New York State Offshore Wind Master Plan

Marine Mammals and Sea Turtles Study

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New York State Offshore Wind Master Plan Marine Mammals and Sea Turtles Study

Final Report

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Notice

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Acronyms and Abbreviations

μPa	microPascal
AMAPPS	Atlantic Marine Mammal Assessment Program for Protected Species
AoA	Area of Analysis
APEM	APEM, Inc.
BIA	Biologically Important Area
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CRESLI	Coastal Research and Education Society of Long Island, Inc.
CZMA	Coastal Zone Management Act
dB re 1 μPa rms	decibels re 1 microPascal root mean square
dB	decibel
DEC	New York State Department of Environmental Conservation
Deepwater Wind	Deepwater Wind, Energy Management, Inc.
DOI MMS	U.S. Department of the Interior Minerals Management Service
DOS	New York State Department of State
DPS	Distinct Population Segment
EA	environmental assessment
EEZ	Exclusive Economic Zone
EIS	environmental impact statement
ESA	Endangered Species Act
FONSI	finding of no significant impact
FR	Federal Register
GARFO	Greater Atlantic Regional Fisheries Office
Hz	Hertz
IAC	Inter-American Convention for the Protection and Conservation of Sea Turtles
IHA	Incidental Harassment Authorization
ITR	Incidental Take Regulation
ITS	Incidental Take Statement
kHz	kiloHertz
km	kilometer
km^2	square kilometer
LOA	Letter of Authorization
m	meter
Master Plan	New York State Offshore Wind Master Plan

MBES	multibeam echo sounders
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
Navy	United States Department of the Navy
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NGO	non-governmental organization
nm	nautical miles
NMFS	National Oceanic and Atmospheric Administration, National Marine Fisheries Service; *also* NOAA Fisheries
NOAA Fisheries	National Oceanic and Atmospheric Administration National Marine Fisheries Service; *also* NMFS
NOAA	National Oceanic and Atmospheric Administration
Normandeau	Normandeau Associates, Inc.
NYCRR	New York Codes, Rules and Regulations
NYSERDA	New York State Energy Research and Development Authority
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OSA	offshore study area
PTS	permanent threshold shift
RFMRP	Riverhead Foundation for Marine Research and Preservation
RI/MA	Rhode Island-Massachusetts
rms	root mean square
SAR	Stock Assessment Report
SEFSC	Southeast Fisheries Science Center
SEL_{cum}	cumulative sound exposure level
SMA	Seasonal Management Area
Study	Marine Mammals and Sea Turtles Study
SWOT	State of the World's Sea Turtles
TTS	temporary threshold shift
UNCW	University of North Carolina at Wilmington
U.S.C.	U.S. Code
USFWS	U.S. Fish and Wildlife Service
WEA	wind energy area

Summary

This Marine Mammals and Sea Turtles Study (Study) reviews a variety of existing data to examine marine mammal and sea turtle use of the Area of Analysis (AoA) and the relative sensitivities of species and species groups to potential offshore wind farm development, in order to assist in planning and siting future wind projects in the AoA. The AoA is a 14,980-square-mile area of ocean extending from 15 nautical miles off 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 (m). Marine mammal and sea turtle abundance and occurrence within the AoA were largely evaluated using several key data sources: Leatherwood et al. (1976), Rhode Island University (1982), U.S. Department of the Navy (Navy; 2007, 2012), Sadove and Cardinale (1993), National Oceanic and Atmospheric Administration Northeast Fisheries Science Center and Southeast Fisheries Science Center (2010, 2011a, 2012, 2013, 2014, 2015), Roberts et al. (2015, 2016), Normandeau Associates, Inc. and APEM, Inc. (2016, 2017), Tetra Tech and Smultea Sciences (2017), and Hayes et al. (2017). Density models by Roberts et al. (2015, 2016) and the Navy (2007, 2012) were also used to make predictions about density of species groups within the AoA. Historical and contemporary survey, tagging, and other data were compared with density predictions to fill data gaps, evaluate support for predictions, and discuss individual species. Location and duration of effort varies among studies. This Study presents the best available science and describes the preliminary results of ongoing research to inform planning for potential wind farm siting in the AoA. Project- and site-specific analyses will be needed when specific projects are proposed in the future.

This Study employed the following methodology. Stock assessment reports (Hayes et al. 2017) were the primary source used to develop a list of marine mammal species with potential to occur in the AoA, irrespective of abundance (Table 2). Appendix A provides a description of additional data sources used, and Appendix B provides a species-specific review of surveys, tagging studies, fisheries interactions, strandings, and anecdotal data for the regularly documented species and species groups, including their spatial and temporal occurrence and behavior relative to use of the AoA. For purposes of habitat-based density mapping to evaluate receptor hotspots, the Study grouped marine mammals into the following receptor groups: high-, mid-, and low-frequency cetaceans; deep- and shallow-diving cetaceans; endangered cetaceans (not including North Atlantic right whales); and North Atlantic right whales (Table 3). Seals and sea turtles were also each considered receptor groups. Receptor groups were

developed relative to potential stressors of noise, increased/different vessel traffic, and permanent structures in the water. Endangered cetaceans and North Atlantic right whales were considered independently based on their potentially higher sensitivity and risk due to low abundance and already stressed populations.

With respect to potential stressors, noise and vessels associated with wind farm development are temporary, while wind turbines in the water are potentially long term. Potential noise stressors are mainly associated with multi-beam echosounders and other bottom survey equipment that produce sound during pre-construction and with pile driving during construction. Noise may cause injury, displacement, and/or changes in behavior. The increased amount and change in type of vessel traffic associated with pre-construction surveys, wind farm construction, and post-construction maintenance may increase the risk of vessel collisions with marine mammals and/or sea turtles. Permanent structures in the water during and after construction may result in longer-term displacement or loss/fragmentation of important habitat. Displacement that pushes animals into higher traffic areas, like shipping channels, may increase vessel collision risk. Loss of important habitat may reduce species' fitness by increasing energy expenditures or reducing access to prey or mates.

The general distributions and predicted densities of marine mammals and sea turtles described in Sections 1 and 2, as well as the occurrence data described in Appendix B, suggest the following:

- Fin whales may have important feeding habitat in the northeastern section of the AoA.
- Right whales, humpback whales, fin whales, and minke whales migrate through the AoA.
- Right whales have the highest predicted densities in the northeastern area of the AoA in spring.
- Right whales are predicted along the coastal boundary of the AoA in winter, along the continental slope in summer, and back toward the northeastern area of the AoA in fall.
- Right whales use the New Jersey coast year-round and may use coastal areas of the New York Bight for both feeding and migration.
- Humpback and fin whales feed (mainly spring through fall) in coastal areas of the AoA along Long Island and New Jersey.
- Seals are predicted to be most abundant in coastal waters and shift their distribution north of the AoA in summer.
- Sea turtles are predicted to occur mainly in the southern part of the AoA, but they have been observed and stranded in northern areas of the AoA, and recent surveys suggest high occurrence of loggerheads throughout the continental shelf area in summer.
- Green turtles are rare in the AoA, and leatherbacks occur in small numbers across the shelf.
- Most receptor groups are predicted to have concentrated use of the continental shelf break and slope and Hudson Canyon, potentially extending along the Hudson Shelf Valley during at least part of the year.

- Mid-frequency cetaceans (mainly the dolphins) are predicted to use the southwestern area of the continental shelf near the Hudson Shelf Valley more than other locations on the shelf.
- Harbor porpoise are predicted to distribute across the continental shelf in winter and spring and concentrate more in the northeastern area of the AoA in summer and fall.

Siting wind farms in the middle of the continental shelf area within the AoA may help reduce potential risks to marine mammals and sea turtles overall. This central area is where marine mammals and sea turtles are observed less often and habitat-based use predictions usually show lowest expected use. Displacement or behavioral responses to noise associated with wind farm development are likely to be temporary, limiting the likelihood of risks to populations, but cumulative and aggregative risk should be considered in siting and mitigation. Predicted densities and documented use patterns indicate that development may pose a high risk to marine mammals and sea turtles in the northeastern corner of the AoA, the continental shelf break and slope, and the areas closest to the coast where North Atlantic right whales, humpback whales, fin whales, and harbor seals frequently are observed to use habitat near shore. The Hudson Shelf Valley may be higher risk compared to other locations on the continental shelf.

