations to govern consultations and permitting (50 Code of Federal Regulations [CFR] Chapter IV Part 402). With respect to the AoA, NOAA Fisheries manages ESA-listed fish and invertebrate species, and the USFWS manages land and freshwater species, as well as Atlantic sturgeon when they are in fresh water (NOAA Fisheries 2017[a]).

As the statute states, ESA consultation is triggered by a federal action, which is any action authorized, funded, or carried out by a federal agency. For example, if BOEM approves a plan for a geophysical survey in the AoA, BOEM is responsible for consulting with NOAA Fisheries to ensure ESA compliance for ESA-listed species under NOAA Fisheries' jurisdiction. For offshore wind energy development, activities that may affect ESA-listed fish species may require an ITS from NOAA Fisheries. Although it is the responsibility of the federal action agency to consult with NOAA Fisheries and USFWS on ESA, offshore wind developers can provide the federal action agency with information and participate in the consultation process to reduce risks that may affect NOAA Fisheries' findings regarding jeopardy, critical habitat, and impacts, and required mitigations. For example, offshore wind developers can provide detailed information about equipment specifications, propose mitigation to reduce impacts, and provide details about practicability of agency-proposed mitigation measures. Under the ESA, a federal agency may consult informally if an action may affect, but is not likely to adversely affect, ESA-listed species and their designated critical habitat (USFWS n.d.).

If adverse effects are expected, then a formal consultation takes place in which the action agency provides details of the action and relevant biological assessment and other details per 50 CFR 402.12 (c) and (d). The outcome of formal consultation is transmitted to the lead federal agency by NOAA Fisheries and USFWS in the form of a Biological Opinion (BO). Developing the BO is the responsibility of a federal agency or agencies, not directly that of developers, but the developer can provide information to support this consultation process when it is necessary. Regulation 50 CFR 402.01 states "Section 7(a)(3) of the Act [ESA] authorizes a prospective permit or license applicant to request the issuing Federal agency to enter into early consultation with the Service on a proposed action to determine whether such action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat." If formal consultation is needed, this process ultimately results in a BO and ITS, as appropriate. A BO is often accompanied by an ITS. The ITS expresses the amount or extent of anticipated "take" (e.g., death, injury, harm, or harassment) of listed species caused by the proposed action and provides an exemption from the ESA Section 9 prohibitions on such take. The Section 9 exemption provided in the ITS is contingent on the federal agency and any applicant complying with reasonable and prudent measures and terms and conditions provided in the ITS (USFWS n.d.).

Section 2.2.2.2 provides a discussion of threatened and endangered species with potential to occur in the AoA.

New York and New Jersey State Endangered Species Laws. New York State's threatened and endangered species regulations are codified in 6 New York Codes, Rules and Regulations [NYCRR] Part 182, which were updated in July 2016 to include provisions for issuance of state incidental take permits. The regulations are implemented by the New York State Department of Environmental Conservation (DEC). The DEC promulgated these regulations pursuant to the State Endangered Species Act (New York State Environmental Conservation Law § 11-0535). In New Jersey, plants and animals state-listed as endangered or threatened are protected under the provisions of the New Jersey Endangered Species Conservation Act of 1973, Title 23 (N.J.S.A. 23:2A-1 to 23:2A-1:15). The New Jersey Department of Environmental Protection, Division of Fish and Wildlife (NJDEP DFW) manages endangered species in state waters and coordinates with NOAA Fisheries and the USFWS to develop management plans and recreational fishing regulations.

1.2.1.2 Magnuson-Stevens Fishery Conservation and Management Act

The MSFCMA, as amended through 2007, 16 U.S.C. §1801, is the primary law governing marine fisheries management in U.S. federal waters. The MSFCMA fosters long-term biological and economic sustainability of our nation's marine fisheries out to 200 nautical miles from shore. In short, the MSFCMA seeks to increase long-term economic and social benefits, ensure a safe and sustainable supply of seafood, prevent overfishing, and rebuild overfished stocks.

The MSFCMA established Regional Fishery Management Councils, which are comprised of federal and state officials and governor-appointed representatives of the commercial fishing, recreational fishing, and marine conservation community from each of the states that are represented on the regional council. Regional Fishery Management Councils are charged with the stewardship of fishery resources through the preparation, monitoring, and revision of fishery management plans to restore depleted stocks and manage healthy stocks (NOAA Fisheries n.d.[a]). Section 1.2.3 provides a discussion of the Regional Fishery Management Councils that are responsible for f isheries management in the region encompassing the AoA.

The 1996 Sustainable Fishery Act amendments to the MSFCMA set forth provisions to identify and protect important habitats of federally managed marine and anadromous fish species, called EFH. Under these provisions, federal agencies that fund, permit, or undertake activities that may adversely affect EFH are required to consult with the NOAA Fisheries regarding the potential effects of their actions on EFH (see Section 2.2.2.1).

1.2.1.3 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) of 1972, 16 U.S.C. §1451 et seq., as amended, encourages the appropriate development and protection of the nation's coastal and shoreline resources. The CZMA, which is administered by the National Oceanic and Atmospheric Administration (NOAA), gives states the primary role in managing these resources. As stated in 16 U.S.C. 1452, the goal is to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone." The implementing regulations of the CZMA are found at 15 CFR Part 930.

Section 307 of the CZMA stipulates that when a proposed federal project would result in "reasonably foreseeable effects" on any coastal resource or use, the action must be consistent to the maximum extent practicable with the enforceable policies of the affected state's federally approved management program (16 U.S.C. 1456). The CZMA requires that projects located within a state's coastal waters must be consistent with the policies that guide coastal management actions. This statute has been interpreted by NOAA's Office for Coastal Management to allow consistency review for certain actions that take place beyond the boundary of state territorial waters (see 15 CFR 930.11(b) and 15 CFR 930.11(g)). In the case of the AoA, this means that consistency review can be requested by states for actions that take place beyond 3 nautical miles from shore if a case can be made within the requirements of the statute that there would be a reasonably foreseeable effect on a coastal resource (e.g., fisheries).

A federal agency proposing an action that may have a reasonably foreseeable effect on coastal resources must submit a consistency determination. A state may disagree with a no foreseeable impacts finding and request official consistency review from NOAA's Office for Coastal Management. Typically, if a state submits a request for consistency review and such review is granted by NOAA's Office for Coastal Management, the permit applicant or federal action agency will address the consistency issues raised by the state and provide the necessary information for a Consistency Certification to the State and NOAA's Office for Coastal Management. Usually, consistency is achieved through appropriate mitigation and/or notifications. For a thorough review of New York's CZMA regulations, see the New York State Energy Research and Development Authority (NYSERDA; 2015) study *Advancing the Environmentally Responsible Development of Offshore Wind Energy in New York State: A Regulatory Review and Stakeholder Perceptions.*

New York and New Jersey Coastal Zone Management Areas. The New York State Coastal Management Program was approved by NOAA's Office for Coastal Management in 1982 (DOS 1982). The main law governing New York State's coastal management is Executive Law Article 42.

The New Jersey State Coastal Management Program was approved by NOAA's Office for Coastal Management in 1978 (NJDEP 1978). Three major laws govern coastal management in New Jersey: the Coastal Area Facility Review Act, the Wetlands Act of 1970, and the Waterfront Development Law.

1.2.1.4 Outer Continental Shelf Lands Act

The OCSLA of 1953, 43 U.S.C. 1331 et seq., describes the area of the OCS and assigns basic authority over that area and all of its natural resources to the federal government for the purpose of oil and gas exploration. The OCSLA, as amended, provides guidelines for the leasing of the OCS and management of the area for other activities, including renewable energy development. Under the OCSLA, the Secretary of the Interior is responsible for the administration of mineral exploration and development of the OCS. The Secretary grants leases to the highest qualified responsible bidder on the basis of sealed competitive bids and formulates regulations as necessary to carry out the provisions of the Act (43 U.S.C.1337). BOEM administers the leasing provisions of the OCSLA and oversees the development of a tract once it has been leased (Rieser et al. 2013). BOEM has both statutory and regulatory obligations to consider impacts on fisheries (see 43 U.S.C Section 1331[2]; 1337[p]; and 30 CFR Part 585.102). 43 U.S.C. 1332(2) states that the OCSLA "shall be construed in such a manner that the character of the waters above the Outer Continental Shelf as high seas and the right to navigation and fishing therein shall not be affected."

With respect to fish and fisheries, permits and leases issued by federal agencies with jurisdiction under the OCSLA are considered federal actions. BOEM is required to conduct inter-agency consultations and may not take actions that do not comply with other federal laws. Actions are also subject to potential consistency review under the CZMA.

1.2.1.5 National Environmental Policy Act

The National Environmental Policy Act (NEPA) of 1969, 42 U.S.C. 4321 et seq., requires that, prior to making permitting decisions, federal agencies assess the environmental effects of their own activities and development projects, and activities by others that require federal licenses or permits. Federal agencies do this by preparing documents that address the environmental consequences, if any, of the proposed action. An environmental assessment (EA) under NEPA contains an analysis for determining whether the impacts of the action will be significant. If significant, an environmental impact statement (EIS) is prepared and issued by the agency. If not significant, a finding of no significant impact (FONSI) is issued, which effectively ends the agency's NEPA obligations for that project. NEPA requires opportunities for public participation in the environmental impact review process (40 CFR 1500-1508). NEPA also established the Council on Environmental Quality (CEQ). The CEQ, within the Executive Office of the President, promulgates guidelines for implementing NEPA procedures that apply to all federal agencies. Federal agencies are also free to create their own additional regulations. The CEQ reviews and approves federal agency NEPA procedures (40 CFR 1500-1508).

Because BOEM will be the lead agency for future offshore wind farms in federal waters, BOEM will oversee, in consultation with other agencies and stakeholders, the required NEPA process for any such proposed offshore wind projects. The results of the NEPA process and consultations can also be used as the partial basis for other consultations, such as ESA and EFH consultations with USFWS and NOAA. For proposed offshore wind farms in federal waters, environmental consultations are required for two phases of the development process—the site assessment and leasing phase, and the construction and operations phase. Site assessment and leasing activities for future development would likely require an EA, while an EIS would likely be required for construction and operations activities (NYSERDA 2015).

1.2.2 State Laws and Regulations

For an offshore wind farm in New York State, approval from the Office of General Services (OGS) would be required for use of any state submerged lands, and approval from the DEC would be required for any project that crosses state-regulated lands such as tidal wetlands. The New York State Public Lands Law also requires the DEC to review proposed state submerged lands easements obtained from OGS. Attainment of any state approvals would require compliance with the State Environmental Quality Review Act process, which is similar to the NEPA process.

Under the Public Lands Law, the DEC reviews a proposed state submerged lands easement and either concurs with the joint proposal for leasing without conditions, recommends to the OGS conditions to protect natural resources based on articles in the State Environmental Conservation Law (e.g., Article 25 on tidal wetlands, Article 34 on coastal erosion hazards), or determines that natural resources cannot adequately be protected under the proposed action (NYSERDA 2015).

Article VII of the Public Services Law applies to transmission lines within state waters, which, upon approval, receive a certificate from the Public Service Commission. The siting of projects subject to Article VII supersedes all local and state jurisdictions. The DEC, a statutory party in Article VII proceedings, advises the Public Service Commission regarding matters related to compliance with the State Environmental Conservation Law and recommends certificate conditions (NYSERDA 2015).

1.2.3 Regional Councils and Commissions

Many marine species migrate along the coastal boundaries of Atlantic coast states. For these species, management responsibility is shared among the states and with federal agencies, including NOAA Fisheries. Three of the principal formal institutions that accomplish this cooperative management of fish and fisheries among states and the federal government in the AoA are the Atlantic States Marine Fisheries Commission (ASMFC), New England Fishery Management Council (NEFMC), and the Mid-Atlantic Fishery Management Council (MAFMC). Together, these councils manage commercial and recreational fisheries for certain species and resources.

1.2.3.1 Atlantic States Marine Fisheries Commission

The ASMFC includes commissioners from 15 Atlantic coast states from Maine to Florida, including Pennsylvania. Each state is represented on the Commission by three Commissioners: the director of the state's marine fisheries management agency, a state legislator, and an individual appointed by the state's governor to represent stakeholder interests. The Commission coordinates the conservation and management of inshore fishery species and promotes responsible utilization of marine fishery resources within the states' jurisdictional waters. Some of the species managed by ASMFC include American eel (*Anguilla rostrata*), American lobster (*Homarus americanus*), Atlantic herring (*Clupea harengus*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), black sea bass (*Centropristis striata*), horseshoe crab (*Limulus* polyphemus), American shad (*Alosa sapidissima*), alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*)(river herring), striped bass (*Morone saxatilis*), summer flounder (*Paralichthys dentatus*), and weakfish (*Cynoscion regalis*). ASMFC develops and implements interstate fishery management plans that govern the conservation and recreational and commercial use of these fisheries (ASMFC n.d.; DEC n.d.).

1.2.3.2 Mid-Atlantic and New England Fishery Management Councils

NEFMC and MAFMC were created by the MSFCMA in 1976 and are responsible for the conservation and utilization of fisheries in federal waters off the New England and mid-Atlantic coasts, respectively. Member states of the NEFMC are Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut; member states of the MAFMC are New York, New Jersey, Pennsylvania, Maryland, Delaware, Virginia, and North Carolina. The AoA is located within waters that host species managed by both NEMFC and MAFMC, and fishing vessels originating in New England and Mid-Atlantic ports fish in the AoA.

Voting members of each council include representatives of the constituent states' fish and wildlife agencies, the NOAA Fisheries Regional Administrator for the Greater Atlantic Region, and private citizens who are knowledgeable about recreational fishing, commercial fishing, or marine conservation. The four non-voting members of each council represent the ASMFC, USFWS, U.S. Department of State, and U.S. Coast Guard (MAFMC n.d.; NEFMC n.d.).

The councils develop fishery management plans and recommend management measures to the Secretary of Commerce through NOAA Fisheries. Species managed by the NEFMC include sea scallop (*Placopecten magellanicus*), monkfish (*Lophius americanus*), Atlantic herring, red crab (*Chaceon quinquedens*), Atlantic salmon (*Salmo salar*), spiny dogfish (*Squalus acanthias*) and skates. The skate fishery management plan includes seven species: winter skate (*Leucoraja ocellata*), barndoor skate (*Dipturis laevis*), thorny skate (*Amblyraja radiata*), smooth skate (*Malacoraja senta*), little skate (*Raja erinacea*), clearnose skate (*Raja eglanteria*), and rosette skate (*Leucoraja garmani*). The NEFMC also manages the Northeast multispecies groundfish fishery, comprised of 13 species of fish, including Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), pollock (*Pollachius virens*), yellowtail flounder (*Limanda ferruginea*), witch flounder (*Glyptocephalus cynoglossus*), winter flounder (*Pseudopleuronectes americanus*), windowpane flounder (*Scophthalmus aquosus*), American plaice (*Hippoglossoides platessoides*), Atlantic halibut (*Hippoglossus hippoglossus*), redfish (*Sebastes fasciatus*), ocean pout (*Macrozoarces americanus*), and Atlantic wolfish (*Anarhichas lupus*), as well as three species of hake managed under the small mesh multispecies program; silver hake (whiting; *Merluccius bilinearis*), red hake (*Urophycis chuss*), and offshore hake (*Merluccius albidus*) (NEFMC n.d.). Species managed by the MAFMC include Atlantic mackerel (*Scomber scombrus*), long-finned squid (*Doryteuthis pealeii*), short-finned squid (*Illex illecebrosus*), Atlantic butterfish (*Peprilus triacanthus*), bluefish (*Pomatomus saltatrix*), spiny dogfish (*Squalus acanthias*), surfclams (*Spisula solidissima*), ocean quahogs (*Artica islandica*), summer flounder, scup (*Stenotomus chrysops*), black sea bass, tilefish (*Lopholatilus chamaeleonticeps*), and monkfish (MAFMC n.d.). Some of these species, such as monkfish and spiny dogfish, are managed cooperatively by both Councils (MAFMC n.d.; DEC n.d.).

1.2.4 State Councils and Commissions

While the jurisdiction of state fishery councils does not extend into federal waters, portions of offshore wind farms, such as transmission cables, will cross state waters. State councils and commissions will have an interest in any such action that may affect fisheries under their management.

1.2.4.1 New York State Marine Resource Advisory Council

The Marine Resources Advisory Council (MRAC) was established by law in 1987 to advise the DEC on marine resources issues, such as commercial and recreational fishing, proposed regulations, and marine resource protection and utilization. The 15 council members include seven representatives each from the State's commercial and recreational fishing industries and the MRAC chair. The MRAC is chaired by the Dean of the School of Marine and Atmospheric Sciences at Stony Brook University, or his/her appointee. The MRAC reviews the allocations and expenditures of the DEC for the care, management, protection, and expansion of marine resources; issues reports to and consults with commercial and recreational harvesters about marine resources programs; and makes recommendations to the DEC about proposed regulations for marine fisheries (DEC n.d.).

1.2.4.2 New Jersey Marine Fisheries Council

The New Jersey Marine Fisheries Council (NJMFC) advises the Commissioner of the New Jersey Department of Environmental Protection (NJDEP) on various issues and management programs related to marine fishery resources. The 11-member council includes representatives from recreational and commercial fishers, fish processors, the general public, and the Atlantic Coast and Delaware Bay sections of the Shellfisheries Council. The NJMFC is unique in state government in that it can veto marine fishery regulations proposed by the NJDEP Commissioner. Along with shared authority, the NJMFC also contributes to the preparation and revision of fishery management plans, holds public hearings on marine fishery issues, convenes species-related citizen panels, and advises the NJDEP Commissioner on departmental policies and planning related to marine resources (NJDEP DFW n.d.).

1.2.4.3 New Jersey Shellfisheries Council

The Shellfisheries Council operates within the NJDEP Division of Fish, Game, and Shellfisheries. The 10-member council is divided into the Delaware Bay Section, with jurisdiction over the Delaware River, Delaware Bay, and their tributaries, and the Atlantic Coast Section, with jurisdiction over tidal waters of the state. Members of the council include representatives of coastal counties who are licensed and practicing shell fishers. The responsibilities of the council are to propose policies to preserve and improve the state's shellfish industry and advise the NJDEP Commissioner and NJMFC about the implementation of shellfish programs. The council, with approval of the Commissioner, also sets the terms and fees for leasing shellfish grounds (NJDEP DFW n.d.).

2 Data and Literature Review

2.1 Methodology

As stated in Section 1.1.1, the principal objectives of this Study were to summarize and synthesize the best available fish and fisheries data on the presence, distribution, and use-patterns of fish and fisheries in the AoA. This section describes the literature and data reviewed to produce the results presented in Sections 2.2 and 2.3.

2.1.1 Data Sources for Fish Species

This Study used a variety of existing data to examine fish species and populations within the AoA. Representative fish species within the AoA were determined using data and online models provided by the Duke University Marine-life Data & Analysis Team (MDAT). EFH, ESA-listed and fish species, fish species of concern, and sensitive habitats occurring within the AoA were determined using NOAA Fisheries data. Numerous fishery-independent studies are conducted by federal and state agencies, non-governmental organizations, and academic institutions in U.S. waters of the Atlantic Ocean. These ongoing surveys were consulted if they overlapped geographically with the AoA or occurred within the nearshore waters between the AoA and the coastline. Background information on these surveys, which was provided by branches of NOAA Fisheries, the ASMFC, the Virginia Institute of Marine Science (VIMS), and the NJDEP DFW, is presented in Section 2.2.3.

2.1.2 Data Sources for Commercial, Recreational, and For-Hire Fisheries

The review of commercial, recreational, and for-hire fisheries data focused on data that could be used to obtain a better understanding of the fisheries within the AoA, including the spatial use of the area, the species fished, the vessel and gear types used, and a general understanding of the revenue from fisheries in the AoA. Several data sources were consulted, including data from NOAA fisheries, reports and map outputs developed by the DOS, BOEM, and regional efforts by the Northeast Regional Council on the Ocean (NROC) and the Mid-Atlantic Regional Council on the Ocean (MARCO). For spatial data in particular, over 50 publicly available maps were reviewed to help determine how different fisheries and fishing gear types utilize the AoA and how this data can best be interpreted for preliminary master planning efforts. A summary of those map products is presented in Section 2.3. Additionally, input from stakeholders, including state and federal agencies; non-governmental organizations; and commercial, recreational, and for-hire fishers, was actively sought and considered throughout the data compilation and review process. Detailed descriptions of stakeholder outreach are included in Section 5.

2.2 Biological Data

2.2.1 Fish and Fisheries Ecology of the AoA and Mid-Atlantic Region

The AoA and broader mid-Atlantic region are host to a great diversity of fish species and have long sustained a large number of commercial, for-hire, and recreational fishing operations. The AoA is part of the New York Bight, an area of ocean extending from Montauk, New York, to Cape May, New Jersey, with the continental shelf as its eastern edge. The area has multiple high-quality estuaries, including the Hudson River estuary, and many of its more than 300 fish species move between estuarine, inshore, and offshore habitats daily, seasonably, or throughout their life cycle (DEC 2017).

The 150-kilometer (km)-long Hudson Shelf Valley bisects the New York Bight region, extending from the Christiansen Basin at a water depth of about 30 meters to the head of the Hudson Canyon at a water depth of about 85 m. The Hudson Canyon is a large underwater canyon located at the continental shelf edge. At the southeast edge of the AoA, along the continental slope, the ocean is more than 2.4 km deep. Sediments in the New York Bight region are primarily sand, with patches of coarse-grained gravel, find-grained silt, rocky outcroppings, and mud deposits. Areas of the shelf in the vicinity of Hudson Canyon are home to deep-sea corals (i.e., sea pens, stony corals, soft corals, and gorgonians) (Lumsden et al. 2007; DEC 2017), which, in turn, provide habitat for multiple fish species. The water currents and, therefore, ecology of the area, are seasonally variable and are largely impacted by the ocean's topography, storms, and fresh water from rivers, particularly the Hudson (DEC 2017).

The MDAT, in collaboration with NROC, has aggregated data and online models of fish species present in the offshore waters along the New York Bright and beyond to create a technical report for agencies to use as a resource in the development process of offshore projects (Curtice et al. 2016; Fogarty and Perretti 2016). The technical report describes the spatial distribution and abundance of fish species in and around the AoA. Select species representing the various fish/fisheries groups within the AoA are listed in Table 1. These species were selected based on recorded individual presence within the AoA as found in the fisheries trawl data from the Northeast Fisheries Science Center (NEFSC) and the Northeast Areas Monitoring and Assessment Program (NEAMAP). Survey samples were gathered in the fall months from September through December. NEFSC bottom trawl data were collected from 1970-2014, and NEAMAP bottom trawl data were collected from 2007-2014 (Fogarty and Perretti 2016). Additional fish species of particular interest are those that have been identified as having EFH within the AoA (Table 2) and those listed as threatened or endangered under the ESA that may be present within the AoA (Table 3).

Table 1. Select Representative Fish Species Occurring within the AoA[a]

Source: Curtice et al. 2016; Fogarty and Perretti 2016; FishBase n.d.

Common Name	Scientific Name
American lobster	*Homarus americanus*
American shad	*Alosa sapidissima*
Atlantic butterfish	*Peprilus triacanthus*
Atlantic mackerel	*Scomber scombrus*
Atlantic herring	*Clupea harengus*
Atlantic sea scallop	*Placopecten magellanicus*
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*
Atlantic torpedo ray	*Torpedo nobiliana*
Barndoor skate	*Dipturus laevis*
Bay anchovy	*Anchoa mitchilli*
Black sea bass	*Centropristis striata*
Blackbelly rosefish	*Helicolenus dactylopterus*
Bluefish	*Pomatomus saltatrix*
Blue shark	*Prionace glauca*
Clearnose skate	*Raja eglanteria*
Common thresher shark	*Alopias vulpinus*
Fourspot flounder	*Hippoglossina oblonga*
Gulf Stream flounder	*Citharichthys arctifrons*
Haddock	*Melanogrammus aeglefinus*
Horseshoe crab	*Limulus polyphemus*
Jonah crab	*Cancer borealis*
Long-finned squid	*Doryteuthis pealeii*
Monkfish (goosefish)	*Lophius americanus*
Northern kingfish	*Menticirrhus saxatilis*
Northern puffer	*Sphoeroides maculatus*
Northern sand lance	*Ammodytes dubius*
Northern sea robin	*Prionotus carolinus*
Northern short-finned squid	*Illex illecebrosus*
Ocean pout	*Macrozoarces americanus*
Ocean quahog	*Artica islandica*
Red hake	*Urophycis chuss*
Red-eye round herring	*Etrumeus sadina*
Rosette skate	*Leucoraja garmani*
Roughtail stingray	*Bathytoshia centroura*
Sand tiger shark	*Carcharias taurus*
Scup (porgy)	*Stenotomus chrysops*
Sea raven	*Hemitripterus americanus*

Table notes are on the next page.

Table 1 continued

Common Name	Scientific Name
Shortfin mako shark	*Isurus oxyrinchus*
Silver hake (whiting)	*Merluccius bilinearis*
Smooth dogfish	*Mustelus canis*
Spiny dogfish	*Squalus acanthias*
Spot	*Leiostomus xanthurus*
Spotted Hake	*Urophycis regia*
Weakfish	*Cynoscion regalis*
Striped bass	*Morone saxatilis*
Striped sea robin	*Prionotus evolans*
Summer flounder (fluke)	*Paralichthys dentatus*
Surfclam	*Spisula solidissima*
Tautog (blackfish)	*Tautoga onitis*
Tilefish	*Lopholatilus chamaeleonticeps*
White hake	*Urophycis tenuis*
Windowpane flounder	*Scophthalmus aquosus*
Winter flounder	*Pseudopleuronectes americanus*
Winter skate	*Leucoraja ocellata*
Witch flounder	*Glyptocephalus cynoglossus*
Yellowtail flounder	*Limanda ferruginea*

[a] Additional representative fish species within the AoA are listed in Table 2 (EFH) and Table 3 (ESA-listed species).

2.2.2 Essential Fish Habitat and other Sensitive Habitats or Species

2.2.2.1 Essential Fish Habitat

As stated in Section 1.2.1.2, the 1996 Sustainable Fishery Act amendments to the MSFCMA set forth provisions to identify and protect important habitats of federally managed marine and anadromous fish species.

Within the MSFCMA, Congress defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and, where appropriate, may include aquatic areas historically used by fish. "Substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities. "Necessary" refers to the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem, and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle. EFH assessments are additionally required to review impacts at each life history stage, as per the 2016 worksheet update (NOAA Fisheries n.d.[b]).

Information on EFH within the AoA was collected through multiple NOAA sources, including the EFH Mapper website (NOAA Fisheries n.d.[c]), GARFO 10- by 10-minute grid EFH blocks (NOAA Fisheries GARFO n.d.[a]), and GARFO skate EFH designations for the New England Skate Complex (NOAA Fisheries GARFO n.d.[b]). Figure 2 shows the 10- by 10-minute grid of EFH blocks within the AoA and the number of species with designated EFH within each block. Of the 52 species with EFH within the AoA, 28 have designated EFH for every life stage, and 24 have EFH designated only for specific life stages (Table 2).

Table 2. Fish with Essential Fish Habitat within the AoA[a,b]

Sources: NOAA Fisheries n.d.(c); NOAA Fisheries GARFO n.d.(a), n.d.(b); Page et al. 2013

Species	Eggs	Larvae/Early Juvenile[c]	Juveniles	Adults
Veneroida				
Surfclam (*Spisula solidissima*)	-	-	X	X
Ocean quahog (*Artica islandica*)	-	-	X	X
Ostreoida				
Atlantic sea scallop (*Placopecten magellanicus*)	X	X	X	X
Decapoda				
Red crab (*Chaceon quinquedens*)	X	X	X	X
Teuthida				
Long-finned squid (*Doryteuthis pealeii*)	X	-	X	X
*Northern Short-finned squid (*Illex illecebrosus*)	X	-	-	X
Lamniformes				
White shark (*Carcharodon carcharias*)	X	X	X	X
Shortfin mako shark (*Isurus oxyrinchus*)	X	X	X	X
*Sand tiger shark (*Carcharias taurus*)	-	X	X	X
Common thresher shark (*Alopias vulpinus*)	X	X	X	X
Basking shark (*Cetorhinus maximus*)	-	-	X	X
Porbeagle shark (*Lamna nasus*)	-	X	X	X
Carcharhiniformes				
Dusky shark (*Carcharhinus obscurus*)	-	X	X	X
Sandbar shark (*Carcharhinus plumbeus*)	-	X	X	X
Tiger shark (*Galeocerdo cuvieri*)	-	X	X	X
Blue shark (*Prionace glauca*)	-	X	X	X
Scalloped hammerhead shark (*Sphyrna lewini*)	-	X	X	X
Smooth dogfish (*Mustelus canis*)	X	X	X	X

Notes are at the end of the table.

Table 2 continued

Species	Eggs	Larvae/Early Juvenile[c]	Juveniles	Adults
Echinorhiniformes				
Spiny dogfish (*Squalus acanthias*)	-	-	X	X
Rajiformes				
Little skate (*Raja erinacea*)	X	X	X	X
Rosette skate (*Leucoraja garmani*)	-	-	X	X
Winter skate (*Leucoraja ocellata*)	-	-	X	X
Clearnose skate (*Raja eglanteria*)	X	X	X	X
Clupeiformes				
Atlantic herring (*Clupea harengus*)	X	X	X	X
Salmoniformes				
*Atlantic salmon (*Salmo salar*)	-	-	X	X
Gadiformes				
Red hake (*Urophycis chuss*)	X	X	X	X
*Atlantic cod (*Gadus morhua*)	X	X	X	X
Haddock (*Melanogrammus aeglefinus*)	X	X	X	-
Silver hake (*Merluccius bilinearis*)	X	X	X	X
*Offshore hake (*Merluccius albidus*)	-	X	-	-
Pollock (*Pollachius virens*)	-	-	X	X
Lophiformes				
Monkfish (*Lophius americanus*)	X	X	X	X
Perciformes				
Black sea bass (*Centropristis striata*)	X	X	X	X
Bluefish (*Pomatomus saltatrix*)	X	X	X	X
Cobia (*Rachycentron canadum*)	X	X	X	X
Scup (*Stenotomus chrysops*)	X	X	X	X
Ocean pout (*Macrozoarces americanus*)	X	X	X	X
Atlantic mackerel (*Scomber scombrus*)	X	X	X	X
King mackerel (*Scomberomorus cavalla*)	X	X	X	X
Spanish mackerel (*Scomberomorus maculatus*)	X	X	X	X
Albacore (*Thunnus alalunga*)	-	-	X	X
Yellowfin tuna (*Thunnus albacares*)	-	-	X	X
Bluefin tuna (*Thunnus thynnus*)	-	-	X	X
Skipjack tuna (*Katsuwonus pelamis*)	-	-	-	X
Atlantic butterfish (*Peprilus triacanthus*)	X	X	X	X
Swordfish (*Xiphias gladius*)	-	-	X	-

Notes are at the end of the table.

Table 2 continued

Species	Eggs	Larvae/Early Juvenile[c]	Juveniles	Adults
Pleuronectiformes				
Windowpane flounder (*Scophthalmus aquosus*)	X	X	X	X
Summer flounder (*Paralichthys dentatus*)	X	X	X	X
Witch flounder (*Glyptocephalus cynoglossus*)	X	X	X	X
*American plaice (*Hippoglossoides platessoides*)	X	X	X	X
Yellowtail flounder (*Limanda ferruginea*)	X	X	X	X
Winter flounder (*Pseudopleuronectes americanus*)	X	X	X	X

Notes:

[a] Area of analysis includes 54 distinct 10-minute square grids within the following latitudes and longitudes, which comprise the four corners of the AoA:

40.525935. -73.948788

41.079429, -71.691717

38.436363, -73.125475

39.757354, -70.568939

[b] Table includes a combination of information provided in the sources listed. However, NOAA sources are not always consistent; therefore, the table is conservatively inclusive.

[c] As sharks give birth to live young, or lay eggs that hatch fully formed, this life stage is more often referred to as early juvenile as opposed to larvae.

Key:

X = EFH designated for this life stage in area of analysis.

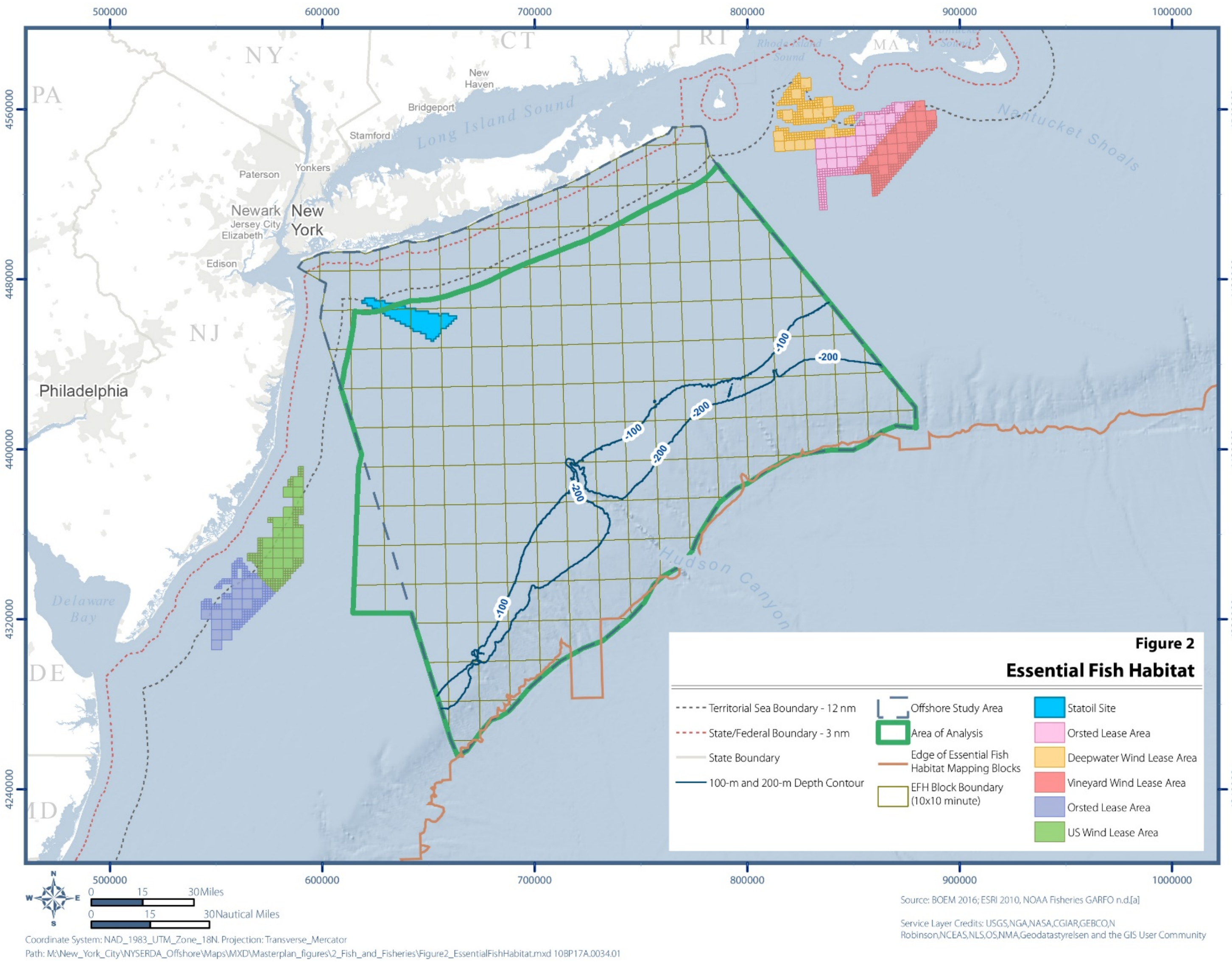
Shaded = EFH not designated for this life stage in area of analysis.

* = species was found in two or fewer grid squares and therefore is less likely to be found within the AoA.

- = species does not have EFH designated habitat for this life stage in area of analysis.

Figure 2. Essential Fish Habitat

Source: BOEM 2016; ESRI 2010; NOAA Fisheries GARFO n.d [a]



Six of the fish species in Table 2 have EFH in only one or two of the 10- by 10-minute grids within the AoA, and the girds that include these species are located along the edges of the AoA.

2.2.2.2 Threatened and Endangered Species

NOAA Fisheries has jurisdiction over 159 endangered and threatened marine species under the ESA, and the AoA is within the GARFO region of NOAA Fisheries. Table 3 lists fish species that are protected, candidates for listing, or proposed for listing under the ESA and may be present in the AoA. A description of these species and the likelihood of their presence within the AoA is provided below. An additional species, the porbeagle shark (*Lamna nasus*), was formerly a candidate for listing, but is not discussed because NOAA Fisheries, after the 90-day review, determined against its federal listing due to the limited threat of immediate decline of its populations (NOAA Fisheries 2016a).

Table 3. NOAA Fisheries Protected, Candidate, and Proposed Species under the Endangered Species Act in the AoA

Sources: NOAA Fisheries 2017a, 2017b

Species	Status	Likely Presence within AoA
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*)	E/T[a]	Yes
Cusk (*Brosme brosme*)	C	Yes
Oceanic whitetip shark (*Carcharhinus logimanus*)	P	Yes
Giant manta (*Manta birostris*)	P	Yes

Note:

[a] The Atlantic sturgeon has five distinct population segments (DPS). The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPS are Endangered; the Gulf of Maine DPS is Threatened.

Key:

C = candidate for listing

E = endangered

P = proposed for listing

T = threatened

Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). In 2012, NOAA Fisheries listed four Atlantic sturgeon distinct population segments (DPS) as endangered, including Chesapeake Bay, New York Bight, Carolina, and South Atlantic (NOAA Fisheries 2016a). Additionally, one DPS (the Gulf of Maine) was listed as threatened (NOAA Fisheries 2016a; 77 Federal Register (FR) 5880 and 77 FR 5914). Although NOAA Fisheries designated critical habitat for the Atlantic sturgeon in August 2017 (effective September 18, 2017), the habitat is confined to rivers and therefore is not found within the AoA (NOAA Fisheries 2017c).

Atlantic sturgeon are an estuarine-dependent, anadromous species. They spend the majority of their adult lives in estuaries and oceans, migrating along the coastline and returning to the rivers they were born in to spawn. Spawning adults typically migrate upriver in spring and downriver/offshore in fall. Atlantic sturgeon eggs are adhesive and are usually laid on hard surfaces (e.g., cobble) in cold, clean waters as water temperature and clarity are important for adequate larvae development (NOAA Fisheries 2016b). Non-breeding adults, sub-adults, and juveniles are also known to seasonally migrate upriver (Bain et al. 1998; Dunton 2014; Dunton et al. 2015). Adult Atlantic sturgeon, when not spawning in rivers, are generally found offshore in areas with gravel and sandy substrates in water 10 to 50 m (33 to 164 feet) deep (NOAA Fisheries 2016b). Juveniles are typically found in estuarine waters or nearshore coastal waters (NOAA Fisheries 2016b). Atlantic sturgeon have been shown to be located along the coastline of New York and New Jersey (Dunton 2014), and within the AoA in fall and winter as bycatch (Dunton et al. 2015). Habitat and life characteristics described for the Atlantic sturgeon indicate the species may be found within the AoA.

Cusk (*Brosme brosme*). Cusk is listed as a candidate species under the ESA (72 FR 10710) and a NOAA Fisheries species of concern (NOAA Fisheries GARFO n.d.[c]). Cusk can be found from New Jersey waters north to the Strait of Belle Isla and the Grand Banks of Newfoundland and typically prefer deep waters with hard and rocky substrate (NOAA Fisheries 2015a). These fish often occur at depths up to 100 m (328 feet) in the Gulf of Maine, and NOAA Fisheries indicated that the cusk is not recognized as a nearshore species (NOAA Fisheries 2015a). Cusk spawn in spring and early summer, and the hatching of eggs and larval development occur in near-surface waters. Juvenile cusk are typically sedentary and solitary and can be found on the seafloor (NOAA Fisheries 2015a). Habitat and life characteristics described indicate the species may be found within the AoA. No critical habitat has been designated for the cusk.

Oceanic Whitetip Shark (*Carcharhinus logimanus*). The oceanic whitetip shark is proposed for listing as threatened under the ESA (81 FR 96304). The species is found in warm tropical and subtropical waters in oceans worldwide, with preferred habitat near the surface, typically far offshore (NOAA Fisheries 2016c). The habitat characteristics described for this species indicate it may be found within the AoA. Although no critical habitat has been designated for the oceanic whitetip shark, in 2015, as a part of a petition to list the species, the Defenders of Wildlife requested that critical habitat be designated concurrent with a final listing, and potential areas of critical habitat were included in the 90-day public comment period for the proposal to list the species under the ESA (NOAA Fisheries n.d.[d]).

Giant Manta (*Manta birostris*). The giant manta is proposed for listing as threatened under the ESA (82 FR 3694). Giant manta are pelagic with a wide distribution in tropical, subtropical, and temperate waters around the globe (NOAA Fisheries 2017d. Giant manta are typically solitary, seasonally visiting productive coastlines, oceanic island groups, and near pinnacles and seamounts in near offshore waters (NOAA Fisheries 2017d). The species is often associated with areas that experience regular upwelling, and have been observed in seagrass beds and along sandy bottoms (NOAA Fisheries 2017d). Habitat and life characteristics described indicate the species may be found within the AoA. There are no designated critical habitats for the giant manta; however, in 2015, a petition from the Defenders of Wildlife requested that critical habitat be determined for the species, concurrent with a final listing decision (NOAA Fisheries n.d.[e]).

2.2.2.3 NOAA Trust Resources

A review of NOAA Trust Resources is required in EFH assessments per the 2016 update of the EFH assessment worksheet (NOAA Fisheries n.d.[b]). NOAA Trust Resources are living marine resources that NOAA actively works to protect and restore (NOAA Fisheries n.d.[f]); as such, these resources may or may not include the previously described ESA-listed species or species with designated EFH. Table 4 lists NOAA Trust Resources by NOAA Fisheries categories and the likelihood of their occurrence within the AoA. Some trust resources were included in previous EFH or threatened and endangered species sections. Because the AoA does not encompass any seagrass beds, coral reefs, nurseries, sanctuaries, national marine sanctuaries, or national estuarine research reserves, these habitats are not discussed further.

Table 4. NOAA Trust Resources in the AoA

Sources: Animal Diversity Web 2014; ASMFC 2017, 2017b; Bigelow and Schroeder 1953; Carlton and Mann 1996; Chang 1990; Chesapeake Bay Program 2012a, 2012b; Clark 1998; Cobb and Castro 2006 (as cited in The International Union for Conservation of Nature and Natural Resources 2017); Commonwealth of Massachusetts 2017; Ecological Research and Development Group 2009; E & E 2009, 2011, 2016; Fay et al. 1983; Hart and Chute 2004; Jenkins et al. 1997; Jensen 2010; Kahnle and Hattala 2010; MacKenzie 1996; Matlock et al. 1991; Morgan et al. 1978; New Jersey Sea Grant Consortium n.d.[a], n.d.[b]; NOAA Fisheries 2007a, 2009a, 2016d, n.d.(g), n.d.(h), n.d.(i); NOAA Fisheries GARFO n.d.(d), n.d.(e); National Wildlife Federation 2017a, 2017b;DEC 2013; Rasmussen and Heard 1995; Smithsonian Marine Station at Fort Pierce 2017; Steimle and Shaheen 1999; Steimle et al. 1999; Tanski et al. 2014; USFWS 2001.

Common Name	Scientific Name	Species Type	Likelihood of Occurrence within the AoA
River herring	*Alosa aestivalis* and *Alosa pseudoharengus*	Anadromous/catadromous	P
American shad	*Alosa sapidissima*		L
American eel	*Anguilla rostrata*		L
Tilefish	*Lopholatilus chamaeleonticeps*	Demersal/groundfish	L
Striped bass	*Morone saxatillis*		L
Tautog (blackfish)	*Tautoga onitis*	Reef/hard bottom species	P
Atlantic menhaden	*Brevoortia tyrannus*	Forage species	P
Atlantic surfclam	*Spisula solidissima*	Bivalve shellfish	L
Atlantic sea scallop	*Placopecten magellanicus*		L
Blue mussel	*Mytilus edulis*		N
Eastern oyster	*Crassostrea virginica*		N
Hard clam	*Mercenaria*		L
Soft clam	*Mya arenaria*		N
Red crab	*Chaceon quinquedens*	Crustacean shellfish	P
American lobster	*Homarus americanus*		L
Horseshoe crab	*Limulus polyphemus*		L
Blue crab	*Callinectes sapidus*		L

Key:

L = Likely

N = Not Likely

P = Possible

2.2.2.4 Species of Concern

Species with status and/or threat concerns, with insufficient available information to indicate a need for listing under the ESA, are termed “species of concern” by NOAA Fisheries GARFO (NOAA Fisheries GARFO n.d.[f]). The following section includes discussion of species of concern within the AoA. As some of the designated species of concern have already been included in previous sections (refer to Section 2.2.2.1 and 2.2.2.2 for the Atlantic bluefin tuna [*Thunnus thynnus*], dusky shark [*Carcharhinus obscurus*], sand tiger shark [*Carcharias taurus*], cusk, and porbeagle shark), they will not be discussed further in this section.

Thorny Skate (*Amblyraja radiata*). Although listing the thorny skate under the ESA was determined to be unwarranted (NOAA Fisheries GARFO n.d.[g]), the species is vulnerable to overfishing and is slow to recover from population declines due to its low productivity (NOAA Fisheries 2017e). Therefore, NOAA Fisheries GARFO has designated the thorny skate a species of concern. The thorny skate is found at depths of approximately 20 to 1,500 meters in the western Atlantic Ocean, from western Greenland to South Carolina (NOAA Fisheries 2017e). The species has been noted over a variety of soft and hard bottom substrates, including gravel, pebbles, sand, soft mud, and broken shells (NOAA Fisheries 2017e; Marine Biodiversity n.d.) and may be present within the AoA.

Rainbow Smelt (*Osmerus mordax*). Rainbow smelt was identified as a species of concern in 2004 due to acid precipitation, overfishing, dams and blocked culverts, and spawning habitat degradation (NOAA Fisheries 2007b). The general area of concern and distribution of the rainbow smelt is from New Jersey to Labrador in rivers and coastal areas (NOAA Fisheries 2007b). The species typically remains in lower salinity, shallow waters close to the coastline (Collette and Klein-MacPhee 2002) and is therefore unlikely to be present within the AoA.

Atlantic Wolffish (*Anarhichas lupus*). The Atlantic wolffish was identified as a species of concern in 2004 due to commercial overfishing, bycatch, and habitat degradation concerns (NOAA Fisheries 2009b). The Atlantic wolffish is typically distributed along the western Atlantic from western Greenland south to Cape Cod, and the species has been infrequently found from southern New England to New Jersey (Collette and Klein-MacPhee 2002). The species prefers complex bottom substrates in depths between 80 and 120 meters (approximately 260 and 390 feet) (NOAA Fisheries 2009b). Since 1963 the NEFSC Bottom Trawl surveys have documented only one wolffish south of Martha's Vineyard, Massachusetts (NOAA Fisheries 2009c), and the depths within the AoA are likely to be more shallow than the species' preferred depth; therefore, the Atlantic wolffish is unlikely to be present within the AoA.

Alewife (*Alosa pseudoharengus*) and Blueback Herring (*Alosa aestivalis*). Alewife and blueback herring are typically referred to collectively as river herring. These species were listed as species of concern in 2006 due to impacts from bycatch and overfishing, impediments (such as dams), habitat degradation, and predation by striped bass (NOAA Fisheries 2009a). Additionally, river herring are currently under an ESA status review (Federal Register 2017). Alewives are anadromous and spawn in spring in coastal rivers with gravel, submerged aquatic vegetation, and detritus (NOAA Fisheries 2009a). When adults are not spawning, they are a schooling species, highly migratory and pelagic, and seasonally migrate (Collette and Klein-MacPhee 2002). This species is distributed from North Carolina up to

Newfoundland (NOAA Fisheries 2009a). Blueback herring are also anadromous, schooling fish that migrate offshore, returning inshore in late spring to spawn (NOAA Fisheries 2009a). Blueback herring are distributed from Florida's St. John's River up through Cape Breton, Nova Scotia (VIMS 2017; Collette and Klein-MacPhee 2002).

2.2.3 Existing Studies

2.2.3.1 Fishery-Independent Surveys

Fishery-independent surveys are typically conducted by state, federal, and university scientists and utilize standardized sampling methods to collect long-term data on fishery resources. Sampling gear used are not bound by management measures (i.e., size and bag limits or mesh sizes) in order to develop unbiased indices of abundance. These types of surveys may also collect additional environmental information, including the age structure of fisheries stocks and fish habitat characteristics (ASMFC 2016; Kilduf et al. 2009).

According to NEFSC (NOAA NEFSC 2012a), fishery-independent surveys are conducted for six main reasons:

- Monitor recruitment.
- Monitor abundance and survival of harvestable sizes.
- Monitor the geographic distribution of species.
- Monitor ecosystem changes.
- Monitor biological rates of the stocks.
- Collect environmental data, and to support other research.

NEFSC Bottom Trawl Survey. The oldest fishery-independent survey included in this Study is the NEFSC bottom trawl survey, which began for the fall in 1963 and for the spring in 1968 (Bonzek et al. 2015; NOAA NEFSC 1988; NOAA Fisheries 1999). This survey utilizes a stratified random sampling design with a trawl designed to catch representative samples of various juvenile and adult demersal and semi-pelagic fish species. The survey program is designed to monitor stock parameters and gather further biological and ecological information on fish and specific invertebrate species (ASMFC 2010; NOAA NEFSC 2012b; NOAA Fisheries 1999; Walsh and Guida 2017). Surveys have generally occurred in depths of 27 to 366 meters, with some occasionally deeper sampling in canyons along the Atlantic Continental Shelf break (NOAA Fisheries 1999). Since 2009 the survey has been conducted with a 400- x 12-centimeter (cm), 4-seam bottom trawl that is fished with 550-kilogram, 2.2-meter Poly-Ice oval trawl doors (NOAA NEFSC 2017a). An additional small-mesh cod-end liner (with 1.3-cm mesh) is used during the spring and fall surveys to catch pre-recruits and macroinvertebrates (NOAA NEFSC 2012b; Walsh and Guida 2017).

Data collected from this survey have been used in fisheries stock assessments for the following previously identified representative species within the AoA (see Table 1): Atlantic butterfish (NOAA NEFSC 2014a), American lobster (ASMFC 2015), Atlantic herring (NOAA NEFSC 2012b), striped bass (ASMFC 2016; NOAA NEFSC 2013a), silver hake (NOAA NEFSC 2011a), white hake (NOAA NEFSC 2013b), black sea bass (NOAA NEFSC 2017b), bluefish (NOAA NEFSC 2015), long-finned squid (NOAA NEFSC 2011a), monkfish (NOAA NEFSC 2010), pollock (NOAA NEFSC 2010), red hake (NOAA NEFSC 2011a), Atlantic mackerel (NOAA NEFSC 2006), scup (NOAA NEFSC 2015), spiny dogfish (Rago and Sosebee 2010), summer flounder (NOAA NEFSC 2013a), witch founder (NOAA NEFSC 2017b), winter flounder (NOAA NEFSC 2011b), and yellowtail flounder (NOAA NEFSC 2012b), as well as an aggregation of seven species of skate (NOAA NEFSC 2007).

Data collected from this survey have also been used in fisheries stock assessments for the following fish with EFH in the AoA (see Table 2): Atlantic butterfish (NOAA NEFSC 2014a), Atlantic Cod (NOAA NEFSC 2013c), Atlantic herring (NOAA NEFSC 2012b), black sea bass (NOAA NEFSC 2017b), bluefish (NOAA NEFSC 2015), long-finned squid (NOAA NEFSC 2011a), monkfish (NOAA NEFSC 2010), pollock (NOAA NEFSC 2010), red hake (NOAA NEFSC 2011a), Atlantic mackerel (NOAA NEFSC 2006), scup (NOAA NEFSC 2015), spiny dogfish (Rago and Sosebee 2010), summer flounder (NOAA NEFSC 2013a), witch founder (NOAA NEFSC 2017b), winter flounder (NOAA NEFSC 2011b), and yellowtail flounder (NOAA NEFSC 2012b), as well as an aggregation of seven species of skate (NOAA NEFSC 2007).

NEFSC Sea Scallop Dredge and Habitat Camera (HabCam) Surveys. NEFSC conducts dredge and HabCam surveys (in collaboration with the Woods Hole Oceanographic Institute) for sea scallops (*Placopecten magellanicus*); these surveys cover Georges Bank and the mid-Atlantic (NOAA NEFSC 2014b, 2016a). Data collected are used to assess numerous biological parameters of the sea scallop stock, including abundance, distribution, and size-at-age distribution (NOAA NEFSC 2012b). The information collected from these surveys has been used in sea scallop stock assessments (Maguire et al. 2015; NOAA NEFSC 2010). Since 1979, the dredge survey has been conducted using a lined dredge and a random-stratified design (NOAA NEFSC 2014b; NOAA Fisheries 1999). The HabCam V4, which has two cameras, side-scan sonar, and oceanographic sensors, was first used in the scallop survey in 2012 (NOAA NEFSC 2014b).

The dredge survey consists of 15-minute tows using a 2.4-meter-wide New Bedford-type scallop dredge. The dredge is equipped with a 1.6-cm case-hardened sweep chain, a 5.0-cm ring chain bag with 3.8-inch mesh webbing, and roller wheels. The NOAA HabCam V4 consists of a fiber optic towed vehicle with stereo cameras that collect paired images of the sea floor. In the past, the dredge tows were conducted in one direction and the vessel was then turned around and the HabCam survey was conducted on the same transect; during the 2016 survey, the two tows occurred concurrently (NOAA NEFSC 2016a).

NEFSC Clam Survey. Since 2012, this survey has been conducted in August and consisted of 5-minute tows using a commercial-style hydraulic dredge with a 4-meter-wide cutting blade modified to retain smaller class sizes of clams (Hennen et al. 2016; NOAA NEFSC 2016b, 2017c, 2017d). Surveys conducted from 1982 to 2011 were performed with different sampling gear and were conducted in June or July (Hennen et al. 2016). The survey area has been divided into northern (Georges Bank) and southern (south of Georges Bank to Cape Hatteras) blocks, which have been surveyed in sequential years beginning in 2012. Every third year has been reserved for gear testing (NOAA NEFSC 2017c, 2017d). Data collected since 1982 from this clam survey have been used in both Atlantic surfclam and ocean quahog stock assessments (NOAA NEFSC 2013b, 2017d).

NEFSC Ecosystem Monitoring Cruises. The NEFSC Oceanography Branch also surveys planktonic organisms (including fish larvae and eggs) of the Northeast U.S. Continental Shelf as part of ecosystem monitoring cruises. The goals of the ecosystem monitoring program include monitoring fishery-related components of the shelf ecosystem and determining effects of biological processes on shelf fish species. Information on ichthyoplankton is collected during shelf-wide research vessel and Ship of Opportunity transect surveys (NOAA NEFSC 2017e, 2017f).

Each shelf-wide research vessel survey includes a zooplankton and ichthyoplankton survey, a water column temperature and salinity survey, and surface primary productivity measurements. The shelf-wide survey is conducted between Cape Hatteras, North Carolina, and Cape Sable, Nova Scotia, on the Continental Shelf and is split into four regions—Gulf of Maine, Georges Bank, Southern New England, and Middle Atlantic Bight. The AoA falls into the Southern New England survey region. Two shelf-wide survey iterations are conducted jointly with the spring and fall bottom trawl surveys, and an additional four survey iterations are conducted in winter, late spring, summer, and fall (NOAA NEFSC 2017f).

Zooplankton and ichthyoplankton surveys conducted during the shelf-wide research vessel survey collect samples throughout the water column and up to 200 meters deep using paired 61-cm-diameter bongo sampler with a 335-micron mesh (NOAA NEFSC 2017f). During the February 2017 survey, an additional 20-cm-diameter polyvinyl chloride bongo frame with a 165-micron nylon mesh net was used at 24 of the sampling locations as part of the Census of Marine Zooplankton. A 20-cm-diameter paired bongo frame with 335-micron mesh nets was used above the 61-cm nets at the remainder of the sampling sites to sample for larval fish and eggs. Samples collected as part of the Census of Marine Zooplankton were genetically analyzed, and fish larvae and eggs collected during the shelf-wide survey were used for aging and genetic analyses (NOAA NEFSC 2017e).

The Ship of Opportunity transect surveys have been conducted on a monthly basis since 1972 along an approximately 450-km transect starting at the Ambrose Light in New York and traveling towards Bermuda (Route MB). MB route surveys are conducted aboard a merchant vessel towing a Hardy Continuous Plankton Recorder at 10-meter depth, which samples for zooplankton and large phytoplankton using a 225- by 234-micron silk grit gauze (NOAA NEFSC 2017f).

NJDEP DFW Ocean Trawl Survey. New Jersey is the only state in the Mid-Atlantic Bight that conducts a fishery-independent trawl survey in its coastal zone (Bonzek et al. 2015). While the NJDEP DFW Ocean Trawl Survey occurs inshore of the AoA, portions of offshore wind farms, such as transmission cables, would cross inshore waters, and data collected from this survey could inform future siting decisions.

The NJDEP DFW's Marine Fisheries Administration began the Ocean Trawl Survey in 1988. Samples are collected for five months (January, April, June, August, and October) at nearly 200 randomly selected sites each year. The survey is conducted in the area between New York Harbor and the Delaware Bay out to the 28 meter depth contour offshore. About 40 sites are sampled during each cruise using a stratified random design based on latitude and depth. The survey is conducted at depths ranging from 5.5 to 27.4 meters using a 25- to 30.5-meter, 2-bridle, 2-seam trawl net with 12- and 8-cm stretch mesh in the body and an additional 6.4-millimeter stretch mesh cod-end liner (Celestino et al. 2011; MAFMC 2015).

Data collected from this survey are used in fisheries stock assessments for the following previously identified representative species within the AoA (see Table 1): American shad, Atlantic sturgeon, horseshoe crab, black sea bass, bluefish, summer flounder, striped bass, winter flounder, and tautog (blackfish; *Tautoga onitis*). The survey is also used in stock assessments for the following fish with EFH in the AoA (see Table 2): black sea bass, bluefish, summer flounder, and winter flounder. Additionally, data from the survey are used in management of the ESA-listed Atlantic sturgeon (see Table 3) (MAFMC 2015).

Northeast Area Monitoring and Assessment Program (NEAMAP) Nearshore Trawl Survey. NEAMAP is a cooperative state and federal survey effort to coordinate and standardize surveys in the waters between Maine and North Carolina. NEAMAP is comprised of the Massachusetts Inshore Trawl Survey, the Maine-New Hampshire Inshore Trawl Survey, and the Southern New England and Mid-Atlantic (SNE/MA) Nearshore Trawl Survey. The SNE/MA Nearshore Trawl Survey is a spring and fall bottom trawl survey that began in 2007 and extends from Martha's Vineyard, Massachusetts, to Cape Hatteras, North Carolina. The survey, which is coordinated by the ASMFC and conducted by VIMS, aims at collecting assessment-related parameters for fish and specific macroinvertebrates. The nearshore trawl is conducted in coastal waters (i.e., between 6.1 and 18.3 meters depth contours in 2014, and between 5.5 and 45.7 meters in 2016), and the survey results are intended to compliment the NEFSC Bottom Trawl Survey, which occurs in deeper waters (ASMFC 2016; Bonzek et al. 2015; MAFMC 2015). While the NEAMAP SNE/MA Nearshore Trawl Survey occurs inshore of the AoA, the depths at which the survey is conducted vary, and portions of the survey may overlap with portions of the AoA. In addition, portions of offshore wind farms, such as transmission cables, would cross inshore waters, and data collected from this survey could inform future siting decisions.

The NEAMAP SNE/MA trawl is performed with a 400- by 12-cm, 3-bridle, 4-seam net and uses a set of Thyboron, Type IV 66-inch doors. The wings and body of the net have 12- and 6-cm stretch mesh webbing, while the cod end has a 2.54-cm knotless nylon line (Bonzek et al. 2015; MAFMC 2015).

Data from this survey are used in fisheries stock assessments for the following previously identified representative species within the AoA (Table 1): American lobster (ASMFC 2015; MAFMC 2015), horseshoe crab (Bonzek et al. 2015), spot (Bonzek et al. 2015), Atlantic butterfish (Bonzek et al. 2015; MAFMC 2015; NOAA NEFSC 2014a), Atlantic sea scallop (Bonzek et al. 2015), black sea bass (NOAA NEFSC 2017b), bluefish (Bonzek et al. 2015; MAFMC 2015; NOAA NEFSC 2015), long-finned squid (Bonzek et al. 2015; MAFMC 2015; NOAA NEFSC 2011a), scup (Bonzek et al. 2015; MAFMC 2015; NOAA NEFSC 2015), spiny dogfish (Rago and Sosebee 2010), summer flounder (Bonzek et al. 2015; MAFMC 2015; NOAA NEFSC 2013a), winter flounder (Bonzek et al. 2015; NOAA NEFSC 2011b), and winter and clearnose skate (Bonzek et al. 2015). The survey data are also used in stock assessments for the following species with EFH in the AoA, as presented in Table 2: Atlantic butterfish (Bonzek et al. 2015; MAFMC 2015; NOAA NEFSC 2014a), Atlantic sea scallop (Bonzek et al. 2016), black sea bass (NOAA NEFSC 2017b), bluefish (Bonzek et al. 2015; MAFMC 2015; NOAA NEFSC 2015), long-finned squid (Bonzek et al. 2015; MAFMC 2015; NOAA NEFSC 2011a), scup (Bonzek et al. 2015; MAFMC 2015; NOAA NEFSC 2015), spiny dogfish (Rago and Sosebee 2010), summer flounder (Bonzek et al. 2015; MAFMC 2015; NOAA NEFSC 2013a), winter flounder (Bonzek et al. 2015; NOAA NEFSC 2011b), and little and winter skates (Bonzek et al. 2015). It is also important to note that there are species, including striped bass, that are likely underrepresented in the NEAMAP SNE/MA surveys due to the timing of migratory patterns (Bonzek et al. 2015).

2.2.3.2 Research Set-Aside Programs

Research Set-Aside (RSA) programs were established by the NEFMC and MAFMC and are jointly run by the two councils and NOAA Fisheries. The RSA programs were created to fund research aimed at improving fishery management decisions and stock assessments. The three active programs were established under the fishery councils' Fishery Management Plans for the Atlantic sea scallop, monkfish, and Atlantic herring. The scallop RSA program was established in 1999, the monkfish RSA program was established in 2005, and the Atlantic herring RSA program was established in 2008. Grants are not awarded as a sum of money; instead, the Councils reserve either portions of Atlantic herring or sea scallop catch or monkfish days-at sea, which are then awarded to grant recipients. These set-asides are then sold to generate research funds. The program responsibilities are divided such that NOAA Fisheries administers the grant award process, and the fishery management councils administer the regulatory and vessel permitting needs, determine research priorities, and monitor harvest activities (NOAA NEFSC 2017g, 2017h).

Each of the three RSA programs has a different research focus. Awarded projects are not necessarily fishery-independent. The current priorities for each RSA program are as follows:

- Atlantic sea scallop: industry-based surveys of current and future access areas, bycatch reduction, loggerhead sea turtle population information, and methods for bycatch avoidance (NOAA NEFSC 2017h; NOAA Fisheries 2016e).
- Monkfish: basic life history information and stock definition, ecological significance, bycatch and discard, and research on gear types to improve selectivity and reduce discard (NOAA NEFSC 2017h; NOAA Fisheries 2015b).
- Atlantic herring: reduction of bycatch of river herring, development of portside sampling, and electronic and/or passive methods to passively monitor net performance (NOAA NEFSC 2017h; NOAA Fisheries 2015c).

2.2.3.3 Normandeau Associates, Inc. and APEM, Inc. Marine Wildlife Aerial Surveys

NYSERDA is currently supporting fine-scale aerial surveys in the AoA. These surveys use high-resolution digital photography to create a baseline of marine wildlife observations that provide information about the distribution and use patterns of marine wildlife in the AoA, including fish. Two initial reports that include taxonomic summaries of sightings are available for summer and fall 2016 (Normandeau Associates, Inc. and APEM, Inc. 2016a, 2017).

The aerial survey method primarily captures images of large bony and cartilaginous fish and fish schools on the ocean surface. These surveys fly at a higher altitude (1,020-1,360 feet) and higher resolution (1.5-cm ground sampling distance) than prior aerial surveys in the region (Normandeau Associates, Inc. and APEM, Inc. 2016b, 2016c), allowing for less startle response in animals reacting to the presence of aircraft. Surveys to date have documented the species shown in Table 5.

Table 5. Species Identified in Marine Wildlife Aerial Surveys

Sources: Normandeau Associates, Inc. and APEM, Inc. 2016a, 2017

Common Name	Scientific Name
Rays	
Bluntnose	*Dasyatis say*
Bullnose	*Myliobatis freminvillii*
Cownose	*Rhinoptera bonasus*
Giant manta	*Manta birostris*
Sharks	
Basking	*Cetorhinus maximus*
Blue	*Prionace giauca*
Bull	*Carcharhinus leucas*
Dusky	*Carcharhinus obscurus*
Great hammerhead	*Sphyma mokarran*
Great white	*Carcharodon carcharias*
Oceanic whitetip	*Carcharhinus longimanus*
Sandbar	*Carcharhinus plumbeus*
Scalloped hammerhead	*Sphyma lewini*
Smooth hammerhead	*Sphyma zygoaena*
Thresher	*Alopias* vulpinus
Tiger	*Galeocerdo cuvier*
Whale	*Rhincodon typus*
Bony Fish	
Ocean sunfish	*Mola mola*

Additional individuals within each of these groups were also documented but could not be identified to the species level. The summer 2016 survey identified 8,407 rays, 942 sharks, and 979 large bony fish. Of these, 155 were presumed ESA-listed sharks, including 21 scalloped hammerheads and 134 unidentified hammerheads, which were conservatively identified in the endangered category due to their possibility of being scalloped hammerheads. In contrast, the fall 2016 survey identified only four rays, four sharks, and 199 large bony fish. One of the sharks, an unidentified hammerhead, was conservatively classified as endangered, again due to the possibility of being a scalloped hammerhead (Normandeau Associates, Inc. and APEM, Inc. 2016a, 2017). It should be noted however that, although the aerial survey reports state the scalloped hammerhead is endangered, not all of the species' DPS are listed as ESA endangered or threatened, including the Northwest Atlantic DPS, which crosses the AoA. Although the species is internationally listed in Convention on International Trade in Endangered Species (CITES) throughout its range, its range is tropical and warm temperate waters, and NOAA has determined that the Northwest Atlantic DPS is not warranted for listing (CITES n.d., NOAA Fisheries n.d.[j]). This species is therefore not include in Section 2.2.2.2 (including Table 3) of this Study, which describes threatened and endangered species on the AoA.

The Normandeau-APEM team is scheduled to gather three years' of baseline aerial survey data for the entire OSA. This survey is gathering data on birds, marine mammals, sea turtles, and fish to obtain information that could inform siting of future wind energy development areas (Normandeau Associates, Inc. n.d.).

2.3 Fishing Industry Spatial and Socioeconomic Data

Spatial data of fishing industry use provides information on fishing areas for commercial, recreational, and for-hire fisheries in the OSA. Several recent studies have created spatial maps of fisheries using information from NOAA Fisheries programs. Each of these studies have considerations that must be taken into account when interpreting data, such as their temporal range (i.e., the number of years of data presented), spatial scale and resolution, type of data considered, methods of aggregation, age of analysis and/or data used, or underlying regulatory or ecological changes that could have impacted fishing data. While an overall review of available spatial fishing industry data are presented below for the purposes of this study, developers of future offshore wind projects should consider the complexities of each dataset when reviewing this information.

2.3.1 Vessel Monitoring System Maps

NOAA Fisheries' Office of Law Enforcement collects and maintains Vessel Monitoring System (VMS) data, which uses a satellite surveillance system to monitor the location and movement of commercial fishing vessels in the waters of certain federally managed fisheries. On-board transceiver units send position reports that include vessel identification, time, date, and location. These reports are typically sent once an hour; however, this frequency may increase if a vessel is approaching an environmentally sensitive area (NOAA Fisheries n.d.[k]).

The Northeast Regional Ocean Council (NROC) received VMS data from the NOAA Fisheries Office of Law Enforcement, which NROC consultants processed and analyzed. Maps characterizing the commercial fishing vessel activity along the northeast coast and in the mid-Atlantic from 2006–2014 were created for seven fisheries: multispecies (American plaice, Atlantic cod, Atlantic halibut, haddock, ocean pout, pollock, redfish, white hake, windowpane flounder, winter flounder, witch flounder, and yellowtail flounder; Battista et al. 2013), monkfish, herring, scallop, surfclam/ocean quahog, mackerel, and squid. Data from 2011–2014 also included information on speed over ground. This was used to create maps that characterize VMS records below a speed threshold, which are indicative of fishing activity rather than vessel transit. These thresholds were set at less than 4 or 5 knots, depending on the fishery, and were vetted through engagement with commercial operations in each fishery (Shmookler 2015).

The project produced 19 maps that include data in three groups for each fishery: 2006–2010, 2011–2014, and 2011–2014 speed-restricted data. Squid and mackerel data are available for 2014 as maps of all data combined and speed-restricted data (Shmookler 2015). The maps show the standardized density for vessels that use VMS on a qualitative scale from high to low. All data layers are publicly available on the northeast (http://www.northeastoceandata.org/) and mid-Atlantic (http://portal.midatlanticocean.org) ocean data portals.

2.3.2 Vessel Trip Report Maps

Vessel Trip Report (VTR) data are collected and maintained by the NEFSC. Vessels carrying permits from NOAA Fisheries GARFO are required to submit a VTR for every fishing trip to provide information on when and where catch occurred (NOAA Fisheries n.d.[l]). VTRs include a single, self-reported latitude/longitude location within an established 3-digit NOAA Fisheries chart area based on where a vessel began to haul back their gear. For a given trip, an additional VTR is required only if the vessel changes the chart area in which they are fishing, the type of gear they are using, or the mesh size or ring size in the gear they are using (NOAA Fisheries 2017f). Therefore, VTR data may reflect a general representation of where vessels may be fishing within a given chart area, compared to more continuous monitoring methods such as VMS.

VTR data were obtained from the NEFSC and processed and analyzed by Rutgers University, in partnership with MARCO (MARCO Mid-Atlantic Ocean Data Portal n.d.[a]). The MARCO Ocean data Portal hosts eight VTR maps aggregated by gear type: bottom trawl <65 feet, bottom trawl > 65 feet, dredge, gillnet, lobster, longline, pots and traps, and seine. All maps contain data from 2011-2013 on a high to low scale representing a density-weighted number based on labor hours equal to the number of crew times the hours spent at a site (MARCO Mid-Atlantic Ocean Data Portal n.d.[b]). All maps are publicly available on the mid-Atlantic Ocean Data Portal (http://portal.midatlanticocean.org) and are also referred to as the "Communities at Sea" maps.

2.3.3 New York Commercial Fisherman Ocean Use Mapping Study

The Cornell Cooperative Extension Marine Program collected information from New York commercial and for-hire fishers to identify key fishing areas within the AoA for the DOS. The DOS obtained VTR data from NOAA Fisheries for all federally licensed vessels fishing in the AoA for 2001-2010. This information was combined with data gathered from extensive outreach to New York State fishers to develop maps of fishing effort in the AoA. The final report contains 20 maps of commercial fishing effort separated by gear type, some of which (all data combined, trawl, and pot) are also separated by season (Scotti et al. n.d.).

2.3.4 Socioeconomic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic Study

NOAA Fisheries conducted a study for BOEM to assess the potential impacts of development of WEAs on fisheries of the U.S Atlantic waters from Massachusetts to North Carolina. To create spatial maps of revenue data, the study primarily used commercial vessel VTR data and spatial data from the Northeast Fishery Observer Program Database (NEFOP) for 2007-2012. Where appropriate, VMS data were also used to analyze specific potential impacts. The study also included 2007–2012 for-hire VTR data and private boat recreational fishing data from the Marine Recreational Information Program (Kirkpatrick et al. 2017). The study contains several tables and figures of socioeconomic data for U.S. Atlantic fisheries and focused information on individual WEAs. The report includes maps of estimated fishing revenue-intensity for the waters surrounding each WEA, as well as a map of the entire study area. These data were also available in an interactive Web-based format on the Marine Cadastre (https://marinecadastre.gov).

2.3.5 MARCO Human Use Data Synthesis Maps

MARCO developed synthesized spatial maps of human use in the mid-Atlantic region from existing data products. For fisheries, the Human Use Data Synthesis (HUDS) project used the existing VMS and VTR data described in Sections 2.3.1 and 2.3.2 plus spatial artificial reef data to create two maps: Theme-Fishing Data, which shows the number of layers that have data in a given 10- by 10-km grid cell; and Use Intensity–Fishing Data, which shows the theme data plus a classification of the intensity present in a given cell (MARCO Mid-Atlantic Ocean Data Portal n.d.[c]). Both maps are publicly available on the Mid-Atlantic Ocean Data Portal (http://portal.midatlanticocean.org).

2.3.6 Recreational Fishing Use Area Maps

The DOS and NJDEP have utilized participatory mapping workshops and surveys sent to charter, party, and private boat captains to capture areas important for recreational and for-hire fisheries in the AoA and other surrounding waters. DOS maps, created in 2011-2012, and NJDEP maps, created in 2003, are publicly available on the Mid-Atlantic Ocean Data Portal (http://portal.midatlanticocean.org). The DOS maps are also available on the New York Geographic Information Gateway (http://opdgig.dos.ny.gov/#/home). These maps show general areas of fishing grounds used by recreational and for-hire fishers in the AoA and identify important offshore fishing areas such as Cholera Bank (MARCO Mid-Atlantic Ocean Data Portal n.d.[d], n.d.[e]).

2.4 Summary of Findings

2.4.1 Biological Data

2.4.1.1 Summary of Essential Fish Habitat and other Sensitive Habitats or Species

As introduced in Section 2.2.2, the AoA contains designated offshore EFH for 52 species in the Atlantic Ocean, and 17 of these species have designated EFH for every life stage (see Table 2). Within the AoA are two fish species that are protected, one species that is a candidate for listing, and two that are proposed for listing under the ESA (see Table 3), and 10 species are listed by NOAA Fisheries GARFO as species of special concern (see Section 2.2.2.4). There are no sensitive habitats within the AoA, as it does not encompass any seagrass beds, coral reefs, nurseries, sanctuaries, national marine sanctuaries, or national estuarine research reserves.

2.4.1.2 Summary of Existing Studies

As discussed in Section 2.2.3, a variety of population studies have been conducted in the AoA and elsewhere, including fishery-independent surveys, RSA programs, and marine wildlife aerial surveys. There are six ongoing fishery-independent surveys within the AoA, two of which occur concurrently. All six surveys are conducted or overseen by NOAA Fisheries' NEFSC. These surveys have a variety of focuses, including demersal, semi-pelagic, commercially valuable bivalves, zooplankton, and ichthyoplankton. The longest-standing survey began in 1963. Two additional fish and select invertebrate surveys are conducted inshore of the AoA and are included in this study due to potential overlap with shallower portions of the AoA and because some wind farm components would cross inshore waters. Information collected in these surveys has been and continues to be used to inform fisheries stock assessments in the Atlantic Ocean (see Table 6), in modeling efforts such as MDAT (see Section 2.1.1), and in collaborative projects such as OceanAdapt (Rutgers University 2017a). OceanAdapt is an effort by the Pinsky Lab of Rutgers University and NOAA Fisheries to provide information on impacts of climate change and other factors on the distribution of marine fish and invertebrate species. The NEFSC survey data have also been synthesized in earlier coastal and marine planning studies by New York State (Stone Environmental, Inc. 2010). In addition to the fishery-independent surveys, three current RSA programs were established under the Fishery Management Plans to fund research. These programs aim to improve fishery management decisions and stock assessments for the Atlantic sea scallop, monkfish, and Atlantic herring.

As discussed in Section 2.2.3.3, NYSERDA's ongoing fine-scale aerial surveys in the AoA have, to date, documented multiple species of ray, shark, and large bony fish. Many more individuals were identified in the summer 2016 survey than in the fall 2016 survey. The Normandeau-APEM team is scheduled to gather three years' of baseline aerial survey data for the entire AoA, which will provide information needed for BOEM's environmental review of proposed wind energy development areas (Normandeau Associates, Inc. and APEM, Inc. 2016a, 2017).

Table 6. Summary of Targeted Life Stages by Fishery-Independent Survey

Sources: Bonzek et al. 2015; Maguire et al. 2015; MAFMC 2015; NOAA Fisheries 1999; NOAA NEFSC 2017f; Walsh and Guida 2017

Responsible Party	Survey	Focus	Eggs	Larvae	Juvenile	Adult
NEFSC	Bottom Trawl	Demersal, semi-pelagic			X	X
	Sea Scallop Dredge	Sea scallop			X	X
	Sea Scallop HabCam	Sea scallop			X	X
	Clam Survey	Atlantic surfclam, ocean quahog			X	X
	Ecosystem Monitoring: Shelf-wide Research Vessel	Zooplankton, icthyoplankton	X	X		
	Ecosystem Monitoring: Ship of Opportunity	Zooplankton, ichthyoplankton	X	X		
NJDEP DFW	Ocean Trawl	Fish, select invertebrates			X	X
ASMFC/VIMS	NEAMAP SNE/MA Nearshore Trawl	Fish, select invertebrates			X	X

Key:

ASMFC = Atlantic States Marine Fisheries Commission

NEAMAP = Northeast Area Monitoring and Assessment Program

SNE/MA = Southern New England and Mid-Atlantic

NEFSC = Northeast Fisheries Science Center

NJDEP DFW = New Jersey Department of Environmental Protection, Division of Fish and Wildlife

VIMS = Virginia Institute of Marine Science

2.4.2 Fishing Industry Spatial and Socioeconomic Data

2.4.2.1 Overview of the Commercial, For-Hire, and Recreational Fisheries of the AoA and Mid-Atlantic Region

New York State's marine waters host a diverse commercial, for-hire, and recreational fishing industry. Commercial fishing is defined as "fishing in which the fish harvested, either in whole or in part, are intended to enter commerce or enter commerce through sale, barter or trade." For-hire, or charter, fishing is defined as "fishing from a vessel carrying a passenger for hire...who is engaged in recreational fishing." Recreational fishing is defined as "fishing for sport or pleasure" (NOAA Office of General Counsel 1997).

A variety of fishing gear is used in the AoA, including rod and reel, longlines, gillnets, seines, beam trawls, otter trawls, paired mid-water and bottom trawls, spears, pots and traps, and dredges (Scotti et al. n.d.). The AoA also contains fishing grounds for fishing boats landing in New York, New Jersey, Rhode Island, Massachusetts, and elsewhere, including major fishing ports such as Cape May, New Jersey; Point Judith, Rhode Island; and New Bedford, Massachusetts.

Fishing grounds in New York are targeted for a variety of species, including scallops, squid, monkfish, mackerel, summer and winter flounder, skates, herring, clams, crabs, lobster, bluefish, black sea bass, spiny dogfish, scup, cod, pollock, striped bass, as well as highly migratory species such as tunas and sharks. In 2010 in New York alone, the DEC issued (for New York State waters) 990 resident and 40 non-resident food fish licenses; 360 resident and 30 non-resident lobster licenses; 578 resident and 28 non-resident crab licenses; 256 resident and 12 non-resident whelk licenses; 501 party/charter (For-Hire) licenses; and 423 food fish and crustacean dealer licenses. Of the New York resident food fish license holders, approximately 304 (31 percent) held federal vessel permits and were home ported in New York State (Scotti et al. n.d.).

All vessels that fish for or possess fish or shellfish from federal waters and that are regulated by NOAA Fisheries GARFO must have a fishing vessel permit from GARFO. While the AoA accounts for only approximately 17 percent of the area in the Greater Atlantic Region, a number of these permit holders fish in the AoA, in addition to vessels from other states. Though fishing vessel permit information is not available specific to the AoA, the below information on total fishing vessel permits issued to permit holders with principal ports in New York, New Jersey, Rhode Island, and Massachusetts demonstrates the upper limit of fishing vessels that might be active in the AoA. A vessel's principal port refers to the port where the majority of the vessel's landings occur. In 2017, the NOAA Fisheries issued 4,207 NOAA Fisheries Greater Atlantic Region Vessel, Dealer, Vessel Operator, and Tuna permits. Of these permit holders, 298 listed New York as their principal port state. Additionally, a total of 451 permit holders listed New Jersey as their principal port state; 254 permit holders listed Rhode Island as their principal port state; and 1,154 permit holders listed Massachusetts as their principal port state (NOAA Fisheries 2017g).

NOAA tracks the commercial, for-hire, and recreational fisheries contribution to the economy. According to NOAA, the commercial fishing and seafood industry (which includes commercial fishing, commercial fish hatcheries and aquaculture, seafood processing, and seafood markets) employed 2,854 people in New York State in 2014, generating $94.4 million in wages and $262.2 million gross domestic product

(NOAA Office for Coastal Management 2014). New York State had 27.1 million pounds in total commercial landings in 2015, which were valued at $51.5 million, of which 52 percent ($26.7 million) were shellfish landings (including clams, oysters, scallops, mussel, lobster, crab, shrimp, and snail). The highest grossing commercial landings in New York were hard clams (northern quahog), eastern oysters, and long-finned squid. Excluding shellfish landings, the highest grossing commercial landings were tilefish, scup, summer flounder, striped bass, monkfish, and silver hake (NOAA Fisheries 2015d). Long Island is home to the top fishing ports in New York State. The Port of Montauk ranked 63rd for commercial fisheries landings by dollar value in the United States, bringing in $15.9 million, or 11.6 million pounds, in 2015. Hampton Bay-Shinnecock ranked 117th, bringing in $4.9 million, or 4.1 million pounds. Greenport ranked 126th, at $0.3 million, or 0.2 million pounds (NOAA Fisheries 2015e).

Portions of the landings in New Jersey, Rhode Island, Massachusetts, and other states are caught in the marine waters of New York State. In New Jersey, the commercial fishing and seafood industry employed 1,443 people in in 2014, generating $51.8 million in wages and $124.5 million gross domestic product (NOAA Office for Coastal Management 2014). In 2015, New Jersey had 148 million pounds in total commercial landings, valued at $166 million. The highest grossing commercial landings in New Jersey were sea scallops (valued at $98 million, or nearly 60 percent of New Jersey's total commercial landings), clams, and menhaden. In Rhode Island, the commercial fishing and seafood industry employed 464 people in 2014, generating $20.6 million in wages and $71.7 million gross domestic product (NOAA Office for Coastal Management 2014). Rhode Island had 76 million pounds in total commercial landings in 2015, valued at $82 million. The highest grossing commercial landings in Rhode Island were long-finned squid, American lobster, and sea scallops (NOAA Fisheries 2015d). In Massachusetts, the commercial fishing and seafood industry employed 4,442 people in 2014, generating $278.2 million in wages and $676.7 million gross domestic product (NOAA Office for Coastal Management 2014). Massachusetts had 260 million pounds in total commercial landings in 2015, which were valued at $524 million. The highest grossing commercial landings in Massachusetts were sea scallops (valued at $265 million, or more than 50 percent of total commercial landings in Massachusetts), American lobster, and eastern oyster (NOAA Fisheries 2015d).

A reported 921,501 recreational anglers fished in New York State waters in 2016, engaging in approximately 4.3 million angler trips. Of these, approximately 113 thousand anglers were out-of-state residents. The most commonly caught (both harvest and release) species for marine recreational anglers in New York in 2016 were scup, black sea bass, summer flounder, bluefish, and Atlantic menhaden (NOAA Fisheries 2016f). Commercially and recreationally caught fish species present in the AoA are further described in Section 2.3.

2.4.2.2 Spatial Data Compilation and Comparison of Methods and Results

The spatial data described in Section 2.3 were used to compile various map types at multiple scales. Some, such as the VMS data, are presented in smoothed heat map formats, whereas others, such as the HUDS maps, are mapped in grid squares. Additionally, the maps contain various types of synthesis products such as vessel presence information, estimated revenue data, and general polygons identifying fishing grounds. Because of this, it was determined that combining the maps into a single spatial map would not be practical, particularly at a scale that would be informative for planning decisions. Instead, the approach was to determine which information from the spatial studies would be most informative and vet this information with stakeholders (outlined in Section 5).