With respect to noise, harbor porpoise, North Atlantic right whales, and other baleen whales are likely to have the highest potential for disturbance. The fluctuation in predicted density and observed use patterns for high- and low-frequency cetaceans over seasons suggests that limiting noise during certain seasons may reduce potential risks for these species. Seasonal mitigation would need to consider site- and project-specific components. Harbor porpoise are predicted to spread across most of the AoA in winter and spring, so these months may be a time of higher risk for pile driving disturbance of harbor porpoise. If a wind farm were proposed toward the northeastern part of the AoA, the spring season would likely present the greatest risk to marine mammals due to noise from pile driving. If the wind farm is closer to the Long Island coast, winter may be a time of higher risk for pile driving affecting North Atlantic right whales, though other seasons may be riskier for fin and humpback whales. Seals are more common along the Long Island coast in spring, fall, and winter than in summer, and sea turtles tend to move northward into the AoA and along the coast in warmer seasons. Thus, coastal development must balance seasonal mitigation according to greatest potential for impacts to particular species.

Changes in types or numbers of vessels may increase the potential for vessel collision. Vessel collision poses a higher risk for North Atlantic right whales, fin whales, and humpback whales than for other species. Vessels' seasonal avoidance of North Atlantic right, fin, and humpback whale high-use areas would help reduce this risk, though siting near the coast may involve trade-offs relative to different use patterns by right, fin, and humpback whales. Appropriate seasons for wind farm surveys, construction, and maintenance would depend on siting (i.e., the location relative to animal use/distribution). Vessel collision risk is also reduced by following laws, regulations, and future permit conditions associated with vessel speed and other mitigation. Any displacement associated with increased vessel traffic is likely to be temporary. With respect to noise, ship traffic noise is common in the AoA (Rice et al. 2014), and wind-related vessel noise will likely be within ambient noise levels.

Permanent structures in the water leading to potential displacement and habitat loss/fragmentation is a potential long-term consequence of wind farm development in the AoA. It is difficult to predict whether marine mammals and/or sea turtles may be displaced, as it would be possible for these species to inhabit the area within a wind farm. In the case of displacement, if suitable habitat were nearby and displacement did not cause undue energy expenditure, populations may not be affected. Risk of displacement can be reduced by siting wind farms in areas that are not considered important feeding, breeding, or migratory areas and by avoiding areas close to shipping lanes, as displacement into shipping lanes could increase risk of collisions with vessels.

The presence, use patterns, and sensitivity of particular receptor groups or species should be considered in the context of attempting to limit effects of potential stressors. For example, North Atlantic right whales are highly vulnerable to vessel collision and are endangered, so special attention might be paid to reducing stressors that may lead to potential increased vessel collision risk in areas or seasons with high right whale use. Another example might be prioritizing risk reduction associated with pile-driving noise for high-frequency cetaceans. Mitigation can address some of the potential risks, and some potential best management practices associated with such mitigation are provided in Section 6.

The data presented in this Study were incorporated into a larger modeling study, the *Environmental Sensitivity Analysis*, which is appended to the New York State Offshore Wind Master Plan. The *Environmental Sensitivity Analysis* evaluates locations of potential environmental sensitivities within the AoA. The objective of the *Environmental Sensitivity Analysis* is to develop a weighting system and map products that will allow for a comparative analysis of the potential risks to marine resources during construction and operation of offshore wind facilities. The *Environmental Sensitivity Analysis* evaluated risks for receptors (e.g., marine mammals and sea turtles) with consideration of seasonal differences in site use (as data allow) that could be relevant to construction-phase sensitivities. This exercise captured differences among potential stressors (e.g., new structures in the water), and the outputs of the mapping reflect these differences in risk.

The sensitivity modeling exercise captured relative risks in three separate series of maps: pre-construction, construction, and operation, with each including seasonal and annual maps. The modeling study used the Roberts et al. (2016) data for habitat-based predicted densities of cetaceans, Roberts et al. (2015) data for habitat-based predicted use patterns of seals, and Navy (2007) data for predicted sea turtle densities because these are currently the best available science on habitat use and density of marine mammals and sea turtles. The maps developed from the modeling were used to identify the relative potential for biological sensitivity among areas of the AoA, as well as areas to propose to the Bureau of Ocean Energy Management (BOEM) for further analysis. These selected sites were submitted to BOEM for further consideration and analysis on October 2, 2017. The resulting maps will also better inform developers about areas of biological importance, potentially reducing the uncertainty and costs of their proposals, though site- and project-specific analyses will be valuable in assessing potential impacts more precisely for particular proposed actions.

1 Introduction

This Marine Mammals and Sea Turtles 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 (m) (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 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 development. The Master Plan identifies the potential future wind energy areas that have been submitted for BOEM's consideration, discusses the State's goal of encouraging the development of 2,400 megawatts 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 nongovernmental organizations (NGOs) 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 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.

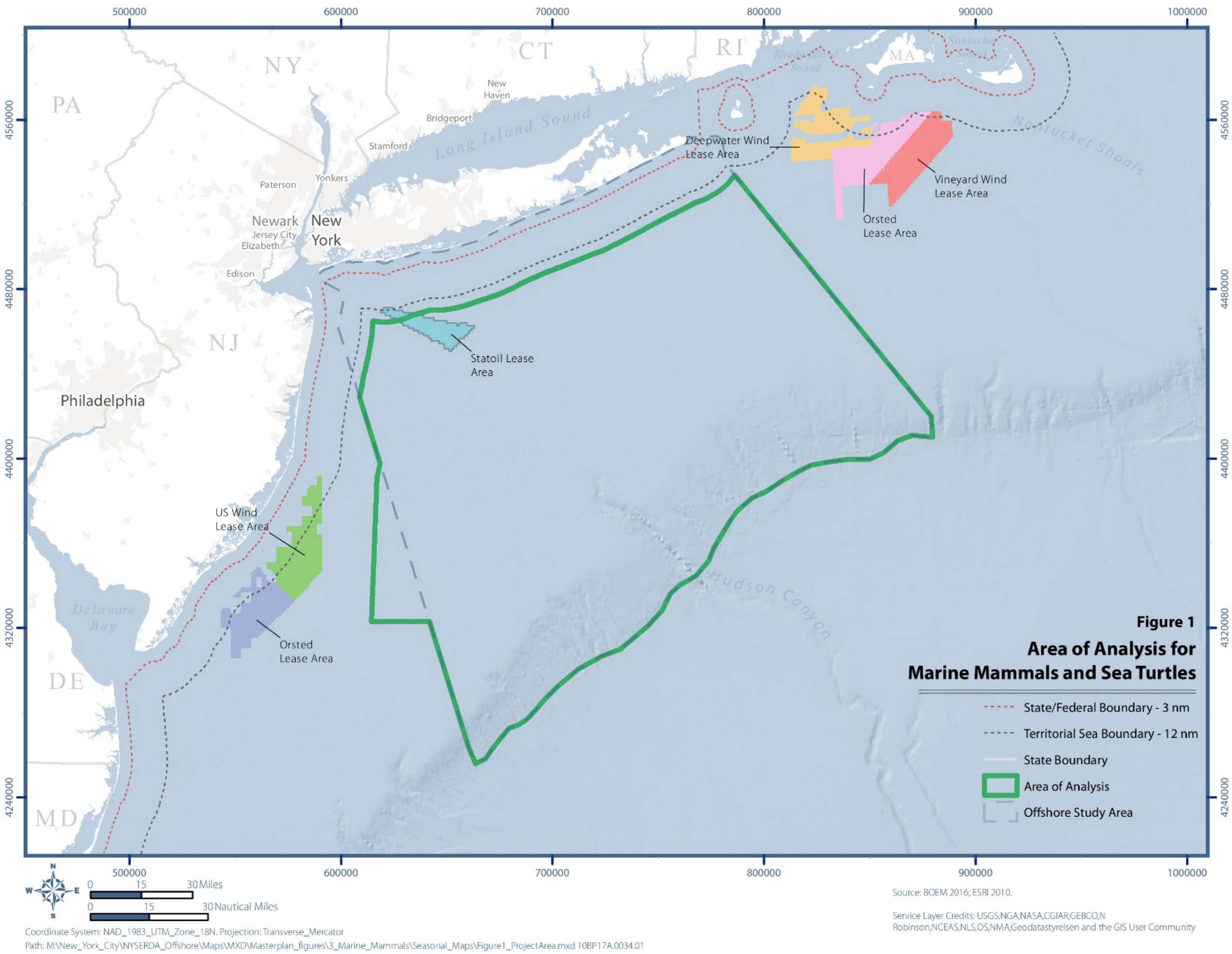
1.1 Scope of Study

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 m (Figure 1). This Study summarizes and synthesizes existing data on the occurrence, density, and distribution of marine mammals (cetaceans and seals) and sea turtles in the AoA. This Study reviews a variety of existing data and models to determine these patterns so that they can be evaluated in the context of future offshore wind farms. This Study also examines the relative sensitivities of species and species groups to offshore wind farm development.