Other data, such as automatic identification system (AIS) data were not included in the summary above but were reviewed and discussed with stakeholders. Since March 2, 2016, U.S. commercial fishing vessels of 65 feet or more in length are required to have an AIS installed. AIS data sets were examined for this study, but several shortcomings are apparent (USCG n.d.). In particular, the requirement for commercial fishing vessels to use AIS has been in effect for a relatively short time a nd commercial fishing vessels may turn off AIS, particularly beyond 12 miles from the coast. Additionally, vessel type is a manually entered field in the AIS data and commercial fishing vessels sometimes do not fill this field, or record type as “Other.”

Data such as VMS are often considered to show a more accurate depiction of fishing effort due to the continuous satellite surveillance system (Rhode Island Department of Environmental Management [RIDEM] 2016). The speed-restricted data in particular can give an indication of highly used areas for a given fishery. These maps provide baseline information to help identify areas important to various fisheries. Figure 3 shows the seven speed-restricted maps available from NROC. These include multispecies (groundfish), monkfish, herring, scallop, surfclam/ocean quahog, mackerel, and squid. The speed restriction gives an indication of active fishing, and combined with the continuous satellite method of data collection, these maps provide an indication of key areas actively used in recent years by certain fisheries. For fisheries such as squid where a single year of data is available, the maps provide a relative indication of areas important to these fisheries, but may not provide an indication of shifts that may occur in the species or fisheries that may be apparent in fisheries where multiple years of data are available. Figure 3 also includes surrounding proposed WEAs for spatial reference.

Figure 3. Vessel Monitoring System (VMS) Data for Major Fisheries within the AoA

Source: BOEM 2016; ESRI 2010; MARCO Mid-Atlantic Ocean Data Portal n.d.[b].

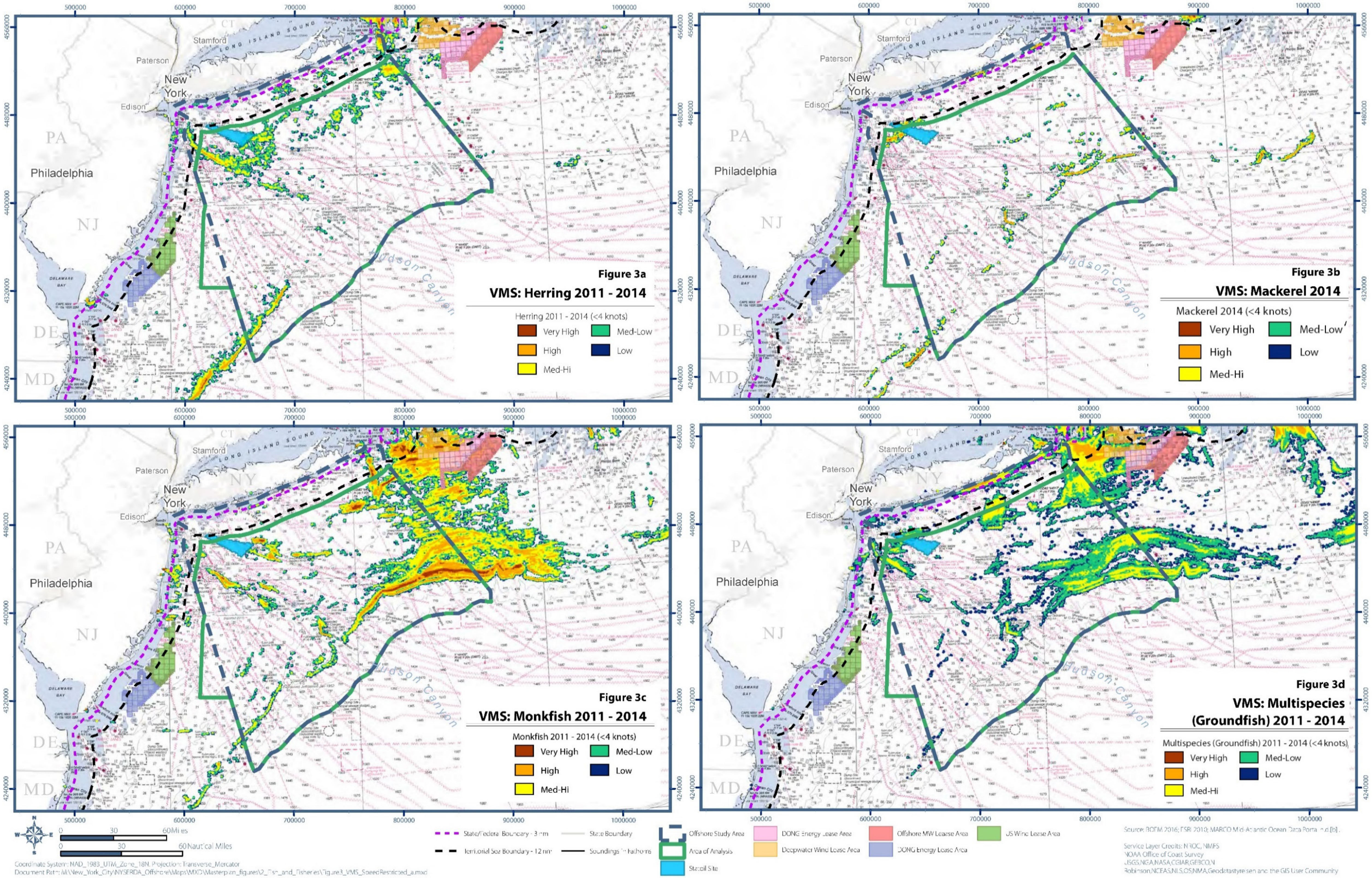
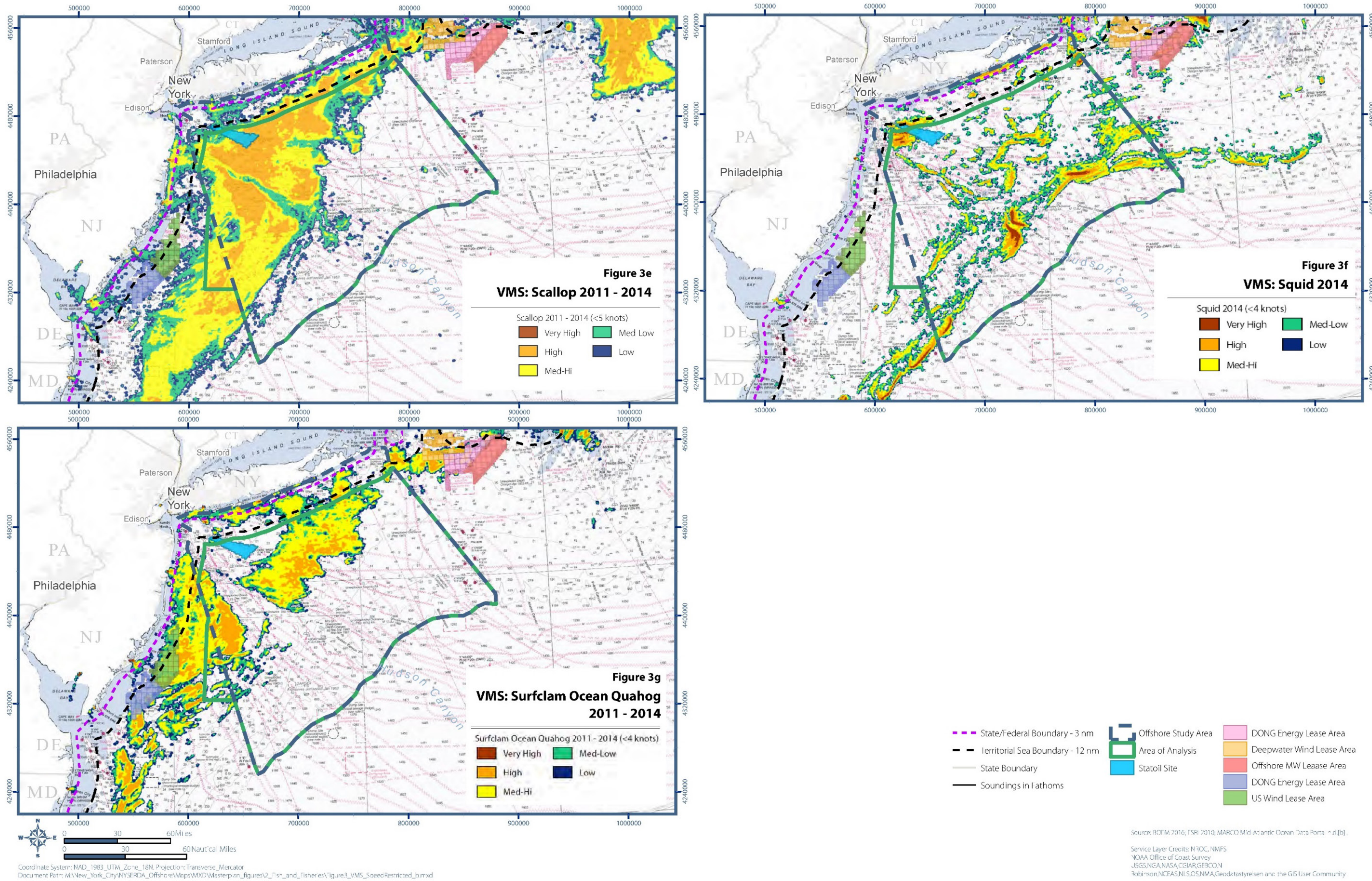


Figure 3. Vessel Monitoring System (VMS) Data for Major Fisheries within the AoA continued

Source: BOEM 2016; ESRI 2010; MARCO Mid-Atlantic Ocean Data Portal n.d.[b].



Since these maps are considered some of the most accurate data on fishery areas, the NROC metadata for the VMS maps is included as Attachment A for reference to detailed methods. This metadata also provides some information on the development of the high to low scale on these maps; in general this scale is a qualitative indication of relative effort of a given fishery.

The study titled *Socioeconomic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic* was developed by NOAA Fisheries to assist BOEM in assessing the potential impacts of WEA development. According to the study report, BOEM will use the study "to inform decision-making related to leases on the North and Mid-Atlantic OCS; help interested stakeholders understand how the report data were developed and what they say; identify areas that require refined data analysis; and conduct an environmental assessment under NEPA." This study provides an alternative method to visualize fishery use of the AoA based on revenue data (Figure 4). Although this study presents a thorough overview of revenue estimates for the region, some stakeholders have voiced concerns that these values are underestimated, possibly due to their reliance on VTR data to determine where landings were caught (RIDEM 2016). Additionally, the study includes data through 2012 and does not include more recent data. These considerations should be taken into account when interpreting the figure; however, the study provides another method to show the relative importance of areas of the AoA based on revenue. For the purpose of this Study, data layers obtained from the Marine Cadastre revenue data were equally portioned between the highest and lowest mean annual value in the AoA to provide the greatest resolution of the data in the Study area.

Additionally, the recreational use area maps described in 2.3.6 were reviewed. These maps give an indication of recreational fishing areas such as Cholera Bank (see Figure 5). This map is presented to acknowledge the considerations of the recreational and for-hire fisheries, as well as an alternative source to spatially depict areas important to fisheries.

Figure 4. Commercial Fishing Revenue Intensity

Source: BOEM 2016; BOEM 2010; Marine Cadastre. n.d

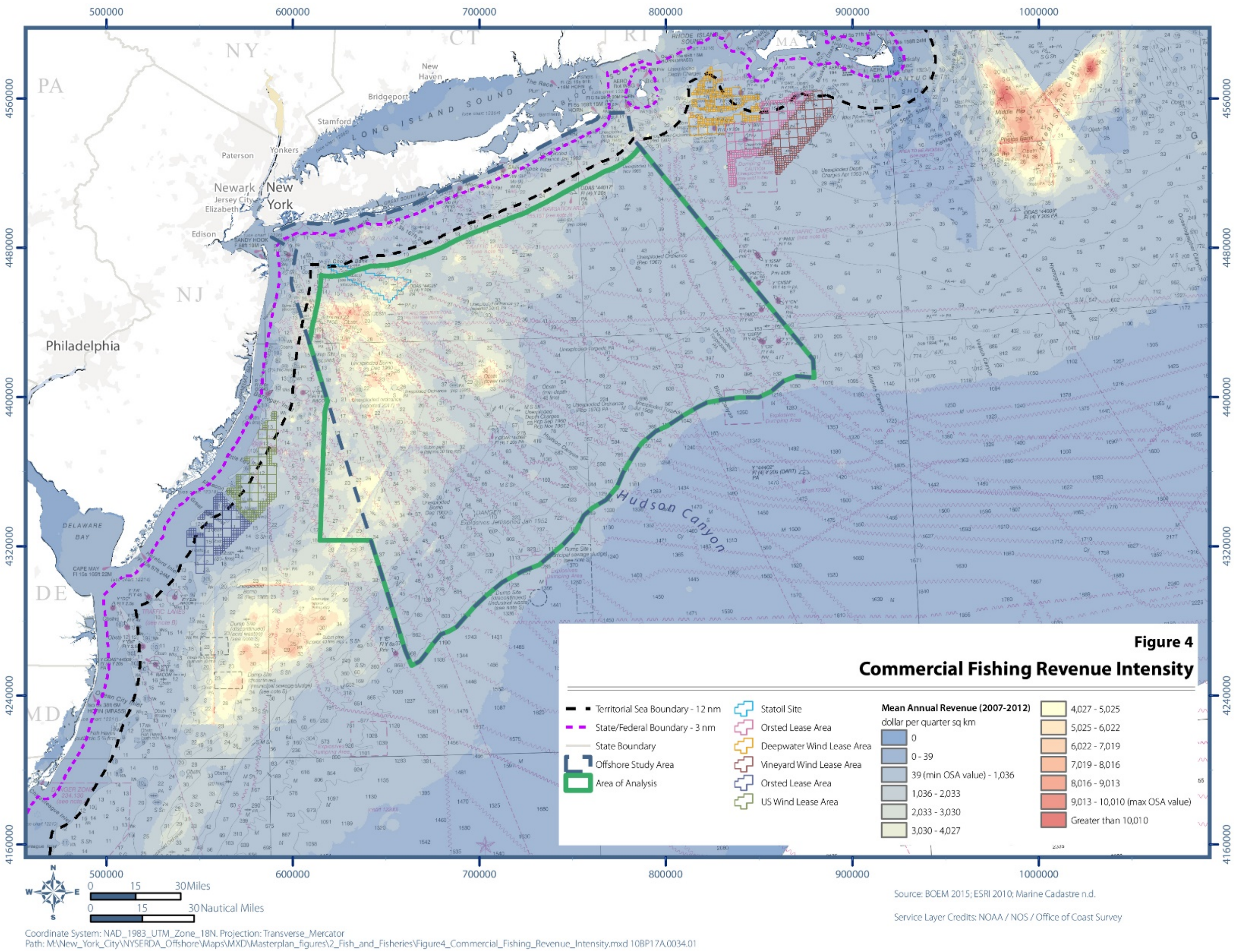
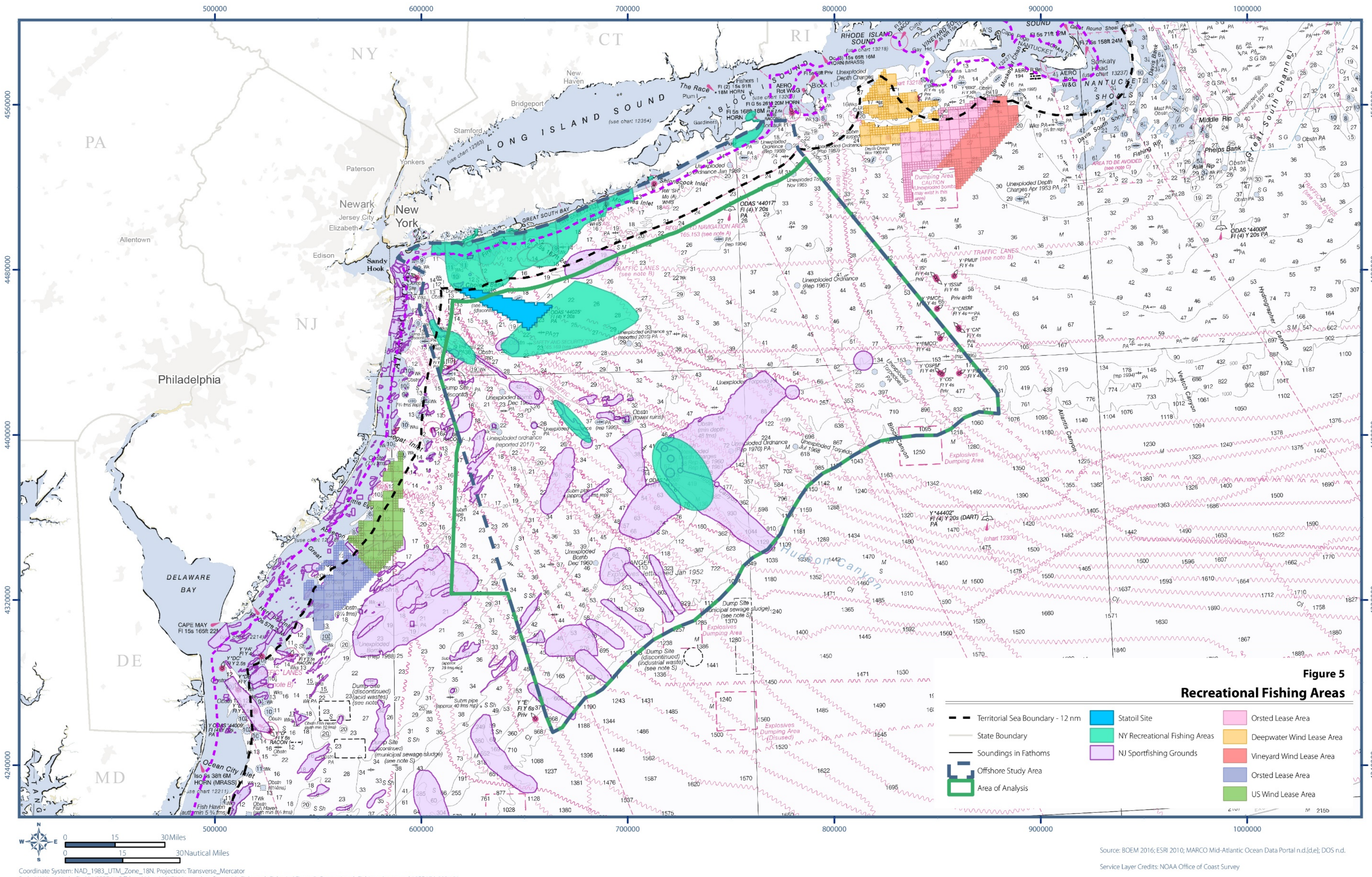


Figure 5. Recreational Fishing Areas

Source: BOEM 2016; ESRI 2010; MARCO Mid-Atlantic Ocean Data Portal n.d.[d,e].DOS n.d.



New Information Compiled for this Study. To supplement these maps and capture fishing vessels that may not be required to carry VMS, the DEC recommended a review of NEFOP data. The DEC obtained data from the NOAA Fisheries NEFSC for this Study. The NEFOP observers collect catch, gear, fishing effort, and biological data for commercial fisheries from Maine to North Carolina (NOAA Fisheries n.d.[m]). Like all the datasets presented, NEFOP data are not intended to be an absolute depiction of effort in the AoA, but was viewed as new data to supplement the existing datasets and potentially capture the activity of vessels not covered in VMS or VTR data. Due to the confidential nature of the data, the DEC was not able to share raw data, but it was able to share data aggregated into a 10-minute square grid that removed any individual identifying information (Maniscalco 2017). Using these data, maps were created of fishing effort aggregated by mobile (trawls, dredges, and purse seines) and stationary (gillnets, hand lines, longlines, pots and traps) gear types. These data are presented on Figure 6, which shows the number of trips observed in a given grid square for each aggregated gear type. Data included information from all states fishing in the AoA from 2011-2017. It should be noted that this dataset includes information that is more recent than the other maps discussed in Section 2.3, which include data through 2014 or earlier. Although NEFOP represents a subsample of the fishing industry data because not all vessels carry observers at any given time, this dataset may capture vessels that are not considered in other studies. Initial review aggregated the observer data into mobile and stationary gear types, under the assumption that these gear categories would face different challenges when fishing in or around a wind farm. Additional maps showing observer trips for scallop, squid, clam (both surfclam and ocean quahog), and multi-species bottom trawl are shown in Appendix A. The multispecies bottom trawl maps show any trips using bottom trawl gear, minus any data that was already captured in the other fishery-specific maps.

In order to address the feasibility of fishing within an offshore wind farm, the State developed scale drawings of common fishing vessels and gear types showing vessels with gear deployed within the relative spacing of wind turbines. These reflect the likely minimum spacing of turbines that is expected for wind farm development in the AoA. The aim of these scale drawings was to provide stakeholders with a better understanding of the area between turbines relative to typical vessel and gear spreads and how vessels may fish and maneuver within wind farms (Figure 7, Appendix B). Also, in contrast to European offshore wind arrays with approximately 0.5 mile spacing between turbines, new arrays are expected to use much larger turbines spaced at least 0.75 to more than 1 nautical mile apart. This expanded spacing is expected to increase opportunities for fishing within arrays, depending on gear types and other factors. Dimensions of typical mobile fishing gear were provided by commercial trawl and dredge makers in major fishing ports, as well as NEFOP data, publicly available scientific reports, and fishing captains. Drawings include side and top views of a typical otter trawl (Figure 7), scallop dredge, and clam/quahog dredge (Appendix B).

Several recent studies have synthesized information from commercial, recreational, and for-hire fisheries and mapped spatial fishery information to gain a better understanding of local fisheries and areas of importance. The map products described in Section 2.3, the newly mapped NEFOP data obtained by the DEC (see Figure 6), and information obtained through recent stakeholder outreach (see Section 5, Figure 8) are tools to help identify areas that are highly used for fisheries, as well as areas where less fishing occurs. An understanding of these maps and datasets, including the scope of each and knowledge of the fisheries and gear types commonly used in the region, will be useful information for developers proposing future offshore wind projects. Engagement of stakeholders has been incorporated into this Study in an attempt to gather the most recent information and to work collaboratively to plan for future offshore wind projects in a way that considers potential impacts on fish and fisheries.

Figure 6. NOAA Fishing Observations, 2011-2017

Source: BOEM 2016; ESRI 2010; DEC and NOAA Fisheries 2011-2017

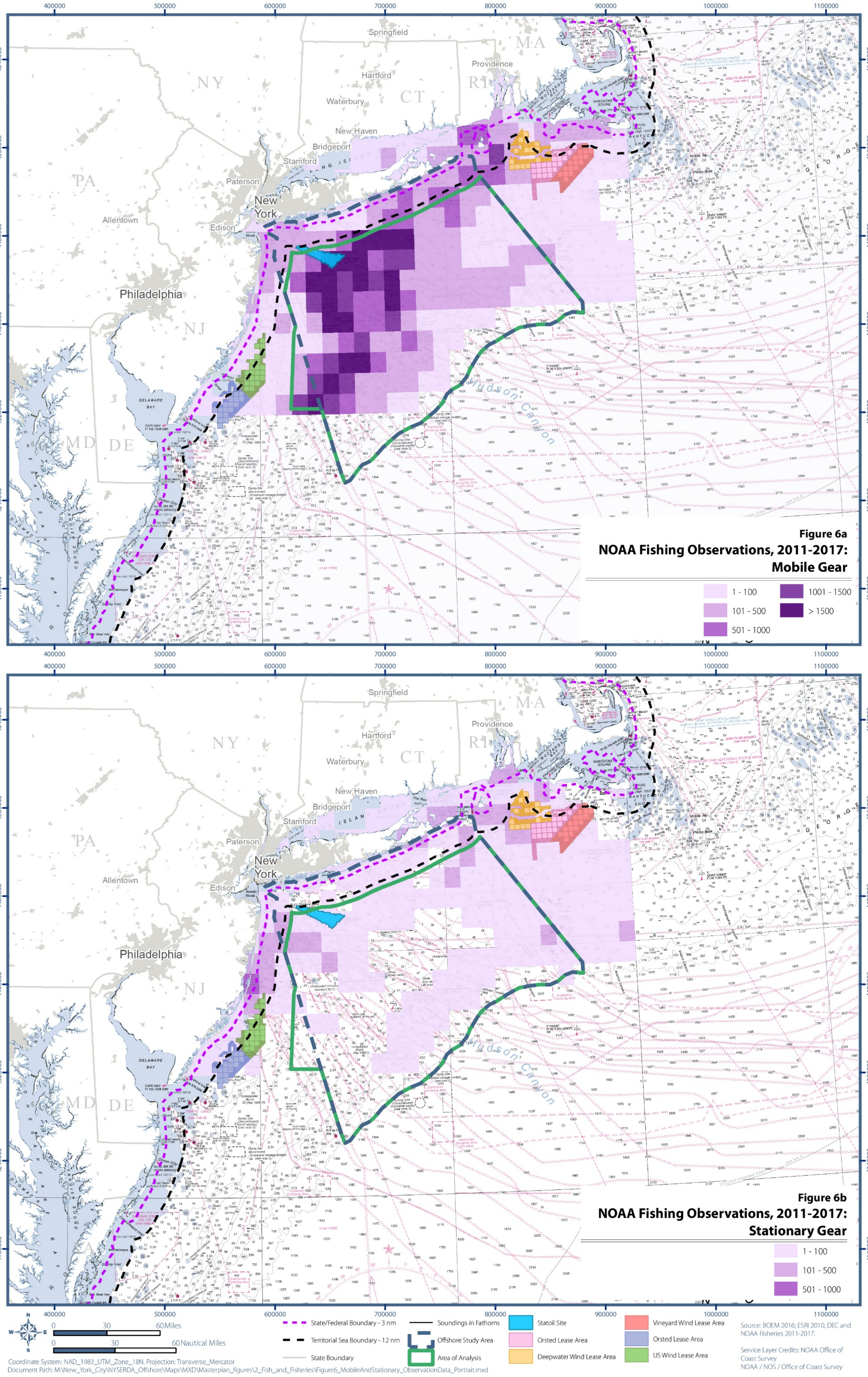


Figure 7. Scale Drawing (Side and Top View) of Typical Otter Trawl Vessel Relative to Wind Turbine Distances. Side View Scale Drawing of Typical Otter Trawl Vessel

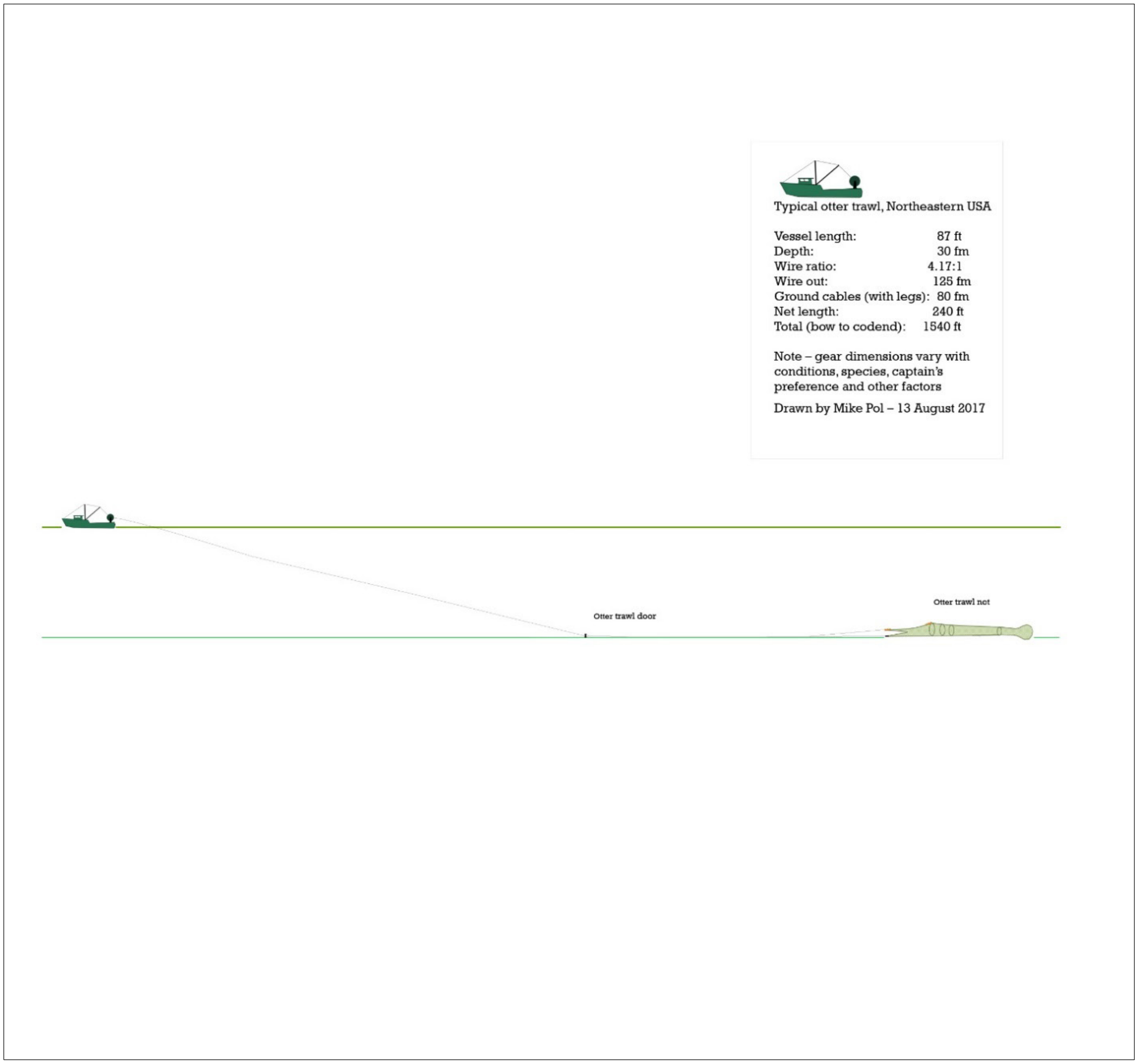
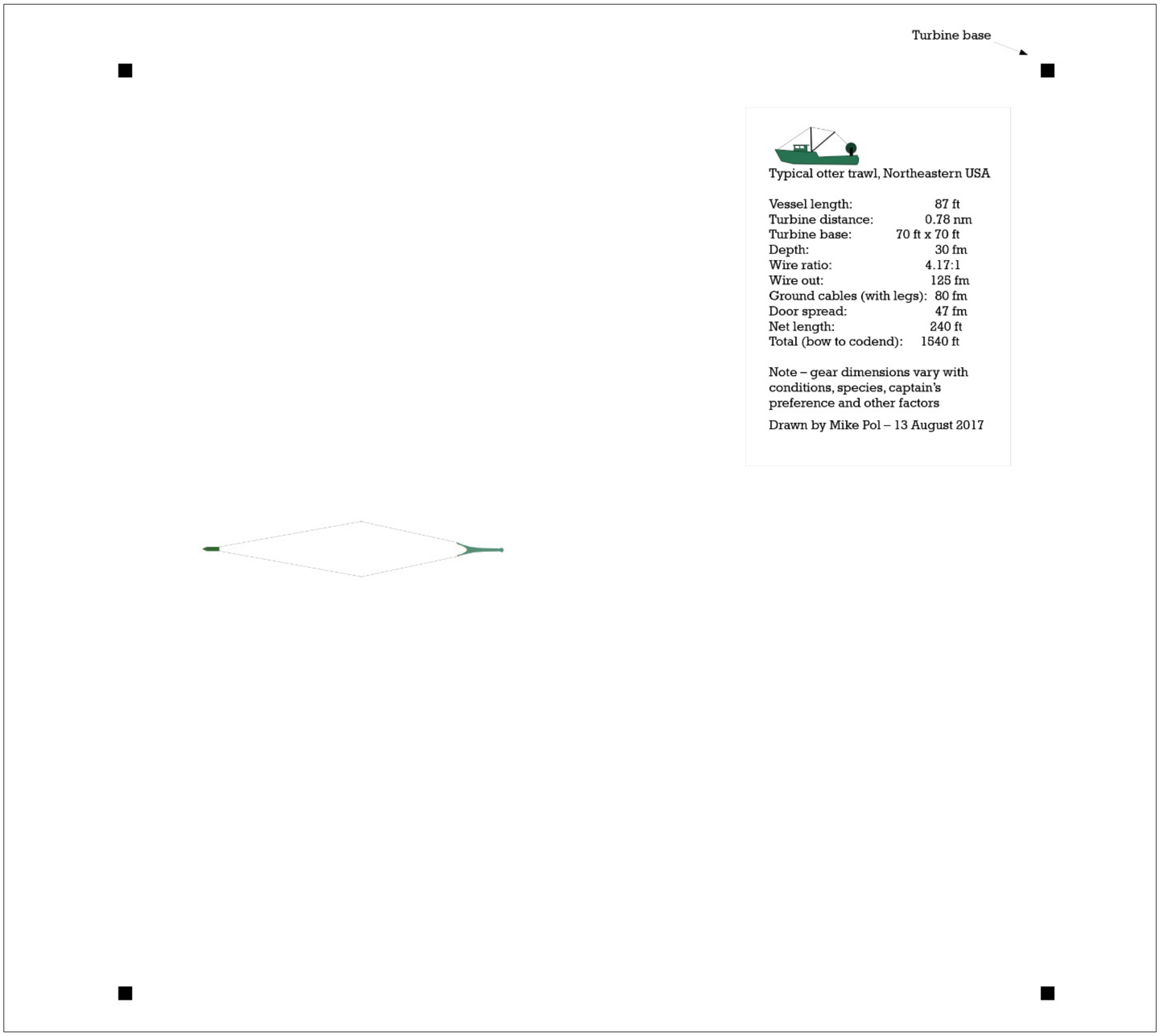


Figure 7 continued



3 Potential Sensitivity and Risk

This section provides an overview of potential stressors and risk and sensitivities to fish and fisheries. These potential stressors are identified during each period of wind farm development: pre-construction, construction, and operation. Any development would be required to follow the legal regulatory processes described in Section 1.2. Additionally, if standard BMPs (discussed in Section 6) are utilized, and/or if other project-specific measures are taken, and/or if measures that may be identified in the future are taken, potential impacts on fish and fisheries may be minimized or eliminated.

3.1 Pre-construction

Pre-construction activities include surveys conducted to identify potential sites for development. These exploratory activities may include geophysical/geotechnical surveys, benthic surveys, acoustic surveys, and/or surveys to identify sensitive species. The impacts of these activities are expected to be limited to disturbance of the seafloor and potentially harmful noise from survey equipment used to collect seafloor information during the site assessment phase.

3.1.1 Seabed Disturbance, Turbidity, and Suspended Sediments

Surveys involving seafloor disturbance would be required to determine bathymetric contours, sediment types, and suitability for proposed turbine foundations and subsea cable routes, and to identify resident benthic communities. Surveys involving piston coring, box coring, and rotary core boring may be conducted during pre-construction. These types of surveys involve some kind of sediment sampling/coring, which can increase suspended sediments and associated turbidity within the surrounding water column.

The extent of impacts from these activities would depend on sediment type, area of disturbance and duration of the exploratory activity. However, as these exploratory activities would be short term and localized, the effects of seabed disturbance, suspended sediment, and turbidity would likely be temporary, with benthic communities recovering to previous densities and biodiversity after exploration (Daan et al. 2009; Hiscock et al. 2002).

3.1.2 Sensory Disturbance

Potential wind farm development sites would require high-resolution geophysical surveys, which have the potential to generate harmful underwater noise. Side-scan sonar and multi-beam sonar, typically employed to identify depth and seafloor features, may also be used. Side-scan sonar frequencies are typically greater than 200 kilohertz, which is inaudible to fish species. Multi-beam sonars have the potential to cause disturbance of high-frequency cetaceans and can result permanent threshold shifts (PTS) in these species (BOEM Office of Renewable Programs 2016). Multi-beam sonars can also cause hearing loss in fish, mask important sounds, and/or cause fish to vacate the immediate vicinity (BOEM 2014).

Increased vessel traffic in the area would increase noise within the AoA. Vessels create a low-frequency noise (under 1,000 hertz [Hz]) and are therefore a concern for fish that use low-frequency sound signals for reproductive selection (Ladich and Myrberg 2006; Picciulin et al. 2010). However, fish are likely to avoid areas of increased vessel traffic during pre-construction activities.

3.2 Construction

Construction activities include pile driving, jet plowing, cable dredging, backfilling, and increased vessel activity. These are typical construction methods used in offshore wind energy development and are discussed in the *Cumulative Effects Study*, which is appended to the Master Plan. Potential impacts on fish from these types of activities include increased turbidity and suspended sediment, sensory disturbances, habitat removal and disruption, changes in predator/prey relationships, and direct injury or death. Additionally, local fishing practices may be temporarily disturbed, and there would be an increased chance of accidental spills as vessel traffic increases. However, the potential for such impacts can be reduced or eliminated through required agency consultations, the use of standard BMPs, and implementation of site-specific safety plans.

3.2.1 Seabed Disturbance, Turbidity, and Suspended Sediments

Construction activities that can potentially, but temporarily, increase suspended sediment and turbidity include site preparation (clearing or grading in areas prior to excavation or placement of foundations), pile driving for monopiles and/or jacket foundations, jet plowing and cable dredging, backfilling, and vessel anchoring. The extent of impacts would depend on the sediment type, extent of disturbance, duration of the activity, and construction methods used (Bergstrom et al. 2013). Generally, coarser sediments fall out of the water column and resettle quickly after disturbance (within hours), while finer sediments can remain suspended in the water column for longer periods (days). Certain construction methods create less seabed disturbance and sediment suspension than other methods. For the Block Island Wind Farm, for example, a jet plow was used, and monitoring was conducted before and after the jet-plowing activities. No sediment plumes were observed (Elliot et al. 2017). Additionally, the total suspended sediment concentrations after jet-plowing activities were determined to be comparable to background levels on both the surface and seafloor (Elliot et al. 2017).

The following are some of the general principles known about the impacts of turbidity and sediment suspension on certain types of sea life. Impacts on filter-feeding organisms such as bivalves occur when turbid waters and sediment deposition clog feeding and respiration organs (Cape Wind Energy Project 2009). Additionally, increased sedimentation and turbidity can cause a decrease in benthic fertilization, larval survival, and settlement (Vaselli et al. 2008; World Wildlife Fund [WWF] 2014). These impacts on benthic species can affect food-web dynamics, and thereby impact fish. However, benthic fauna generally adapt to minor, temporary increases in suspended sediments (i.e., due to naturally reoccurring redistribution of sediments) by physiological mechanisms such as expelling filtered sediments or reducing filtration rates (Bergstrom et al. 2012; Clarke and Wilbur 2000).

Suspended sediment and turbid water can cause physiological stress and injury to fish. Increased suspended sediments and turbidity can interfere with fish gill gas absorption (Clarke and Wilbur 2000; Germano and Cary 2005) and cause decreases in available dissolved oxygen (DO) (Johnston 1981). Additionally, because higher water temperatures during summer result in lower DO concentrations, summer dredging can exacerbate low DO conditions (Hatin et al. 2007). These impacts may cause fish to migrate to more favorable adjacent habitats; however, these effects are typically associated with long-term exposure to elevated turbidities (Burton 1993 [as cited in NOAA Fisheries 2012]). Short-term elevated turbidities are expected to occur below suspended sediment levels of approximately 500 milligrams per liter, and suspended sediment levels may be as high as 700,000 milligrams per liter before acute mortality occurs, depending on the species (Burton 1993 [as cited in NOAA Fisheries 2012]). It should also be noted that other activities that occur regularly within the AoA similarly affect turbidity on a short-term basis. For example, mobile fishing gear such as bottom trawls, scallop dredges, and hydraulic clam dredges disturb the seafloor when used. Any negative impacts on fish from short-term increases in turbidity resulting from construction associated with offshore wind energy development would likely be temporary.

When the seafloor is disturbed during excavation, pile-driving, and backfilling activities, potentially contaminated sediments could be released into the water column. The extent of potential impact would depend on species type and the contaminant(s); however, general effects could include the direct intake of the contaminant(s), bio-accumulation, and/or the pollution of surrounding waters. These effects, if not addressed through project siting and BMPs, could cause direct injury or death and/or result in a reduction of available food sources, and thereby impact higher trophic levels that rely on those food sources (Roberts 2012).

3.2.2 Sensory Disturbance

Construction activities that can cause sensory disturbances to fish include pile-driving and excavating activities, backfilling, and increased vessel traffic. Sensory disturbances can be auditory, vibratory, and visual. The sensory disturbances caused by the presence of humans and project-related vessels and equipment could potentially cause fish and other mobile aquatic species to avoid or abandon otherwise suitable habitat or induce stresses that could disrupt essential life processes such as foraging and spawning. Sensory disturbances associated with construction would be of limited duration.

3.2.2.1 Noise

Fish utilize sound to communicate aggression and courtship (Bass and Ladich 2008; Kasumyan 2008), and many species use sound for prey and predator detection, for orientation, and even as a primitive form of echolocation (Andersson 2011; Fay and Popper 2000; Popper and Fay 1993). These processes could be disrupted by noise during construction activities, and fish may experience both behavioral and physiological impacts from noise effects.

Behavioral effects due to noise impacts may include reactions such as avoidance and moving to deeper waters (Pearson et al. 1992). Although temporary, construction noise may cause fish to relocate to quieter water elsewhere (European Commission 2016; Small et al. 2017). Fish may display flight reactions and be displaced up to 1 km from the source of the noise disturbance (Bergstrom et al. 2012). Other behavioral effects could include altering schooling behavior (Hawkins et al. 2014). In a recent study, sheepshead (*Archosargus probatocephalus*) repeatedly exposed to average pile-driving sound levels of 157 decibels (dB) re 1 microPascal (µPa) per pile strike did not display evidence of displacement from the study area (Iafrate et al. 2016); only one fish out of 13 left the pile-driving area after 10 days of the activity. However, in the same study, two grey snapper (*Lutjanus griseus*) out of four left the pile-driving area after 3 days of activity, so impacts may be species dependent (Iafrate et al. 2016).