All of the species discussed in this Study are federally protected under the Marine Mammal Protection Act (MMPA) and/or the Endangered Species Act (ESA). Therefore, available data and reports were also used to assess ways to reduce potential risks and provide BMPs for developers when siting, constructing, and operating an offshore wind farm within the AoA. This Study is based on current information, and the recommendations and conclusions herein will be subject to change as new information and technology become available.

Figure 1. Area of Analysis for Marine Mammals and Sea Turtles.

Source:BOEM 2016; ESRI 2010



Section 1 describes the scope, regulatory framework, and objectives of the Study. Section 2 presents seasonal distribution and density analyses for cetaceans, seals, and sea turtles likely to occur in the AoA, including information specific to the endangered North Atlantic right whale. Section 3 presents types of potential risks and resource sensitivities to be considered in planning wind energy projects. Section 4 presents conclusions from Sections 1 through 3. Section 5 describes stakeholder input. Section 6 discusses potential guidelines and BMPs for wind farm development in the AoA. Section 7 lists references cited. Appendix A lists the data sources used to obtain marine mammal and sea turtle data. Appendix B presents an analysis of existing literature on seasonal and behavioral use of the AoA by marine mammals and sea turtles.

1.2 Study Objectives

The three principal objectives of this Study are to:

1. Review and summarize existing data regarding marine mammal and sea turtle occurrence, density, and distribution in the AoA. There is special focus on information about the North Atlantic right whale because of this species' endangered status.
2. Identify activities associated with future offshore wind farm pre-construction, construction, and operation, and characterize the sensitivity of marine mammals and sea turtles present within the AoA to these activities. Where activities and animals may coincide, assess and summarize the relative risk of development in these areas.
3. Provide guidelines and BMPs that future offshore wind developers may consider to avoid or minimize potential project impacts on marine mammals and sea turtles.

Results of this Study are intended to help reduce uncertainties and risks to marine mammals and sea turtles and should make it more cost-effective for developers to plan and conduct site-specific studies.

1.3 Regulatory Framework

The Study has been prepared with consideration of federal and state statutes, regulations, and policies that are pertinent to the future development of offshore wind farms in the AoA. Specifically, there are several statutes that are specifically relevant to the protection of marine mammals and sea turtles and their habitat. Other statutes will require an understanding of the presence of marine mammals and sea turtles, as well as other aspects of the environment, in order for reviewing agencies to approve and/or permit a wind development project. This section focuses on the ESA, under which consultations and, potentially, incidental take statements will be required for ESA-listed marine mammals and sea turtles; the MMPA, under which incidental harassment authorizations or letters of authorization will be required for any marine mammal harassment; the Magnuson-Stevens Fishery Conservation Act (MSA), under which sea turtles are managed as "fish" (though the ESA provides stricter rules for listed sea turtles); and the Inter-American Convention for the Protection and Conservation of Sea Turtles, under which the U.S. has agreed to reduce human activities that could potentially affect sea turtles. Understanding these statutes and the agency regulations and policies associated with their implementation is important to the development of offshore wind farms.

1.3.1 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 (NOAA) Fisheries (NOAA Fisheries) may list species as either endangered or threatened depending upon the species' biological status and threats to the species' existence. The ESA prohibits the take of any threatened and 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 USFWS promulgated regulations to govern consultations and permitting (50 Code of Federal Regulations [CFR] Chapter IV Part 402). NOAA Fisheries manages ESA-listed marine mammal and sea turtle species; the USFWS manages sea turtles when they are on land (e.g., during nesting) (USFWS 2017).

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 issues a permit for a geophysical survey in the AoA, BOEM is responsible for consulting with NOAA Fisheries to ensure ESA compliance for marine mammals and sea turtles (as well as other ESA-listed species under NOAA Fisheries' jurisdiction). For offshore wind development, activities that may affect ESA-listed marine mammals and/or sea turtles may require an Incidental Take Statement (ITS) from NOAA Fisheries. Although it is the responsibility of the federal action agency to consult with NOAA Fisheries regarding the ESA, offshore wind developers can inform the consultation process by providing the lead federal action agency the information necessary to assess and reduce any potential effects to listed species and critical habitats. For example, offshore wind developers can provide detailed information about equipment specifications, propose mitigations to reduce impacts, and provide details about the 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 (NOAA Fisheries Greater Atlantic Region Fisheries Office [GARFO] n.d.). If adverse effects are expected, then a formal consultation takes place in which the federal action agency provides details of the action and relevant biological assessment and other details per 50 CFR 402.12 (c) and (d). Again, this is the responsibility of a federal agency, not directly that of the developer, but the developer can provide information to support this consultation process when 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 will ultimately result in a Biological Opinion and ITS, as appropriate (NOAA Fisheries GARFO n.d.). For wind farm development, a Biological Opinion and ITS would generally be required for pile driving during construction and any other activities that may expose listed species to noise above thresholds established by NOAA Fisheries that result in incidental take (see Section 1.3.2). An ITS is combined with MMPA permitting in the case of ESA-listed marine mammals. NOAA Fisheries GARFO (n.d.) provides guidance on stressors and issues to consider with respect to the ESA. This guidance also provides thresholds of concern for noise for sea turtles (injury = 180 decibels re 1 microPascal root mean square [dB re 1 µPa rms], behavior = 166 dB re 1 µPa rms). Exceeding these thresholds would trigger a likely need for an ITS that includes take associated with noise. Popper et al. (2014) recommend mortality and potential mortal injury thresholds for sea turtles exposed to pile driving as 201 dB re 1µPa (cumulative sound exposure level [SEL_{cum}]) or >207 dB re 1 µPa (peak decibels [dB]). Popper et al. (2014) do not provide suggested levels for recoverable injury, temporary threshold shift (TTS), masking, or behavior, though they indicate that these impacts are potentially high when sea turtles are "near" (no specific definition provided) the sound source. Popper et al. (2014) base their noise thresholds for sea turtles on levels for fish that do not hear well, as they believe these would be conservative estimates for sea turtles, though they state that sea turtles' rigid external anatomy may provide protection from effects of impulsive sound from pile driving; presumably, this protection mainly extends to internal anatomy. Table 1 shows ESA-listed species that are known to occur within the AoA.

Table 1. ESA-listed Species Known to Occur within the AoA

Common Name	Scientific Name	ESA Status
Cetaceans		
Blue Whale	*Balaenoptera musculus musculus*	Endangered
Fin Whale	*Balaenoptera physalus physalus*	Endangered
Sei Whale	*Balaenoptera borealis borealis*	Endangered
North Atlantic Right Whale	*Eubalaena glacialis*	Endangered
Sperm Whale	*Physeter macrocephalus*	Endangered
Sea Turtles[a]		
Loggerhead Turtle (Northwest Atlantic Ocean Distinct Population Segment[b])	*Caretta caretta*	Threatened
Leatherback Turtle	*Dermochelys coriacea*	Endangered
Kemp's Ridley Turtle	*Lepidochelys kempii*	Endangered
Green Turtle (North Atlantic Distinct Population Segment[b])	*Chelonia mydas*	Threatened

[a] Hawksbill turtles are also listed as threatened under ESA but are extremely uncommon in the AoA.

[b] Loggerhead turtles are split into nine Distinct Population Segments (DPSs) and green turtles into 11 DPSs under the ESA, with each listed separately

In addition to the protections generally afforded to ESA-listed species under the ESA, NOAA Fisheries has promulgated regulations specific to North Atlantic right whale protection that are applicable to the AoA. In 2008, NOAA Fisheries finalized a rule that vessels 65 feet or larger must travel at 10 knots or less near key port entrances in designated Seasonal Management Areas (SMAs) and any Dynamic Management Areas to be later identified by NOAA Fisheries (73 Federal Register [FR] 60173). These speed restrictions apply to the port of New York and to the SMA designated in that region from November 1 to April 30 (see Appendix B, Section B.1 for a full description of the North Atlantic right whale SMA boundaries). In 2013, NOAA Fisheries issued a final rule to eliminate the sunset clause on speed restrictions set forth in 73 FR 60173 (78 FR 73726). Further, NOAA Fisheries established North Atlantic right whale critical habitat in 1994 (59 FR 28805) and expanded this critical habitat in 2016 (81 FR 4837); critical habitat does not include any of the AoA.