Physiological impacts on fish can occur from sudden changes in water pressure, such as those produced by high-intensity sounds and the impacts of sound produced from pile-driving and excavation activities, and may include primary and secondary stress responses (Wysocki et al. 2006). Fish with swim bladders (such as herring and cod) can be vulnerable to pressure changes, which can cause capillaries to rupture or the swim bladder to rapidly expand and contract (Hastings and Popper 2005). Species with swim bladders can detect both pressure oscillations and particle accelerations within the acoustic field, while fish without swim bladders (such as flounder) are relatively insensitive to sound (Andersson 2011; Wahlberg and Westerberg 2005). The more air present within the swim bladder, the more sensitive the species is to auditory impacts (Wahlberg and Westerberg 2005); therefore, noise will physiologically impact species differently. As some species have swim bladders and some do not, Radford et al. (2012) suggested it is essential to understand both pressure and particle motion when defining noise impacts on fish. Radford et al. (2012) found that, when exposed to varying degrees of particle acceleration in laboratory experiments, goldfish (*Carassius auratus*), bigeye (*Pempheris adspersus*), and common triplefin (*Forstergyian lappillum*) varied in sensitivity. Common triplefin (which do not have swim bladders) were found to be the least sensitive to pressure thresholds, and goldfish were found to be the most sensitive (Radford et al. 2012).

Lethal and sub-lethal physical damage due to noise has been reported in several studies, indicating that noise 90-140 dB above the hearing threshold of fish can injure the inner ear (Enger 1981; Hastings et al. 1996). Studies by Hastings et al. (1996) and McCauley et al. (2003) demonstrated that fish exposed to continuous, high-intensity sound can experience inner ear damage. Ear injuries can lead to PTS or temporary threshold shifts (TTS). PTS is a permanent, non-recoverable reduction in hearing sensitivity due to damage caused by either a prolonged exposure to a sound or temporary exposure to a very intense sound. TTS is a temporary, fully recoverable reduction in hearing sensitivity due to exposure to greater-than-normal sound intensity.

Noise injury thresholds have been established by the Fisheries Hydroacoustic Working Group and adopted by NOAA Fisheries (Buehler et al. 2015; NOAA Fisheries GARFO n.d.[h]). The dual criteria for potential injury to all fish species is as follows: (1) Peak sound pressure level (SPL) of 206 dB re 1 μPa and (2) 187 dB cumulative sound exposure level (SEL_{cum}) re 1 μPa^2-sec for fish weighing 2 grams or more, or 183 dB SEL_{cum} re 1 μPa^2-sec for fish weighing 2 grams or less (Buehler et al. 2015; Stadler and Woodbury 2009). NOAA additionally identifies thresholds for behavioral disturbances to fish as 150 dB re 1 μPa root-mean-squared (Buehler et al. 2015; NOAA Fisheries GARFO n.d.[h]). However, recent studies indicate some species, such as the Chinook salmon (*Oncorhynchus tshawytscha*), physiologically respond to pile driving at sound levels at least 16 dB (SEL_{cum}) higher than the current injury threshold described (Normandeau Associates, Inc. 2012). Although Chinook salmon are not found within the AoA, the study indicates the potential for other fish species to respond to pile driving at levels higher than injury thresholds. Additionally, continuous sound activities such as vibratory pile driving are expected to produce higher injury thresholds than impact pile driving; therefore, existing thresholds can be considered conservative estimates (Buehler et al. 2015).

The greatest noise impacts associated with the construction of wind farms is expected to be from pile driving activities for installation of monopiles for the wind turbine generators (WTGs). The average pile takes 4,000 to 6,000 hammer blows to install (Energinet.dk 2015), and jacket foundations require about 1.5 times more hammer blows and more than twice the time to install versus monopiles (Norro et al. 2013). Studies on noise generated from pile driving suggest that peak sound levels can range between 165 and 195 dB within 10 meters of the source (Illingworth and Rodkin 2007) and be as high as 135 dB 1 km from the source (Richardson et al. 1995). Thomsen et al. (2006) noted that during pile-driving activities, cod and herring may experience ear damage and/or death within a few meters of the activity, and may perceive the sound produced up to 80 km away.

Mueller-Blenkle et al. (2010) studied these effects on Atlantic cod and common sole (*Solea solea*), species whose range and habitat characteristics are present within the AoA. When hearing pile-driving noises from an underwater loudspeaker for the first time, cod and sole displayed horizontal directional swimming responses away from the source of the noise (Mueller-Blenkle et al. 2010). Andersson (2011) similarly studied the effects of pile-driving noise on cod and sole behavior using an underwater loudspeaker in semi-natural conditions (a mecocosm, 40 meters wide, with natural seafloor materials). Andersson (2011) showed that cod and sole demonstrate significant behavioral reactions to pile-driving events up to 70 km away. When exposed to sound pressures between 153 and 133 dB re 1µPa, cod first demonstrated a non-moving stance, then increased swimming speeds. Cod displayed similar behavioral responses to particle acceleration levels between 6.5×10^{-3} and 8.6×10^{-4} meters per second squared (m/s^2) and to sound pressures between 156 and 142 dB re 1 µPa. Sole, although lacking a swim bladder, were also shown to have behavioral reactions to pile-driving noise. At particle acceleration levels of 6.5×10^{-3} to 4.1×10^{-4} m/s^2, sole increased swimming speeds. As sole do not sense sound pressure due to lack of a swim bladder, a sound pressure threshold was not determined. However, as sole were shown to react to increased particle acceleration, they may be impacted by pile driving from particle motions transported through the seafloor.

In a study by Andersson (2011), repeated exposure to pile-driving sounds resulted in less pronounced behavioral reactions (changes in swimming speeds), indicating that fish were acclimating to surrounding noise stressors. However, it should be noted that this phenomenon was noted only individually, not on the testing group as a whole.

After agency consultations, developers may be required to utilize some measure of noise impact minimization. These could include pile-driving soft-starts, bubble curtains, pingers, or other sound-reducing materials or measures. Noise from increased vessel traffic during construction activities may also minimally affect resident fish species. As noted in Section 3.1.2, vessels create a low-frequency noise (under 1,000 Hz) and therefore are a concern for fish that use low-frequency sound signals for reproductive selection (Ladich and Myrberg 2006; Picciulin et al. 2010). However, fish are likely to avoid areas of increased vessel traffic during construction activities.

3.2.2.2 Vibrations

Vibratory effects from seafloor-disturbing activities during construction may cause physiological and/or behavioral changes in fish, as well as direct physical damage (see Section 3.2.8). Generally, pile-driving activities produce energy that propagates into the water column, causing waves (seismic and compressional) to emanate into surrounding water (Roberts and Elliott 2017). Additionally, indirect energy from water-borne sources such as shipping vessels may be propagated through the seabed (Roberts and Elliott 2017). The level of vibratory impact from pile driving is heavily dependent on substrate type and size as well as the distance of the activity and the type of wave propagation created (Svinkin 2004; Roberts and Elliott 2017).

Stress responses such as variations in heartbeat, the production of stress proteins, and oxygen production adjustments have been noted in fish exposed to vibratory impacts (Celi et al. 2014; Florey and Kriebel 1974; Wale et al. 2013b). Flounder species are particularly susceptible to vibratory impacts on the sea floor (Chapman and Sand 1974; Karlsen 1992; Sigray and Andersson 2011). Vibratory impacts are likely to affect spawning and feeding grounds of flatfish due to their constant connection with the seafloor. While adults can relocate to suitable surrounding areas, eggs and larvae do not have the ability to escape the effects of vibratory activities.

Vibrations caused by bottom-disturbing activities impacts benthic invertebrates similarly to flatfish, which can in turn impact higher trophic levels through food web dynamics (Roberts and Elliott 2017). Literature reviews suggest benthic invertebrates such as tube-dwelling polychaetes (Dill and Fraser 1996), sea shrimp (Klages et al. 2002), and crustaceans (Monteclaro et al. 2010; Popper et al. 2001; Roberts and Breithaupt 2015) have the ability to sense vibrations and may even utilize that sense to aid in burrowing, feeding, and detection of predators (Roberts and Elliott 2017). Studies conducted by Roberts et al. (2015, 2016, 2017) indicated that blue mussels and hermit crabs (*Pagurus bernhardus*) sensed sediment vibrations and demonstrated behavioral responses at 300 meters (from blasting activities) and up to 220 meters (from backhoe dredging activities). However, the organisms may have sensed the vibrations at even shorter distances, as behavioral responses were only the end point for the observation.

Bivalve species may also experience changes in valve closures due to vibratory effects. As bivalves respire anaerobically when closed, they need to re-open to dispel wastes. If bivalves are closed in the long-term, death can occur (Akberali and Trueman 1979; Curtis et al. 2000).

3.2.2.3 Visual

Construction activities could cause fish to avoid the area due to visual stimuli (Feist et al. 1992; Guthrie and Muntz 1993; Huijbers et al. 2012) such as lighting used and the appearance of previously non-existent equipment and structures. These visual stimuli may cause fish to exhibit a startle or avoidance response, and fish will likely avoid the area completely during pile-driving and excavating activities. Visual stimuli are expected to be temporary (and lighting is expected to follow all applicable navigational regulations) and would likely be a minor impact as fish are expected to return to original habitats and exhibit regular behaviors following construction and adjust to the new visual landscapes.

3.2.3 Habitat Removal and Disruption

Construction activities that cause fish habitat removal and disruption include site preparation (clearing or grading in areas prior to excavation or placement of foundations), pile driving for monopiles, and/or jacket foundations, installation of turbines, jet plowing and cable dredging, and increases in vessel traffic. Each of these activities would either remove benthic and/or fish habitat, or disrupt pre-existing habitat conditions. Once WTGs are built, pre-existing open-water habitats would additionally be impacted as they are converted to artificial, reef-like habitats. Habitat conversion is discussed within the post-construction section (Section 3.3.2).

3.2.3.1 Removal

Benthic habitat would be permanently altered in locations designated for WTG installation. However, the amount of habitat removed would be minimal when compared with the available habitat adjacent to offshore wind farms. Additionally, newly added structures would provide previously non-existent hard surface habitat, which would be available for use by benthic communities, likely increasing benthic colonization (Deepwater Wind 2012; Rhode Island Ocean Special Area Management Plan [RI Ocean SAMP] 2010; WWF 2014).

Benthic habitat would also be removed by excavation activities for cable burial. After construction is complete and cables are buried, benthic communities would be able to recolonize the seafloor; therefore, habitat removal from excavating and jet-plowing activities would be temporary. Van Dalfsen and Essink (2001) found that seabed-disturbing activities such as jet plowing could actually cause benthic diversity and abundance to increase with colonizing species after the activity. The anticipated recolonized communities may then increase available food patches for fish.

3.2.3.2 Disruption

Habitat would be disturbed throughout construction due to increased sensory effects (see Section 3.2.2), increased vessel traffic, and construction activities occurring within the water and on the seafloor. Fish may be displaced from regular swimming, foraging, and spawning habitats and are expected to relocate to nearby, less-disturbed habitats, assuming the alternative habitat has adequate prey and other resources for increased numbers of fish. Construction activities would likely be short term and localized in nature.

3.2.4 Changes in Prey Availability and Increased Competition/Predation

The temporary displacement of fish during construction activities due to effects of turbidity, sensory disturbances, and habitat disruption could potentially impact existing food web dynamics. Stenberg et al. (2011) found that benthic epifauna growing on the WTGs provided increased feeding opportunities for other fish, which redistributed fish in patchy assemblages distributed throughout the wind farm impact area. Additionally, some fish may be drawn to construction sites due to availability of prey exposed by excavation (Vallejo et al. 2017). While this may be seen as a benefit, the alteration of what prey is available for various fish species can also change fish distribution patterns, which can have unknown but temporary consequences (Buckley and Hueckel 1985; Jansson et al. 1985; Stenberg et al. 2011).

Noise associated with construction (pile driving, excavating, and increased vessel traffic) could cause displacement of fish species, which could disrupt foraging, reproductive behaviors, and/or other biologically important activities. Fish close to construction noise may also experience higher predation as a result of the inability to sense their surroundings (Andersson 2011). When exposed to motorboat playback noise, Simpson et al. (2015) noted that damselfish showed an increased metabolic rate associated with stress. This response to sensory disturbance from vessel traffic could result in an increased risk of predation.

The increase in suspended sediments and turbidity described in sections 3.1.1 and 3.2.1 could result in increased competition and predation. Long-term (4 or more days of 24-hour exposure) elevated turbidity has been shown to reduce marine fish feeding rates by 20 percent and reduce efficiency of the foraging process (Grecay and Targett 1996; Utne-Palm 2001). Fish have an increased probability of encountering predators if forced to forage for longer periods of time (Gerristen and Strickler 1977). While construction activities would occur longer than 4 days, turbidity levels would both rise, then return to low levels, in a cyclical pattern as construction starts and stops. Overall, construction activities would likely be relatively short term, with long-term predation impacts associated with increased turbidity unlikely as turbid conditions would settle to pre-existing conditions following construction.

3.2.5 Direct Injury/Mortality

Construction activities that could potentially injure or kill fish include site preparation (clearing or grading in areas prior to excavation or placement of foundations), pile-driving and dredging activities, and anchor placement for supporting vessels. Direct impacts from construction activities could include potential smothering, burying, or crushing of fish. Additionally, if construction were to occur in sensitive recruitment or spawning areas, fish may experience a higher level of impact, as these activities would then be impacting the reproductive success of the population as a whole (Bergstrom et al. 2014). Fish eggs and larvae would be the most sensitive to construction activities, as juveniles and adults are expected to effectively swim away and avoid injury or death (RI Ocean SAMP 2010; U.S. Army Corps of Engineers [USACE] 2014a). Direct injury or mortality from noise and vibratory effects could also occur, as previously discussed in Section 3.2.2.

Seafloor-disturbing construction activities can result in direct, permanent impacts (injury and/or mortality) on benthic communities in the immediate path of cleared areas. Mortality of benthic organisms would likely occur within the footprint of pile-driving and excavation activities, either from direct collision and removal, or from being smothered. Additionally, indirect, temporary impacts from increased sediment suspension could decrease the ability of some benthic species to filter feed. Despite these impacts, benthic communities are expected to recolonize on disturbed seabed areas and to begin new colonization on installed structures and foundations.

Increased vessel traffic is not expected to cause direct injury or mortality, as fish generally have the ability and reaction speed to move out of the way, with the potential exception of the Atlantic sturgeon. In the nearby Delaware Estuary (southwest of the AoA), Brown and Murphy (2010) reported that 28 Atlantic sturgeon mortalities were reported, with 50% resulting from apparent vessel strikes. However, the AoA is located in a more open and deeper water environment as compared to the Delaware Estuary, which has relatively limited space for Atlantic sturgeon to avoid oncoming vessels. The AoA also experiences a regular flow of vessel traffic coming to and from the New York and New Jersey coastline; therefore, additional impacts on fish (including Atlantic sturgeon) injury and mortality due to temporary increased vessel traffic would likely be negligible.

3.2.6 Changes to Local Fishing Practices

During construction, fishing vessels would likely be required to avoid the active areas due to safety concerns for the fishers, construction workers, and construction equipment. Construction timeframes (and subsequent exclusion from fishing) would depend on the size, number, and distribution of turbines.

Fishers experiencing displacement from traditional fishing grounds during construction activities may experience reduced income or other economic impacts (Reilly et al. 2016), as they would be temporarily unable to access areas previously available to them. Fishing conducted outside of construction work areas may also be impacted as construction activities would displace resident fish, potentially effecting surrounding areas of the AoA not in the immediate workspaces.

Displacement during construction activities would be short term; however, impacts on commercial, recreational, and for-hire fishers once operational activities commence could be more complex. Discussion of potential operational impacts of wind farms on fishing practices is included in Section 3.3.4, and a discussion of BMPs and potential mitigation measures is presented in Section 6.

3.2.7 Accidental Spills and Vessel Traffic

The potential for accidental spills of petroleum, paint used on exterior surfaces, and/or other chemicals from construction vessels would potentially be increased with the increase in vessel activity in the AoA. Additionally, waste from survey vessels, if not properly managed, could accidentally become marine litter. Fish can ingest small plastic particles or be stuck within the debris, which can cause injury or death (Derraik 2002; Gregory 2009).

All vessels operating within the AoA would likely adhere to standard BMPs (see Section 6) and would be required to provide site- and project-specific spill plans to minimize the potential for accidental spills and debris within the AoA. The potential for accidental discharges of liquids and debris would likely extend over a relatively short period of time during construction activities.

3.2.8 Impacts on Existing Sensitive Fish and Habitats

Potential impacts on fish with designated EFH, fish with protected status, and NOAA Trust Resources would be the same, or similar, as those described for other fish and benthic species described in sections 3.2.1 through 3.2.7. The potential for and extent of impacts would be highly dependent on seasonality of the species and its life history characteristics, the exact locations of wind farm sites, the number of WTGs and the spacing between them, materials used, and the anticipated construction timeframe. Before wind farm construction begins, developers would be required to consult with appropriate federal and State agencies to identify which species and habitats are most at risk and the best ways to minimize those risks. Typical minimization measures include seasonal and time-of-year restrictions that avoid important migration patterns and spawning activities.

3.3 Post-construction and Operation Impacts

Once construction is complete and wind farms are operational, impacts on fish and fisheries may include sensory disturbances such as noise, electromagnetic fields (EMFs), and vibrations. Additionally, previously open-water habitat will be converted to an artificial reef-like habitat, prey availability and competition between species may shift, and there could be changes from pre-existing fishing practices.

It is possible that, after wind farms are fully operational, other utilities would request to place satellites or other equipment on offshore WTGs for dual use. While it is difficult to predict what other ventures may seek to use the WTG structures, any added equipment would have to be small and unobtrusive so as to not interfere with the functionality of the WTG. If additional vessels, dredging, drilling, or any other equipment or methods are needed to install any added structures, developers would be required to obtain a permit and evaluate impacts, similar to (or as part of) the initial process to develop the wind farm, and any potential impacts of those efforts would be analyzed on a case-by-case basis.

3.3.1 Sensory Disturbance

Sensory disturbances to fish from post-construction and operational activities would result from operating WTG noise, vibrations, and EMF detection. Discussion of injury thresholds and general physiological and behavioral responses to these impacts from construction have been previously discussed in Section 3.2.2. The following section includes additional discussion of sensory disturbance effects specific to the operation of WTGs.

3.3.1.1 Noise

As discussed in Section 3.2.2.1 for pile-driving noise, the extent to which fish detect noise varies based on species and conditions. Based on a review of existing field and laboratory data, Wahlberg and Westerberg (2005) predicted that, at a distance of 0.4 to 25 km (with wind speeds of 8 and 13 m s^{-1}), Atlantic salmon, Atlantic cod, and goldfish (representative of carp and other sound sensitive *Carassius* species) could detect offshore wind turbines; however, Hoffmann et al. (2000) determined that wind turbine noise does not affect fish once the mechanical disturbances from construction are complete, and Wahlberg and Westerberg (2005) found that wind turbines did not cause temporary or permanent hearing loss in fish within a few meters. Lindell (2003) and Sigray and Andersson (2011) similarly found that noise created by the rotating blades was approximately 0.5 to 2 Hz and was either masked by wind or the surface of the water. In another study by Westerberg (1994 [as cited in Andersson 2011]), tracking studies showed the swimming behavior of adult European eels (*Anguilla anguilla*) did not change when passing a small offshore wind turbine 0.5 km away. However, when the rotor of the small offshore wind turbine was stopped, Westerberg noted that the number of cod and roach (*Rutilus rutilus*) within 100 meters increased by a factor of 2 (Westerberg 1994 [as cited in Andersson 2011]). The results of studies on the noise impacts from the general operation of WTGs are therefore somewhat varied, but most concluded that noise from turbines does not have adverse impacts on fish.

In a study by Xi Engineering Consultants Limited (2013), the noise output of three WTG foundation structures (jacket, monopile, and gravity) were modeled for potential impacts on marine species. Acoustic outputs were compared with marine species' hearing and behavioral response curves, and fish species examined included European eels, allis shad, sea trout, and Atlantic salmon. The results indicated that

European eels and Atlantic salmon can detect monopile foundation WTGs at greater distances than gravity foundations; and sea trout and allis shad are unable to detect noise of operating WTGs at distances greater than 100 meters.

Noise other than that expected from the general function of WTGs includes noise generated from the gearbox and the generator (Betke et al. 2004; Lindell 2003), which can be transferred into the water and seafloor through WTGs. Noise generated from a wind turbine with a concrete gravity foundation and a steel monopile was recorded at less than 600 Hz, with a dominant tone between 100 and 200 Hz (Andersson et al. 2011; Sigray and Andersson 2011). As noted in Section 3.2.2, vessel traffic generates less than 1,000 Hz; therefore, noise generated from wind turbines is expected to be less than noise produced by vessel traffic. Wahlberg and Westerberg (2005), Madsen et al. (2006), and Tougaard et al. (2009) found similar results. It should be noted, however, that wind speeds vary and can produce gusts or be relatively calm or non-existent, which effects how much noise is generated.

Hazard prevention devices such as foghorns may also generate sound. The Block Island Wind Farm utilizes foghorns when poor visibility or inclement weather are determined to be a threat to navigation (USACE 2014a). These foghorns are expected to produce only low-level sounds when hazard prevention is necessary, and are centrally located within the wind farm (USACE 2014a).

The overall consensus seems to be that expected noise from operational turbines is minimal within the marine environment (Bergstrom et al. 2014; Petersen and Malm 2006; Westerberg and Lagenfelt 2008; Wilhelmsson et al. 2010).

3.3.1.2 Vibration

When Gray et al. (2016) surveyed fishers operating in post-construction wind farms, they found that the fishers were concerned over the impact of vibrations on fish behavior and presence in the area. The internal mechanics of WTGs and the unpredictable nature of wind propelling the turbine blades can produce infrasonic vibrations (Dean 2007; Lozano-Minguez et al. 2011); however, these are difficult to predict and are particularly difficult to measure in soft sediments (Nedwell et al. 2003). Relatively limited research is available on the effects of mechanical vibrations on fish; however, vibratory effects would be extremely localized in nature (Andersson 2011; Nedwell et al. 2003).

3.3.1.3 Heat

The potential heat produced by high-voltage cables is expected to be heavily dependent on substrate type, burial depth, cable type, and ambient temperatures (Emeana et al. 2016; Meissner et al. 2006). Typical cable burial depth is expected to be 1 to 2 meters. Emeana et al. (2016) conducted an experiment on various depths and sediments and found that: (1) for clay and coarse silts, temperatures were only raised within a 40-cm radius of the buried cable; (2) for fine sands, significantly raised temperatures were noted up to 1 meter above the cable; and (3) for very coarse sands, significantly raised temperatures were noted up to 100 cm. Although heat injury thresholds for fish and benthic species have not been specified with regard to cable-producing temperatures, the German Federal Maritime and Hydrographic Agency enforces a regulatory limit of no more than 2° Celsius above ambient temperature within 20 cm deep into the seafloor.

Borrman (2006 [as cited in Meissner et al. 2006]) completed laboratory trials with mud shrimp (*Corophium volutator*) and a polychaete worm (*Marenzelleria viridis*) to test the simulated effects of heat from buried cables. Borrman determined that, although mud shrimp distribution could not be correlated with temperature gradients within the simulated seabed, the polychaete worm favored areas with less heat and showed significant movements away from sediments with higher heat. It can therefore be hypothesized that benthic species and bottom-dwelling fish may avoid areas of higher heat emissions (Meissner et al. 2006). However, as developers assess possible sites for wind farms, the sediment type and required burial depth to minimize risk of heat (and potential fishing gear snags, further discussed in Section 3.3.4.1) would be considered, and burial depths would be discussed during construction planning to be approved by developers and BOEM for the permitting process. If cables are buried deep enough or covered well enough (dependent on site-specific area and sediment), the chance of negative impacts would be reduced.

3.3.1.4 Electromagnetic Fields

Cables transmitting power between WTGs and those linking power grids and generating stations would contain electricity that produces EMFs. Modern cables are covered with various sheathing materials that shield direct electric fields from the marine environment (Claisse et al. 2015; Dunlop et al. 2016). However, EMFs are typically measureable around the cables (WWF 2014). As fish and other marine species swim through EMFs, induced electric fields are created (Gill et al. 2012), which could theoretically impact fish and fisheries for the duration of the operational life of the WTGs. Electric fields are measured in units of volts per meter (V/m), and alternating current magnetic fields (referred to as magnetic flux densities) are measured in units of milliGauss in the United States and in Tesla in Europe.

EMFs are detectable above buried marine cables; however, the detectability and extent of impacts are expected to be limited to immediately adjacent water over the cables. Normandeau Associates, Inc. et al. (2011) modeled EMF levels (assuming the cable would be buried 1 meter below the seafloor) and found that, immediately above the buried cable, the alternating current magnetic fields were strongest (7.85 microtesla [µT]), and at 10 meters above the seafloor, the magnetic fields were highly diminished (0.13µT). Similarly, direct current magnetic fields were measured at 78.27 µT directly above the buried cable and 0.83 µT at 10 meters above the seafloor (Normandeau Associates, Inc. et al. 2011). A comprehensive literature review by Claisse et al. (2015) suggests fish avoid areas where EMF registers between 400 and 1,000 microvolts per meter (µV/m).

Although typically detectable only in close range to buried cables, many fish species can detect EMFs (Gill et al. 2005). EMFs could dissuade fish from entering the area, potentially impacting migration, foraging, and reproductive behaviors (Electric Power Research Institute 2013). Studies on the effects of EMF from buried cables have also been conducted in the Pacific Northwest; although not located within the Atlantic region, these studies are applicable as they directly involve investigating the effects of buried cables on fish. The Trans Bay Cable is an operating 400 MW buried transmission line located between San Francisco and Pittsburg, California. The Trans Bay Cable runs beneath the San Francisco Estuary and crosses the migratory pathway of Chinook salmon and green sturgeon (*Acipenser medirostris*); therefore, magnetic field surveys were conducted (Kavet et al. 2016). Using Geometrics magnetometers at four locations within the estuary, readings were taken along survey lines. Scientists found that successful migration of Chinook salmon and adult green sturgeon through the waterbody was not changed as a result of an activated underwater cable crossing. Although travel time increased for outbound green sturgeon migrations, the travel time decreased for inbound migrations, and as previously stated, the success of the migration was unchanged. After cable crossing analyses, misdirections, and array data were reviewed, Chinook salmon were even shown to be attracted to activated underwater cables (Kavet et al. 2016).

Another study was conducted in the Pacific Northwest by BOEM, where they investigated densities of marine life on the sea floor due to both energized and un-energized buried cables (placed by the same manufacturers) within the Santa Ynez Unit Offshore Southern California Planning Area (BOEM 2016a). After conducting surveys on energized and un-energized cables at depths of 76 to 213 meters, the study determined that there was no significant difference in fish living around energized, un-energized, and natural habitats; and invertebrates were similar in species and variability around all three habitats (BOEM 2016a). Additionally, the study determined that there was no evidence that EMF produced by the energized cables were attracting or repelling electro-sensitive species, and EMF diminished to background levels starting approximately 1 meter from the cable (BOEM 2016a). Cable burial at sufficient depth (depth not defined within the study) was concluded to be an adequate tool for preventing the emissions of EMF at the sea floor (BOEM 2016a).

Woodruff et al. (2013) conducted laboratory trials with Atlantic halibut, Dungeness crab, and American lobster. The purpose of the study was to document behavior such as activity levels and activity location preference relative to an EMF source. Woodruff et al. (2013) found that behavioral responses indicating explicit avoidance or attraction to EMF intensity were relatively low. However, the study also noted that the test subjects' life history lends them to be largely inactive, making conclusions on changes to behavior difficult to study.

Kramer et al. (2015) reported that bottom fishes, scombrids, and elasmobranchs likely experience EMF impacts more than other species. The existing literature shows that many magnetic-sensitive fish species have some kind of response to EMF (Claisse et al. 2015). Putman, Jenkins, et al. (2014) and Putman Scanlan, et al. (2014) found that Pacific salmon navigation during migrations is aided by magnetic fields, and Durif et al. (2014) found the same effect in eels. Elasmobranchs also rely on Earth's magnetic field to navigate and detect their prey (Dunlop et al. 2016; Kempster et al. 2012). In addition, due to their ampullae of Lorenzini (Claisse et al. 2015), elasmobranchs likely experience EMF effects more than other fish. Claisse et al. (2015) determined six out of 99 Hawaiian fish species exhibited some degree of direct evidence for magneto-sensitivity; the six species included five sharks and the yellowfin tuna. However, catsharks were found to show no preference (or were unable to differentiate) between natural and artificial electric fields with the same strengths (Kimber et al. 2011). Additionally, Bedore and Kajiura (2013) determined elasmobranchs' median sensitivity when using electroreception to detect their surroundings was between 5 and 48 microvolts per meter (0.5 to 4.8 μV/m), which is well below the estimated range of detection described above by the Claisse et al. (2015) literature review. Additional information regarding ongoing studies of EMF effects on elasmobranchs is provided in Appendix C, Section C.3.7.

An ongoing EMF study being conducted by the University of California, Santa Barbara is testing the effects of submarine power cables on rock crab (*Cancer* spp.) and Dungeness crab. The study is in response to concerns expressed by West Coast fishers that EMF from renewable energy power cables under the seafloor will affect crab harvesting. Although full results have not yet been realized, a status update shows that when 529 rock crab and 307 Dungeness crab were tested in the field, both were shown to cross unburied AC power cables when a baited commercial trap was located nearby (BOEM 2017a).

Although conducted within a freshwater (as opposed to marine) environment, Dunlop et al. (2016) found that a submarine wind energy cable in the Great Lakes had no detectable effects on the composition or spatial patterns of fish, either inshore or offshore. The team used electrofishing and acoustical surveys to come to their conclusion that depth and substrate types within fish habitats were more influential in the variation of fish densities than fish proximity to buried cables producing EMF.

Other ongoing research into the effects of EMF includes investigating the potential for impacts on growth and development. Woodruff et al. (2012) exposed salmon to EMF intensities between 0.1 and 3 μT (to mimic the possible range of wind turbines and other marine hydrokinetic devices), which resulted in the suppression of melatonin levels. Similarly, Lee and Yang (2014) noted behavioral differences in teleost fish that were exposed to EMF as embryos.

In general, fish are likely to acclimate to continuous operational EMF, with no indications of behavioral changes (Wahlberg and Westerberg 2005), and some small-bodied demersal fish have been recorded in abundance near WTGs two years after pile-driving activities (Wilhelmsson et al. 2006a). After completing a project-specific EMF assessment for the Block Island Wind Farm, Deepwater Wind found that EMF was not expected to negatively impact marine organisms, their behavior, orientation, or navigation (USACE 2014a). Additionally, offshore New York and New Jersey already experience anthropogenic EMF within the marine environment from existing tunnels, subsea cables, and bridges (Copping et al. 2016; see also the *Aviation and Radar Assets Study*, which is appended to the Master Plan).

3.3.2 Habitat Conversion

3.3.2.1 Permanent Structures

The physical placing of turbines in the seafloor would convert an open-water habitat to one with fixed structures. Added fixed structures would create a new hard-bottom habitat similar to an artificial reef, which may vary greatly from pre-existing habitat (Andersson 2011; Elliott and Wilson 2009; Svane and Petersen 2001; Wilhelmsson et al. 2006a). Recolonization of benthic and semi-pelagic fish species would depend on material, shape, and distribution of the wind farms (Andersson and Ohman 2010; Raoux et al. 2017) but would likely begin within days or hours after installation of WTGs (Andersson et al. 2009; Golani and Diamant 1999; Wilhelmsson et al. 2006b). Epibenthic species are expected to begin recolonizing, which would then attract other fish as the ecosystem develops the ability to provide food, shelter, and spawning habitat (Andersson et al. 2009; Andersson and Ohman 2010; Wilhelmsson et al. 2006a). Foundations of WTGs can accumulate macroalgaes and mussel shells, which are often used as nesting materials, and Moreau et al. (2008) noted that gravid females of two species of goby (*Pandaka lidwilli* and *Monodactylus argenteus*) were found at the base of several foundations.

Bohnsack (1989 [as cited in Andersson 2011]) proposed two hypotheses for why fish are drawn to artificial reef-like habitats. The first is that fish are behaviorally attracted to physical structures when compared to the option of a featureless habitat. The second is that structures are conducive to production as fish will have a protective refuge and increased foraging and reproductive potential (Copping et al. 2016). The physical presence of newly added structures increases the likelihood of larvae to find the newly available habitat suitable for settlement and recruitment (Neira 2005). The time of year when the structures are submerged and their distance to other structures would heavily influence which species are driven to colonize first (Andersson et al. 2009; Connell 2001). The material of the structures also plays a large role in whether or not fish would be attracted to the turbines and would determine which species can be productive on them. For example, barnacles and tube worms are likely to be found on steel, smooth surfaces, and algae and hydroids are likely to be found on rough surfaces such as concrete (Andersson et al. 2009; Andersson and Ohman 2010). Bergstrom et al. (2013) noted that blue mussels have been shown to increase in number around newly installed WTGs in wind farms on the Swedish west coast and elsewhere in the Baltic Sea.

Current literature shows that species are impacted in different ways as a result of newly introduced artificial reef-like habitat that WTGs create. This change can have beneficial effects on fish species numbers and diversity (Andersson 2011; Bergstrom et al. 2014; Brodin and Andersson 2009; Langhamer and Wilhelmsson 2009; Wilhelmsson et al. 2006a; Wilson and Elliott 2009). In a 7-year post-construction evaluation of the Horns Rev Offshore Wind Farm in Denmark, surveys indicated species diversity increased with a clear horizontal distribution within close proximity to each individual turbine, and fish species numbers also increased (Stenberg et al. 2011). The cumulative effect of introduced structures was shown to increase aggregations of larger gadoid species (cod and whiting), and the study specifically noted (through use of telemetrics) that cod were moving in and out of the WTG structures (Stenberg et al. 2011). There was an observed decline in demersal fish abundance from before to after construction activities; however, it was noted that abundance of demersal and pelagic species in the control area was lower than before deployment of the wind farms as well, leading the authors to believe fish occurrence in that portion of the North Sea may be due to larger-scale processes than the construction of wind farms (Stenberg et al. 2011). Other studies have shown similar results where gadoid species had a high affinity for WTG structures (Hille Ris Lambers and ter Hofstede 2009; Lokkeborg et al. 2002). Pelagic species are also likely to increase in number around the WTGs, as the number of small benthic and semi-pelagic fish are expected to increase as food availability increases over time due to the expected new growth of epibenthic communities (Andersson 2011), thus benefiting apex predators (Raoux et al. 2017).

Researchers in the North Sea found that operational wind farms triggered the growth of blue mussel populations due to the introduced hard structures (Slavik et al. 2017). These mussels now provide a large available food source, previously nonexistent. Mussels can attract fish and crabs, which attract larger sea turtles and marine mammals. When investigating these increasing numbers of mussels, Slavik et al. (2017) determined that a typical offshore turbine has the potential to support up to four metric tons of shellfish, increasing the number of mussels in the southern North Sea by 10% (Slavik et al. 2017, Alvarez 2017).

The conversion of habitat from open water to an artificial-reef has also been shown to have negative impacts on fish species. In the Denmark study described above (Stenberg et al. 2011), the overall impact of the wind farm area as a whole was compared to a control area, and the results showed that species diversity decreased, as evidenced by a lower number of fish species being caught; however, the control site abundance estimates were also lower than before construction. Similarly, many studies have found that flatfish do not experience shifts in abundance due to offshore wind energy development (Hille Ris Lambers and ter Hofstede 2009; Lindeboom et al. 2001; Stenberg et al. 2011). Negative impacts (e.g., localized anoxia around foundations) can result from new bacterial and algal colonies that develop on the newly added structures. In the western Baltic Sea, assemblages higher up on WTGs have been found to trap excess nutrients present in the water column and transport it as organic debris to the seafloor, which creates anoxic conditions at the foundation of the structures (Zettler and Pollehne 2006). Similarly, in the North and Baltic seas, Andersson (2011) noted a band of *Beggiatoa* bacteria species approximately 30 cm wide surrounding the base of wind turbine foundations. The accumulation of bacteria is likely the result of lower circulation and is not expected to be a concern around turbines in good circulation areas. As the AoA is not as surrounded by landmass compared to the North and Baltic seas, the possibility of bacteria accumulation is expected to be low.

Another potentially negative effect of converted habitat is that species composition may shift in such a way that fish species not previously present become abundant (Andersson 2011); as a result, pre-existing fish populations may be minimized. In a study by Kritzer et al. (2016), a variety of habitat categories were evaluated for their status and importance by ranking fish and habitats in multiple regions via expert opinion and a multilayered review process. This study concluded that coastal inert substrates had the highest score of importance and value in waters of the mid-Atlantic Ocean, and noted that soft sediments in particular are important for many species for different life stages, despite the fact that productivity is not as easy to visually see in comparison with other habitats such as seagrasses and corals. Although there is ample soft-bottom habitat in surrounding areas that will not be impacted, many fish and benthic species residing in pre-existing soft-bottom habitats would be impacted by the conversion to hard-bottom habitat.

Factors such as the time and season the structures are submerged, water depth, salinity, and temperature will influence which benthic communities develop on newly introduced structures and how successful their growth will be (Becerra-Munoz et al. 2007; Andersson 2011; Glasby 1999, 2000; Guichard et al. 2001; Knott et al. 2004; Relini et al. 1994). The time factor also impacts how species are affected by newly introduced habitat. Fish communities experience natural variations over periods of several years (Holbrook et al. 1994; MacKenzie and Köster 2004); therefore, it is difficult to distinguish which impacts are due to habitat conversion and which are a result of natural change.

Newly introduced structures may also inadvertently create hospitable conditions for invasive species to colonize (Copping et al. 2016). Species may be transported via passing vessels from many originating locations and may find refuge on existing structures such as WTGs (Andersson 2011; Leppäkoski and Olenin 2002). As a result of the Horns Rev 1 Offshore Wind Farm 1 in Denmark (previously mentioned), the amphipods *Jassa marmorata* and *Caprella mutica* and the midge *Telmatogon japonicas* were noted within the wind farm where they had not previously been seen (Ørsted et al. 2006). Similarly, the same midge was discovered at the Yttre Stengrund and Utgrunden wind farms in 2007 where the species had not previously been seen (Brodin and Andersson 2009).

Substrate such as rock or gravel is typically installed around the foundations of WTGs to prevent erosion and scour effects. This added substrate can increase the available surface area for benthic species to develop. Wilson and Elliot (2009) determined the scour and erosion protection around turbines added up to 2.5 times more surface area than was removed to install the structures.

3.3.2.2 Cable Placement

Habitat would also be temporarily converted where dredging activities occur for cable placement. The seafloor would be dredged to place the cable, which would remove existing benthic communities and bottom contours. Benthic communities would become re-established after construction activities are completed, and re-established communities may not comprise the same species and community structure as the original communities. Some species may recolonize more quickly than others, or new species could move in.

3.3.2.3 Physical Oceanography

Another change to existing habitat conditions after construction of WTGs is the anticipated shift in hydrographic conditions (Brostrom 2008; Copping et al. 2016; Stenberg et al. 2011). Elsamprojekt (2002 [as cited in Stenberg et al. 2011]) found that wind farms experienced a modeled reduction in current speeds of less than 15 percent (5 meters from the foundations), and wave height reduction was noted to be less than 3.5 percent. Guichard et al. (2001) determined that WTGs additionally create transient water velocities and local turbulence effects around the structures. Changes in kinetic energy surrounding WTGs may impact mixing, sediment transport, and circulation (Copping et al. 2016), which has the potential to then change benthic habitat conditions and water quality as a result of shifts in oxygenation and the movement of plankton and other larvae throughout the water column (Copping et al. 2013). These changes in environmental factors due to anthropogenic structural habitat change may also negatively impact recruitment in species (e.g., mackerel) that have episodic fluctuations in stock size (Macura et al. 2016; Anderson and McBride 1976).

Whether or not a change in hydrographic conditions is beneficial or harmful to fish populations is a debated topic within the current literature, and few post-construction studies have been completed on the effects of hydrographical change (Copping et al. 2016). A multibeam echo sounder and sediment profile and plan view imaging survey was conducted within the AoA from June-August 2017. Detailed analysis of these data are underway and will be published as *Analysis of Multibeam Echo-Sounder and Benthic Survey Data*, which is appended Master Plan. Rothschild and Osborn (1988) noted that fish would actually have an increase in plankton feeding opportunities as changes in water turbulence and movement create a higher probability of encountering plankton within the water column. Additionally, hydrodynamic models to date have indicated that overall impacts on the physical environment are unlikely (Copping et al. 2016), and more than 100 WTGs would have to be installed (this theoretical model included 20 rows of 5 turbines each) in order to detect a change in circulation that would have benthic, fish, or overall ecosystem consequences (Yang et al. 2014). Individual project sites are expected to have less than 100 turbines; therefore, impacts on marine life from changes in hydrologic conditions are unlikely.

3.3.3 Changes in Prey Availability and Increased Competition/Predation

When habitat is disturbed as described above, the benthic species that colonize on the installed turbine foundations may be different from those that were previously present in the area, which could alter food web dynamics of the ecosystem. An increase in newly colonized individuals could provide higher trophic levels with additional food sources (Bergstrom et al. 2013), which is known as the “reef effect” (Langhamer 2012; Petersen and Malm 2006; Raoux et al. 2017). Many studies have reviewed this phenomenon from wind farm development (Bergstrom et al. 2013; Leonhard et al. 2011; Lindeboom et al. 2011; Maar et al. 2009; Reubens et al. 2011, 2013, 2014; Wilhelmsson et al. 2006a; Wilhelmsson and Malm 2008) and it is further discussed as a benefit in Section 4.1.

As described in Section 3.3.2, the alteration of habitat type can alter which fish species are prevalent within installed WTGs acting as artificial reef-like habitat. This may cause some fish species to experience an increase in predation risks (Copping et al. 2016) and may increase the chance of introducing non-native aquatic plant and wildlife species. Introduction of non-native wildlife species could result in adverse impacts on native species through predation or increased competition for resources.

3.3.4 Changes to Local Fishing Practices

After wind farms are established within the AoA, their physical presence (along with the associated buried cables) would alter the pre-existing fishing conditions within the area. Commercial, for-hire, and recreational fishing concerns typically associated with wind farms include gear and vessel damage, financial risk, exclusion from typical areas and types of fishing, navigational hazards, and alteration of existing fish populations.

3.3.4.1 Potential for Gear and Vessel Damage

The physical presence of wind turbines and the buried cables running between them has posed concerns regarding the risks of snagging nets and collision of nets and vessels. However, this risk can usually be mitigated through minimum burial depth requirements. For example, burial depths for the Block Island Wind Farm had a target depth of 2 meters (Deepwater Wind 2012). When the substrate encountered would not yield to the required depth, additional measures were used, such as placement of concrete mats (Deepwater Wind 2012). In the event that the bottom substrate is rocky and cables cannot be sufficiently buried, cables may be installed on top of the seafloor with additional protective layers added around it, similar to the Block Island Wind Farm.

The most commonly used fishing gear in offshore New York waters is the otter trawl, which involves dragging a net along the ocean floor (Vigliotti 2016). Fishing vessels regularly towing trawls avoid many “hangs” (rocks, shipwrecks, etc.) in the AoA that may damage their nets, and wind farms will present additional obstacles that fishing vessels must actively avoid. In some cases, particularly in rough weather, fishers with gear extending more than 0.25 miles from their vessels may find it difficult to operate within a wind farm. Other fishing methods that use clam or scallop dredges would similarly be more likely to avoid areas with WTGs, depending on type of ground gear being used by individual fishing vessels. Figure 7 and Appendix B include additional detailed information on typical fishing gear used off the coast of New York.

After six wind farms and cable routes were established in the eastern Irish Sea, Gray et al. (2016) stated the majority of fishing activity within the area changed due to (1) fishers fearing potential vessel and gear damage and (2) the potential of vessels breaking down and colliding with the turbines. Sufficient communication of visible and buried components of the project to local fishers can reduce the potential for such impacts. The Block Island Wind Farm found that fishers were also concerned with what was to be done with gear damaged on WTGs (USACE 2014b). (See Section 6 for suggested BMPs to minimize impacts on fishing gear and vessels.) Some fishers also commented that they believed time would increase their confidence in fishing within wind farms, and others stated the corridors between the turbines that did not have cables laid still made for good demersal trawl gear fishing (Gray et al. 2016), despite initial fears that cables would snag trawling gear.

3.3.4.2 Financial Risk

Another concern from local fishers is the potential increase of financial risk (Reilly et al. 2016; Vigliotti 2016). In a study by Gray et al. (2016), it was shown that a majority of fishers thought the loss of fishing grounds was not fully offset by the monetary compensation offered. The displacement of vessels may reduce the catch per unit effort of vessels due to increased competition in areas outside the AoA, the potential change in catch composition, and fishers' inexperience in new areas. Additionally, many fishers are concerned about potential snags and other damages to fishing gear and vessels within WTGs that could cost money. Concerns have been raised that marine insurance companies may also increase insurance premiums if fishers choose to fish within wind farms (WWF 2014), due to the perceived increased risk of damages. However, as of 2010, Sunderland Marine, the world's largest insurer of fishing vessels, does not impose restrictions or higher premiums on their members (RI Ocean SAMP 2010).

Another potential financial impact is that fishers may choose to travel further away than usual to avoid wind farm areas, which would cost more money in fuel and could increase conflicts among fishers accessing similar resources.

3.3.4.3 Displacement

The number one concern of surveyed European fishers (Gray et al. 2016) was the loss of fishing grounds and fishing opportunities within wind farms. Fishers have also noted that the occasional maintenance work involved in the upkeep of the WTGs further displaced them, as they were excluded from certain areas at various times, and they expressed concern over the cumulative spatial encroachment that wind farms threaten (Gray et al. 2016).

Wind farms could create a conflict for space, which may limit certain fishing practices (e.g., trawling) due to snag and collision potential previously described. Additionally, exclusion areas may be imposed around each WTG. In the United Kingdom, a 164-foot (50-meter) exclusion area was established around each WTG during operation (RI Ocean SAMP 2010). In the U.S., the developers of the Block Island Wind Farm considered a 300-foot (91-meter) exclusion area on the seafloor around each WTG to discourage mobile fishing gear (Deepwater Wind 2012); however, boaters proposed they be free to approach the WTGs on the surface with no exclusion area. Ultimately, the U.S. Coast Guard (USCG) implemented safety zones only during construction. The 300-foot (91-meter) exclusion area is not likely to be a standard practice, and the USCG has said it does not intend to restrict access to wind farms. The Cape Wind project did not propose an exclusion area at all during operation other than requiring that fixed gear be placed in a manner that would not affect maintenance vessel access to the WTGs and buried cables (Minerals Management Service [MMS] 2009).

The USCG has the authority to establish regulated navigation areas or limited access areas such as safety zones or security zones in ports or places that fall under the jurisdiction of the U.S. The USCG will evaluate the use of these measures on a case-by-case basis, taking into account the navigational risk assessment required for each future offshore wind farm project. BOEM does not have the authority to restrict vessel traffic or fishing activities in and around offshore wind facilities. Ultimately, fishing within a wind facility will be the decision of the vessel operator, based upon a variety of factors, including any arrangements, agreements, or mitigation measures adopted by the developer, or modification of fishing practices by vessel operators to reduce the risk to fishing within or nearby the facility.

Recreational boaters and charter boat operations would likely not experience exclusion areas once a wind farm becomes operational. The Block Island Wind Farm, for example, has not implemented exclusion rules during operational activities for surface fishing. Based on the experiences noted in other wind facilities and similar in-water structures, wind turbines will most likely have a neutral or slightly positive impact on recreational and for-hire fishing activity while in operation, in both the short and long term (Kirkpatrick et al. 2017). These impacts mainly derive from the expected aggregation of recreationally targeted fish that prefer complex, hard-bottom habitat.

3.3.4.4 Navigational Hazards

Newly established wind farms can be a navigational concern for commercial and recreational boaters that are unused to the structures' whereabouts. However, the USCG would require proper navigational lighting for nighttime and aerial hazards to provide for navigational safety, and BMPs could aid in minimizing the potential for impacts. BMPs may include traffic management measures, an established control center maintaining constant monitoring during operation, and supplying mariners with information on navigation safety issues (MMS 2009).

Shadows where none previously existed are another potential navigational concern, as shadows would be created and would flicker when turbines are operating. This, however, is not anticipated to cause any additional hazards to boaters. The developers of the Block Island Wind Farm conducted a shadow flicker analysis, which determined that turbine-produced shadows would not impact the adjacent shoreline, and boaters directly underneath the turbines where the shadow flicker would be most pronounced are not expected to be highly impacted as the phenomenon will be intermittent and short term (USACE 2014a).

The AoA contains existing obstacles requiring mariners to navigate around, including environmental and oceanographic buoys that monitor weather and wave conditions. All sitings of ocean-deployed assets would be completed in consultation with coastal authorities such as the USCG; therefore, heavily used marine vessel transit corridors would be avoided and structures would be charted to avoid hazards to navigation.

3.3.4.5 Potential Shift in Existing Fish Populations

Fish typically taken by trawl fishing may be favorably impacted by the aversion of trawl fishing in wind farms within the AoA; however, the possibility then exists that species' diversity in the area w ould shift as described in Section 3.3.2. Local fishers surveyed after construction of the six wind farms in the eastern Irish Sea did not see evidence that the turbines had created a better fishing area due to nursery or refuge-like conditions. However, they did recognize that each wind farm project could have differing effects on the fishing industry, and there may not be sufficient long-term monitoring data to be conclusive (Gray et al. 2016). Fishers surveyed in this study also noted that the number of prawns seemed to have decreased in areas developed for wind farms. However, the majority of North West England fishers, wind farm companies, and local fishery officers believed the recent changes seen in fishing activity in the area could be attributed more to rising fuel costs and the reduction of total allowable catch on other fish than the development of the wind farms (Gray et al. 2016).

3.3.5 Impacts on Existing Sensitive Fish and Habitats

Impacts on fish with designated EFH, fish with protected status, and NOAA Trust Resources due to operational impacts of wind farm development would be the same, or similar, as those described for other fish and benthic species described above in Sections 3.3.1 through 3.3.4. The potential for and extent of impacts is highly dependent on seasonality of the species and life history characteristics, the exact locations of wind farm sites, the number of WTGs, the spacing between them, materials used, and the anticipated construction timeframe. Before wind farm construction begins, developers would be required to consult with appropriate federal and state agencies to identify which species and habitats are most at risk and the best ways to minimize those risks. Typical minimization measures include seasonal and time-of-year restrictions that avoid important migration patterns and spawning activities.

4 Potential Benefits

Potential environmental and socioeconomic impacts, both negative and positive, could results from the construction and operation of offshore wind farms. However, because offshore wind farms are a relatively new phenomenon, studies on the impacts have only been undertaken in recent years. These studies are necessarily limited to operating offshore wind farms, most of which are in northern Europe. Results of wind farm impact studies indicate that potential adverse risks of offshore wind farms occur mostly during construction (e.g., noise from pile driving, sediment dispersal), although some adverse risks may occur during operation as well (e.g., effects of habitat conversion such as invasive species and shifts in existing populations). Enhanced diversity and species abundance may also arise during operations (Bergstrom et al. 2014) and create beneficial impacts; these impacts are discussed in Section 3. Socioeconomic benefits, such as employment opportunities and improved port facilities, can arise before construction and carry through operations (ESS Group 2016; ICF, Inc. 2012).

4.1 Environmental Benefits

4.1.1 Reef Effect

Hard surfaces placed in the marine environment, such as offshore wind turbines and oil and gas platform foundations, attract many marine organisms and create new habitat capable of supporting encrusting organisms and fish (Helvey 2002; Love et al. 1999). This reef effect is well known to improve local habitats and support biodiversity (Mikkelsen et al. 2013) and species abundances (Bergstrom et al. 2013; Leonhard et al. 2011; Reubens et al. 2011, 2013; Wilhelmsson et al. 2006a). However, factors such as the lack of complexity of the baseline habitat conditions, the type of construction material used (Qvarfordt et al. 2006; Wilhelmsson and Malm 2008), and the local species pool (Bergstrom et al. 2014) may influence the response to the artificial reef effect.

Conversely, offshore wind farms have the potential to alter local biodiversity, allow the introduction of non-native species, benefit some species more than others, or be detrimental to some species, as discussed in Section 3.3 (Bergstrom et al. 2014; Inger et al. 2009). However, studies have concluded that, given that offshore wind farms have the potential to create additional habitat and attract marine organisms, the overall effects on marine animals are positive (Slavik et al. 2017). Site-specific conditions would influence the type and extent of benefits and impacts arising from construction of offshore wind farms within the AoA. However, it is anticipated that construction of offshore wind farms within the AoA could enhance species diversity and abundance as a result of the artificial reef effect.

4.1.2 Sheltering Effect

Fishing activity is not routinely prohibited within offshore wind farm boundaries, but some vessel activity may be reduced as a consequence of reduced use of mobile fishing gear (i.e., trawls) due to perceived risk of fishing within the boundaries (Bergstrom et al. 2014; Leonhard et al. 2011). During construction, safety or exclusion zones are placed around or adjacent to offshore wind farms Once a project is constructed, operational safety zones would be approved only if there is a justification for their implementation, and the USCG does not intend to restrict access to the waters around offshore wind farms (Fishing Liaison with Offshore Wind and Wet Renewables Group [FLOWW] 2014). Additionally, during bad weather or rough seas, fishers may elect to avoid offshore wind farm areas for safety reasons. For example, experience in the United Kingdom indicates that vessels are reluctant to enter into developed WEAs when wind speeds exceed 9.35 meters per second, a speed generally associated with wave heights of 2 to 3 meters (Kirkpatrick et al. 2017). Therefore, offshore wind farms have the potential to act as a conservation area (Inger et al. 2009; Wilhelmsson and Langhamer 2014). While empirical evidence from existing offshore wind farms is limited, and artificial reefs can be visited more frequently than natural reefs because of the perceived increase in recreational value by sport fishers, incidental fishing exclusion could increase local species abundances because of reduced fishing pressure, reduced bycatch within the project area, and seasonal variability in recreational fishing (Leonhard et al. 2011; Lindeboom et al. 2011; Wilhelmsson and Langhamer 2014; Simard et al. 2016).

4.1.3 Climate Change and Renewable Energy

Climate change has direct and indirect effects on fish and commercial fisheries (Blanchard et al. 2012; Brander 2007). Warming sea surface temperatures have resulted in poleward shifts in the distribution of fish and plankton, changes in food web interactions, and temporal variability (Blanchard et al. 2012; Brander 2007; Nye et al. 2009; Tasker 2008). Even slight warming periods can result in very large ecological changes (Oviatt 2004). Increased amounts of carbon dioxide in the atmosphere reduce ocean pH (i.e., acidification), which causes changes in photosynthesis rates and impacts shell-forming invertebrates, which can impact species distributions based on food or resource availability (Doney et al. 2009; Feeley et al. 2004). These species distribution changes have directly impacted commercial and recreational fisheries. Notably, winter flounder and American lobster populations have shifted northward and impacted commercial and recreational fisheries in the AoA (Rutgers University 2017b). Climate change may also result in new fisheries in the AoA. Investing in renewable energy sources would reduce or slow the impacts of climate change on commercial, for-hire, and recreational fisheries.

By investing in offshore wind, New York State has the opportunity to become more energy independent by reducing dependence on fossil fuels. This would also reduce greenhouse gas emissions, which will reduce or slow the impacts of climate change. Additionally, offshore wind will increase energy security and stimulate in-State economic development. The New York Ocean Action Plan identifies offshore wind farms as having significant potential as a source of renewable energy for New York State, which will also help to meet one of the goals of the New York Ocean Action Plan (DEC 2017): Goal 3: Increase resilience of ocean resources to impacts associated with climate change.

Offshore winds blow harder and more uniformly than onshore winds and, therefore, have the potential for an increased, steadier production of energy than onshore wind farms (Musial and Ram 2010; Musial et al. 2016; BOEM 2017b). For New York State to reach Governor Andrew M. Cuomo's mandate for 50 percent of the State's electrical generation to come from renewable energy by 2030, investment in offshore wind energy is necessary (Office of the Governor 2016). Offshore wind speeds have been assessed for the whole of the U.S., and New York State has robust wind resources, which reinforces why New York State has good potential for offshore wind energy development (Musial and Ram 2010; New York Energy Policy Institute [NYEPI] 2014).

4.2 Socioeconomic Benefits

4.2.1 Supply Chain

The existing domestic supply chain for onshore wind farm components could be expanded (Navigant 2013; Tetra Tech, Inc. 2010) if demand warranted. The Merchant Marine Act of 1920 (more commonly known as the Jones Act) may be a factor in the increase in domestically built specialized vessels such as jack-up crane vessels or large floating derrick barges. The Jones Act requires the shipment of goods or passengers between U.S. ports to be U.S.-built and -flagged vessels (46 U.S.C. § 883). The vessels currently used to install offshore wind turbines are either converted oil and gas barges, which will not sustain the industry in the long run, or are foreign built and therefore not compliant with the Jones Act (ESS Group 2016; Navigant 2013; Tetra Tech, Inc. 2010). In June 2017, Zentech and Renewable Resources International announced the first U.S.-built offshore wind jack-up installation vessel (Zentech 2017).

Additionally, port facilities in the U.S. need to undergo improvements to support offshore wind farm construction and operation (ESS Group 2016; Tetra Tech, Inc. 2010). New Bedford, Massachusetts, is one of the largest commercial fishing ports in the U.S. and has already undergone such modifications, which have benefited the fisheries industry. These modifications include channel deepening, resulting in increased access and navigation for maritime properties; improved boat launch facilities; and additional berthing spaces (ESS Group 2016).

4.2.2 Employment

Construction and operation of the offshore wind farms will also lead to temporary and permanent jobs. Previous studies and models provide varying estimates of job creation and economic benefits to local economies (NYEPI 2014). Additionally, offshore wind farm construction provides opportunities for fishery industry vessels. Vessels are needed for conducting scientific studies prior to, during, and following construction. Studies may require fishing vessels capable of trawling, in which case local fishing vessels may be contracted. Construction contractors may also contract local industry vessels to ferry workers or provide security during installation operations.

There could also be employment opportunities in manufacturing wind turbine components, permitting and designing port modifications, financing, and specialized vessel manufacturing.

4.2.3 Additional Infrastructure

Benefits could result from the installation of additional infrastructure on the offshore wind farms. For example, the installation of cellular towers on offshore wind farms has the potential to improve offshore communication and safety by increasing cellular reception at sea, which currently is limited and not reliable. In addition, the installation of weather monitoring stations could provide more accurate updates on weather conditions at sea. Developers and stakeholders have suggested there is a possibility of installing other types of infrastructure, which requires investigation into feasibility.

5 Stakeholder Feedback

New York State's fishing community is a key stakeholder group whose views should be actively solicited and considered as plans for offshore wind energy development move forward. Throughout this master planning process, the State has been engaging and will continue to engage fisheries stakeholders.

Stakeholder feedback is an important element of this Study for identifying fishery use within and adjacent to the AoA, and for informing the development of guidelines and BMPs to be considered for the siting, construction, and operation of future wind farms in the AoA in a responsible manner. Although the State has not attempted to verify the accuracy of the feedback received from stakeholders, that feedback is summarized and incorporated throughout this Study.

5.1 Stakeholder Input Methods

The State reviewed materials from outreach efforts from previous projects aimed at offshore wind energy development and fisheries executed by other agencies and communicated with State and federal resource managers and project teams to develop an outreach strategy for fish and fisheries. Throughout the master planning process, the State has undertaken direct actions to adhere to—and surpass—the early planning recommended guidelines and BMPs described in Section 6 to actively solicit input from fishery stakeholders early in the planning process.

The State used a range of notification tools to reach out to the fishing community and appointed a fisheries liaison (described in Section 5.1.1) to communicate directly with stakeholders. The State's outreach included phone and email correspondence, attendance at state and regional fisheries meetings, site visits to fishing docks, and public meetings. Notices regarding public meetings were sent through State and regional electronic mailing lists, such as the New York MRAC list and the MAFMC list. Notifications regarding the offshore wind master planning process and meetings specifically related to fishery outreach were also provided through the State's offshore wind web page (https://www.nyserda.ny.gov/offshorewind).

5.1.1 Commercial Fishing Liaison

A key part of the State's outreach strategy was its appointment in May 2017 of a Fisheries Liaison with extensive experience in the fishing industry to help advise and facilitate communication strategies and interactions with fishers. This liaison has served as a mediator between the State and the fishery stakeholders to assist in the development of, and to facilitate, outreach activities. The credentials and role of the Fisheries Liaison are described below:

- Knowledgeable about commercial, recreational, and for-hire fisheries in the offshore planning area.
- Communicates effectively with industry representatives and fishing groups.
- Advises and assists in implementing communication strategies with industry representatives and fishing groups, such as initiating stakeholder contacts, disseminating meeting information, and gathering sensitive industry data.
- Assists in organizing meetings to solicit input and comments on the project, available and recommended datasets, and future research needs.
- Assists in the identification and collection of available fisheries data.
- Meets with industry representatives and fishing groups in New York and other states.
- Advises on strategies to mitigate potential adverse impacts of offshore wind energy project construction and operation based on stakeholder input and knowledge of local fisheries.
- Assists in the ongoing development of a stakeholder list, including relevant fishery community individuals, officials, and organizations.
- Ensures bilateral communication between the State and industry representatives and fishing groups and timely distribution of information between groups.

The Fisheries Liaison's outreach efforts have included over 200 in-person meetings, conference calls, webinars, and conversations via email. Key companies, agencies, and organizations engaged throughout the process include the following:

- Alice's Fish Market
- Alyssa Ann Sportfishing
- Atlantic Capes Fisheries
- Charterboat OH Brother
- Commercial Fisheries Research Foundation
- Coonamessett Farm Foundation
- Double D Charters
- Fisheries Survival Fund
- Fishermen's Dock Cooperative, Inc.
- Fishing Vessel Illusion
- Fishing Vessel Patriot
- Garden State Seafood Association
- Long Island Commercial Fishing Association
- Lund's Fisheries
- Massachusetts Division of Marine Fisheries
- Mid-Atlantic Fishery Management Council
- National Oceanic and Atmospheric Administration

- New England Fishery Management Council
- New York State Department of Environmental Conservation
- Ørsted
- Other Offshore Wind Fisheries Liaisons
- Rhode Island Department of Environmental Management
- Sea Keeper, LLC.
- Seafreeze Shoreside, Inc.
- Surfside Foods, LLC.
- Weejack Charters

In-person meetings with fisheries stakeholders and their representatives occurred at many events and through at least 21 on-site meetings at or near fishing ports between June and August 2017. The dates and locations of these meetings are outlined in Table 7.

Table 7. Portside Meeting with Fisheries Stakeholders/Representatives for the New York State Offshore Wind Master Plan

Date	Location
June 16, 2017	Greenport, NY
June 17, 2017	Shinnecock, NY
June 23, 2017	Shinnecock, NY
June 24, 2017	Shinnecock, NY
July 11, 2017	Freeport, NY
July 12, 2017	Shinnecock, NY
July 13, 2017	Montauk, NY
July 14, 2017	East Hampton, NY
July 15, 2017	Shinnecock, NY
July 24, 2017	Cape Cod, MA
July 24, 2017	Narragansett, RI
July 25, 2017	Fairhaven, MA
July 28, 2017	Point Judith, RI
July 28, 2017	Jamestown, RI
August 4, 2017	Point Pleasant, NJ
August 15, 2017	Cedar Beach, NY
August 18, 2017	East Hampton, NY
August 21, 2017	Patchogue, NY
August 28, 2017	Belford, NJ
August 30, 2017	Montauk, NY
August 30, 2017	Point Judith, RI
August 31, 2017	New Bedford, MA

5.1.2 Commercial Fishing Meetings

The State also participated in numerous regional and local fisheries meetings to gather input from fisheries stakeholders between November 2016 and August 2017 (Table 8).

Table 8. Fishery-Focused Meetings for the New York State Offshore Wind Master Plan

Date	Stakeholder	Location
November 15, 2016	MRAC	East Setauket, NY
December 6, 2016	Long Island Traditions	Port Washington, NY
December 12, 2016	MAFMC	Baltimore, MD
January 17, 2017	MRAC	East Setauket, NY
April 17, 2017	MAFMC	Avalon, NJ
April 18, 2017	MRAC	East Setauket, NY
May 10, 2017	Fisheries Survival Fund	New York, NY
May 19, 2017	Mid-Atlantic Regional Planning Body, Ecologically Rich Areas Workshop	Dover, DE
May 31, 2017	NYSERDA/DEC/DOS	Conference call
June 15, 2017	NYSERDA/DEC/DOS/BOEM	Conference call
June 22, 2017	East Hampton Trustees Meeting	East Hampton, NY
June 27, 2017	Fisheries Survival Fund	New York, NY
August 9-10, 2017	Fisheries Open House at MAFMC	Philadelphia, PA
August 16, 2017	Fisheries Open House	Shinnecock, NY
August 17, 2017	Fisheries Open House	Montauk, NY
August 28, 2017	Fish and Fisheries Study Stakeholders	Webinars

The State's representatives participating in fisheries outreach were also present at six general open house meetings in New York in July and August to engage with stakeholders expressing fisheries concerns. Additionally, State representatives formally presented information on the New York State Offshore Wind Master Plan and stakeholder engagement process at the MRAC meeting on January 17, 2017, in East Setauket, New York.

Three meetings identified in Table 8 were held in direct response to stakeholder feedback regarding concerns that the times and locations of the State's more general public meetings conflicted with the schedules of some active fisheries stakeholders. In response, the State coordinated with the MAFMC and commercial fishing stakeholders to hold several days of fisheries-focused open house meetings in August at locations identified as more convenient for fisheries stakeholders. These were held at the

MAFMC meeting in Philadelphia on August 8-9, 2017; in Shinnecock, New York, on August 17, 2017; and in Montauk, New York, on August 18, 2017. State representatives staffed these meetings for 8 to 11 hours per day, allowing stakeholders to visit at their convenience, ask questions, and provide input to the State.

During many of these outreach efforts, stakeholders were provided with existing maps of fishing data as well as blank maps and charts of the AoA, upon which the stakeholders were invited to provide information on areas important for their specific fishery. The State digitally captured these areas and additional information to supplement and vet the information on existing map products. Fishing areas captured from stakeholder input are shown on Figure 8. The State also developed scale drawings of standard fishing vessels and gear types for comparison to the minimum expected spacing of future wind turbines in the AoA. The aim was to provide stakeholders with a better understanding of the area between turbines relative to typical vessel types and gear spreads (see Section 2.4.2.2 and Appendix B). In meetings, calls, and emails with fishers and their representatives, many diverse ideas have been expressed. Section 5.2 presents a summary of this information.

5.2 Overview of Stakeholder Comments

During outreach efforts, fishers identified important fishing grounds on charts, as well as areas where they believed the impacts of future offshore wind energy development on fishing could be minimized.

Several recreational fishers believe that turbines will increase and improve fishing opportunities by providing structures that attract fish. However, some fisheries stakeholders expressed concerns for the following potential issues:

- Access to fishing grounds.
- Economic impacts on commercial fishing.
- Thoroughness of consideration of public comments in the development of plans to implement offshore wind farms.
- Cumulative effects of multiple offshore wind farms and regulatory actions.
- Effects on fish and fishery resources.
- Environmental impacts.
- Safety, technical, and economic challenges regarding the feasibility of fishing among turbine towers.

The following suggestions for enhancing the compatibility of offshore wind energy development and fishing were made by one or more fisheries stakeholders:

- Provide fishers “a seat at the table” in planning, implementing, and operating future offshore wind energy projects.
- Before construction of any future offshore wind facilities, develop plans for implementing research and monitoring using inputs from fishers, scientists, and resource managers.
- Prior to construction, develop plans for identifying potential impacts on fishing, and for compensation in case such impacts occur. Compensation may focus on fishery enhancement for the benefit of affected fishers.
- Arrange future turbines in straight lines to reduce obstacles to towing trawls and dredges. A single straight line would allow towing on both sides. A few long, straight rows may be better than a square array of turbines.
- Align rows of turbines along a consistent water depth where feasible, since mobile gear is often towed along a consistent depth.
- Increased distance between turbines may make fishing among them more feasible.
- Bury cables at least 6 feet into the sediment.
- Minimize the number of cables crossing towing lanes between turbine rows.
- Consider lining up turbines along Loran or latitude/longitude lines, similar to reference lines that static and mobile gear fishers use to reduce conflict (static gear between certain turbines as markers may be an alternative).
- In addition to latitude and longitude, provide information to fishers using Loran reference lines since many continue using Loran reference frames.
- Consider employing fishers and their vessels to service the construction and maintenance of offshore wind facilities.

5.2.1 Summaries of Written Comments, Extended Conversations, and Meetings

5.2.1.1 Stakeholder Comments Received on the Draft Fish and Fisheries Study

Stakeholder feedback was solicited on a draft of this Study. A draft of this Study was circulated to state and federal regulators, non-governmental organizations, and other stakeholders on August 23, 2017, and two webinars summarizing the Study were provided to stakeholders on August 28, 2017. The following entities were provided with the draft Study for comment and invited to the August 28 webinars:

- NOAA.
- USFWS.
- BOEM.
- USACE.
- DEC.
- DOS.
- East Hampton Board of Trustees.
- Town of Southampton.
- Massachusetts Division of Marine Fisheries.
- Rhode Island Department of Environmental Management.
- MAFMC.

- MAFMC Clam Advisory Council.
- NEFMC.
- New York MRAC.
- Rhode Island Coastal Resources Management Council.
- Empire State Development.
- Sea Risk Solutions.
- Kelley, Drye, and Warren, LLP.
- Long Island Commercial Fishing Association.
- Garden State Seafood Association.
- Seafreeze Ltd.
- The Town Dock.
- Rhode Island Commercial Fishermen's Association.
- Surfside Foods LLC.
- Montauk Boatman and Captains Association.
- Montauk Fish Dock, Inc.
- New York Sportfishing Federation.
- Fish Vessel Illusion.
- Cornell Cooperative Extension of Suffolk County.
- Commercial Fisheries Research Foundation.
- Coonamessett Farm Foundation.
- Wildlife Conservation Society.
- The Nature Conservancy.
- Natural Resources Defense Council.
- National Wildlife Federation.

A total of 193 questions and comments were received on the Study draft. These questions and comments focused on the following major topics/themes:

- The regulatory framework.
- Details of species and habitats discussed.
- Biological and fishing industry data reviewed in the study.
- Potential risks and sensitivities and potential benefits.
- Suggestions for additional data/studies to review.
- Comments from the fishing industry about the need to make a living fishing in the AoA.
- Editorial corrections (misspelling, grammar, missing spaces, etc.).

Stakeholder questions and comments have not been checked for accuracy. The views expressed by the stakeholders, which are summarized below, are not necessarily those of the Study authors or the State.

The final version of this Study was updated after consideration of these stakeholder comments. For example: text was edited to clarify and correct content, where appropriate; information was added on the complexities of the data and studies reviewed; additional studies were reviewed in text; and descriptions of studies and data more appropriate to other environmental study subject areas included in the Master Plan process were removed. Comments on the Study draft included the following, with the number of similar comments noted in parentheses:

- Clarifications to the Fishery Management Councils' roles, the geographic boundaries of their jurisdictions, and the species they manage (6).
- Clarifications on state/federal regulatory jurisdictions and/or procedures (5).
- Information on species presence and/or potential impacts that was requested to be included in the Study, including deep sea corals, winter flounder, Atlantic sturgeon, river herring, striped bass, surfclam, sea scallops, and red crab (9).
- Corrections to species' common or scientific names (5).
- Suggestions for representative species list and additional species to include in the Study (4).
- Comments related to the sources/interpretation of the EFH information (4).
- Clarifications of regulatory authority for threatened and endangered species (2).
- Recommendations to include species that are proposed for listing as threatened or endangered in the Study (2).
- Requests that the Study note that critical habitat for Atlantic sturgeon was designated in August 2017 but is outside the AoA (3).
- Suggestion to discuss other potential species life history impacts, such as for the possibility of recruitment failure (when juveniles do not survive to enter the fishery) (1).
- Comments regarding surveys for biological data, such as clam survey data, NEAMAP survey, MDAT core biomass maps and underlying data, Block Island Wind Farm studies, and aerial wildlife survey (7).
- Suggestions for alternative ways to summarize fisheries/ports/fishing revenue in the AoA (4).
- Considerations for fishing industry data reviewed in the Study, including:
    - Clarification of species covered by multispecies data layers (2).
    - Temporal range of the data (5).
    - Age of the data reviewed (3).
    - Considerations for interpretation of fishery observer data (3).
    - Questions regarding the ability to accurately determine revenue from VTR data (3).
    - Other underlying data considerations such as regulatory changes during the time periods studied (2).
    - Note that in the *New York Commercial Fishermen Ocean Use Mapping* study (Scotti et al. n.d.), only approximately 35 percent of those with a federal fishing license gave information for the report (1).
    - Concerns with accuracy of HUDS analysis and underlying data (1).

- Suggestions to describe/reference construction techniques (2).
- Suggestions on ways to clarify potential impacts and types of impacts to be addressed in the Study, such as:
    - Noting whether species from studies reviewed are found in the AoA (2).
    - Standardizing units of measure (3).
    - Question related to whether there are cumulative impacts with new cables (1).
    - Describing experiences from the Block Island Wind Farm (5).
    - Possible changes in predator/prey dynamics (2).
    - Potential for introduction of invasive species (2).
    - Impacts of habitat changes (e.g., change from sandy bottom to hard structure) (3).
    - Possibility of resuspension of sediment due to scour (1).
    - Suggestions for additional impacts on fisheries, such as changes to catch per unit effort of fishing vessels (1).
    - Potential impacts of rock piles or concrete mattresses on fishing gear (3).
    - General caution in drawing conclusions as to the extent and significance of potential impacts (2).
- Comments related to interpretation of potential benefits such as shelter effects, impacts on tourism, port modifications, reef effect, and climate change mitigation (8).
- Comments recommending additional studies/reports for review (15).
- Suggestions of additional BMPs (2).
- Suggestions for future studies (2).
- Suggestion to note that the current publicly available data may not include the most up to date data available and that updated data should be used when evaluating site-specific areas (1).
- Concern regarding the comparison of turbidity impacts of construction techniques to fishing gear that impacts the sediment (1).
- Questions/suggestions related to cross-references to other sections of the Study, such as referencing information in BMPs or discussing how knowledge gained from scale drawings and gear characteristics could influence evaluation of potential impacts (4).
- Statements regarding the need for vessels to continue to fish in the area and make a living and/or that viewshed impacts should not be considered above fishery impacts (10).
- Comment noting that the projects should be sited in State waters (1).
- Concern regarding the length of time given for stakeholder review of the draft Study (1).
- Request to review updated report draft (1).
- Suggestions on places to clarify language or phrasing used in the Study (35).
- Editorial suggestions/grammatical corrections (6).
- Support for the data in the Study or compliments on portions of the Study, such as BMPs and scale drawings of fishing vessels (6).

Additionally, after the August review of the full Study, an updated draft of this stakeholder feedback section was sent to the same stakeholders for review on October 18, 2017. Two stakeholders provided comments, which have been incorporated into the Study updates as described above.

5.2.1.2 Summaries of Stakeholder Input from Extended Conversations and Meetings

Meeting with a fishing industry scientific and technical researcher and advisor – July 2017. The director of an organization that conducts scientific and technical research and provides services to the fishing sector expressed general support for offshore wind energy development but cautioned that it needs to be done carefully and with full consideration of the fishing industry. He agreed with the approach of consulting fishers prior to choosing offshore wind sites, and he is opposed to granting leases in response to unsolicited lease applications without adequate prior study and stakeholder consultation. He felt that the Statoil (Empire Wind) lease was granted without adequate study and in disregard of inputs from fishers.

- The following recommendations from the director were noted:
  - Monitoring and study before site selection should occur to get baseline data.
  - Stakeholder consultation with entities such as NOAA Fisheries, regional management councils, academic and university groups, fishers, and others is needed to develop proper research designs for data collection. Inputs from fishers and other stakeholders should be considered before site selection.
  - Monitoring during and after construction should occur to check for potential impacts.
  - There should be prior development of a mitigation plan in case fisheries impacts are identified.
  - Mitigation could mean contributions to fisheries enhancement work for overall fishery, not funds paid to individual fishers.
- Other opinions:
  - One flaw with the BOEM process has been lack of stakeholder input on research, design, and development.
  - In the best scallop areas, the minimum depth is closer to 30 fathoms than 20 fathoms. There might be scope for siting offshore wind in depths of 15 to 25 fathoms.
  - He suggested other industry and agency contacts.

Meeting with captain/owner of a trawler involved in fishery management for more than 30 years – July 2017. The stakeholder stated that:

- He has fished many years along the whole of the East Coast.
- Squid is one of the most important species for him now.
- He provided information to BOEM and the DOS about fishing areas and tows, and did not feel his inputs were fully considered.

- He provided specifications and details of his trawl gear and pointed out that these vary by fisher, depth, species, and conditions:
  - Door spread in a 33-fathom depth is estimated at 50-60 fathoms.
  - In deep water (50 fathoms and deeper), the towing wire length to depth scope is 3:1.
  - In shallow water, to get door spread the scope may be 10:1 or 15:1.
  - Tow speed is 2.2 to 3.8 knots.
- He fishes with references in latitude and longitude. Many fishers still use Loran time difference lines, but different companies have different offsets, so their actual position is less certain.
- Time difference lines off Long Island are roughly parallel to shore and bathymetric curves.
- He provided a printout from his plotter showing many concentrated tows around the Mud Hole and Cholera Bank.
- Yellowtail flounder were fished a lot at depths of 20-30 fathoms in the past, but the quota is too low now.
- Waters near New Jersey traditionally are not as rich for fish as other areas.
- He confirmed that squid show in large concentrations but in unpredictable areas. Every year, fishers try a few of the most productive spots:
  - Cholera Bank/Hudson Canyon.
  - South of Long Island within eight miles of beach.
  - West of Nantucket.
- Squid are sensitive to low-frequency vibrations, which are produced by turbines

Meeting with captain/owner of a trawler and head of a commercial fisher's organization – July 2017. The stakeholder stated that:

- The organization negotiated with Deepwater Wind concerning Block Island Wind Farm.
- He tows trawl as close to Block Island Wind Farm turbines as possible.
- He does not tow south of Long Island.
- He supports offshore wind but wants provisions that protect fishing.
- Any necessary mitigation/compensation should be for the benefit of fishery overall.

Meeting with Fishery Liaison of a Vessel Owner/Seafood Buyer/Processor – July 2017.

- The stakeholder opposes offshore wind energy development and provided information to the DOS and BOEM, but believes that the information was not fully considered.
- He believes power generation should be on land or in New York State waters.
- For planning offshore wind energy development outside three miles, there should be a focus on <u>avoidance</u> of Hudson Canyon and surroundings. Avoid all fishing grounds between eastern and southern shipping lanes. Hudson Canyon is very productive due to structured bottom and outflow of the Hudson River.
- The area between eastern shipping lanes/fairways could be OK for a straight, narrow wind farm.
- The area inshore of eastern shipping lanes might be OK in places, but Long Island fishers should be consulted.
- Vessels supplying this company do not fish much near New Jersey.

- Squid is very important, also mackerel trawled on the bottom and herring trawled on the bottom or mid-water.
- The stakeholder supports the idea to place turbines in straight lines and along bathymetric curves.
- Squid depth is shore to 150 fathoms.
- Squid and other species are caught deeper in winter and move to shallower waters in summer.
- The stakeholder confirmed that squid show in large concentrations but in unpredictable areas.
- The stakeholder heard of herring trawlers hanging up on mats covering cables from Block Island Wind Farm, which damaged their gear.
- The stakeholder experienced difficulty trying to file a claim related to hanging up on mats.
- Block Island Wind Farm routed cable through a traditional fish trap site.
- The stakeholder is concerned about environmental effects. British fishers who came to the U.S. reported silting that destroyed nephrops fishery and some offshore areas where now only dogfish are found (documentation of these claims may not be available).
- The stakeholder indicated that representatives to offshore wind from commercial fisheries were handpicked, not representative of broader commercial fishing interests.

Meeting with representative of major vessel owner/seafood buyer – July 2017. The stakeholder:

- Recognizes that offshore wind is coming, but is concerned and wants to engage to minimize impacts on fishing.
- Is concerned about habitat effects and impacts on species.
- Did not know specific fishing areas, but later, in consultation with the fleet manager, provided a chart of the main productive areas in the AoA of concern for vessels of this company.
- Stated that the areas deeper than 20 fathoms south of the shipping lanes are important to them, and squid is their major concern.
- Mentioned the electronic vessel trip report system, which could be an additional information source.
- Recommended talking with the State agency for fisheries.

Meeting with Rhode Island Department of Environmental Management (RIDEM) staff – July 2017.

- The liaison described the State’s fisheries outreach and Master Plan development.
- Important aspects of the fishery liaison’s background and duties were discussed.
- Agency staff indicated that Rhode Island fishers’ complaints about the Statoil lease included:
  - Insufficient prior consultation about site selection.
  - Fishers’ comments were not fully considered.
  - Some catch data are reported to be incorrect, underestimated squid catches.
  - No response to comments nor clarification of reasons for choice.
- They stated that:
  - Fishers want input on site selection.
  - Fishers want input on research design, scientific plans, and details.
  - Fishers feel pressure from regulations and spatial expansion of other marine uses and pressures.

- The staff member discussed local fishing contacts and technical aspects (use of Loran references, fishers' representatives).
- They noted that it is important to put Loran lines on charts.
- RIDEM has VMS data from NMFS since Rhode Island has a regulatory/enforcement role. They are able to share the data, but there are millions of records that will take a few more months to analyze.
- They noted that the data portals are also helpful sources.

Meeting with New Bedford fishing/offshore wind liaison – July 2017.

- The individual represents New Bedford fishers as liaison to Vineyard Wind.
- Their main concerns include safety issues—radar, allusion, USCG rescues; and economic impact on fishing.
- The stakeholder indicated they think the State will get a lot of concerns from New Bedford fishers against wind farms in New York Bight.
- They recommended:
    - The State should also talk with New Bedford scallop captains.
    - Fishery management Sector Heads as good sources to consult.
    - To consider attending a NEFMC meeting.
- They noted that groundfish, squid, and butterfish are important.
- Mackerel and herring are important species caught with mid-water trawls.

Meeting with New Jersey trawler owner/captain and fishers' representative – August 2017.

- The area inside the western border of the AoA sees less fishing effort than some other areas. The seabed is rough for trawling but OK for scalloping.
- The area around the Mud Hole is heavily fished. Lobster pots are fished on its western bank, and there is a lot of trawling around Mud Hole.
- He believes the best place for offshore wind in this area is south of Long Island, from 8 miles offshore out to depths of 20 fathoms.
- Trawlers still use Loran for towing.
- Lining up turbines in long rows would be good.
- Aligning rows with bathymetric curves would be good.
- He believes offshore wind is not profitable, with projects being abandoned or cancelled.
- He disagrees with siting New York wind energy projects off New Jersey and plans to write to his congressional representative to oppose it.
- Turbines should be sited near New York, closer to shore.
- Visibility should not be as important as an economic activity such as fishing, which many people and jobs depend on.
- He agreed that, within the AoA, fishing is generally less off New Jersey than in many eastern areas.

Open House at Mid Atlantic Fishery Management Council (MAFMC) meeting – August 2017. The State hosted an open house meeting at the location of the MAFMC meeting in Philadelphia from 11 am to 7 pm on August 8, 2017, and from 8 am to 7 pm on August 9, 2017. Charts of fishing areas, the AoA, and notes about fishing grounds were discussed. Scale drawings of a trawl, scallop dredge, and quahog dredge were presented and discussed. There was no disagreement with the dimensions or portrayal of those drawings. Approximately 15 commercial and recreational fishers and a number of fishery agency staff attended at various times. There were extended discussions with representatives of the clam/quahog fishery (see that fishery's section below). General comments and questions of attendees are captured in Section 5.2.

New York Sportfishing Federation Board – August 2017. In a meeting with the three Board members present, they expressed concern about the possible effects of offshore wind energy development on fish resources. Other points included:

- Possible effects on migration of tuna and other species.
- The 17-fathom depth in the New York Bight is very important for recreational fishing.
- Cholera Bank is important for recreational and commercial fishers. Large party boats frequent this area.
- They understand that fishing will be allowed in wind farms. They felt that tying up to turbine bases for sportfishing should be allowed.
- They recommended more outreach to New Jersey recreational/charter fishers.

Open House – Shinnecock Dock, New York – August 2017. From 10 a.m. to 7 p.m. on August 16, 2017, the State hosted an open house in the town of Southampton building on the dock at Shinnecock. Notices about this event and the subsequent open house in Montauk, New York, were sent to more than 50 fishers and others interested in offshore wind planning and were placed on the dock in advance of the meetings. Seven to ten fishers and vessel owners came to the Shinnecock event to discuss their fishing grounds, examine charts of potential offshore wind energy development areas, learn about offshore wind energy development, express their concerns, and ask questions. Seven representatives of New York State, as well as other interested parties, also spent time at the open house. Comments included the following:

- Fishers questioned the economic and technical viability of offshore wind farms, including electrical rates and durability of turbines.
- Fishers questioned the feasibility of fishing among turbines due to the size and configuration of their gear, characteristics of the turbines, other seabed obstacles, and multiple vessels working the same areas.
- The belief was expressed that almost all fishers are opposed to offshore wind, but if it is coming, they want input to the planning and process.