1.3.1.1 New York State Endangered Species Law

Several species of sea turtles and cetaceans are also protected under New York law (Title 6 New York Codes, Rules and Regulations [NYCRR] 182.1–182.16). In the AoA, the species listed as endangered include Kemp's Ridley sea turtle, leatherback sea turtle, sperm whale, sei whale, blue whale, humpback whale, and North Atlantic right whale (NYCRR 182.5). Hawksbill sea turtles are also listed as endangered but are extremely uncommon in the AoA; their distribution tends to be outside of the AoA. The species listed as threatened include green sea turtle and loggerhead sea turtle (NYCRR 182.5). The harbor porpoise (*Phocoena phocoena*) is considered a species of special concern in New York

(DEC n.d.[a]). New York has not yet revisited the status of the humpback whale after the species' recent federal status change from endangered to a West Indies Distinct Population Segment (DPS) that is not listed (DEC n.d.[b]). Therefore, the population of humpback whales in the AoA remains listed as endangered by the State of New York but is not federally listed as threatened or endangered.

1.3.2 Marine Mammal Protection Act

The MMPA of 1972, 16 U.S.C. 1361 et seq., enacted a national policy to protect populations of marine mammals from declining beyond the point at which they would not be able to function successfully within their environment. The MMPA prohibits, with some exceptions, the "take" (to harass, hunt, capture, kill, or attempt to harass, hunt, capture, or kill any marine mammal [16 U.S.C. 1362]) of marine mammals in U.S. waters and by U.S. citizens on the high seas. It also prohibits the importation of marine mammals and marine mammal products into the U.S. Harassment, which is defined in the statute as either Level A or Level B. Level A harassment "has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment "has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild."

If an offshore wind development project, or any part of an offshore wind development project, is likely to harass marine mammals, a permit must be obtained from the NOAA Fisheries Permit Office. This permit can be either an Incidental Harassment Authorization (IHA) or a Letter of Authorization (LOA) issued under an Incidental Take Regulation (ITR). IHAs are issued for one year and can be obtained without an ITR. LOAs can be issued for up to five years and require an ITR. In general, an offshore wind developer needs to evaluate whether a development action (e.g., sub-bottom surveys, pile driving) may harass marine mammals, and if so, a permit may be needed. With respect to sound, NOAA Fisheries has developed guidelines that include thresholds for received sound levels for Level A and Level B harassment, included in its *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts* (NOAA NMFS 2016a). At received levels considered to potentially cause permanent threshold shift (PTS) in hearing, Level A harassment may occur (NOAA NMFS 2016a). For Level B harassment, NOAA Fisheries uses an interim sound threshold guideline of 160 dB re 1 micropascal (µPa) rms for pulsed sound and 120 dB re 1 µPa rms received level for continuous sound (see http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/

threshold_guidance.html). NOAA uses two measures of potential harassment: peak dB and SEL_{cum}. NOAA NMFS (2016a) also uses auditory weighting functions to assess susceptibility to noise-induced hearing loss dependent on the hearing range of the marine mammal.

Prior to the finalization of acoustic guidance, Tougaard et al. (2015) expressed concerns about extrapolating hearing sensitivities among species, although such extrapolation is necessary due to a lack of audiograms and hearing experiments on many species. Tougaard et al. (2015) suggested that bottlenose dolphins' hearing should not be extrapolated to harbor and finless porpoises, and NOAA NMFS (2016a) specifically considered this recommendation. Tougaard et al. (2015) also recommended applying frequency weighting with a filter function. Frequency-dependent auditory weighting functions were developed as part of NOAA NMFS (2016a), but NOAA Fisheries reported that the filtering modifications suggested by Tougaard et al. (2015) do not have sufficient data for quantification and that conservative factors in the development of the weighting functions are sufficient to address the concern raised by Tougaard et al. (2015). Wright (2015) critiqued the small sample size used to develop the thresholds during the public comment period on the proposed guidance. NOAA Fisheries acknowledged the small sample size in its response but explained that the intent was to predict a most likely threshold rather than a worst-case scenario based on the lowest limits for each step in the methodology (81 FR 51694). NOAA Fisheries also responded that auditory weighting functions were based on more than just the composite audiogram (81 FR 51694).

In order to issue a permit to "take" marine mammals, including take by harassment, Section 101 of the MMPA states that NOAA Fisheries must find that take has negligible impacts to marine mammal stocks, affects a small number, and does not have un-mitigatable adverse impact on subsistence use. NOAA Fisheries provides instructions on how to apply for an IHA or LOA on its website (NOAA NMFS 2016b). Offshore wind development in the AoA may trigger permitting requirements under the MMPA for activities such as bottom surveys and pile driving.

Key differences between the ESA and MMPA include their listing and enforcement processes. Furthermore, the MMPA emphasizes the role of marine mammals in their ecosystems and preempts state authority, while the ESA focuses on the risk of extinction and encourages states to enact stronger protections (Rieser et al. 2013). Significantly, the ESA is triggered by a federal action, and consultation is the responsibility of federal agencies; however, the MMPA applies directly to all action proponents, so permits associated with the MMPA are the responsibility of offshore wind developers, though the NOAA Permit Office issuing MMPA permits will be required to consult with the appropriate NOAA

Fisheries Office regarding ESA-listed species. If ESA-listed species are included in an IHA or LOA, consultations between NOAA Permit Office and, in this case, GARFO, result in one marine mammal permit document for the developer that includes all mitigation required to comply with both statutes. The existing ITS under the ESA relative to BOEM permits is generally revised and issued to the NOAA Permit Office for the listed species under the existing Biological Opinion coincident with the issuance of an MMPA IHA to the developer.

1.3.3 Magnuson-Stevens Fishery Conservation Management Act

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

Under the MSA, fish are defined as "finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds." As such, sea turtles are managed under the MSA. However, as the sea turtles in the AoA are all listed under the ESA, that stricter statute will determine how potential impacts to sea turtles will be addressed, and any necessary permits would be issued under ESA (see Section 1.3.1).

The MSA established Regional Fishery Management Councils, which consist of federal and state officials. The councils are responsible for creating fishery management plans, both to restore depleted stocks and to manage healthy stocks. Regional Fishery Management Councils are charged with "[e]xercising sound judgement in the stewardship of fishery resources through the preparation, monitoring, and revision of such plans."

1.3.4 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) of 1972, 16 U.S.C. §1451 et seq., as amended, administered by NOAA, encourages the appropriate development and protection of the nation's coastal and shoreline resources. The CZMA gives states the primary role in managing these resources. As stated in 16 U.S.C. 1452, the goal of the act 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 federal project may have 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 coastal management program (16 U.S.C. 1456). The CZMA requires that projects located within a state's coastal waters be consistent with the policies that guide coastal management actions. This statute has been interpreted by the NOAA Office of Coastal Management to allow consistency review for actions that take place beyond the boundary of state territorial waters (see 15 CFR 930.11(b) and 15 CFR 930.11(g)). This means that states can request consistency review 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 is a reasonably foreseeable impact on a coastal resource. Consistency review may be requested by states (including any states that feel they have a coastal resource in the AoA) for permits issued for take of marine mammals and sea turtles. Any IHA or ITS can be subject to such a review independent of other permitting actions. In other words, states can make multiple requests for review of multiple federal actions related to offshore wind farm development in the AoA, including requests for review of marine mammal and ESA-listed species take permits.

The two states with coastal waters closest to the AoA are New York and New Jersey. The New York State Coastal Management Program was approved by the NOAA Office of Coastal Management in 1982 (DOS 1982). The main law governing New York coastal management is Executive Law Article 42. The New Jersey State Coastal Management Program was approved by the NOAA Office of 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.

Any federal agency proposing an action that may have reasonably foreseeable effects on coastal resources must submit a consistency determination. Individuals proposing actions subject to federal approvals must also be consistent with state laws under the CZMA. A state may disagree with a "no foreseeable effects finding" and request official consistency review from the NOAA Office of Coastal Management. Typically, if a state submits a request for consistency review and such review is granted by the NOAA Office of Coastal Management, the permit applicant or federal action agency will address the consistency issues raised by the state and provide the necessary information to the state and NOAA Office of Coastal Management in the form of a Consistency Certification. Usually, consistency is achieved through appropriate mitigation and/or notifications. With respect to marine mammals and sea turtles, consistency review may be requested by potentially affected states for any permits that are needed in association with these species, even if actions will be further than 3 nautical miles from shore.

1.3.5 Outer Continental Shelf Lands Act

Enacted in 1953, the OCSLA (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. This act, as amended, provides guidelines for managing and leasing the OCS. Under the OCSLA, the Secretary of the Interior is responsible for administering 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). The Energy Policy Act of 2005 amended Section 8 of OCSLA to give BOEM the authority to identify offshore wind development sites within the OCS and to issue leases on the OCS for activities that are not otherwise authorized by the OCSLA, including wind farms. BOEM administers the leasing provisions of the OCSLA and oversees the development of a tract once it has been leased (Rieser et al. 2013).

With respect to marine mammals and sea turtles, permits and leases issued under the OCSLA are considered federal actions. BOEM is required to conduct inter-agency consultations and may not issue permits that are not in compliance with other federal laws. Permits are also subject to potential consistency review under the CZMA (as described in Section 1.3.4).

1.3.6 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 a proposed action. The severity of the impact determines the type of document required by the agency. 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 action. Citizens and public officials must be able to access environmental information regarding the proposed action before a federal agency makes a decision. The information must be based on the best possible data, open to public scrutiny, and subject to expert agency response. NEPA also 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 the NEPA procedures that apply to all federal agencies. Federal agencies must adhere to the NEPA procedures, but they are also free to create their own 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, in consultation with other agencies and stakeholders, oversee the required NEPA process for any such proposed offshore wind projects. For offshore wind farms proposed 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 operation activities (NYSERDA 2015).

With respect to marine mammals and sea turtles, permits issued for take of these species require NEPA review specific to them, regardless of any other NEPA review of the proposed action. Issuing a permit is considered a federal action. NOAA Fisheries can incorporate existing NEPA documents by reference or adopt an EA or EIS to meet its NEPA requirements with respect to permits, if the content of such prior analyses is sufficient to meet the NEPA needs for those permits.

1.3.7 Inter-American Convention for the Protection and Conservation of Sea Turtles

The Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) of 2001 is an intergovernmental agreement between the Americas and nation states within the Americas that provides the legal structure to take action for the conservation of sea turtles. Furthermore, the IAC promotes the protection and recovery of the populations of sea turtles and the habitats on which they depend on the basis of the best available data and taking into consideration the environmental, socioeconomic, and cultural characteristics of the involved "Parties" (states that have consented to be bound by the IAC) (Article II, Text of the Convention; IAC 2001). Currently, there are six sea turtle species protected under the IAC, three of which occur within the AoA (leatherback, loggerhead, and Kemp's ridley).

The IAC currently has 15 contracting Parties, in addition to one country awaiting national ratification. Each Party has developed its own framework within which to operate in accordance with the IAC (IAC 2015) that establishes regulation of all activities within its territory. However, sea turtle distribution occurs throughout multiple regions, requiring that Parties agree on a series of protocols for protection and conservation of sea turtles throughout the region. See Section 6 for BMPs related to this agreement. Member states are required to report annually on their activities supporting the convention (NOAA NEFSC 2014).

There are no permits required under the IAC, but it is important to recognize that the U.S. signed this international agreement and has agreed, to the extent practicable, to reduce human activities that could seriously affect sea turtles, particularly during important activities like migration and nesting.

2 Data Review Methods and Summary of Findings

2.1 Data Review Methods

2.1.1 Data and Literature Review

This Study used a variety of existing data to examine marine mammal and sea turtle use of the AoA a nd the sensitivities of species and species groups to potential risks from offshore wind farm development. Data were first collected from surveys, tagging, fisheries interactions, stranding, and anecdotal reports on seasonal and behavioral use/occurrence patterns of marine mammals and sea turtles within the AoA. These data were then considered in evaluating potentially important areas for marine mammals and sea turtles in the AoA. Appendix A describes major data sources used in this review, and Appendix B presents a summary of the literature and data collected as part of this Study.

Following the data review, analyses of habitat-based density predictions were conducted to predict high-use areas. Density predictions rely on a subset of the available data (Roberts et al. 2015, 2016; Navy 2007). The potential value of habitat-based density modeling is that it is predictive of where whales are likely to occur when survey effort is low or does not exist for an area. Logistics can make surveying the slope area more difficult and expensive than surveying the continental shelf, and weather and ocean conditions can make surveying more difficult outside the summer season, requiring more speculation in areas further offshore and outside of summer. Historical and contemporary studies complement and supplement density analyses that predict habitat use patterns of marine mammals and sea turtles in the AoA. See Appendix B for an overview of results of historical and ongoing studies that were considered in evaluating potential risk of wind farm development to marine mammals and sea turtles. The results from the data review presented in Appendix B were integrated with the predicted density analyses, described in Section 2.2, to draw conclusions about distribution and use patterns of marine mammals and sea turtles in the AoA (see Section 4). In cases in which additional information or conflicting information existed in the literature relative to density predictions, specific discussion of these discrepancies or additional data is included in the potential sensitivities and risks and conclusions/synthesis.

This review considers six species of baleen whales (Mysticeti), the sperm whale, dwarf and pygmy sperm whales (*Kogia* spp.), dolphins (Delphinidae), harbor porpoise, beaked whales (*Mespolodon* spp. and *Ziphius cavirostris*), four species of seals (Phocidae), and four species of sea turtles (Cheloniidae). Table 2 summarizes abundance, status, distribution, and occurrence of marine mammals and sea turtles in the AoA. Several species listed in Table 2 that are extremely rare in the AoA are not reviewed in Appendix B (see Appendix B, Section B.4 for a list of extremely rare species).

Table 2. Marine Mammals and Sea Turtles in the Mid-Atlantic: Abundance, Status, Distribution, and Occurrence

Species	Scientific Name	Stock	Best Population Estimate in Stock Assessment Report[a]	Best Population Estimate Roberts et al. (2016)[b]	Strategic Status[c]	ESA Status[d]	Main Distribution in/near AoA[e]	Occurrence in AoA[f]
Baleen Whales								
North Atlantic right whale	*Eubalaena glacialis*	Western North Atlantic	440[g]	535 Winter, 416 Spring, 379 Summer, 334 Fall	Strategic	Endangered	Coastal and Continental Shelf; November through April	Common
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	823[g]	205 Winter, 1,637 Summer	None	None	Coastal and Continental Shelf; Spring, Summer and Fall	Common (migratory in spring & fall, coastal feeding spring through fall)
Fin whale	*Balaenoptera physalus physalus*	Western North Atlantic	1,618	4,633	Strategic	Endangered	Coastal and Continental Shelf	Common
Sei whale	*Balaenoptera borealis borealis*	Nova Scotia	357	98 Winter, 627 Spring, 717 Summer, 37 Fall	Strategic	Endangered	Continental Shelf; Spring and Summer	Rare (mainly north of AoA)
Minke whale	*Balaenoptera acutorostrata acutorostrata*	Canadian east coast	2,591	2,112 Summer, 740 Winter	None	None	Coastal and Continental Shelf; Spring and Summer	Uncommon
Blue whale	*Balaenoptera musculus musculus*	Western North Atlantic	Unknown	11	Strategic	Endangered	Continental Slope and Oceanic	Uncommon (mainly north of AoA)
Bryde's whale	*Balaenoptera edeni*	N/A	No Stock Assessment Report	7	N/A	None	Continental Shelf and Slope	Extremely Rare
Sperm Whales								
Sperm whale	*Physeter macrocephalus*	North Atlantic	1,815	5,353	Strategic	Endangered	Continental Slope and Oceanic; year-round with peak in summer	Common
Kogia spp.	*Kogia sima & Kogia breviceps*	Western North Atlantic	2,598	3,785	None	None	Continental Slope and Oceanic	Common
Beaked Whales								
Northern bottlenose whale	*Hyperoodon ampullatus*	Western North Atlantic	Unknown	90	None	None	Continental Slope and Oceanic	Extremely Rare
Cuvier's beaked whale	*Ziphius cavirostris*	Western North Atlantic	6,532	14,491[h]	None	None	Continental Slope and Oceanic	Common
Mesoplodont beaked whales	*Mesoplodon spp.*	Western North Atlantic	7,092	14,491[h]	None	None	Continental Slope and Oceanic	Common
Dolphins								
Killer whale	*Orcinus orca*	Western North Atlantic	Unknown	11	None	None	Oceanic	Extremely Rare
Pygmy killer whale	*Feresa attenuata*	Western North Atlantic	Unknown	Not Modeled	None	None	Continental Shelf and Oceanic	Extremely Rare
False killer whale	*Pseudorca crassidens*	Western North Atlantic	442	95	Strategic	None	Continental Slope and Oceanic	Extremely Rare
Melon-headed whale	*Peponocephala electra*	Western North Atlantic	Unknown	1.175	None	None	Oceanic	Extremely Rare
Risso's dolphin	*Grampus griesus*	Western North Atlantic	18,250	7,732	None	None	Continental Slope and Oceanic (range contracts to Mid-Atlantic Bight in winter)	Common
Pilot whale, long-finned	*Globicephalus melas*	Western North Atlantic	3,464	18,977[i]	Strategic	None	Continental Shelf, Slope and Oceanic (northward along slope in late-winter and spring, more on shelf in late-summer and fall)	Common
Pilot whale, short-finned	*Globicephalus macrorhynchus*	Western North Atlantic	15,913	18,977[i]	Strategic	None	Continental Shelf, Slope and Oceanic (northward along slope in late-winter and spring, more on shelf in late-summer and fall)	Common

Table notes are at the end of the table.