- Fishers are concerned that cables may hinder their fishing, particularly if cables are buried less than 6 feet beneath the seabed and if concrete mattresses are used.
- Fishers are concerned that turbine construction will inevitably lead to heavy equipment lost overboard, causing snags for fishing gear. (Post-construction trawl surveys could help with identification of any new snags.)
- One trawler indicated that turbines outside shipping lanes would also be at risk because ships are not following the lanes as much as they did in the past.
- Fishers agreed that the idea of lining up rows of turbines according to customary tow directions, including along consistent bathymetry, could make it more feasible to use mobile gear in offshore wind energy development areas. Alignment parallel to the direction of current may also make trawling and dredging more feasible.
- Many fishers still navigate and communicate using Loran lines as reference. Loran broadcast ended in 2010, but some navigation equipment converts GPS positions to Loran automatically. Fishers had thousands of snags and tows marked with Loran, so many have continued using the system. For example, many lobstermen and gillnetters set their static gear along selected Loran lines ending in five and develop agreements with mobile-gear fishers to avoid conflicts.
- One recreational charter dive captain who works as far as 27 miles offshore indicated that diving near turbines may be good because the structure will attract fish. He stated that tying up to a turbine is not allowed, but a dive boat can drop divers then back off and return to pick them up.
- Scallop fishing is widespread south of Long Island, mainly by dredgers but also by trawlers. Day boats from Long Island and trip boats from other states work there.
- Scallop fishing is done mainly in depths of 20 fathoms and more. Depths of 20-25 fathoms are generally fished less intensively, but this is an important area for the smaller day boats. Both large and small boats work more intensively in depths greater than 25 fathoms. Maximum common scallop depth is reported to be around 50 fathoms (although some sources indicate deeper scalloping).
- Scallop trawlers tow at about 3.5 knots. Scallop dredgers often work at 4.6-5 knots (and other sources confirm speeds to 5.7 knots).
- Fishers looked at the scale drawings of trawls and dredges among turbines and did not object to the characterization. The captain of a 65-foot trawler confirmed that his maximum door spread is about 45 fathoms, comparable to the 47 fathoms drawn for the Fish and Fisheries study.
- Several fishers confirmed that they do not fish much in the western parts of the AoA west of the Mud Hole, although they indicated there is scalloping there. These Long Island fishers cautioned that New Jersey fishers may fish more in that area.
- One trawler commented that turbines may cause problems for gillnets that move across the seabed. However, a later conversation with a gillnetter confirmed that the monkfish gillnets that work offshore in possible offshore wind energy development areas are securely anchored. Regulations intended to prevent whales dragging buoys require the use of 22-pound Danforth anchors. These types of gillnets move only if they are dragged by trawls or dredges or by heavy storms. Gillnets used near the beach for other species are a different style and use lighter weights. These are usually tended continuously and move across the bottom more, but this style of fishing is not practiced offshore in potential wind farm areas.

- Squid are among the major species that provide income for the commercial trawl fleet. They tend to be caught in large quantities in particular areas that shift from season to season. Important and well-known squid trawling areas include:
    - From Long Island beaches near shore outward to about 6-8 miles from shore.
    - South of Long Island in 30-35 fathom depths, particularly around November.
    - Cholera Bank.
    - The Mud Hole.
    - The west side of Nantucket.
- Scup is a very important commercial species. An important depth range for scup is 30-40 fathoms.
- Some areas that were important for groundfish are less fished now due to low stocks and quotas, but fishers want to ensure that these areas can be fished after a future recovery.
- Fishers reported that the direction of current is variable south of Long Island.
- The larger trawlers normally fish offshore in deeper water during the winter, following the resources to shallower areas in summer.

Open House – Montauk Library, New York – August 2017. The State hosted an open house from 12:00 pm to 7:00 pm on August 17, 2017. Seven Montauk fishers and commercial vessel owners came to learn and comment about plans for offshore wind energy development. Many of the points noted above from the Shinnecock event were reiterated. Specific comments from this meeting included:

- Almost all fishers are opposed to offshore wind, but if it is coming, they want input to the planning and process.
- A trawler captain stated that the Mud Hole is heavily fished, but the area west of it is not as actively fished.
- Fishers previously caught large quantities of yellowtail flounder in 20 fathoms depth, but the stock is depressed now.
- The Statoil lease area is heavily trawled for squid.
- In winter, trawlers work on scup and fluke at the upper shelf break and fish closer to shore in summer.
- A captain of a large trawler stated that he typically works 5-7 months per year in areas deeper than 33 fathoms, which is the maximum depth proposed for offshore wind energy development according to current plans. He noted that January-April are typically the best months for trawlers.
- Fishers are concerned about the uncertainty regarding squid sensitivity to disturbance from offshore wind energy development.
- Some trawlers use Olex navigation and fishing software, as well as P-Sea Windplot II (other trawlers have cited Globe software for fishing).
- Many fishers still use Loran bearings for navigation, marking tows and hangs, sharing information, etc., with automatic plotter/software conversion from GPS.

- Fishers generally supported the idea that long, straight rows of turbines aligned with customary tow directions (such as consistent depth lines) could increase the feasibility of towing mobile gear in offshore wind areas.
- Most or all fishers shown the scale drawing of a trawler working among turbines did not disagree with the dimensions.
- A compensation plan should be developed based on vessel history, which could include AIS, vessel records, dealer records, VTR, etc. It was pointed out that not all fishers have comprehensive catch records. The challenges of compensation programs and difficulty with the groundfish compensation program were mentioned.
- One trawler captain suggested raising quotas as compensation, but many issues about that were pointed out.
- It was suggested that offshore wind arrays should leave lanes for safer and easier navigation into major ports.
- Lining up turbines along the edges of shipping channels was suggested.
- New Bedford scallop fisherman often work now on rich beds in 30-34 fathom depths.
- Day boat scallop fisherman from Long Island often stay shallower than 30 fathoms.
- The typical ratio of scallop dredge tow wire to water depth is 3:1 or 4:1.
- One day boat captain said about 10 scallop day boats out of Shinnecock, Montauk, and Point Judith commonly work south of Long Island.
- Two members of Concerned Citizens of Montauk expressed concern about potential environmental effects and impacts on Montauk fishers.
- A charter boat captain expressed concern about potential impacts of offshore wind on Cox Ledge resources. She was reluctant to discuss specific fishing areas.
- Four or five concerned citizens expressed support for offshore wind but also wanted to ensure that fishers will continue to be allowed to fish in offshore wind areas.

Meetings with members of the East Hampton Town Trustees Harbor Management Committee. A State representative attended the meeting of the Harbor Management Committee on June 22 and spoke with Board members, fishers, and representatives of Deepwater Wind. By invitation, State representatives also attended their meeting on August 16. On August 18, a meeting was held with two Board members to discuss fisheries outreach in more detail and address their questions regarding impacts on fisheries and other issues. The fisheries study, outreach to date, and the chart on which fishers' inputs have been marked were reviewed. Board members had questions about the impacts of turbines and cables, which were addressed. Their questions about electrical rates and distribution of the power from offshore wind were deferred to other sources of information.

Inputs from the Fisheries Survival Fund Representative. The State received input from the representative of the Fisheries Survival Fund, whose membership includes most of the large vessels in the scallop fishing industry. Two meetings were held in May and June 2017. Using data from recent scallop surveys, the Fund representatives outlined areas that were of primary importance to their fishery.

They indicated that many areas in water depths from 20 to 50 fathoms were valuable for scallop fishing. They suggested areas that the State could recommend to satisfy the offshore wind energy requirements of the Master Plan and provided GIS files for easy viewing/integration.

Inputs from the clam/quahog dredge sector. Representatives from the surfclam and ocean quahog sector have taken the initiative to work with NOAA and BOEM to provide the State with historic and recent spatial and quantitative data on catch areas. State representatives had meetings with fleet managers, dredger captains, and a sector representative throughout the outreach process. The following comments were noted:

- Surfclams are currently caught mainly near New Jersey west of the Mud Hole, focusing on areas beyond 3 miles from shore to water depths of about 30 fathoms. In recent years, harvest areas have generally moved deeper and farther east.
- Ocean quahogs are generally caught in deeper water and farther east. One meeting with captains and fleet managers specializing on ocean quahogs is summarized below.
    - Ocean quahogs are now caught mainly in eastern (Nantucket-Ambrose) shipping lanes, safety fairways and separation zones, and areas south of these lanes. The best depths are 160-200 feet (26-33 fathoms), with a maximum depth of 240 feet (40 fathoms). Siting of offshore wind energy development north of the Nantucket-Ambrose shipping lane and fairway (inbound lane) would not affect ocean quahog fishing. New Bedford quahog dredgers work the same area as New Jersey boats. Surfclam dredgers work much closer to New Jersey and would be very concerned about any expansion of the AoA westward toward New Jersey. These dredgers work an area hard until the catch drops and then move on. They may return 6 months later and catch rates return to high. In contrast to finfish and scallops, clams do not migrate horizontally, so if offshore wind energy development excludes dredging out of an area, those clams are lost to harvest. Clammers would be very concerned about any westward expansion of the AoA closer to New Jersey and any wind farm siting there for New York. Two wind farm leases are already established near New Jersey and that is enough. In response to the scale drawing of a clam dredger among turbines, a fleet manager did not disagree with the dimensions but expressed concern that the constraints particular to clam dredging would probably not allow safe operation within a wind farm.
- One commenter from this sector provided the following comments in writing:
    - "To start with the premise that [the State] will identify potential offshore wind development sites that will not be noticeable from the shoreline" makes many of the other claims unobtainable.
        - This is a master plan that works well for property owners that don't want to see the wind farms but will benefit from the renewable energy and less well for all others.
        - NYSERDA studies cannot ensure the best possible sites and lowest cost solution if they are not considering the areas closest to shore. A site 15 miles from shore will be much more expensive to develop and maintain than one that is five miles [from shore].

        - You can't have a balanced evaluation if you are not evaluating all areas, including areas closest to shore.
    - To guarantee the least amount of harm to all users of offshore resources you MUST consider the inshore waters off Long Island, NY in all of your evaluations. Anything less is irresponsible and unfairly favors one user group to the detriment of the others.
    - Thank you for considering my comments."

- Written comments of the clam/quahog sector via a representative of several companies included:
    - "…the proposed eastern Long Island area is a very large ocean quahog bed which is fished every day by a number of large clam boats (some as large as 165 feet). The area off of New Jersey between 40 and 50 meters has a large set of surfclams and fishing is conducted in the area all along that depth by NJ surfclam boats."

- The stakeholder providing the below comments expressed opposition to wind farm development, but the following suggestions were also made to the State in the event that offshore wind is developed.
    - Place the turbines 2 nautical miles apart in each direction.
    - Allow fishing within the array.
    - If there are to be exclusion zones, they should not be more that 100 yards around each turbine. The array operator must agree not to put in a larger exclusion zones later.
    - New York must agree that there will never be an exclusion zone around the entire array.
    - Place the turbines so that they follow the coast and therefore the tide runs along the array and the shoals.
    - Where possible, set the turbines on top of the shoals and at the bottom in the mud, leaving the shoulders of the shoals open.
    - Mount and maintain AIS on every turbine.
    - Bury the cables a minimum of seven feet below the surface of the bottom.
    - Every five years survey the cables to make sure that they are at least 7 feet below the surface of the bottom.
    - If a large storm occurs, survey the cables within six months after the storm.
    - In any case where they are found to be above seven feet they are to be reburied to a minimum of seven feet.
    - When the array is retired, all the turbines, cables, and pads around the foundation are to be completely removed along with any other equipment that is in service of the array. The foundations are to be either completely removed or cut off at least seven feet below the bottom surface.
    - Array operator agrees to have a full-time staff that interface's with the fishing industry regarding all their activities within the array.

Inputs from tilefish longline interest at MAFMC meeting – August 2017. A representative of tilefish longline interests was among several sources indicating that they have no activities shallower than 33 fathoms. The fishery liaison responded that, since this is the maximum depth now being considered by the State for offshore wind energy development, no impacts on this fishery are anticipated.

Meeting and call with a Moriches gillnetter – August 2017.

- This stakeholder did not believe that offshore wind is feasible or economical.
- He is skeptical of State and federal management.
- He acknowledged that offshore wind will probably be developed in the region.
- The stakeholder provided information about gillnetting south of Long Island.
- He noted that his gillnet fishing grounds are generally south and east of Moriches. He works with other Moriches and Shinnecock gillnetters to avoid "stepping on each other."
- While beach fishing he is required to stay at least 1,500 feet from shore, and there is controversy about the distance.
- He noted that beach fishing sets are very short, on the order of an hour depending on fish movements.
- Offshore depth ranges targeting monkfish are mainly 20 to 35 fathoms, sometimes as shallow as 15 fathoms or as deep as 40 fathoms.
- He fishes 20 nets for monkfish, each one 1,800 to 2,000 feet long. He generally hauls half the nets each day. Some boats fish up to 30 nets, with each one 2,400 feet long, and on an unusual day may haul all of them.
- He noted that nets are usually aligned northeast-southwest, typically on Loran lines ending in 5 to reduce potential for conflict with other fishers.
- When not gillnetting he works on clam and other fisheries in the bay.
- The stakeholder and the liaison discussed the feasibility of gillnetting between turbines, which the stakeholder did not discount.
- He agreed that arranging turbines in straight lines generally according to consistent bathymetry may make fishing in offshore wind energy development areas more feasible.
- In response to another fishers' observation that gillnets move, he confirmed that the monkfish gillnets that work offshore in potential offshore wind energy development areas are anchored securely. He noted that regulations intended to prevent whales dragging buoys require the use of 22-pound Danforth anchors. These types of gillnets move only if they are dragged by trawls or dredges or by heavy storms. Gillnets used near the beach for other species are a different style and use lighter weights. These are usually tended continuously and move across the bottom more, but this gillnet style is not used offshore in potential wind farm areas.

Meeting with New Jersey seafood cooperative manager and trawler captain – August 2017. They are very concerned about offshore wind energy development, on top of regulatory pressures that have strongly impacted commercial fishing. They questioned whether offshore wind energy development planners would take their concerns seriously. A trawler captain expressed appreciation for this consultation in advance of suggesting offshore wind sites. The following comments were heard:

- Belford commercial boats are reported to be all day boat trawlers with a few purse seiners.
- No gillnetters or scallopers are based here.
- The main fishing areas include:
  - Mud Hole from the north end to Monster Ledge, about 45 miles off Manasquan.
  - Cholera Bank.

- Along the beach off Long Island for squid in summer as far east as Fire Island.
- They generally stay north of Barnegat Light.
- Areas along the western edge of the AoA are not heavily fished.
- Lobster boats are based in Shark River and work mainly along the sides of Mud Hole.
- A few purse seiners work from Belford and fish mainly in Sandy Hook Bay, sometimes in the ocean.

Meeting in Point Judith with four fishers and three fishers' representatives – August 2017.

In response to a request from a fishing company, a State representative travelled again to Point Judith to meet with commercial fishers. The fishers expressed strong concern about offshore wind energy development and shared information about their fishing grounds. The following points were expressed:

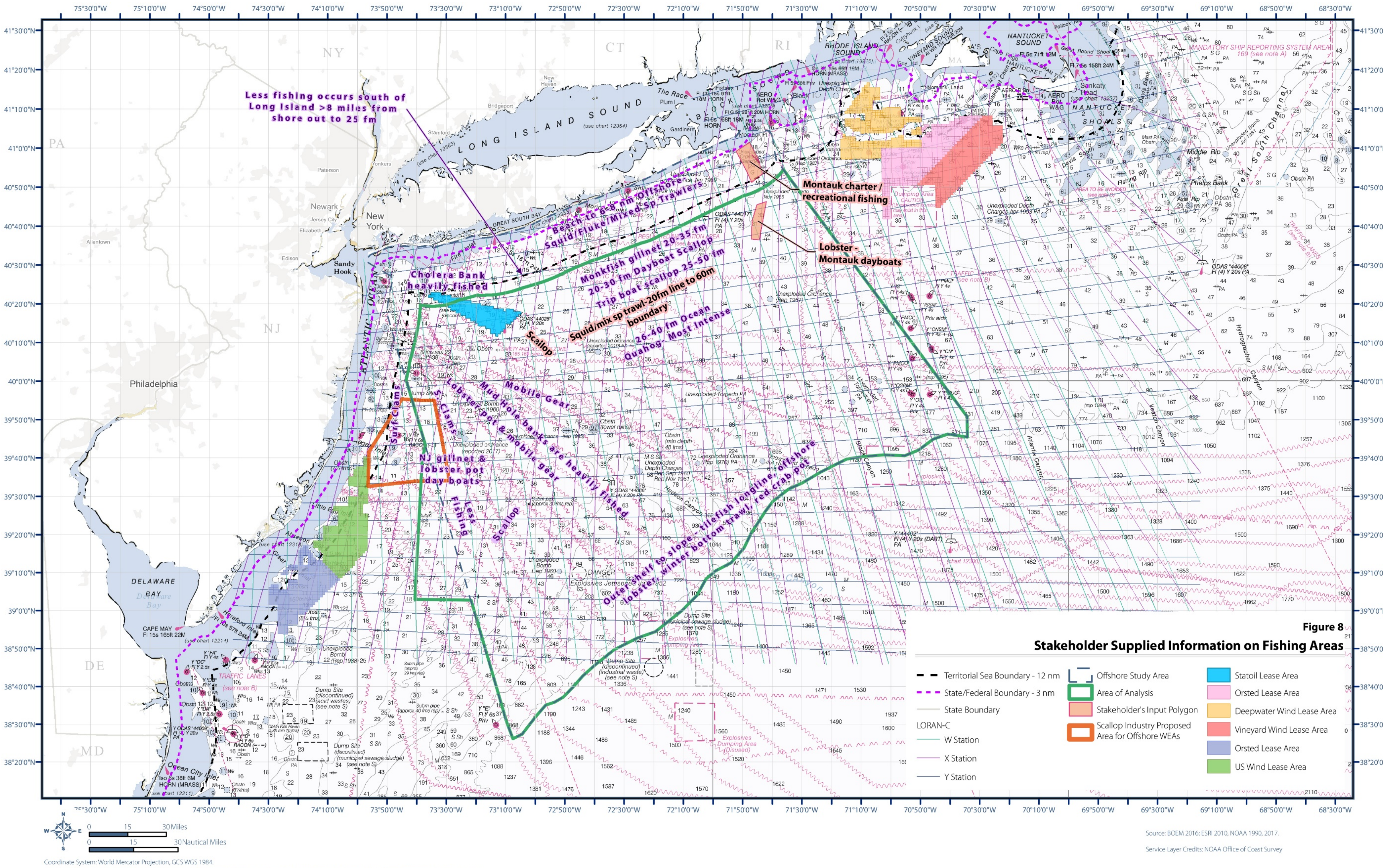
- Important fishing grounds south of Long Island include not only areas deeper than 30 fathoms, but also areas as shallow as 17 fathoms, as well as areas closer to the beach for summer squid.
- Areas within 15 miles of Long Island should be seriously considered for offshore wind energy development. Such areas would have less impact on fishing than areas farther offshore. They questioned the propriety of impacting a productive economic activity with food and employment benefits in order to reduce visual/aesthetic concerns.
- They questioned the feasibility of maintaining turbines in this region and potential abandonment without removal, citing short-term financial incentives and tax credits.
- Squid is important to them, but several other species are also important. Point Judith commercial fishers have traditionally worked on a variety of species to cope with seasonal and population fluctuations. That ability is being curtailed by regulations, and they are concerned that offshore wind energy development will bring additional pressure.
- Although Point Judith is not one of the major scallop ports, they pointed out that the separation zone between the Ambrose shipping lanes is heavily fished by scallopers.
- The 30-fathom edge is heavily fished by scallopers and others.
- Productive grounds south of Long Island include depths from 17 to 30 fathoms for scallops and flatfish.
- They don't fish much on the west side of the Mud Hole or along the western boundary of the AoA.
- Baseline research and monitoring is important and should include input from fishers in design, planning, and implementation. Research should be done by independent, trusted entities.
- They expressed concern that some fishers working with Block Island Wind Farm might not be objective.
- They had no objection or comment on the scale drawings of fishing among turbines.
- One trawler captain reported snagging a concrete mattress from a Block Island Wind Farm cable and stated that there is a substantial area of mattresses along that cable. He did not lose gear but expressed concern to the cable owner.
- One fishers' representative reported that Scottish fishers feel duped by wind farms but they have not experienced a related drop in fishing.

- There was concern that, although fishing may not be restricted initially in offshore wind energy development areas, such restrictions may be imposed if there are accidents or conditions are imposed by insurance companies (including companies insuring wind farm owners).
- They reacted positively to the concepts of turbines in straight lines aligned with depth contours.
- Considering the challenges of fishing in offshore wind energy development areas, there was a consensus that trawls are more challenging to haul back than scallop and clam dredges since trawls have larger gear, more towing wire and ground cables, doors, and longer nets.
- They reiterated that fishers should have a seat at the table. Models of fishers/offshore wind or cable committees were cited, and the response was positive.

Meeting at Massachusetts Division of Marine Fisheries – August 2017. A State representative met with two managers of the Massachusetts Division of Marine Fisheries. An overview of fisheries outreach for the Master Plan was presented, along with a summary of progress to date. The complexities of regional activities in offshore wind energy development were discussed, as was the need for increased communication and cooperation.

Figure 8. Stakeholder Supplied Information on Fishing Areas

Source: BOEM 2016; ESRI 2010, NOAA 1990, 2017



6 Guidelines and Best Management Practices

Materials from several regulatory guidance and BMP documents (BOEM 2013, 2015, n.d.[a], n.d.[b]; E & E 2014; Hooker 2014; McCann 2012; VCZMP 2015), lessons learned from existing offshore wind farm projects (FLOWW 2014; Gray et al. 2016; Lipsky et al. 2016; Moura et al. 2015), and recommendations from planning workshops and stakeholder engagement meetings (MAFMC 2014; Petruny-Parker et al. 2015) were reviewed to develop recommended practices for reducing potential risks to fish and fishery resources during development of a future offshore wind farm. Through the State's fisheries outreach activities (summarized in Section 5), fishers have also expressed ideas about BMPs . Guidelines summarized from regulatory guidance documents are subject to change over time, and new guidance or regulations may also arise after publication of this Study. Guidelines are also subject to the established laws and regulations for a given agency, council, commission, or other organization. Prospective developers should consult with BOEM and other federal and State agencies for up-to-date regulatory requirements and recommended BMPs. This Study does not intend to propose changes to existing guidance or to develop new guidance. The State is in the planning phase for offshore wind energy development, the outcome of which will help to inform their next steps, including an approach to develop guidelines.

A full summary of industry guidelines and BMPs are presented in Appendix D. This synthesis of offshore wind guidelines and BMPs that have been suggested by various sources acknowledges each potential offshore wind energy development site will have site-specific characteristics informing what measures may be appropriate. BMPs have been attributed to the various phases of offshore wind energy development, as well as to particular themes of concerns or risk types. The strategies suggested for consideration at the project development stage are summarized below.

1. Utilize Effective Stakeholder Engagement and Communication Techniques and Practices.
    - Prospective developers should work cooperatively with commercial, recreational, and for-hire fishing entities and interests to ensure that construction and operation of the project will minimize potential conflicts with fishing interests.
    - Communications with fishers should be conducted early in project development and often. Communications should be done in a manner that is adaptive to the needs of fishers (i.e., meeting times when fishers are available), and messaging should be through direct mailings, letters and emails, and announcements in fisheries trade publications. Notices and other communications should be provided to existing councils and commissions for distribution, such as the MRAC, MAFMC, NEFMC, and ASMFC.

- Consider steps to increase transparency in communication, such as improving notification to stakeholders on how their input is considered and documentation of the decision-making process.
- Prospective developers should hire representatives for the roles of a Fisheries Liaison and a Fisheries Representative to best facilitate effective and transparent communications.
- Consider developing a standing committee or committees to address offshore wind energy development and fishing issues from early planning through installation and operation. Such a committee should include developers and representatives of the diverse fisheries potentially affected, including representations from the MAFMC and NEFMC. Successful models have been implemented in Europe and (for submarine telecom cables and fishing) on the U.S. West Coast.

2. Use Collaborative Monitoring Models to Develop Trusted Baseline Data.

- Engage and hire multiple interests (industry, fisheries scientists and managers, offshore wind energy developers, and BOEM) for the development of survey protocols and for conducting the environmental monitoring. Developers should hire locally and involve fishers, as well as value and utilize traditional and local expert knowledge, in the environmental monitoring processes.
- Fisher's presence aboard surveys should be encouraged and considered on a case-by-case basis to support siting and routing, and to reduce the potential for conflicts with static and mobile fishing gear.
- Study priority can be based on the reproduction, growth, and survival of species that are commercially or ecologically important, have undergone or are in the process of rebuilding, any species identified for significant impacts or associated with significant uncertainties, or are protected or endangered.

3. Conduct Planning Exercises, Analysis, Site Assessment, and Site Characterizations.

- Review planned activities with the potentially affected fishing organizations and port authorities to prevent unreasonable conflicts due to fishing gear, or due to the location and timing of exclusion zones. Consult with fishers to inform project siting, turbine location, spacing and design, and inter-array and transmission cable routes and design.
- Prioritize avoidance of highly valued fishing grounds during times of the year that provide the best fishing opportunities and during vulnerable times for the species (i.e., spawning and foraging).
- Dockside facilities coordination, including an investigation with the fishing communities and ports to determine any impacts on dock access, fuel access, or other activities that may interact with fishing operations.
- Consider the potential for the introduction of invasive and non-native species based on site- and project-specific conditions.

4. Construction.
    - Use practices and operating procedures that reduce the likelihood of vessel accidents, loss or accidental deposit of equipment that may cause fishing gear snags, or fuel spills.
    - Bury cables to depth to avoid interaction with fishing vessels or gear operation where practicable. Inspect cables periodically to ensure that adequate coverage is maintained.
    - Implement measures to minimize scour and sedimentation, turbidity, and noise impacts on surrounding sensitive habitats.

5. Implement Safety Procedures.
    - Create a communication protocol and/or a point of contact for communicating real-time hazards or emergencies to fishing vessels (centralized entity, channel for disseminating information, such as a vessel monitoring system, text, smart phone apps, etc.). Designate the emergency response organization and identify roles and responsibilities for individuals and agencies tasked with implementing the plan. Develop protocols and plans for search-and-rescue or salvage operations, as well as operational requirements for wind farm shutdowns.
    - Include safety lighting on towers at a height visible to smaller vessels and during low visibility (fog) as they approach close to the tower, and also include radar reflection, AIS on fixed stations, radar and beacon, etc., and consider augmented safety functions on turbines such as helipad, cell tower, and very high frequency (VHF) functions.
    - Develop and conduct training and emergency readiness drills to prepare for emergency situations.

6. Understand the Tradeoffs and Mitigate Impacts on Those Most Affected.
    - Coordinate with fishing communities to develop guidelines on disruption settlements and community funds that could help prevent eligible fishers from not receiving compensation and others from receiving too little.
    - Compensation can account for increased costs (i.e., fuel subsidies to fishers), gear or vessel loss or repair, loss of fishing revenue, vessel or gear modifications, assistance with gear modifications, and/or the purchase and installation of new or additional safety equipment or gear modification, or other fishery enhancement activities agreed to by the parties involved.
    - Evaluate historical fishing activities on the proposed project sites, evaluate financial effects of temporal and spatial restrictions on fishing caused by the project, the amount of fishing that would continue on the site once the project is constructed, pressure on other fishing grounds by displaced fishers, including the types of fishing methods employed at the project site, species of fish caught, and estimated value of the catch from the project site.
    - Promote the local fisheries, recreational fishing, and tourism to enhance visibility and market for these industries.

7. Operation.

- Facilitate environmental surveys to ensure that restoration is complete, and that mitigation is effective and all impacts are accounted for.
- Design ecosystem and habitat enhancements to attract commercially targeted species and provide lasting benefits to the fisheries in the offshore wind farm area.

8. Decommissioning.

- Consult with the fishing industry as to how the offshore wind farm infrastructures and materials are to be removed.

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Appendix A. NEFOPs Observer Data Separated by Fishery