Table 2 continued

Species	Scientific Name	Stock	Best Population Estimate in Stock Assessment Report[a]	Best Population Estimate Roberts et al. (2016)[b]	Strategic Status[c]	ESA Status[d]	Main Distribution in/near AoA[e]	Occurrence in AoA[f]
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic	30,403	37,180	None	None	Coastal, Continental Shelf and Slope	Uncommon (tend to be North of AoA)
White-beaked dolphin	*Lagenorhynchus albirostris*	Western North Atlantic	2,003	39	None	None	Continental shelf	Extremely Rare
Short-beaked common dolphin	*Delphinus delphis*	Western North Atlantic	55,690	86,098	None	None	Continental Shelf and Slope (shift north of AoA summer to fall)	Common
Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic	44.715	55,436	None	None	Continental Shelf and Slope	Uncommon (tend to be South of AoA)
Pantropical spotted dolphin	*Stenella attenuate*	Western North Atlantic	4,439	4,436	None	None	Continental Slope and Oceanic	Extremely Rare Tend to be south of AoA)
Striped dolphin	*Stenella coeruleoalba*	Western North Atlantic	54,807	75,657	None	None	Continental Slope and Oceanic (Spring concentration along shelf edge in Mid-Atlantic Bight)	Common
Fraser's dolphin	*Lagenodelphis hosei*	Western North Atlantic	Unknown	492	None	None	Continental Slope and Oceanic	Extremely Rare
Rough-toothed dolphin	*Steno bredanensis*	Western North Atlantic	271	532	None	None	Continental Slope, Shelf, and Oceanic	Extremely Rare
Clymene dolphin	*Stenella clymene*	Western North Atlantic	Unknown	12,524	None	None	Continental Slope and Oceanic	Extremely Rare
Spinner dolphin	*Stenella longirostris longiristris*	Western North Atlantic	Unknown	262	None	None	Continental Slope and Oceanic	Extremely Rare
Common bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic, offshore	56,053	97,476[j]	None	None	Outer Continental Shelf and Slope (mostly absent in winter when shift southward)	Common
Common bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic, northern migratory coastal	11,548	97,476[j]	Strategic	None	Coastal	Rare (stock is found w/i 0-25m depth which would mainly be shoreward of AoA)
Porpoises								
Harbor porpoise	*Phocoena*	Gulf of Maine/Bay of Fundy	61,415	17,651 Winter, 45,089 Summer	None	None	Coastal and Continental Shelf (shift north of AoA in summer)	Uncommon (mainly north and east of AoA)
Seals								
Harbor seal	*Phoca vitulina concolor*	Western North Atlantic	66,884	Not Estimated[k]	None	None	Coastal, (September to May)	Common
Gray seal	*Halichoerus grypus*	Western North Atlantic	Unknown[l]	Not Estimated[k]	None	None	Coastal, (September to May)	Uncommon
Harp seal	*Pagophilus groenlandicus*	Western North Atlantic	Unknown[l]	Not Estimated[k]	None	None	Coastal, January to May	Extremely Rare
Hooded seal	*Cystophora cristata*	Western North Atlantic	Unknown[l]	Not Estimated[k]	None	None	Coastal and Continental Shelf	Extremely Rare
Ringed seal	*Pusa hipsida*	N/A	No Stock Assessment Report	Not Estimated[k]	N/A	None	Coastal and Continental Shelf	Extremely Rare

Table notes are at the end of the table.

Table 2 continued

Species	Scientific Name	Stock	Best Population Estimate in Stock Assessment Report[a]	Best Population Estimate Roberts et al. (2016)[b]	Strategic Status[c]	ESA Status[d]	Main Distribution in/near AoA[e]	Occurrence in AoA[f]
Sea Turtles								
Leatherback Turtle	*Dermochelys coriacea*	N/A	N/A	N/A	N/A	Endangered	Coastal and Continental Shelf (Spring to fall with peak in summer)	Uncommon
Loggerhead Turtle	*Caretta*	Northwest Atlantic Ocean DPS[m]	588,000[n]	N/A	N/A	Endangered	Coastal and Continental Shelf (Spring to fall with peak in summer)	Common
Kemp's Ridley Turtle	*Lepidochelys kempii*	N/A	N/A	N/A	N/A	Endangered	Coastal and Continental Shelf (Spring to fall with peak in summer)	Uncommon
Green Turtle	*Chelonia mydas*	North Atlantic DPS[m]	N/A	N/A	N/A	Threatened	Coastal and Continental Shelf (Spring to fall with peak in summer)	Uncommon

[a] Best population estimates in the Stock Assessment Reports (SARs) (Hayes et al. 2017) generally consider only the portion of the population found in U.S. Exclusive Economic Zone (EEZ) waters and may not include the entire U.S. range, depending on available survey data. Most cetacean population estimates are based on 2011 Atlantic Marine Mammal Assessment Program for Protected Species surveys (NOAA NEFSC and SEFSC 2011a; Palka 2012; Hayes et al. 2017), with the exceptions of the following: humpback whales are based on surveys in the Gulf of Maine and Bay of Fundy in 2008; North Atlantic right whales are based on maximum number of photo-identified individuals (in 2012); Northern Migratory Stock of bottlenose dolphins is based on aerial surveys in 2010 and 2011 from Florida to New Jersey; short-beaked common dolphins are based on Canadian Trans-North Atlantic Sighting Survey in 2007 and include areas outside the U.S. EEZ; pantropical spotted dolphins are based on surveys in 2004; and white-beaked dolphins are based on a survey in 2006. The harbor seal population estimate is based on 2012 surveys along the Maine coast.

[b] Roberts et al. (2016) use habitat-based density modeling to predict densities of cetaceans in the U.S. Western Atlantic EEZ, including the New York Offshore Study Area. Because these densities are the best available for evaluating use patterns of marine mammals for take estimation under the MMPA, it is important to consider how the abundance estimates derived from this modeling differ from abundances reported in the SARs (Hayes et al. 2017), which typically rely on 1–2 years of survey data rather than the 24 years of data included in Roberts et al. (2016). Roberts et al. (2016) do not include the NOAA NEFSC and SEFSC (2011a) surveys used in Palka (2012) to estimate abundance for most species in the SARs (Hayes et al. 2017), but these and additional data from 2010, 2012, 2013, 2014, and 2015 are being added to Roberts et al. (2016) models. Roberts et al. (2016) includes Bryde's whales (*Balaenoptera edeni*) based on four sightings from 1992–2005, but there is no stock assigned by NOAA Fisheries, so this species is omitted for purposes of this study.

[c] In the MMPA the term "strategic stock" means a marine mammal stock—(A) for which the level of direct human-caused mortality exceeds the potential biological removal level; (B) that, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the
ESA [16 U.S.C. 1531 et seq.] within the foreseeable future; or (C) that is listed as a threatened species or endangered species under the ESA (16 U.S.C. 1531 et seq.), or is designated as depleted.

[d] In the ESA, the term "endangered species" means any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to humans. The term "threatened species" means any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range

[e] The distribution of marine mammals and sea turtles tends to be coastal, along the continental shelf, continental slope, and/or oceanic (deep) waters. These are general distributions and do not preclude the occurrence of any species in any area within the AoA. There are no specific depth cutoffs that define these regions, but coastal stocks typically do not extend to the shelf break and are generally close to shore. Continental shelf stocks are not typically found on the shallow water plain extending to the slope area where depth drops quickly to >1,000m and becomes the deep oceanic area. Determination of general distribution of marine mammals for purposes of this table was based on information provided in Leatherwood et al. (1976) and the SARs (Hayes et al. 2017) and for turtles, was from status reviews and 5-year reviews under ESA (see Appendix B, Section B.3). More detailed information and citations for distribution and seasonal movements can be found in Appendix B, Section B.1 to B.3.

[f] Occurrence in the AoA is derived from sightings and information provided by Hayes et al. (2017) and Roberts et al. (2016), which both compile sighting data from multiple surveys into maps. Common species are seen regularly during most of the year and predicted to occur regularly in the AoA. Uncommon species occur for briefer parts of the year and/or maintain most of their population outside of the AoA most of the year. Rare species are usually not present in the AoA or occur in very small numbers compared to population size. Extremely rare species have been observed in the AoA or nearby regions, but these observations are likely extralimital or very unusual.

[g] The minimum population estimate is reported as the best population estimate in the SAR.

[h] Roberts et al. (2016) grouped the following species in their analysis, Blainsville's beaked whale, Cuvier's beaked whale, Gervais' beaked whale, Sowerby's beaked whale and True's beaked whale.

[i] Roberts et al. (2016) grouped the following species in their analysis, Pilot Whale long finned and Pilot Whale short-finned.

[j] Roberts et al. (2016) did not differentiate the stocks of bottlenose dolphins, similar to how NOAA Fisheries estimates in stock assessments.

[k] Roberts et al. (2016) did not estimate seal densities; however, Roberts (2017) provided preliminary models of seal densities without differentiation among species or stocks (Roberts et al. 2015). The total seal abundance predicted by these models is 15,002 (CV=0.17) in winter and 98,747 (CV=0.55) in summer; however, this abundance does not consider proportion of the population hauled-out during in-water surveys, so do not reflect actual population sizes.

[l] Hayes et al. (2017) report the population sizes of these seal species as "unknown" because surveys have not been conducted within the U.S. because of the northerly location of rookeries; however, they also report that estimates based on surveys at pupping areas north of the U.S. have resulted in population estimates of 505,000 gray seals in 2014, 7.1 million harp seals in 2012, and 592,000 hood seals in 2005.

[m] DPS = Distinct Population Segment defined under the ESA (76 FR 58868).

[n] NOAA NEFSC and SEFSC 2011b

2.1.2 Density Modeling

To evaluate marine mammal and sea turtle density patterns, existing density models were combined across identified "receptor" groups that could be susceptible as a group to "stressors" associated with offshore wind development in the AoA. Density models included Roberts et al. (2015, 2016) and Navy (2007). See Appendix A for descriptions of the density models used in this analysis. Potential stressors are discussed in detail in Section 3 and include noise, structures in the water, and increases/changes in type of vessel traffic. Receptor groups were chosen based on potential risk associated with stressors: cetaceans may have different risks associated with noise based on hearing range (i.e., high, mid, and low frequency); North Atlantic right whales and other endangered cetaceans may be more sensitive due to population stress; and shallow- and deep-diving cetaceans may have different likelihoods of vessel collision. Therefore, these receptor groups are evaluated, along with seals and sea turtles, as separate groups (Table 3).

Table 3. Marine Mammals and Sea Turtle Receptor Groups Considered in this Study

Receptor Group[a]	Members of Receptor Group
High-Frequency Cetaceans	Harbor porpoise, dwarf and pygmy sperm whales
Mid-Frequency Cetaceans	Sperm whales, beaked whales, dolphins
Low-Frequency Cetaceans	Baleen whales
Seals	Harbor and gray seals
Sea Turtles	Loggerhead, leatherback, and Kemp's ridley (no data for green)
North Atlantic Right Whale	North Atlantic right whale
Other Endangered Cetaceans	Sperm whale, blue whale, sei whale, fin whale
Deep-Diving Cetaceans	Sperm whale, pygmy and dwarf sperm whale, beaked whales, pilot whales, spinner dolphin
Shallow Diving Cetaceans	Dolphins not listed in "Deep-Diving Cetaceans," harbor porpoise, baleen whales

[a] High-, mid-, and low-frequency cetaceans were defined by Finneran (2016). Shallow- and deep-diving cetaceans were defined as typically diving ≤200 m or >200 m based on NOAA NEFSC (2014). See Section 3 for more details.

Models used in this desktop analysis to predict densities of receptor groups in the AoA during winter (December to February), spring (March to May), summer (June to August), and fall (September to November) were developed from Roberts et al. (2015, 2016) and Navy (2007).

The models for cetaceans were obtained from Roberts et al. (2016). Note that these models do not contain the most current NOAA NEFSC and SEFSC (2010, 2011a, 2012, 2013, 2014, 2015) data, and effort in the AoA was limited. Density patterns were modeled using habitat-based environmental parameters to predict expected use patterns (Roberts et al. 2016). For harbor seals and sea turtles, this Study used Navy (2007) as updated in Navy (2012) with models developed in SMRU Ltd. (2012) and published on marinecadastre.gov. In addition, Roberts et al. (2015) "seal" density models were included in this evaluation, though these models are preliminary. Models of sea turtles available on marinecadastre.gov were loggerhead, leatherback, and Kemp's ridley. (See Appendix A for more detailed descriptions of these datasets and models.)

Density models in Roberts et al. (2016) provided monthly predictions for 15 species of cetaceans, as shown in Table 4. The remaining 13 models provided annual predictions. Annual models were not habitat-based density estimates because sufficient data were not available to run the contemporaneous and climatological models. In these cases, stratified models were employed to spread a predicted abundance of individuals in the U.S. Atlantic Exclusive Economic Zone (EEZ) across the EEZ. In cases in which data suggested that a species was not present in a particular area (e.g., north of a certain latitude or farther from shore than a certain depth contour), density was forced to zero in that area in the stratified models. Also, for some species, density was less than 1/100 km^2 in the AoA or part of the AoA, making the value effectively zero in that location. As a result, four species models predicted zero density and nine species models predicted zero density in part of the AoA (Table 4). Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of endangered baleen whales in the New York Bight. These modeling and mapping efforts differ from density mapping and should not be confused with Roberts et al.'s (2016) models. Sightings per unit effort is not the same as predicted density, which uses line-transect theory to evaluate effective strip widths, detection functions, and correction factors for perception and availability biases associated with sightings and effort. Maps of sightings per unit effort provide a visual representation of sightings that considers the amount of trackline surveyed relative to the number of sightings, but does not address sighting biases (aside from effort) and does not relate use to habitat preferences.

Table 4. Cetacean Density Model Characteristics

Source: Roberts et al. 2016

Species	Monthly Prediction (Yes or No)	Density = Zero in AoA (Yes or No)
North Atlantic right whale	Yes	No
Humpback whale	Yes	No
Fin whale	Yes	No
Sei whale	Yes	No
Minke whale	Yes	No

Table 4 continued

Species	Monthly Prediction (Yes or No)	Density = Zero in AoA (Yes or No)
Blue whale	No	No
Bryde's whale	No	Yes
Sperm whale	Yes	No
Dwarf and pygmy sperm whale	No	Yes except slope and oceanic
Northern bottlenose whale	No	Yes except slope and oceanic
Beaked whales	Yes	Yes except slope and oceanic
Killer whale	No	No
Pygmy killer whale	N/A	N/A
False killer whale	No	No
Melon-headed whale	No	Yes
Risso's dolphin	Yes	No
Pilot whale	Yes	No
Atlantic white-sided dolphin	Yes	No
White-beaked dolphin	No	No except slope and oceanic
Short-beaked common dolphin	Yes	No
Atlantic spotted dolphin	Yes	Yes except slope and oceanic
Pantropical spotted dolphin	No	Yes except slope and oceanic
Striped dolphin	Yes	Yes except slope and oceanic
Fraser's dolphin	No	Yes
Rough-toothed dolphin	No	Yes except slope and oceanic
Clymene dolphin	No	Yes
Spinner dolphin	No	Yes except slope and oceanic
Common bottlenose dolphin	Yes	No
Harbor porpoise	Yes	No

For Navy (2007) (updated in Navy [2012]), stratified models spread harbor and gray seals across the EEZ in a few zones of density. The density for harbor seals is predicted to be less than 0.01 per km^2 in winter, spring, and fall, with a decline to zero in summer. These data have limited application for determining where harbor seals may be patchy and congregate in the AoA. Likewise, gray seals are predicted in two zones in the AoA, one that includes the east half and one that includes the west half. Predicted densities remain the same year-round, with zero predicted in the west half of the AoA and >0.03 per km^2 predicted in the east half. To better understand the potential for seals to show varying density across the AoA, data from Roberts et al. (2015) were evaluated. These are monthly habitat-based models that provide some sense of potentially preferred habitat for seals.

Sea turtle models (Navy 2007) (updated in Navy [2012]) are density predictions for each of the four seasons. The data used by Navy (2007, 2012) consists of aerial and ship-based surveys conducted from 1998 to 2005. Greene et al. (2010) combined some of these data with data available from surveys from 1979 to 2003 and later augmented these data to include surveys and observations through 2007 on northeastoceandata.org to depict sightings per unit effort for leatherback and loggerhead sea turtles in spring and summer. As noted above, sightings per unit effort is not the same as predicted density, which uses line-transect theory to evaluate effective strip widths, detection functions, and correction factors for perception and availability biases associated with sightings and effort; however, it provides a visual representation of sea turtle sightings that considers the amount of trackline surveyed relative to the number of sightings.