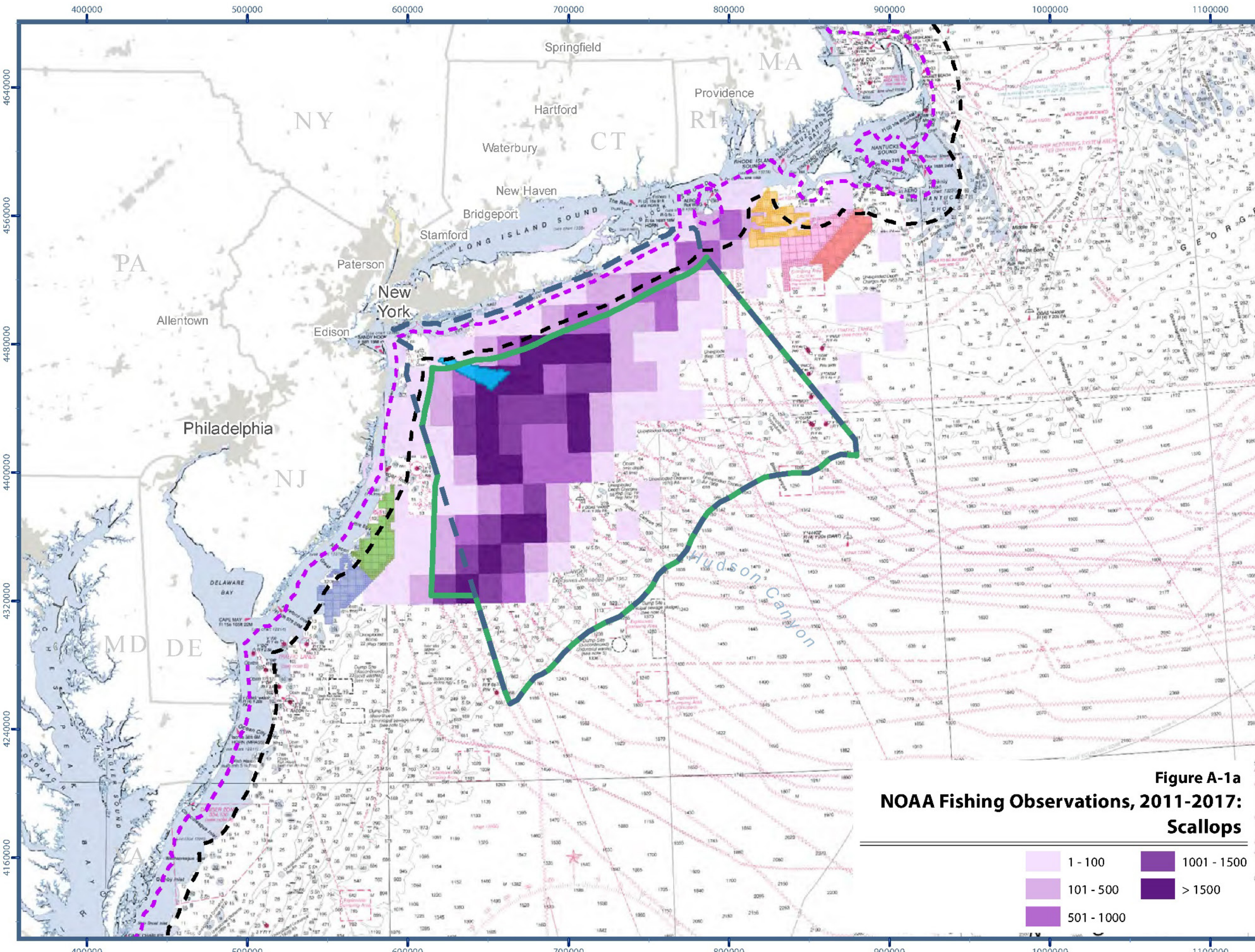


Figure A-1a
NOAA Fishing Observations, 2011-2017: Scallops

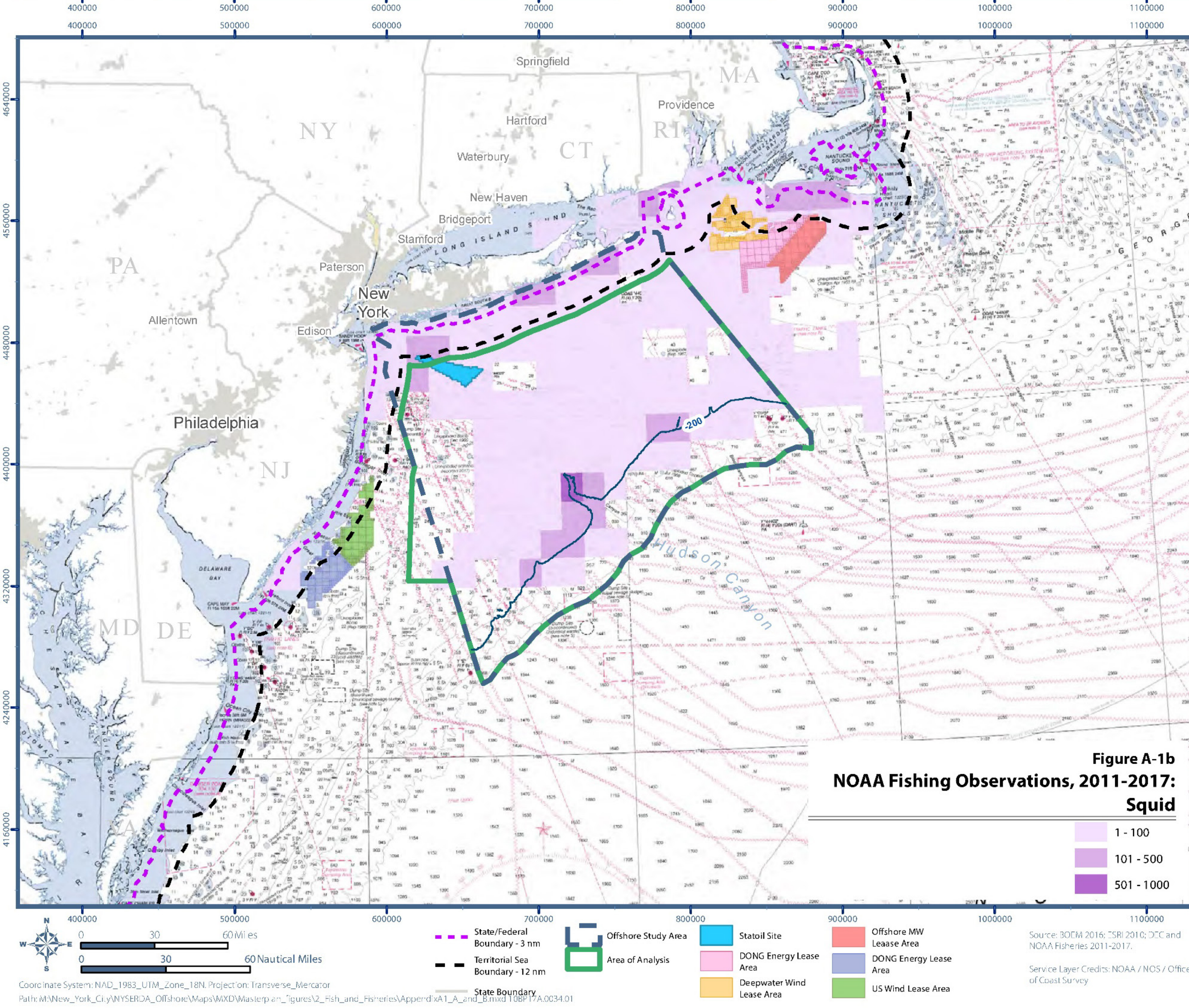


Figure A-1b
NOAA Fishing Observations, 2011-2017: Squid

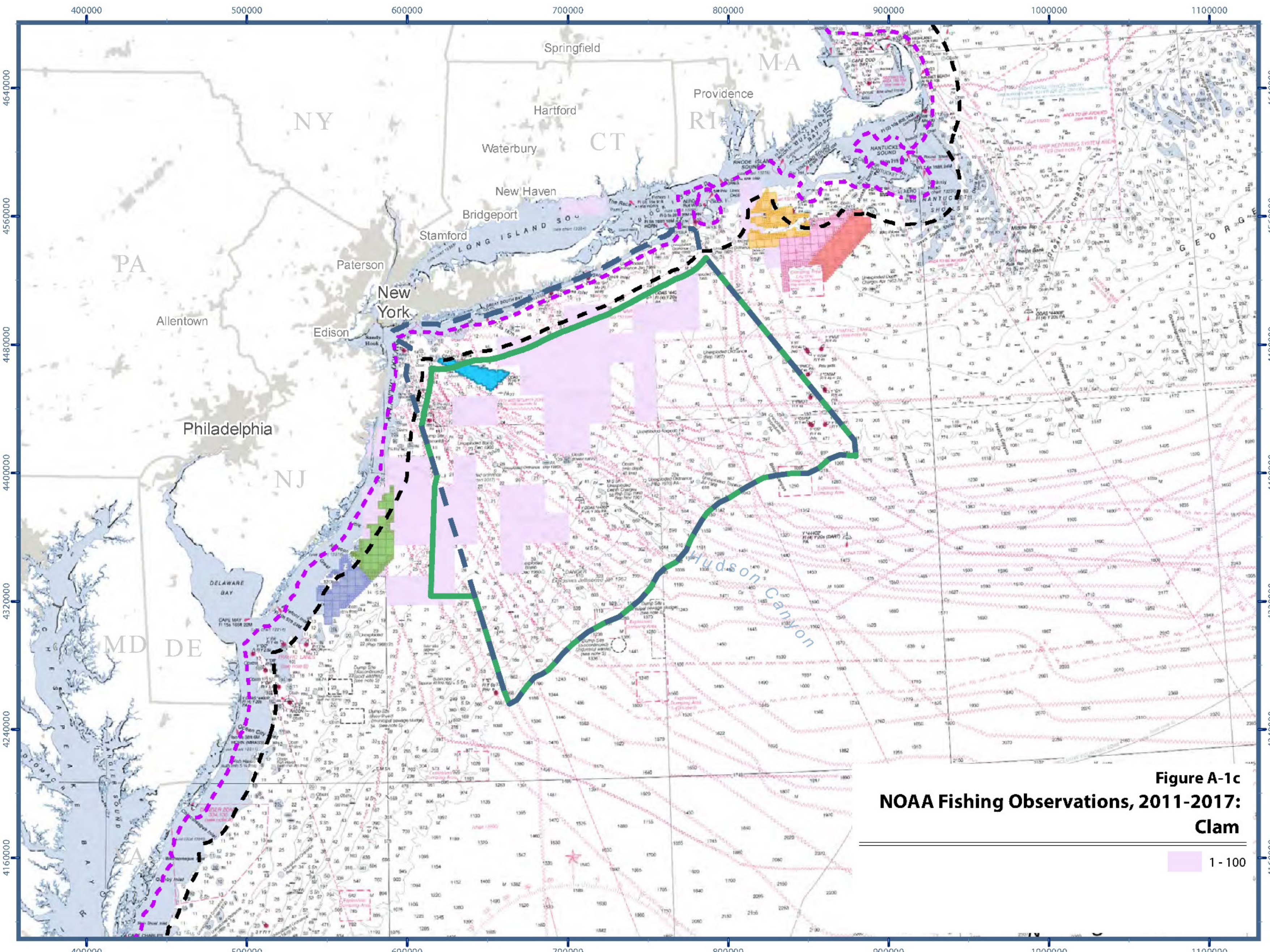


Figure A-1c
NOAA Fishing Observations, 2011-2017: Clam

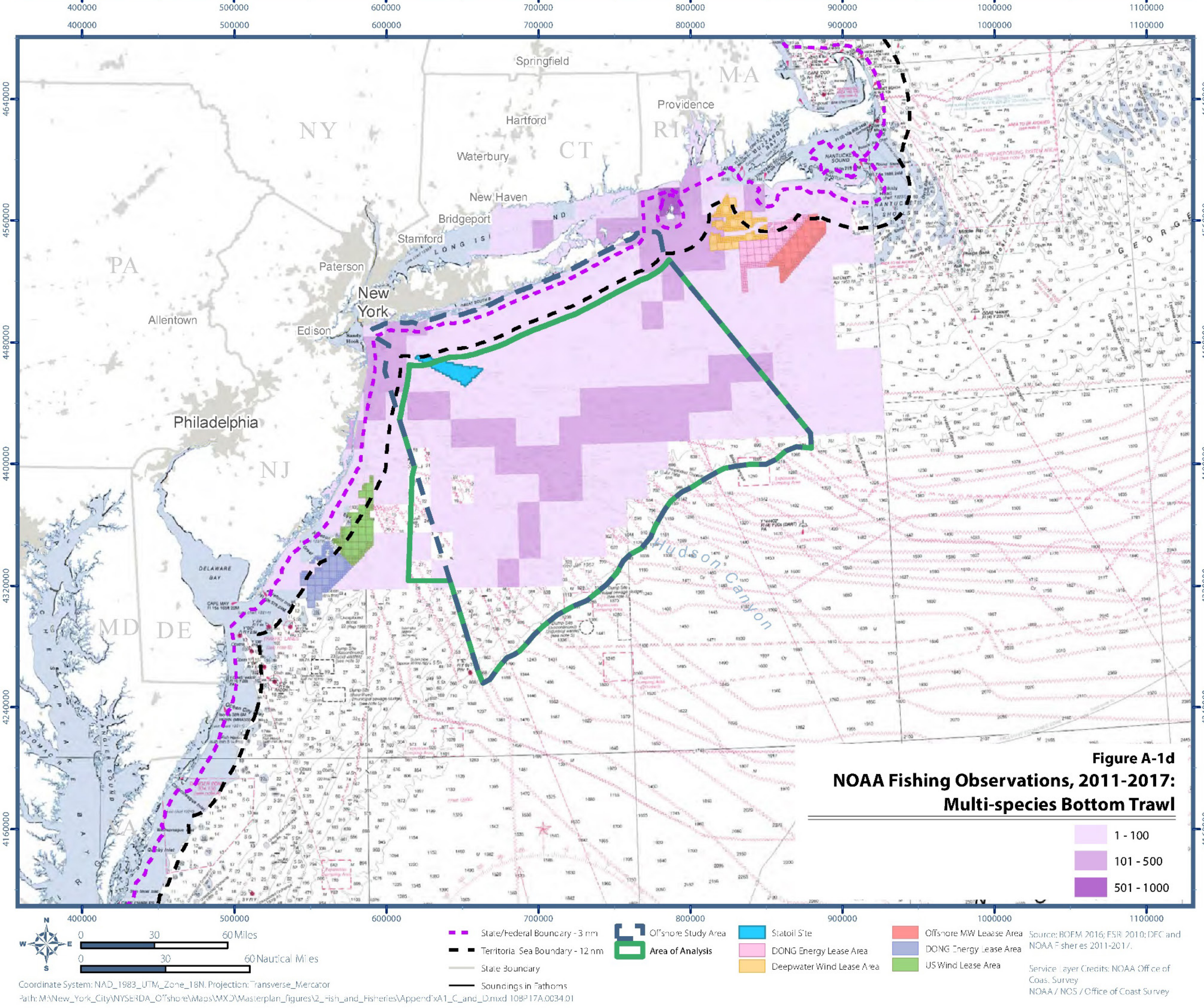
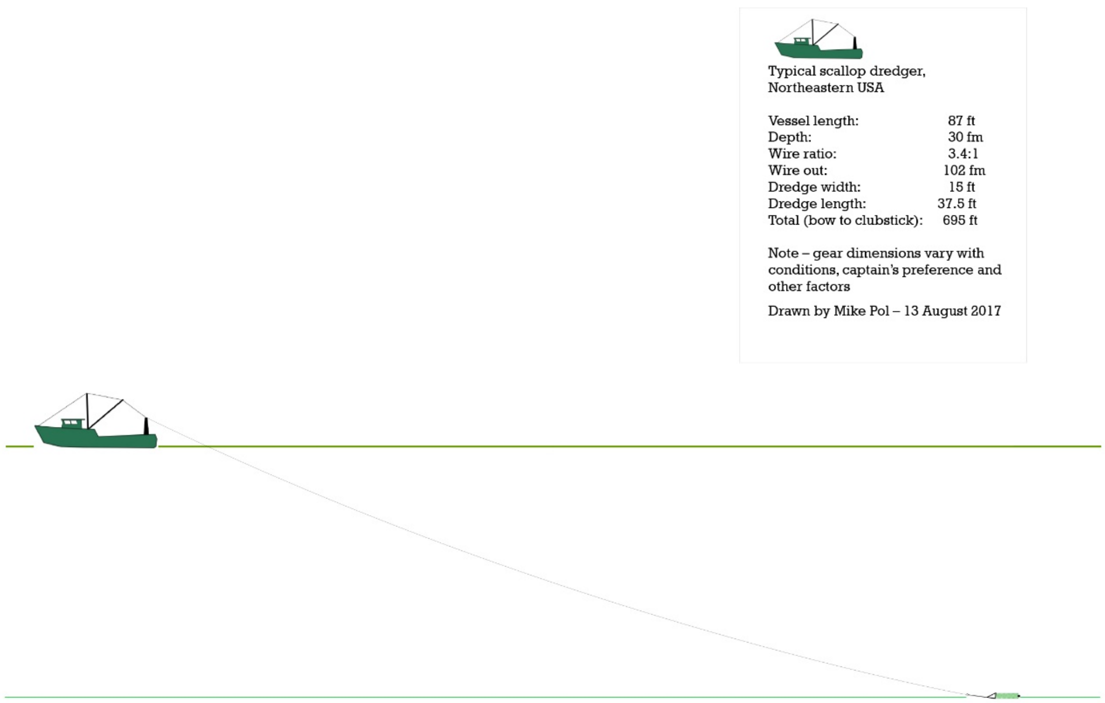
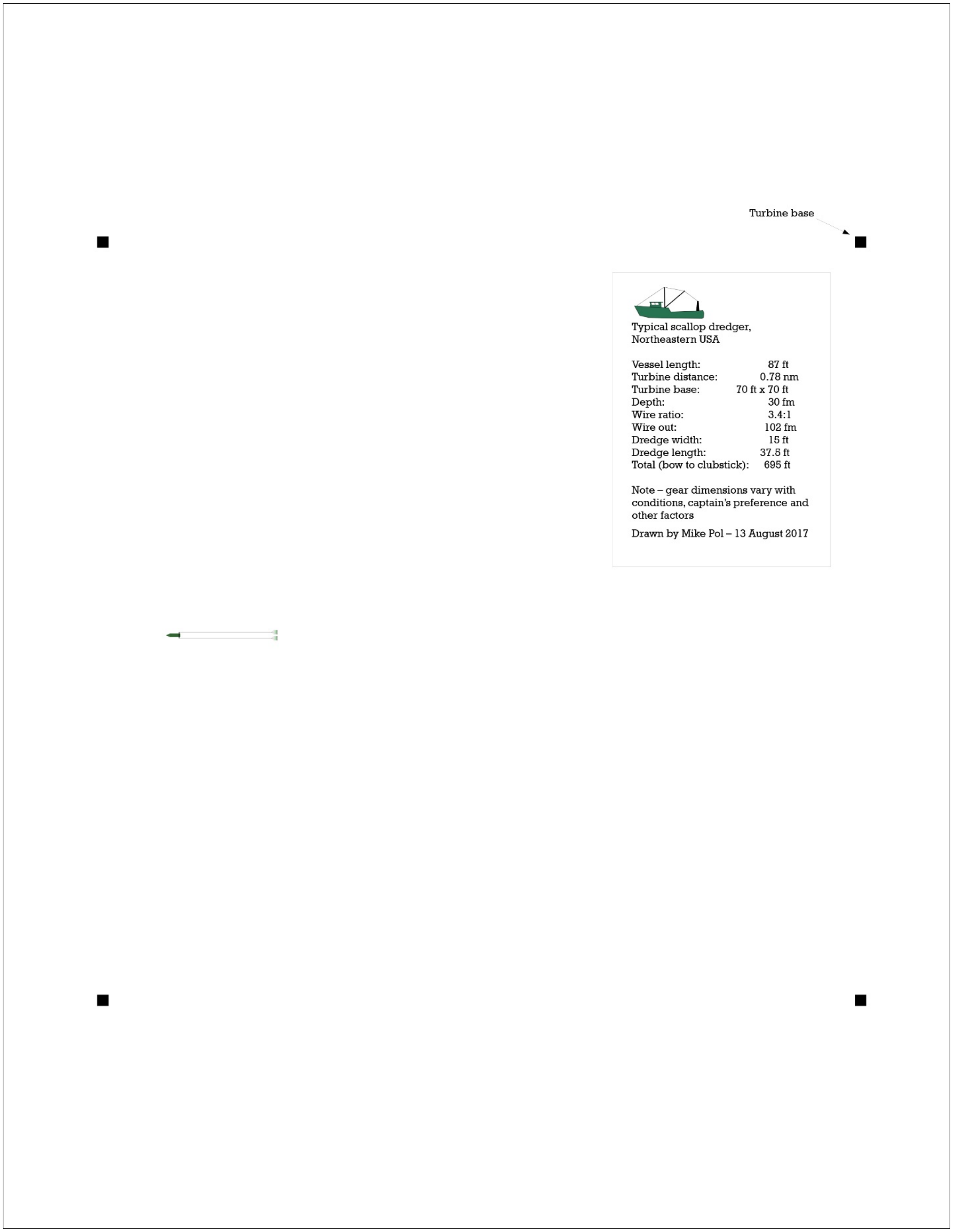
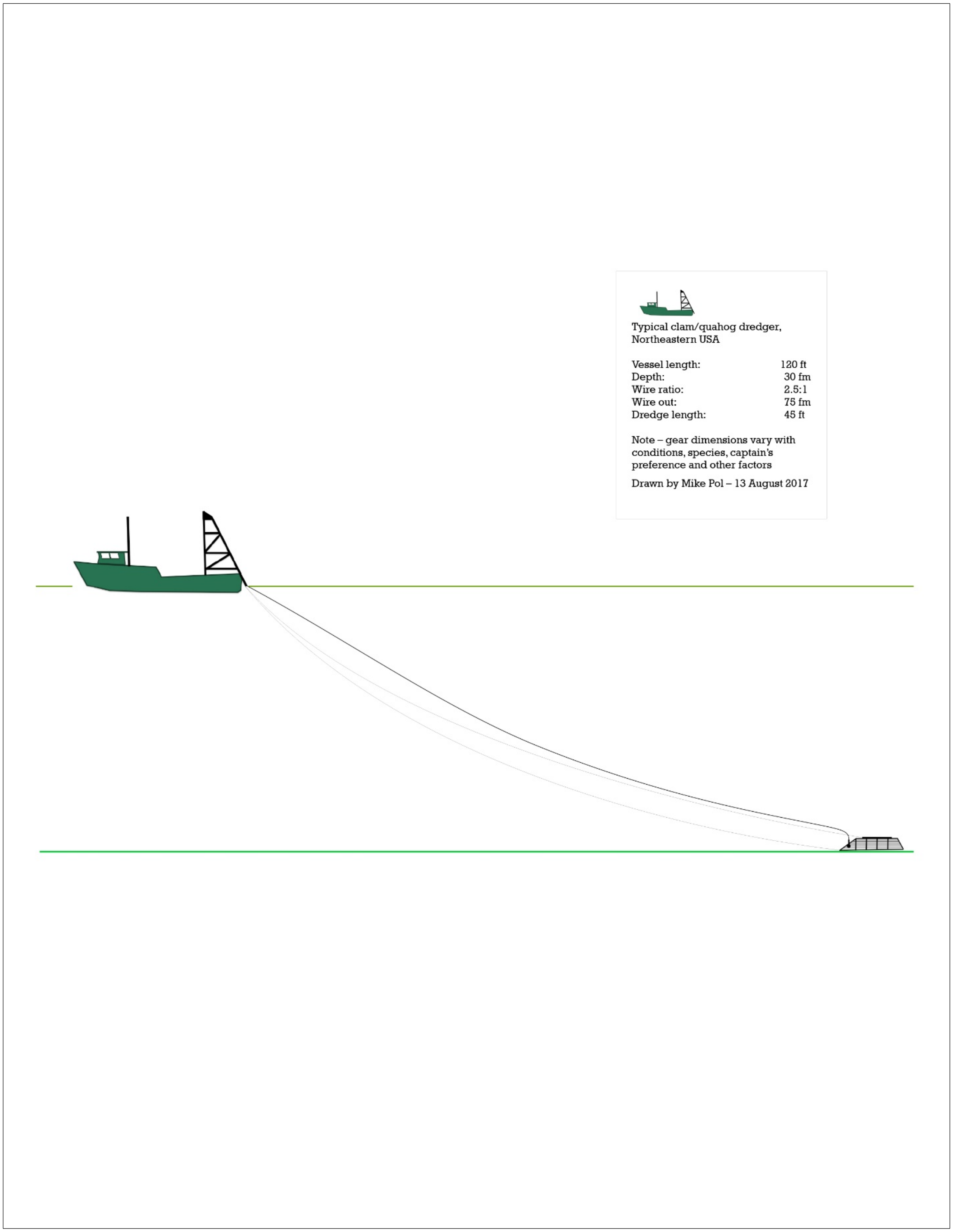


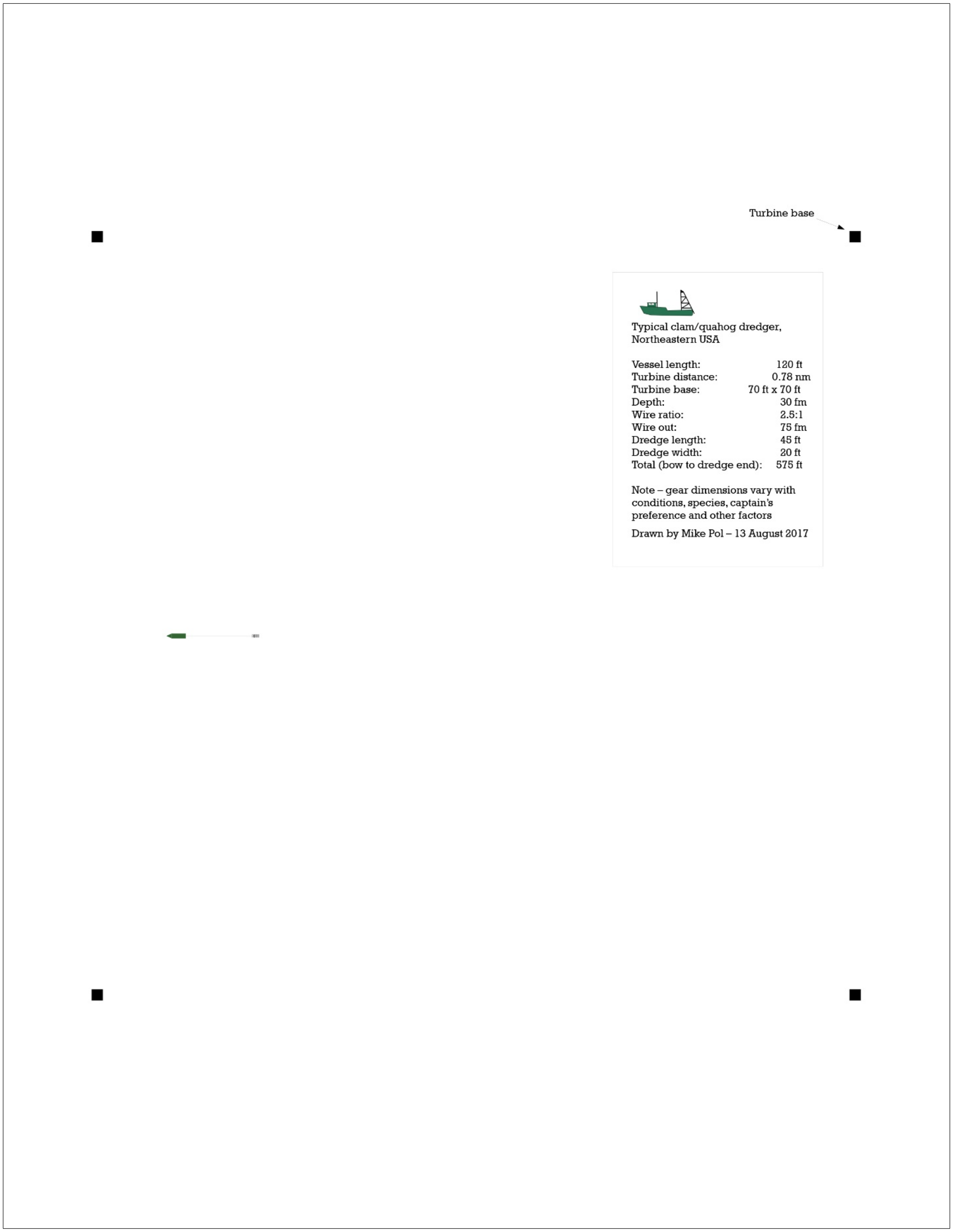
Figure A-1d
NOAA Fishing Observations, 2011-2017: Multi-species Bottom Trawl

Appendix B. Scale Drawings of Fishing Gear Within Offshore Wind Turbines


Typical scallop dredger, Northeastern USA
Vessel length: 87 ft
Depth: 30 fm
Wire ratio: 3.4:1
Wire out: 102 fm
Dredge width: 15 ft
Dredge length: 37.5 ft
Total (bow to clubstick): 695 ft
Note – gear dimensions vary with conditions, captain's preference and other factors
Drawn by Mike Pol – 13 August 2017


Turbine base
Typical scallop dredger, Northeastern USA
Vessel length: 87 ft
Turbine distance: 0.78 nm
Turbine base: 70 ft x 70 ft
Depth: 30 fm
Wire ratio: 3.4:1
Wire out: 102 fm
Dredge width: 15 ft
Dredge length: 37.5 ft
Total (bow to clubstick): 695 ft
Note – gear dimensions vary with conditions, captain's preference and other factors
Drawn by Mike Pol – 13 August 2017


Typical clam/quahog dredger, Northeastern USA
Vessel length: 120 ft
Depth: 30 fm
Wire ratio: 2.5:1
Wire out: 75 fm
Dredge length: 45 ft
Note – gear dimensions vary with conditions, species, captain's preference and other factors
Drawn by Mike Pol – 13 August 2017


Turbine base
Typical clam/quahog dredger, Northeastern USA
Vessel length: 120 ft
Turbine distance: 0.78 nm
Turbine base: 70 ft x 70 ft
Depth: 30 fm
Wire ratio: 2.5:1
Wire out: 75 fm
Dredge length: 45 ft
Dredge width: 20 ft
Total (bow to dredge end): 575 ft
Note – gear dimensions vary with conditions, species, captain's preference and other factors
Drawn by Mike Pol – 13 August 2017

Appendix C. Population Structure and Distribution Studies for Offshore Wind Projects

Population structure and distribution studies for offshore wind projects are typically conducted by the developers, contractors, or their associates and utilize standardized sampling methods to collect data on the potential effects of offshore wind projects for various stages of construction (i.e., pre-construction, construction, and operation). These types of surveys may be used to inform siting and development, construction, and operation, as well as site-specific mitigation, if necessary. Other studies have been undertaken to better understand the impacts of offshore wind development as and after they are constructed. This section presents summaries of the methods used to conduct environmental monitoring at various offshore wind energy development projects in the United Kingdom (UK), Denmark, Sweden, and the Unites States. These surveys consistently address population and distribution changes of fish species and habitat alterations as a result of construction practices (sediment disruption, pile driving, etc.), continuous noises from wind farm operation, in-water wind turbine structures, as well as any electromagnetic field (EMF) disturbance due to buried cables. These surveys are most often conducted by specialized researchers or environmental consulting firms; however, in some cases, the surveys have been entirely conducted or facilitated by members of the local fishing communities. Existing surveys include specimen sampling using bottom trawls or dredges, benthic grabs, diver sampling or video recording, and pound nets. In situations where the monitoring surveys were unable to collect appropriate sample sizes for yearly comparisons, it is common practice to rely upon the long-term sampling efforts of states or regional agencies to support the analysis of offshore wind energy development impacts on fish and fisheries.

Many of the developments described here were constructed in the early 2000s and have provided valuable information for more recent developments. Unfortunately, information pertaining to pre-construction and post-construction environmental monitoring of many of the more recent developments are proprietary information and are not yet available. It is expected that the newer developments will follow suit in performing similar monitoring studies.

C.1 United Kingdom Offshore Wind Energy Project Studies

C.1.1 North Hoyle Offshore Wind Farm

The North Hoyle Offshore Wind Farm, which is located approximately 6 kilometers (km) off the North Wales coast at Prestatyn, features 30 turbines generating a maximum export capacity of 60 megawatts (MW). Offshore construction began in 2003 and finished in 2004. Pre-construction and post-construction monitoring for biological resources was conducted for the development of North Hoyle. Five years' of monitoring data (from 2001 through 2006) were analyzed to fully examine the impacts of offshore wind turbines on benthic organisms and fish fauna (CEFAS 2009; NWP Offshore Ltd. 2003).

NPower Renewables conducted pre- and post-construction trawl surveys; however, due to very low catches before construction, there are no comparable pre- and post-construction survey data of the fish communities (NPower Renewables 2005). Determinations of fishery impacts relied on agency data and sampling (Michel et al. 2007).

National Wind Power (NWP) Offshore Ltd. conducted pre-construction surveys of benthic organisms in September 2002 for the development of the North Hoyle Offshore Wind Farm. NWP Offshore Ltd. took samples of these organisms at 17 predetermined locations in and around the offshore wind farm development site using a 0.1-meter^2 (m^2) Day grab method over a two-day period. Three samples were collected at each site, along with a single sediment sample (NWP Offshore Ltd. 2003).

The Centre for Environment Fisheries and Aquaculture Science (CEFAS) produces annual beam trawl survey reports on the relative abundance of demersal fish species in the vicinity of the North Hoyle Offshore Wind Farm. Data from the 2006 report, when compared to the baseline data of 2001, indicate that the impacts of offshore wind development on fish were minimal and dissipated very quickly. The 2005 report identified a slight decline in commercial catches in 2004 and 2005, but there was no significant impact on the fish (NWP Offshore Ltd. 2007; CEFAS 2009).

C.1.2 Kentish Flats Offshore Wind Farm

Kentish Flats is located in the Thames Estuary off the coast of Kent, England, about 8 to 10 km north of Herne Bay and Whitstable. The wind farm consists of 30 turbines with a capacity of 90 MW (CEFAS 2009; Vattenfall 2009). The Swedish power company and developer Vattenfall performed technical surveys and studies that provided pre-construction, post-construction, and annual sampling data on the benthic invertebrates and fish within the development site and along the cable route of the Kentish

Flats Offshore Wind Farm. Pre-construction monitoring was conducted in 2004, and post-construction monitoring began in late 2004 and finished by the end of 2007. The surveys were designed to provide population data on invertebrate and fish communities and their habitats in the offshore study area (Vattenfall 2009).

The sampling sites included the following: five sites within the wind farm area; three sites within the near field area; eight sites spaced out around the wind farm area; three sites along the cable route; and four sites nearby but further removed from the wind farm area to act as controls. Benthic samples were collected using a Hamon grab 0.1-m^2 and a 2-m beam trawl (Vattenfall 2009).

Seasonal fish trawl surveys were conducted both pre-construction and post-construction in order to understand the influence of wind farm development on local fish populations. Pre-construction surveys were performed in April, June, and August 2004, and post-construction surveys were performed in July and October 2005, and March and June 2006. These surveys involved the use of triple-rigged otter trawls and bass trawls used by the local commercial fishers in the wind farm area and at a remote reference site to sample both pelagic and demersal species (Vattenfall 2009). Based on the findings from the fish monitoring, Vattenfall concluded that construction and operation of the Kentish Flats Wind Farm has not had any largely harmful or long-term effects on fish populations in the area (Vattenfall 2009; CEFAS 2009).

C.1.3 Barrow Offshore Wind Farm

The Barrow Offshore Wind Farm is a 30-turbine, 90 MW installment located off the coast of England in the eastern Irish Sea. As a supplemental requirement of its Food and Environment Protection Act license, Barrow conducted baseline and post-construction monitoring to determine the species richness and distribution of fish in the vicinity of the Barrow Offshore Wind Farm. The wind farm was constructed in 2005 and 2006, and post-construction surveys were conducted in 2006 and 2007 (CEFAS 2009; NIRAS 2007).

Otter trawling and beam trawling methods were used for each survey. Otter trawling was used to survey adult commercial species, and beam trawling was used to survey juvenile fish and invertebrates (NIRAS 2007). Catches from within the wind farm area were compared to control sites outside of the wind farm area (NIRAS 2007). Based on the results of these trawling surveys, Barrow concluded that construction and operation of the Barrow Offshore Wind Farm has not resulted in changes in the male/female ratios, nor were any significant species distribution or population changes observed (NIRAS 2007; CEFAS

2009). Post-construction EMF measurements have not been conducted due to sufficient existing data. The cable type, sediment type, and current direction studied at Burbo Power Offshore Wind Farm (see below) by Collaborative Offshore Wind Research into the Environment (COWRIE) are thought to be comparable to those at the Barrow Offshore Wind Farm (CEFAS 2009).

C.1.4 Burbo Bank Offshore Wind Farm

The Burbo Bank Offshore Wind Farm is located on the Great Burbo Flats in Liverpool Bay, England. The farm is comprised of 25 turbines and is capable of generating 90 MW of electricity. Baseline studies, pre-construction monitoring, construction monitoring, and post-construction monitoring were conducted for this wind farm. In spring 2006 through 2008, annual 4-m beam trawl surveys were conducted, and in fall 2005 through 2008, annual 2-m beam trawl surveys were conducted. The developer, Ørsted, also reviewed fisheries data from other independent surveys, anecdotal information obtained through the Fisheries Liaison officer, and other sources. Some of the fish surveys were conducted by local fishers. Based on the results of the initial trawling surveys, construction and operation of the Burbo Bank Offshore Wind Farm has had no significant effects on the fish population or distribution (CEFAS 2009). However, the final statistical comparison of all years of surveys was not available.

Monitoring was conducted in collaboration with COWRIE EMF studies[1] (Gill et al. 2009). EMF generated by the cables were monitored in situ using pod data loggers. The pod data loggers recorded the EMF emissions and its characteristics relative to their orientation and distance from the cable (Gill et al. 2009). The COWRIE EMF study suggests that the maximum EMF emissions at Burbo are below the values that are potentially impactful to fisheries (CEFAS 2009; Gill et al. 2009).

C.1.5 Reef Effect Investigation of United Kingdom Offshore Wind Farms

In 2007, the Scottish Association for Marine Science (SAMS) and PML Applications Ltd. prepared a literature review for the UK Department for Business, Enterprise and Regulatory Reform to analyze the artificial reef effect of offshore wind structures. This was chiefly done by conducting a desktop study of existing information on the likelihood of fish to colonize around offshore wind farm turbines

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[1] The COWRIE EMF studies, referenced as Gill et al. 2009, established by the Crowne Estate (an offshore wind developer and governmental entity), is a study that was commissioned with the objective to determine whether EMF-sensitive fish respond to controlled EMF fields. The study was conducted in the Burbo Bank and North Hoyle Wind Farms, two farms located near Liverpool, England. The study was conducted by a consortium of representatives from Cranfield University, Center for Marine and Coastal Studies, Center for Fisheries, Environment and Aquaculture Sciences, the Centre for Intelligent Monitoring Systems, and the University of Liverpool.

and their scour protection structures. PML Applications Ltd. and SAMS gathered large amounts of data from the Department for Business, Enterprise and Regulatory Reform, the British Ocean Data Centre, the CEFAS, and other online sources. Based on their analysis of the scientific literature, SAMS and PML Applications Ltd. concluded that predictable assemblages of organisms can be found on and around the turbine structures when considering their proximity to adjacent habitats, such as rocky shores. Furthermore, individual species enhancement is dependent on site-specific factors (e.g., characteristics of the artificial reef, indigenous fish populations at the time of development) (Linley et al. 2007).

C.2 Other European Offshore Wind Energy Projects

C.2.1 Yttre Stendgrund and Utgrunden Offshore Wind Farms

To investigate the artificial reef effect of offshore wind structures, Wilhelmsson et al. (2006) performed demersal fish surveys in the Strait of Kalmar in 2003 by conducting a visual census using scuba divers. The sampling area included two locations—Yttre Stendgrund Offshore Wind Farm and Utgrunden Offshore Wind Farm—divided into 72 transects. The transects were located from 1 to 20 m from the monopiles to account for varying fish composition. The large assemblages of demersal and semi-pelagic fish on and near the monopiles indicates that turbine structures act as artificial reefs and fish aggregation structures. There was no depth-related diversity or species richness along the vertical structures, but Wilhelmsson et al. (2006) did discuss that this may be due to insufficient surveying.

C.2.2 Lillgrund Offshore Wind Farm

Lillgrund Offshore Wind Farm is located about 10 km off the coast of southern Sweden and includes 48 turbines capable of generating 110 MW of power. Langhamer et al. (2016) studied the artificial reef effect by examining the response of shore crabs to the Lillgrund Offshore Wind Farm site and at two controlled sites. Shore crabs were sampled during the summers of 2011 and 2012. Two linked double-fyke nets were used to capture the shore crabs at 10 random locations in the wind farm area and at 10 more location at each controlled site. A mark-recapture method was applied to ensure that proper shore crab quantities were recorded. Due to very low recapture rates, Langhamer et al. (2016) explains that this study does not accurately show changes to shore crab population at Lillgrund Offshore Wind.

C.2.3 Horns Rev Offshore Wind Farm

Horns Rev Offshore Wind Farm is situated 15 km off the coast of western Denmark and contains 80 turbines capable of generating 160 MW. Baseline studies were produced from eleven years of beam trawl data from two Dutch research vessel surveys (Sole Net Survey and the Beam Trawl Survey) conducted in the North Sea (Ørsted and Vattenfall 2006; DIFRES 2000).

Additionally, Jensen et al. (2003) investigated the impacts of the construction of Horns Rev Denmark in 2002 on sandeels. The study involved pre- and post-construction density surveys (post-construction density surveys were 1 year after construction, and two and/or three years after construction). A sandeel dredge was used to obtain the samples from the seabed. Jenson et al. (2003) found the greatest abundance of sandeels in the area outside of the wind farm and therefore outside of the direct impact area.

C.2.4 Nysted Offshore Wind Farm

Nysted Offshore Wind Farm is located 10 km south of Lolland, Denmark, and consists of 72 turbines capable of generating about 165 MW (Ørsted and Vattenfall 2006). A baseline study was conducted for two years to develop a baseline study of fish at two identical sampling locations in early summer, and a baseline study of fry was conducted with three identical sampling sessions in the fall.
The field study consisted of sampling every second day from 4-pound nets placed along the cable trace. The 4-pound nets were modified in 2002 into directional 2-pound nets to study the directionality of the fish movements. Additionally, an Aquadopp Current Meter with automatic and continuous logging was placed between the pound nets and logged measurements of conductivity, temperature, current speed, and direction. The study analyzed the catch per unit effort and weight to determine different catches in the directional pound nets (Bio/consult 2002, 2003, as cited in Ørsted and Vattenfall 2006).

Post-construction hydro-acoustic surveys were carried out along transects inside and outside the wind farm using a split-beam transducer mounted on a pan-and-tilt unit attached to the side of a survey vessel. The hydro-acoustic surveys were conducted to quantify fish stocks around the new hard structures. Underwater video and supplementary fishing was performed simultaneously with the acoustic surveys to determine the species composition and calibrate the acoustic signals (Ørsted and Vattenfall 2006). The fishing was carried out with survey gill nets and a small pelagic trawl. (Hvidt et al. 2006).
The results of the post-construction surveys indicated that the fish communities at Nysted Offshore Wind Farm have not experienced distribution effects directly due to construction. (Ørsted and Vattenfall 2006).

C.3 United States Offshore Wind Energy Projects

C.3.1 Block Island Wind Farm

Block Island Wind Farm is a five-turbine installation capable of generating 30 MW. This wind farm is located about 4.8 km southeast of Block Island, Rhode Island, and is the first offshore wind farm in the U.S. Prior to its construction, Deepwater Wind conducted a literature review, including the RI Ocean Special Area Management Plan (RI Ocean SAMP, a comprehensive evaluation of the coastal resources found in and around the area of Block Island Wind Farm) and performed field surveys to evaluate the crustacean and demersal finfish seasonality, abundance, and distribution in the development area. Two fish trawl surveys, including a 2-year pre-construction survey and a 3-year post-construction survey, were scheduled in Deepwater Wind's Environmental Report (2012) to provide an impact assessment of the local demersal finfish. These surveys were intended to provide information on the seasonality of finfish and post-construction impacts on their community (Deepwater Wind 2012). Deepwater Wind also proposed to conduct a ventless trap survey to gather information on lobsters in and around the wind farm area. This survey involved a 1-year pre-construction survey and, at a minimum, a 1-year post-construction survey to evaluate the lobster community. Deepwater Wind did not predict effects on benthic organisms and sited the wind farm such that there would be minimal impacts on finfish. It was expected that the short-term construction activities would result in temporary displacement of finfish due to disturbances of habitat (Deepwater Wind 2012). Surveys for the Block Island Wind Farm began in 2012 and are ongoing; however, survey reports are not currently publicly available. Once completed, statistical models can be used to determine whether there are differences in survey results before, during and post-construction and examine the potential effects of wind turbine construction and operation on lobster populations.

C.3.2 New Jersey Baseline Study for Offshore Wind Energy Development

The New Jersey Ocean Stock Assessment (New Jersey OSA) Program conducted field sampling to survey fish and invertebrate populations in the waters off New Jersey's coast for the purpose of pursuing offshore wind farm development. Surveys were completed using a three-in-one otter trawl. The study area, which borders a barrier island chain along New Jersey's coast, was divided into 15 areas based on location and depth in order to capture spatial dynamics. Beginning in 1991, the annual surveys have consisted of 39 hauls for each survey; two hauls from each strata and nine additional hauls from the larger of the strata. The New Jersey Department of Environmental Protection (NJDEP) gathered the ocean trawl data from the New Jersey OSA Program from 2003 through 2008 to determine the representative fish and invertebrate species in the study area. The data were then sorted into two groups according to economic value and landings of the fish and invertebrates. The NJDEP concluded that the coastal waters of New Jersey within the study area contain valuable commercially and recreationally caught fish. There is annual variability of fish in the area, exhibiting different ranges in both abundance and seasonality (NJDEP 2010).

C.3.3 Cape Wind Offshore Wind Energy Project

Cape Wind Associates and the former Minerals Management Service initiated a comprehensive evaluation of the biological resources in Nantucket Sound, Massachusetts, as part of an environmental impact statement (EIS) for a proposed offshore wind farm. The Minerals Management Service published a Notice of Intent in the Federal Register in 2006. Existing data were aggregated to examine fish seasonality, occurrence, distribution in the proposed project area, and species abundance. The Massachusetts Division of Marine Fisheries (MassDMF) collects bi-annual trawl survey data on the distribution and abundance of fish and invertebrate species in Massachusetts' state waters, and these data were used for this project. These surveys are fishery-independent and have been performed during spring and fall every year since 1978. These data and other available fisheries data from the Division of Marine Fisheries and the National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) were used in the analysis of the project area. Cape Wind Associates expects impacts on fisheries resources as a result of wind farm construction; however, they concluded that the duration and severity of these impacts would be variable. Specifically, the EIS discussed that it is possible that demersal fish species are more likely to experience higher mortality rates due to slower response and avoidance time (Minerals Management Service [MMS] 2009).

C.3.4 Wilmington-East Wind Energy Area

The Bureau of Ocean Energy Management (BOEM) has identified the Wilmington-East Wind Energy Area (Wilmington-East WEA) is a potential offshore wind farm site. The WEA is located in Long Bay off the coast of North Carolina, about 29 km south of Bald Head Island and extending 50 to 55 km to the south-southeast. A baseline assessment of benthic communities and habitats was conducted in the Wilmington-East WEA through the collaboration of the University Of North Carolina Institute Of Marine Sciences, BOEM, and NOAA's National Centers for Coastal Ocean Science. This survey involved the use of a split-beam echsounder to detect fish within the water column by emitting high-frequency pulses of sound through the water and recording the echo from fish and other objects of varying densities. The purpose of the survey was to obtain data on the distribution of representative fish species within the WEA. The results of the survey indicated that diverse communities of organisms are likely to be found at highly complex structures. Tall hardbottom ledges supported higher values of species richness, abundance, and overall biomass. Moreover, hard-bottom habitats contained largely diverse communities of corals (hard and soft), bryozoans, and macroalgae species (BOEM 2016a).

C.3.5 Rhode Island/Massachusetts Wind Energy Area

The Rhode Island lobster industry, the University of Rhode Island, and Roger Williams University worked together to develop a ventless trap survey protocol for determining seasonal patterns and distribution of American lobster. This consortium then conducted two years (2014–2015) of pre-construction monitoring within the Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA) in southern New England. Twenty-four predetermined lease blocks within the RI/MA WEA were selected for monitoring. Each lease block was divided into five subdivisions, and one of the five subdivisions at each lease block was randomly chosen for sampling. A new set of subdivisions was chosen for sampling during each year (Collie and King 2016).

Ventless traps were alternated with standard traps to account for comparable commercial catch rates. It was concluded from the surveys that lobsters prefer boulder habitats to sandy sediments. In the RI/MA WEA, lobster abundance increased with depth; however, this is not very reliable due to the limited range in depth within the WEA. Temperature along the benthos was the best indicator of lobster presence. The optimal temperature range for lobsters within the WEA is 12 to 18 degrees Celsius; the summer months, particularly August and September, yielded the highest catch rates of lobsters. The Jonah crab was the most abundant species caught during this series of surveys (Collie and King 2016).

C.3.6 Pacific Northwest Offshore Continental Shelf

Henkel et al. (2014) performed a study to evaluate mega-invertebrate communities and their habitats along the Pacific Northwest Offshore Continental Shelf. This band of offshore area is an increasingly important location for offshore wave and wind energy development. To better understand macroinvertebrates and their ecology in this area, Henkel et al. aggregated diver data that were collected during the early 1990s and compared it to a series of recent dives from 2011–2012. Oregon State University geologists used a manned submersible in the early 1990s to survey the sea floor off the coast of Oregon and Washington at three separate sites. In late August 2011, Henkel et al. used a remotely operated vehicle to survey for macroinvertebrates and their habitat at the same three locations. After analysis of the video recordings, Henkel et al. determined that substrata of higher relief consolidated rock supported high densities and diversities of sessile organisms, while more motile organisms were found in habitats containing unconsolidated sediments (Henkel et al. 2014).

C.3.7 BOEM Environmental Studies Program: Ongoing Studies

The U.S. Naval Facilities Engineering Command is conducting a study in and around the Virginia WEA and the Sandbridge Shoal sand borrow site in BOEM's Mid-Atlantic Planning Area to provide BOEM with information on the distribution, seasonality, and abundance of the endangered Atlantic sturgeon population within this area. The study involves the use of previously tagged Atlantic sturgeon in the Mid-Atlantic from other research programs, supplemented with fish caught in the offshore area of Virginia. Acoustic tags are attached to individual fish, and passive acoustic receivers are placed along the seabed to track fish movement. Additional receivers will be deployed in the WEA to acquire locational data specific to Atlantic sturgeon in that area. The first three years will be primarily fieldwork and data collection, and the last two years will consist of data aggregation and analysis, ending in 2020. Data downloaded from the passive acoustic receivers and data from mobile surveys conducted by autonomous underwater vehicles (AUVs) will be synthesized and evaluated in the overall analysis. The project kick-off meeting was held in October 2015, deployment of receptors was completed in s pring 2016, and the final report is scheduled to be completed in July 2020 (BOEM 2017a).

Stony Brook University, with support from the New York State Department of Environmental Conservation (DEC), is using acoustic telemetry to track fish movement in the North Atlantic. Acoustic tags are attached to individual fish, and passive acoustic receivers are placed along the seabed. BOEM is expanding the range of this monitoring effort by placing acoustic receivers along the Outer Continental Shelf (OCS) with particular focus on the New York WEA. Specifically, BOEM is targeting the endangered Atlantic sturgeon population by tagging 100 individuals along with 118 individuals of other fish species of commercial importance within the New York WEA. A minimum of 31 receivers will be placed within the New York WEA. The relative abundance of the tagged fish species can be calculated from the results of this monitoring effort. The acoustic receivers were deployed in fall 2016, and fish tagging began in 2016 and will continue in 2017. The final report is scheduled to be completed in winter 2017 (BOEM 2017b).

The University of Delaware and Delaware State University are also using acoustic telemetry to track fish movement in the mid-Atlantic; the method of fish tagging is comparable to that used by Stony Brook University. BOEM will expand the monitoring area to include the Delaware WEA (DE WEA) along the OCS to study the seasonal occurrence and habitat use of this area by Atlantic sturgeon and winter skates. Fifty Atlantic sturgeon and 50 winter skates in the DE WEA have been tagged, along with other commercially important fish in the area. BOEM has deployed 25 acoustic receivers in the DE WEA for a total of two years. Mobile surveys are scheduled to be conducted by AUVs, which take measurements of temperature, salinity, and oxygen. Finally, habitat models for Atlantic sturgeon and winter skates will be developed following the completion of the surveys. Fish tagging and the deployment of acoustic receivers were completed in spring 2017. This study will continue through 2018, and the final report is scheduled to be completed in March 2019 (BOEM 2017c).

The NOAA Fisheries is conducting a study within proposed WEAs from Massachusetts to North Carolina to provide BOEM with baseline information of benthic habitats and epibenthic macroinvertebrate communities. The data will enable BOEM to improve offshore wind energy development siting and provide developers with a baseline to inform project decisions. The monitoring method involves the use of multi-beam sonar and imaging surveys of benthic habitat at 11 identified WEAs. The imaging surveys will consist of high-resolution geophysical surveys, videography, and still imagery to ensure complete analysis of the benthic habitat. The project began in 2013, and the final report is scheduled to be completed in January 2018 (BOEM 2017d).

An ongoing study of the effects of EMF on elasmobranchs and lobsters is being conducted by the University of Rhode Island (BOEM 2017e). This study is focusing on two existing offshore cables (the Cross Sound cable and the Neptune cable), and will assess the electric and magnetic fields of the cables by reviewing shutdown, standby, and full power operation modes. Additionally, this study will review the movement of elasmobranchs and lobsters around the cables. Skates and lobsters are being caught and fitted with acoustic telemetry tags, placed in 24-hour holding enclosures, and placed either on a cable or at a controlled distance from a cable, and are then monitored with GoPro© cameras and floating hydrophones (BOEM 2017e).

HDR Environmental is conducting Real-time Opportunity for Development Environmental Observations (RODEO) at the Block Island Wind Farm, using real-time observations of construction and initial operation stages, which will help gage potential environmental effects of future wind facilities (BOEM 2017f). These real-time observations will include the following assessments: sound environment during construction; visual activities during and after construction; air quality emission sources during construction; sediment disturbance and recovery; mitigating or abatement measures; and monitoring technologies/techniques (BOEM 2017f). This study is underway with a projected finish date in December 2019.

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Appendix D. Summary Tables of Fish and Fisheries BMPs from Other Offshore Wind Studies

The guidelines and best management practices (BMPs) presented in the subsequent tables include a summary of the following regulatory guidance and BMP documents and documents summarizing planning workshops and stakeholder engagement meetings related to offshore wind and fish and fisheries:

- Bureau of Ocean Energy Management (BOEM) 2015 – Guidelines for Providing Information on Fisheries Social and Economic Conditions for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 Code of Federal Regulations (CFR) Part 585.
- BOEM 2013 – Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585.
- BOEM n.d.(a) – Previously Identified Offshore Wind Development Concerns.
- BOEM n.d.(b) – Possible Best Management Practices and Mitigation Measures to Reduce Conflicts between Fishing and Wind Industries.
- Hooker 2014 – Bureau of Ocean Energy Management Fishing and Offshore Energy - Best Management Practices.
- McCann 2012 – Developing Environmental Protocols and Modeling Tools to Support Ocean Renewable Energy and Stewardship.
- Ecology and Environment 2014 – Development of Mitigation Measures to Address Potential Use Conflicts between Commercial Wind Energy Lessees/Grantees and Commercial Fishermen on the Atlantic Outer Continental Shelf: Report on Best Management Practices and Mitigation Measures.
- Virginia Coastal Zone Management Program (VCZMP) 2015 – Collaborative Fisheries Planning for Virginia’s Offshore Wind Energy Area.
- Fishing Liaison with Offshore Wind and Wet Renewables Group (FLOWW) 2014 – Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison.
- Lipsky et al. 2016 – Addressing Interactions between Fisheries and Offshore Wind Development: The Block Island Wind Farm.
- Moura et al. 2015 – Options for Cooperation between Commercial Fishing and Offshore Wind Energy Industries: A Review of Relevant Tools and Best Practices.
- Gray et al. 2016 – Changes to fishing practices around the UK as a result of the development of offshore windfarms – Phase 1.
- Petruny-Parker et al. 2015 – Identifying Information Needs and Approaches for Assessing Potential Impacts of Offshore Wind Farm Development on Fisheries Resources in the Northeast Region.
- Mid-Atlantic Fishery Management Council (MAFMC) 2014 – Offshore Wind Best Management Practices Workshop.

D.1 Strategies

Strategies for BMPs and guidelines have been attributed to the various phases of offshore wind development, as well as to particular themes of concerns or risk types. The following represent the recommended strategies:

1. Using effective stakeholder engagement and communication techniques and practices.
2. Using collaborative monitoring models to develop trusted baseline data.
3. Conducting planning exercises, analysis, site assessment, and site characterizations.
4. Constructing.
5. Implementing safety procedures.
6. Understanding the tradeoffs and mitigating impacts on those most affected.
7. Operating.
8. Decommissioning.

Using Effective Stakeholder Engagement and Communication Techniques and Practices

BOEM BMP 1. Lessees and grantees shall work cooperatively with commercial and recreational fishing entities and interests to ensure that the construction and operation of the project will minimize potential conflicts with commercial and recreational fishing interests.	Hooker 2014
Communications with fisheries should: • Initiated early in project development, communications should continue often, should be ongoing, and be collaborative. • Develop a strong and respected network of stakeholders for consultation. • Work toward an outcome that balances the needs of the fisheries activities and energy development. • Meeting scheduling should be adaptive to times fishers are available. • Ensure parties are aware of the decision-making process and that all information and data are publicly available and easily accessible. • Ensure consistent and accessible messaging that is in plain language and provides visual representations (e.g., technology design, maps of impacted areas). o Communication should be varied, i.e., through direct mailings, letters and emails, and announcements in fisheries trade publications.	BOEM 2015, n.d.(b); Lipsky et al. 2016; VCZMP 2016
Transparency. Developers, agencies, and all stakeholders should facilitate transparency during all phases of the development process.	Lipsky et al. 2016; MAFMC 2014; VCZMP 2016

Using Effective Stakeholder Engagement and Communication Techniques and Practices continued

<table>
<tr><td><u>Development of a Fisheries Communication and Outreach Plan.</u> BOEM recommends that lessees develop and implement a project-specific communication plan. This plan should establish the processes for information sharing in an ongoing way that is credible, transparent, and establishes the role of the diverse commercial and recreational fishing communities and other affected stakeholders. The implementation of the plan will be timely, credible, and will facilitate two-way communication that leverages existing formal and informal outreach. It is recommended that the plan should:

Establish the roles and responsibilities of Fisheries Liaisons and Fisheries Representatives.
Describe plans for communicating with fishers at sea.
Describe any activities to educate the public, with an emphasis on educating fishers and boaters on construction issues and other pertinent alerts.
Ensure the communication is using the information channels that the recreational and commercial fishers are used to, including a mix of direct contact through e-mail, text message, phone calls to land lines and cell phone numbers, U.S. mail, as well as a project-sponsored 24-hour phone service for project information.
Focus on being adaptive and responsive to best ensure the affected industries are effectively and authentically engaged.
Tailor outreach to specific communities, ports, and impacted fisheries.
Focus on developing trust.
For roles, responsibilities and BMPs to facilitate the role of the Fishing Liaison, developers should review recommendations in FLOWW 2014.

BOEM n.d.(a) has developed a list of concerns that should be addressed in any Fisheries Communication and Outreach Plans, including: exclusion zones/access, regulations, communications, siting process, safety, electric and magnetic fields (EMF), radar interference, maintenance, health, fish, liability, and enforcement.</td><td>BOEM 2015; Hooker 2014; Lipsky et al. 2016; MAFMC 2014; VCZMP 2016</td></tr>
<tr><td><u>Establish a Fisheries Liaison.</u> It is recommended that a position or function typically employed directly or contractually by the developer provide fisheries community outreach, communication, and coordination services.
The third-party fisheries liaison is required (OSAMP Sections 560.2.10 and 1160.7.6) to have knowledge and understanding about fisheries, and his or her role is to facilitate direct communication between commercial and recreational fishers. Commercial fishers should have regular contact with and direct access to the fisheries liaison throughout all stages of the project: pre-construction, construction, operations, and decommissioning.</td><td>FLOWW 2014; Lipsky et al. 2016; Moura et al. 2015</td></tr>
<tr><td><u>Establish a Fisheries Representative.</u> It is recommended that a position or function be established, often funded by but not employed by the developer, to "speak for" the fishing community's interests and to conduct outreach/communication. Developers should develop clear guidelines for the selection and responsibilities of the fisheries representative, which can be outlined in the Fisheries Communication and Outreach Plan.</td><td>FLOWW 2014; MAFMC 2014; Moura et al. 2015</td></tr>
<tr><td><u>Government-to-Industry and Industry-to-Industry groups</u>. It is recommended that formal and informal groups (e.g., working groups, advisory bodies, committees) be established with representation from local fishing industry groups, offshore wind developers, and/or government for voicing concerns and facilitating discussions on collaborative problem solving. These groups can be established with the intent to meet regularly, i.e., once a month, to discuss ongoing operations or needs for changes.

Example Group: Port Operational Interface Group. A group of developers, fishermen's associations, and vessel operations contractors that meet regularly to discuss port operations and any need for changes.
</td><td>VCZMP 2016</td></tr>
</table>

Using Effective Stakeholder Engagement and Communication Techniques and Practices continued

Safety Communications Systems. It is recommended that fishers provide input on the development of a safety management system. This system shall describe clear communication protocols with the fishing industry, such as use of Radio Navigational Warnings (via a dedicated VHF channel) and Notices to Mariners.	VCZMP 2016
Cable Communication and Navigational Awareness System. It is recommended that the developer establish a system to ensure fishers/other mariners have access to information about cable placement and other changes that wind farm development may have had on navigation to ensure safe passage and to avoid gear fouling (e.g., websites, updated navigational charts).	Moura et al. 2015; VCZMP 2016
Fishing Industry Capacity Building. It is recommended that developers support the fishing industry by enhancing the capacity of fishing interests to engage on fish/wind or other related issues.	Moura et al. 2015

Using Collaborative Monitoring Models to Develop Trusted Baseline Data

Conduct cooperative environmental monitoring. It is recommended that developers engage and hire multiple interests (industry, fisheries scientists and managers, offshore wind energy developers, and BOEM) to assist in the development of survey protocols, appropriate sampling procedures, and survey design, as well as to collaboratively identify and prioritize data gaps. The involvement of fishers in designing environmental monitoring procedures for commercial finfish and shellfish could improve the understanding of offshore wind impacts, facilitate cooperation, and inform project siting and other decision making. • It is recommended that developers hire locally and include fishers in environmental monitoring and implementation of surveys. • It is recommended that developers value and use traditional and local expert knowledge.	Gray et al. 2016; Lipsky et al. 2016; MAFMC 2014; Petruny-Parker et al. 2015
Ensure BOEM's Fisheries Pre-Construction Survey Guidelines are followed. These guidelines should be used to assess the fisheries ecosystems, facilitate finalizing development plans, and identify and inform mitigation measures.	BOEM 2013; McCann 2012; Petruny-Parker et al. 2015
Ensure adherence to BOEM's guidelines on acquiring information on fisheries social and economic conditions. This should be done in a manner that appropriately solicits information on social and economic conditions of both recreational and commercial fishing activities, e.g., fishing seasons and locations and types of fisheries that could be affected by the lessee's proposed activities.	BOEM 2015
Baseline Data Collection. It is recommended that developers use the best available data on fishing activities and fishery resources to establish environmental and economic baselines and to identify candidate wind energy areas with no- to low-conflict with fishing. • The required research and monitoring should be funded by wind energy developers or wind energy developers and BOEM. • Studies should include: existing benthic and epibenthic biological communities, high-resolution bathymetry and substrate, harvest species abundance, migratory fish patterns, and spatial and temporal fishing patterns by fishery type. • Research priorities should be based on the reproduction, growth, and survival of species that are commercially or ecologically important, have undergone or are in the process of rebuilding, or any species identified for significant impacts or associated with significant uncertainties, or are protected or endangered. • An ideal research program would include different gear types for survey work (including otter and beam trawls, pot/traps, fixed nets, and hook and line) and would be accompanied by acoustic telemetry, icthyoplankton sampling, tissue stomach sampling, visual surveys (habitat cameras), interferometric sonar surveys, and oceanographic observation and modeling (stratification and flow assessments) with data collection occurring during all four seasons. • Data management protocols need to ensure that all resultant data are publicly accessible and available for outside analysis and must include appropriate control sites so that impacts can be properly assessed.	Gray et al. 2016; MAFMC 2014; Moura et al. 2015; Petruny-Parker et al. 2015; VCZMP 2016,
Enhancing Fisheries Science and Management. It is recommended that for any data-poor species, monitoring efforts develop specific measures to enhance the state of the science for these species.	VCZMP 2016

Conducting Planning Exercises, Analysis, Site Assessment, and Site Characterizations

<table>
<tr><td><u>BOEM BMP 2. Lessees and grantees shall review planned activities with potentially affected fishing organizations and port authorities to prevent unreasonable fishing gear conflicts. Lessees and grantees shall minimize conflict with fishing activity and gear by notifying state and federal regional fishery management organizations and local fishing groups of the location and timeframe of the project construction activities well in advance of the mobilization and with updates throughout the construction period.</u>

Establish guidelines that specify when, where, and how exclusion zones can be established.
Develop a detailed publicly available schedule prior to construction.
Both commercial and recreational fishers should be allowed to continue their activities with as few disruptions as possible.
Highly valued grounds should be disrupted as little as possible at those times of year that provide the best fishing opportunities and during vulnerable times for the species (i.e., during spawning and foraging).
The developer should consult with fishers to inform project siting, turbine location, spacing and design, and inter-array and transmission cable routes and design, the earlier in the process the better.
</td><td>Hooker 2014; MAFMC 2014; VCZMP 2016; Gray et al. 2016; Moura et al. 2015</td></tr>
<tr><td><u>Cable Route Planning, Installation, and Removal Techniques.</u> It is recommended the developer obtain input from the fishing community on cable route selection for all cables and proposed installation and removal methods. Planned cable corridors should reflect an understanding of local fishing attributes so that high-quality fishing areas are avoided, trenching activities will not expose risks or other material that could negatively impact trawling or other similar activities, and cable-burial techniques adhere to the most current technical methods for minimizing electromagnetic fields and to minimize interactions with mobile fishing gear to the greatest extent practicable.</td><td>Ecology and Environment 2014; Moura et al. 2015</td></tr>
<tr><td><u>Dockside Facility Coordination.</u> It is recommended the developer investigate with the fishing communities and ports any impacts on dock access, fuel access, or other activities that might interfere with fishing operations.</td><td>Ecology and Environment 2014</td></tr>
<tr><td><u>Wind Facility Configuration.</u> It is recommended the developer consider many alternative wind facility configurations, including size, spacing, and access route planning. Developers should consider the following in their siting studies: important fishing areas, transit schemes, fishing gear clearance issues, safety, and likelihood for future wind development in the local area.

It is recommended the developer, to the greatest extent practicable, consider "micro-siting" options such as modest changes to turbine locations to protect routes, fishing ledges, reefs or other natural features conducive to fish congregation, breeding, rearing, and or juvenile activity.

Additionally, it is recommended the developer consider turbine layouts that minimize contiguous barriers that may restrict the normal flow of water bodies, larvae, eggs, and other planktonic resources and that may potentially run parallel to the migration routes of key species.</td><td>Ecology and Environment 2014; Petruny-Parker et al. 2015</td></tr>
<tr><td><u>Turbine Micro-Siting.</u> It is recommended that the developer consider fishing ground characteristics and access issues for various vessel and gear types.

Avoid placement in critical habitat areas and along migration routes.
</td><td>Moura et al. 2015; VCZMP 2016</td></tr>
<tr><td><u>Vessel Transit Considerations.</u> It is recommended that the developer consider routing options to improve navigational safety in areas where freedom of vessel movement is inhibited by restricted ocean space and other obstructions to navigation.</td><td>Moura et al. 2015</td></tr>
<tr><td><u>Platform Design Considerations.</u> It is recommended that the developer use materials and turbine platform designs that are conducive to minimizing negative impacts.</td><td>Petruny-Parker et al. 2015</td></tr>
</table>

Constructing

<u>BOEM BMP 3.</u> Lessees and grantees shall use practices and operating procedures that reduce the likelihood of vessel accidents and fuel spills. Lessees and grantees shall avoid or minimize impacts on the commercial fishing industry by marking applicable structures with U.S. Coast Guard-approved measures to ensure safe vessel operation. • It is recommended the developer institute measures or a spill control plan to facilitate the prevention of and response to accidents and spills in wind energy areas. This plan should include reduced speed zones and a pollutant and debris removal plan.	Hooker 2014a; Petruny-Parker et al. 2015
<u>BOEM BMP 4</u>. Lessees and grantees shall avoid or minimize impacts on the commercial fishing industry by burying cables, where applicable, to avoid conflict with fishing vessels and gear operation. If cables are buried, lessees and grantees shall inspect cable burial depth periodically during project operation to ensure that adequate coverage is maintained to avoid interference with fishing gear/activity.	Hooker 2014a
<u>Coordinating Construction Schedules.</u> It is recommended that developers consider temporal factors in scheduling construction activities to minimize impacts on fisheries and fishing activities, avoid high-use areas, and reduce conflicts with seasonal or other closure periods. Schedules will be publically available to reduce conflicts with fishing schedules.	Ecology and Environment 2014; VCZMP 2016
<u>Minimization of Scour and Sedimentation.</u> It is recommended that developers evaluate scour and sedimentation potential through modeling. Lessees will work with BOEM to design a scour protection system to reduce and minimize impacts on sediment near the tower base.	Ecology and Environment 2014
<u>Minimization of Turbidity.</u> It is recommended that the developer use technology and construction methods to minimize disturbance and turbidity during construction, operation, and decommissioning.	Ecology and Environment 2014
<u>Maximize Fishing Access.</u> It is recommended that the developer maintain fishing access to a wind farm site to the maximum extent practicable during all phases of wind farm development and operation.	Moura et al. 2015
<u>Turbine Markings</u>. It is recommended that the developer use warning lights, including marine navigational lighting, and avian obstruction lighting, radar beacons, and reflective tape on turbines for navigational safety.	Moura et al. 2015
<u>Employ Construction Noise-Reduction Measures</u>. It is recommended that the developer avoid the use of impact pile-driving methods, if possible, by using alternatives such as vibratory hammers, drilled shafts, or press-in piling. Use bubble nets, acoustic harassment devices, and or slow-start procedures to reduce noise exposure and minimize impacts on mobile organisms. Also, schedule noise-generating activities in closed fishery seasons.	Moura et al. 2015.; Petruny-Parker et al. 2015
<u>Cable burial.</u> • It is recommended that developers bury submarine cables at a depth sufficient to create a physical barrier between cables and fishing gear to minimize risk to fishing gear, and between cables and EMF-sensitive species to minimize impacts on those species and reduce heat radiation into the water column. • It is recommended that developers require the continued monitoring of cable route and reburial if cables become uncovered. Developers may hire fishers to conduct surveys. • It is recommended that developers use two or more parallel cables in each cable route with electric currents running in opposite directions (bipolar system of transmission) to offset EMF and minimize their strength. Otherwise, wrap cables with highly permeable materials or materials with high conductivity to reduce the strength of EMF.	Petruny-Parker et al. 2015; Moura et al. 2015

Constructing continued

Install Scour-Protection Devices. These devices should be installed around turbine foundations at the time of construction and use midline buoys on anchor sweeps to minimize negative benthic impacts from anchor line sweeps.	Petruny-Parker et al. 2015
Minimize Impacts on Sensitive Habitat. During construction and maintenance work, it is recommended that developers provide vessel operators with detailed maps that identify sensitive habitat areas so as to minimize anchoring.	Petruny-Parker et al. 2015

Implementing Safety Procedures

Port and Shoreside Improvements. It is recommended that the developer and/or the port fund improvements to onshore infrastructure associated with fishing and wind facilities.	Moura et al. 2015
Develop Communication Protocols and a Point of Contact. It is recommended that the developer create a communication protocol or a point of contact for communicating real-time hazards or emergencies to fishing vessels (centralized entity, channel for disseminating information – Vessel Monitoring System, text, smart phone apps, etc.). The protocol should designate the emergency response organization, and identify roles and responsibilities for individuals and agencies tasked with implementing the plan.	Ecology and Environment 2014; VCZMP 2016
Develop New and Update Navigation Aids and Protocols. It is recommended that the developer update nautical charts to reflect new offshore structures and associated navigational hazards. It is recommended that the developer develop protocols for designating the right-of-way between vessels in the offshore wind farms. These protocols can include: • Turbine signs (identifying number, foundation type, scour protections). • Power air draft markings (indicates gap between water surface and blades). • Markings of designated transit zones for vessel traffic.	VCZMP 2016
Development of Gear-Specific Hazard Avoidance Plans. It is recommended that the developer create operating protocols to minimize gear entanglements (e.g., inspection and maintenance to ensure cable burial) and collisions, as well as protocols for handling gear entanglements, e.g., who to contact, retrieval protocols, and rules regarding compensation.	BOEM n.d.[b]; VCZMP 2016
Emergency Planning. • It is recommended that the developer develop and conduct training and emergency readiness drills to prepare for emergency situations. • It is recommended that the developer design the offshore wind farm(s) to augment current safety and emergency practices, e.g., provide helipad, add cell tower and VHF functions to turbines, etc. • It is recommended that the developer provide tie-offs to the tower or at least nearby mooring buoys (most emergencies are mechanical). • It is recommended that the developer provide safety ladders painted in contrast color of tower. • It is recommended that the developer establish a role for fishers in improving safety practices. • It is recommended that the developer design operational requirements and procedures for wind farm shutdown during search-and-rescue or salvage operations.	BOEM n.d.[b]; Ecology and Environment 2014; MAFMC 2014; VCZMP 2016,
Visibility at Night and in Fog. It is recommended that the developer include safety lighting on towers at a height visible to smaller vessels and during low visibility (fog) as they approach close to the tower, and also include radar reflection, AIS on fixed stations, radar and beacon, etc.	VCZMP 2016

Implementing Safety Procedures continued

Employ Guard Vessels. It is recommended that the developer employ guard vessels during construction and any major maintenance efforts.	VCZMP 2016
Provide Updated Vessel and Personal Safety Equipment to Fishers. It is recommended that developers provide vessel and personal safety equipment to fishers operating in or near a wind farm site. This may include radar, global positioning systems (GPS), life rafts, and emergency position-indicating radio beacon and floatation suits, or possibly the developer may provide the necessary funds for updating equipment that may be procured from developers through low-interest loans or grants.	Moura et al. 2015

Understanding the Tradeoffs and Mitigating Impacts on Those Most Affected

Compensation Fund: The developer and fishing industry representatives should develop a compensation fund and the processes for managing the fund. A compensation plan should establish the sources and amount of funding, the terms of compensation, necessary data to measure losses, clear instructions on access to and management of the compensation fund, and a description of the processes. • FLOWW 2015 has developed guidelines on disruption settlements and community funds that could help eligible fishers to receive the appropriate compensation. It is recommended that developers use this resource to develop their Compensation Plans for instituting a Compensation Fund. • The developer and fishing industry representatives should evaluate historical fishing activities on the proposed project sites, evaluate any financial effects of any temporal and spatial restrictions on fishing caused by the project, the amount of fishing that would continue on the site once it is constructed, and pressure on other fishing grounds by displaced fishers. The evaluation should include the types of fishing methods employed at the project site, species of fish caught, and estimated value of the catch from the project site. • Compensation can account for increased costs (i.e., fuel subsidies to fishers), gear or vessel loss or repair, loss of fishing revenue, vessel or gear modifications, assistance with gear modifications, and/or the purchase and installation of new or additional safety equipment or gear modifications. • The development of the Compensation Fund and the Compensation Fund Plan should be transparent to facilitate the development of agreements and should include the publication of public meeting minutes. • Claims should be evidence-based. Claims can include the period of impact, seasonality, number of vessels and intensity, historic use patterns, the importance and proportion of area lost to fishing, any significant deviation or extended transit to fishing grounds, accessibility to other fishing grounds or stocks, and costs for gear relocation or removal. • The Compensation Plan should include a negotiating mandate to enable all parties to speak on behalf of their interests. • Any compensation agreements should apply where relevant if the developer of an offshore wind development sells or transfers ownership. • The Compensations Plan should include an alternative dispute resolution, and, in instances where a resolution cannot be met, a mutually agreed upon third party shall be introduced. • The Compensation Plan and Fund should be developed to build trust. Effective implementation of FLOWW 2014 guidelines are likely to lead to a process that all parties trust, leading to high levels of cooperation.	Ecology and Environment 2014; FLOWW 2015; Gray et al. 2016; Lipsky et al. 2016; Moura et. al 2015; VCZMP 2016,

Understanding the Tradeoffs and Mitigating Impacts on Those Most Affected - continued

Fishing Community Funds. It is recommended that the developer pay into a fund that finances community projects aimed at supporting the fishing industry and shoreside enhancements (e.g., installation of new refrigeration/freezer units, gear or fuel storage facilities, freezers, ice machines, shelters or other equipment, safety training, and certification for wind farm support work).	Moura et al. 2015; VCZMP 2016
Insurance Support: It is recommended that developers provide financial support for potentially higher insurance premiums required of fishers choosing to fish within wind farm areas.	Moura et al. 2015
Fish Habitat Restoration and Improvements. It is recommended that developers design improvements to fishery habitat to enhance fishery production. Where possible, habitat that is disrupted should be restored to pre-construction conditions. Additional construction of new structures outside the offshore wind farm planning areas should be explored to provide alternatives to areas experiencing seasonal or spatial closures.	VCZMP 2016

Understanding the Tradeoffs and Mitigating Impacts on Those Most Affected continued

Development of Mutually Beneficial Business. It is recommended that developers purchase fuel directly from a fuel co-op established and operated by local fishers	Moura et al. 2015
Local Biodiesel Production Facilities: It is recommended that developers install biodiesel-production units at ports to reduce the use of conventional diesel by fishers; this would facilitate the development of sustainable fishing industry practices. The developer could use fish waste by-products for raw material, which, in-turn, could result in reduced fuel costs for both fishers and developers.	Moura et al. 2015
Local fisheries promotions. It is recommended that developers provide funding for marketing campaigns to enhance the visibility and market of fishery products to increase demand for locally produced food and increase fisheries' viability and profitability.	Moura et al. 2015
Recreational Fishery Promotions. It is recommended that developers provide funding for marketing campaigns to enhance the visibility and market of commercial charters or party boat fishing for both sport and tourism fishing in affected areas. This would offset losses to the charter and party boat industry as a result of a closure of the offshore wind farm areas during construction or maintenance.	Lipsky et al. 2016; VCZMP 2016
Tourism and Recreation Promotion. It is recommended that developers provide funding for marketing campaigns to enhance the visibility and market of the tourism and recreation markets. Promotion should focus on opportunities for fishers to supplement income through guided sight-seeing tours, recreational fishing, diving, and other activities.	Moura et al. 2015
Provision of Additional or Supplemental Employment Opportunities. It is recommended that developers provide additional or supplemental employment opportunities for fishers as guards/patrols, data collectors for research, providing vessels for environmental assessments, and other services.	Moura et al. 2015
Promotion of Knowledge Exchange. It is recommended that developers promote a knowledge exchange within the fishing industry and between the fishing industry and developers to support existing fishing opportunities and development of new opportunities.	Moura et al. 2015

Operating

Environmental Monitoring Plan. It is recommended that developers develop procedures for operational monitoring and maintenance: • Procedures should include specifics for monitoring following storm events and the identification of safety zones during maintenance. • Procedures should incorporate an adaptive management approach.	Ecology and Environment 2014
It is recommended that developers design and implement restoration and mitigation surveys to ensure storms, ocean currents, gear entanglements, or other natural or mechanically induced events will not disrupt cover that overlies cables or disrupt restoration before the restored environment is fully re-established. The survey findings should be communicated routinely to the fishing industries.	Gray et al. 2016; VCZMP 2016,
It is recommended that developers remove all waste material.	Gray et al. 2016
Fisheries Management Measures. It is recommended that fisheries managers develop management principles to increase overall fishery functioning and profitability. (e.g., catch shares, permit discount programs, fisheries/vessel sustainability certifications).	Moura et al. 2015
Habitat Enhancements. It is recommended that developers design and implement ecosystem habitat enhancements such as the creation of artificial reefs on wind farm infrastructure or attracting commercially targeted species. Also, enhancing shellfish and finfish stocks via transfer of hatchery or wild juveniles or mature animals to wind farm area is recommended.	Moura et al. 2015

Decommissioning

It is recommended that developers reach an agreement with the fishing industry on what offshore wind farm infrastructures and materials are to be removed following decommissioning and how they are to be removed.	Gray et al. 2016

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Attachment A. VMS Metadata

Vessel Monitoring Systems (VMS) Commercial Fishing Density
Northeast and Mid-Atlantic Regions

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Prepared for:
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1. INTRODUCTION

NROC received VMS data for the Northeast Reporting System from the National Marine Fishery Service (NMFS) Office of Law Enforcement (OLE) and delivered them to RPS ASA for processing and analysis. NMFS describes VMS as “a satellite surveillance system primarily used to monitor the location and movement of commercial fishing vessels in the U.S.” The system uses satellite based communications from on-board transceiver units, which vessels operating in certain federally managed fisheries are required to carry. VMS data are subject to strict confidentiality and resulting products were created such that identifiable vessel locations which did not conform to criteria mandated by OLE were removed.

These datasets characterize the density of commercial fishing vessel activity for seven fisheries in the northeast and mid-Atlantic regions of the U.S. based on Vessel Monitoring Systems (VMS) from NMFS for the years 2006 to 2014[1]. The fisheries include Multispecies, Monkfish, Herring, Scallop, Surfclam/Ocean Quahog, Mackerel, and Squid. Data were available for all fisheries for the entire time date range with the exception of Squid and

[1] NROC conducted the first phase of spatial characterization of fisheries in 2012 using VMS data from 2006 to 2010, which resulted in four density products showing broad scale patterns of vessel activity published to Northeast Ocean Data for the multispecies, monkfish, scallop, and surfclam/ocean quahog fisheries. Individually identifiable vessel locations were removed to ensure points that represented unique vessel locations or tracks were not included in the final products. Because speed over ground was not included, these products did not differentiate between transits and fishing. The full report of the spatial characterization of commercial fisheries is on NROC’s website at http://northeastoceancouncil.org/2013/09/23/report-describing-first-phase-of-the-commercial-fishing-mapping-project-is-now-available/.

Mackerel, which were designated specific fishery codes by NMFS in 2014. Along with VMS data analysis, NROC conducted extensive outreach to numerous fishermen, agencies, and organizations across the region to obtain feedback on the patterns reflected in the VMS.

The VMS data contained geographic coordinates of the vessel at the time of transmission, day, and vessel Declaration Code, which signifies fishery plan, programs, and associated geographic or gear type information. Data from 2011 to 2014 also included speed over ground (SOG) information in order to assess the possibility of identifying transit vs. fishing activity based on speed thresholds identified by industry and agency interviews.

The final products show the standardized density of locations for vessels that use VMS for each fishery for two aggregate time periods. Most fisheries used the time frames 2006-2010 and 2011-2014, however the Surfclam/Ocean Quahog fishery used 2006-2010 and 2012-2014, since habitat closures implemented by the New England Fishery Management Council in 2102 significantly impacted the spatial use patterns in this fishery when compared with the period before 2012. Squid and Mackerel products are available for 2014 only due to data availability from NMFS. Data were log transformed and standardized, and are best interpreted qualitatively. There are two types of products:

- Density grids that characterize all VMS records for each time period.
- Density grids that characterize VMS records below a speed threshold for the 2011-2014 period only. Speed thresholds were vetted through engagement with fishermen in each fishery.

These products represent efforts to expand on the initial phase of work and to refine the spatial characterization methodology such that speed thresholds could be analyzed and a finer resolution could be used. A full list of the 19 products is below:

- Multispecies 2006-2010
- Multispecies 2011-2014
- Multispecies 2011-2014 (< 4 knots)
- Monkfish 2006-2010
- Monkfish 2011-2014
- Monkfish 2011-2014 (<4 knots)
- Herring 2006-2010
- Herring 2011-2014
- Herring 2011-2014 (< 4 knots)
- Scallop 2006-2010
- Scallop 2011-2014
- Scallop 2011-2014 (< 5 knots)
- Surfclam/Ocean Quahog 2006-2010
- Surfclam/Ocean Quahog 2012-2014
- Surfclam/Ocean Quahog 2012-2014
- Squid 2014
- Squid 2014 (< 4 knots)
- Mackerel 2014
- Mackerel 2014 (< 4 knots)

2. PURPOSE

In 2014 the Northeast Regional Ocean Council (NROC) commissioned with George Lapointe, a fisheries consultant, to undertake a project that describes how New England's commercial fishing industries, utilize the region's ocean space. Datasets were configured to spatially represent specific fisheries and timespans. Subsequently shared with members of those industries, these datasets were refined based on feedback and information gleaned over the course of 50 community meetings.

3. SOURCES AND AUTHORITIES

- Vessel Monitoring Systems (VMS) – National Oceanographic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)
- George Lapointe, NROC Fisheries Consultant
- Stakeholder Fisherman, Agencies, and Organizations in the Northeast region
- VMS Activity Declaration Code Format For the Greater Atlantic Region, NMFS (March 2014) https://www.greateratlantic.fisheries.noaa.gov/vms/doc/vms-declaration-code-glossary-march-2014.pdf

4. DATABASE DESIGN AND CONTENT

Database Name: VMSCommercialFishingDensity

Dataset Status: Complete

Multispecies 2011-2014:

(This example represents data details specific to a select fishery density grid; other products have similar information.)

Native storage format: ArcGIS File Geodatabase Raster
Columns and Rows: 6814, 13332
Number of Bands: 1
Cell Size: 100
Pixel Type: 32 Bit floating point
Linear Unit: Meter (1.000000)
Angular Unit: Degree (0.0174532925199433)
Statistics:
Minimum: -1.961158633232117
Maximum: 4.61347246170044
Mean: 6.158711055485074e-009
Standard Deviation: 1.000000088819612

5. SPATIAL REPRESENTATION

Reference System: North American Albers Equal Area Conic
Horizontal Datum: North American Datum 1983
Ellipsoid: Geodetic Reference System 1980
False Easting: 0
False Northing: 0
Central Meridian: -96
Standard Parallel 1: 20
Standard Parallel 2: 60
Latitude of Origin: 40

Geographic extent: 1322410.62061 to 2324110.62061, -1352818.02339 to 895381.976606

IS0 19115 Topic Category: economy, environment, oceans

Place Names:

Atlantic Ocean, Cape Cod Bay, Cape May, Chesapeake Bay, Connecticut, Delaware, Delaware Bay, Georges Bank, Gulf of Maine, Hudson River, Long Island Sound, Maine, Maryland, Massachusetts, Massachusetts Bay, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Rhode Island Sound, United States, Virginia

Recommended Cartographic Properties:

(Using ArcGIS ArcMap nomenclature)

Classification, 5 classes, color mode: HSV

Low (<-1):	blue (222-91-48)
Medium-Low (-1 - 0):	green (154-85-79)
Medium-High (0 - 1):	yellow (60-100-100)
High (1 - 2):	orange (40-100-100)
Very High (>2):	red (20-100-66)

Scale range for optimal visualization: 1,000,000 to 4,000,000

6. DATA PROCESSING

Processing environment: ArcGIS 10.3, Windows 7 Professional, Intel Core i5 CPU

Processing Steps:

Background

NROC submitted a series of data request to NMFS to obtain VMS data in three separate deliveries. NROC contractors working with the data signed a Non-Disclosure Agreement

(NDA) before receiving the data due to strict data confidentiality. The end products generated from the raw data had identifiable vessel locations removed such that the aggregate VMS products adhered to the "Rule of Three," where no fewer than three VMS points were represented in any location across the suite of maps. Data were secured on a password protected hard drive connected to a vetted contractor's computer.

Data Processing

VMS data were received from NMFS OLE in 2012, 2014, and 2015 for the time periods 2006-2010, 2011-2013, and 2014, respectively. Raw data files for each year were organized in monthly text or comma-separated-values (csv) files and required some pre-processing to make the information fit for importing into a GIS. Each record in the VMS files included:

- Latitude
- Longitude
- Declaration code
- Date
- Speed (2011-2014 only)

VMS files dated after 2010 included speed over ground (SOG) in knots, which was requested after the first phase of the project to aid in identifying areas where vessels were engaged in fishing or in transit.

Once formatting of the raw data was complete, Python scripting was used to import the information into point feature classes and incorporate latitude, longitude, declaration code, date, and SOG into attribute fields. Feature classes were organized into databases based on fishery plan code, which occupies the first three characters of the declaration code. A sample declaration code is below and the first three characters indicate it belongs to the herring plan.

HER-HER-XXXXXX

The following plans were used to select VMS points into specific fishery level products; Squid and Mackerel codes were both identified by fishery program for declaration codes within the Squid/Mackerel/Butterfish (SMB) plan.

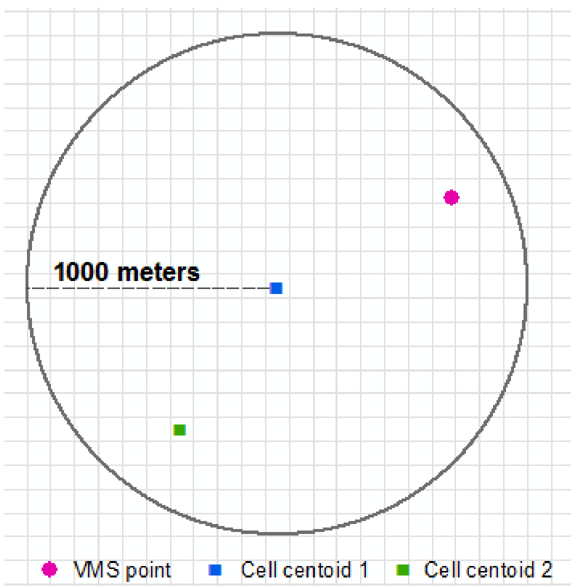
- Herring (HER)
- Multispecies (NMS)
- Monkfish (MNK)
- Scallop (SES)
- Surfclam/Ocean Quahog (SCO)
- Squid (SMB-SHM, SMB-SQL, SMB-SQM) - 2014 only
- Mackerel (SMB-MAH, SMB-MAS, SMB-MHS) - 2014 only

More information on declaration codes can be found in the VMS Activity Declaration Code Format for the Greater Atlantic Region (NMFS, 2014). Attribute queries were performed on the VMS points to identify which records belonged to each of the fisheries listed above by year. The Squid and Mackerel products were only available for 2014, since beginning in 2014 NMFS implemented the new plan code for SMB for those species. Annual fishery products were further aggregated into two time periods for 2006-2010 (five years) and 2011-2014 (four years).

Density Analysis

Density was plotted onto a raster grid with a resolution of 100 meters. Values were generated for each 100 meter grid cell based on a search radius of 1000 meters. A grid cell within 1000 meters of a VMS point would be assigned a density value. Cells within 1000 meters of multiple VMS points would be assigned higher density values.

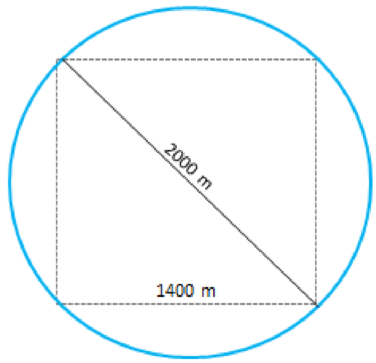
The figure below shows a grid with 100 meter cells. The central blue cell has a single VMS point (pink) within its 1000 meter search neighborhood, and would therefore be assigned a density value. Based on this example the green cell would be assigned a value of zero since there is no VMS point within the search radius.



Screening Analysis

In order to preserve data confidentiality using the Rule of Three, a screening grid of 1400 by 1400 meters was used to remove VMS points from the analysis if fewer than three points occurred within a screening grid cell. A 1400 meter square is the largest square that fits entirely within a 1000m radius (2000 meter diameter) circle.

The figure below shows a 1000 meter radius circle with a nested 1400 meter square inside. The diameter of the circle and the diagonal of the square have the same length. The screening analysis identified grid squares with fewer than three VMS points; VMS points within cells that did not meet the Rule of Three were removed from the data analysis.



This screening step was performed prior to any density analysis and creation of density grids.

A list of steps below outlines the processing:

	Process Steps Description
1	Modify raw data from NMFS in text or csv files as needed to import them into a GIS
2	Import data as points into ArcGIS using Python based on the latitude and longitude coordinates and incorporate information into fields for Date, Declaration Code, Latitude, and Longitude. For data after 2010, an additional field included Speed Over Ground (SOG). Invalid points were reviewed and removed in a parallel quality control process. Annual features classes were created for each fishery based on plan code within the Declaration Code.
3	MERGE annual feature classes into aggregate products for the appropriate time periods. Herring, Monkfish, Multispecies, and Scallop time periods used the time frames 2006-2010 and 2011-2014, while Surfclam/Ocean Quahog used 2006-2010 and 2012-2014. A single period for 2014 was used for the Squid and Mackerel fisheries.
4	Create a 1400 meter polygon grid for the Atlantic Coast within the Exclusive Economic Zone (EEZ): 1. CREATE FISHNET in the coordinate system North American Albers Equal Area Conic for the extent 1302620, -1586945, 2382020, 944255 (-82.676, 25.545, -63.509, 44.503) 2. CLIP fishnet grid to U.S. waters within the EEZ
5	Join VMS point feature classes with the 1400 meter grid and identify grid cells with three or more VMS points: 1. SELET BY LOCATION the 1400 meter grid with the VMS points using "intersect the source layer feature" and EXPORT to a new gridded dataset that only contains grid cells that overlay VMS points. This step eliminates unnecessary data to save processing time. 2. JOIN the 1400 meter grid from Step 1 with VMS data using the "Join data from another layer based on spatial location" option to determine the count of VMS points in each cell. The output contains a new attribute field with the number of VMS points in each cell. 3. SELECT BY ATTRIBUTE to identify grid cells with three or more VMS points ("Count_" >=3) 4. SELET BY LOCATION using "select from the currently selected features" to identify VMS

	points that occur within grid cells that have at least three points. 5. EXPORT selected VMS point features to new dataset
6	Run POINT DENSITY under Spatial Analyst to create a density surface using the selected and exported VMS points (Cell Size = 100, Neighborhood = Circle, Radius = 1000, Area units = Square Kilometers) Note: A 1000 meter search radius results in a 2000 meter diameter circle. The largest square which fits inside a 2000 meter circle has 1400 meter dimensions. Therefore, a 1400 meter grid was used to screen out VMS points if fewer than three occurred within a grid cell. This was necessary to adhere to the Rule of Three mandated by NMFS OLE to preserve data confidentiality.
7	Standardize output density grids using a log transformation technique: 1. RASTER CALCULATOR expression using the LN() function 2. ZONAL STATISTICS to determine the standard deviation (stdev) and mean (mean) of the transformed product (ln) 3. RASTER CALCULATOR expression to produce standardized products (ln – mean)/stdev

7. QUALITY PROCESS

Attribute Accuracy: VMS data are considered authoritative and no testing was performed.

Logical Consistency: Point data used to generate the raster densities were represented by a set of coordinate pairs and were processed with the assumption that no duplication was present in the raw data.

Completeness: These products represent VMS records in the northeastern and mid-Atlantic in coastal and offshore waters within the EEZ. Products represent the standardized density of VMS records within each fishery that conformed to the Rule of Three applied in this analysis and therefore characterize the important geography and main scope of each fishery. Since fishery plans were used to group the data, plan codes not represented by the seven fisheries discussed above are not included, nor are vessels whose declaration code was characterized as *Power Off*, *Power On*, *Antenna Blockage*, *Normal*, *GPS Off*, or *Invalid*. Other records with declaration codes such as *Null* or *Declared out of Fishery* are also not represented. Records in the scallop fishery that indicated a vessel had a powered down status were also removed. Multispecies and monkfish may have overlap due to the nature of reporting and permitting within those fisheries. Incorrect coordinates which indicated a vessel was inland or outside the study area were removed. In cases where records appeared to have reversed latitude and longitude, the coordinates were corrected and included. Due to the high amount of signals sent from VMS transmitters in port areas, ports show up as high density however they should not necessarily be understood as important fishing locations. A review investigated whether standardized values changed substantially if ports were screened out of the datasets, however that did not have an effect on values.

Positional Accuracy: Horizontal accuracy is dependent on the location of the transmitted VMS locations from GPS and includes errors associated with this technology. The density grids represent a smoothed heat map of the VMS vessel activity. While the original data had accurate and precise coordinate information, the density surfaces expands the fine scale footprint of the VMS points by assigning information to 100 meter cells and using a 1000 meter search neighborhood to smooth the data. While this affects positional accuracy at a fine scale, it provides visually informative results at a regional and sub-regional level.

Timeliness: 2006 to 2014

Use restrictions: This dataset is part of a broad effort to spatially characterize commercial fisheries in the northeast. Any interpretations or conclusions based on this data are the responsibility of the user. Users are expected to read through this documentation and understand its contents. Any use of these products must cite NROC and RPS ASA as the source. It is highly recommended to read the full report available on NROC's website.

Distribution Liability: Data are not for download. These products are available online through ArcGIS tile cache services, which are accessible from the data download page on Northeast Ocean Data (http://www.northeastoceandata.org/data/data-download/). The information should not be used for legally binding purposes. NROC and RPS ASA are not responsible for any interpretations, assumptions, or conclusions based on these data. Any redistribution of these data shall reference NROC and RPS ASA as the creator and any derived products must have documented process steps. Users must assume responsibility to determine the appropriate use of these data.

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