To evaluate potential areas where receptor groups may be present in higher densities, monthly maps were clipped to the AoA and averaged for each species for each season, and these seasonal mean density maps were added together across the species in the receptor group. This approach does not normalize across the receptor groups, so maps among receptor groups are not comparable, but maps within receptor groups across seasons indicate predicted high and low use patterns for groups. Colors on the figures in Section 2.2 represent the same densities within a receptor group, but not among receptor groups. For example, red on a North Atlantic right whale figure may not correspond to the same density as red on a mid-frequency cetacean figure, but both signify highest relative density within the receptor group.

Because many species use the slope and oceanic regions heavily, summed densities did not easily show nuances in use patterns predicted for the continental shelf. Therefore, maps were also created for receptor groups for just the continental shelf to allow for visualization of differences in density only in that region for receptors.

2.2 Summary of Density Model Findings

This section summarizes the analysis of the density models only. Additional detail on the occurrence and use patterns of marine mammals and sea turtles in the AoA is provided in Appendix B, which summarizes existing literature related to surveys, tagging, fisheries interactions, strandings, and anecdotal information. Historical and contemporary survey, tagging, and other data reviewed in Appendix B were compared with density predictions to fill data gaps, evaluate support for predictions, and discuss individual species to draw final conclusions in Section 4.

Analyses of relative densities of marine mammals are categorized by generalized cetacean hearing and diving groups, seals, sea turtles, and endangered cetaceans—i.e., the receptor groups previously defined in Section 2.1.2 and Table 3—with the North Atlantic right whale are considered separately from low-frequency cetaceans and endangered cetaceans due to its endangered status. Although the figures in the sections below are scaled to highest densities within the geographic area included in the figure, the maximum densities described in the text refer to the entire AoA. Thus, these values may be smaller than the maximum densities that appear in the legends of the figures.

2.2.1 High-Frequency Cetaceans Distribution, Density, and Seasonal Patterns

Three species of high-frequency cetaceans are found in the AoA: pygmy and dwarf sperm whales and harbor porpoise. Habitat-based density models from Roberts et al. (2016) used in analysis of high-frequency cetacean density patterns extrapolate to predicted use patterns of these three species differently. Pygmy and dwarf sperm whales are combined in Roberts et al. (2016); however, lack of sightings of this species complex results in an inability to model seasonal shifts or relative abundance across the EEZ. Therefore, harbor porpoise are the driver of high-frequency cetacean seasonal patterns in the current analysis of high-frequency cetacean density in the AoA.

In the winter season, the highest predicted density region of high-frequency cetaceans within the AoA borders the northern boundary of the AoA and reaches 0.15 individuals/km^2. The region of lowest density borders the continental slope, which is along the southwestern boundary of the AoA. There are intermediate density regions bordering the eastern boundary and the southeast corner of the AoA (Figure 2A). The predicted spring distribution is similar to that of winter, but the highest density regions within the AoA (up to 0.17/km^2) extend over a wider spatial range, stretching from the northern border of the AoA along the shelf to the shelf break (Figure 2B). (See Table 2, footnote e for extents of coastal, shelf, slope, and oceanic areas.) The summer (maximum 0.08/km^2) and fall (maximum 0.02/km^2) densities within the AoA differ from winter and spring. For both summer and fall, the highest predicted densities of animals occur along the northeast boundary of the AoA, and the lowest densities along the southeast boundary of the AoA and along the continental slope (Figures 2C and 2D).

To better visualize the relationship in density levels across seasons, maps of density scaled to the annual highest density value are provided in Figure 3. When maps are scaled to the highest seasonal density value for each season, the same color on different seasonal maps does not represent the same density on these different maps; thus, scaling all seasonal maps for a receptor group to the highest annual density makes the densities represented by the colors match across the seasonal maps and better show changes in density among seasons. As shown, high-frequency cetaceans are predicted to be much less common in the AoA in summer and fall. While Figure 2 indicates predicted preferred habitat over the seasons, Figure 3 shows changes in predicted seasonal densities over the year.

Based on the predicted distributions, harbor porpoise would be expected in largest densities across the central area of the continental shelf in the AoA in spring, most likely with some low occurrence in the northern part of the AoA in summer and fall and more shoreward distribution in winter. Roberts et al. (2016) refine these data further into monthly predictions that indicate highest predicted use in December to April, with movement starting northward in May, and an absence of harbor porpoise predicted in the AoA in July to September, with movement starting southward into the AoA again in October. Dwarf and pygmy sperm whales, as mentioned above, were not evaluated to season in Roberts et al. (2016) and are predicted to occur only in low density on the continental slope and ocean waters of the AoA.

Figure 2. High-Frequency Cetaceans: Scaled to Highest Seasonal Predicted Density.

Source: BOEM 2016; ESRI 2010; Roberts et al. 2016

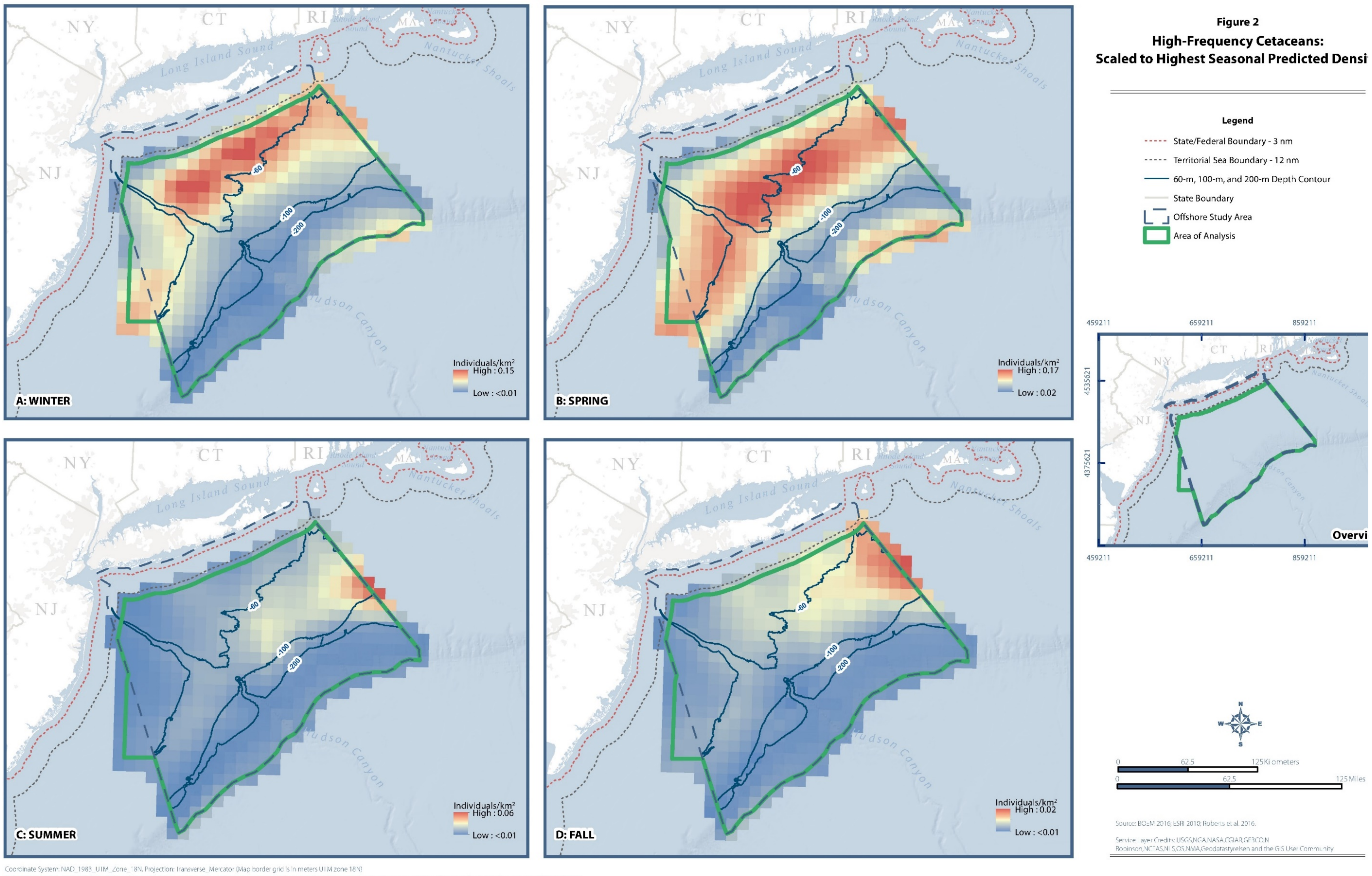
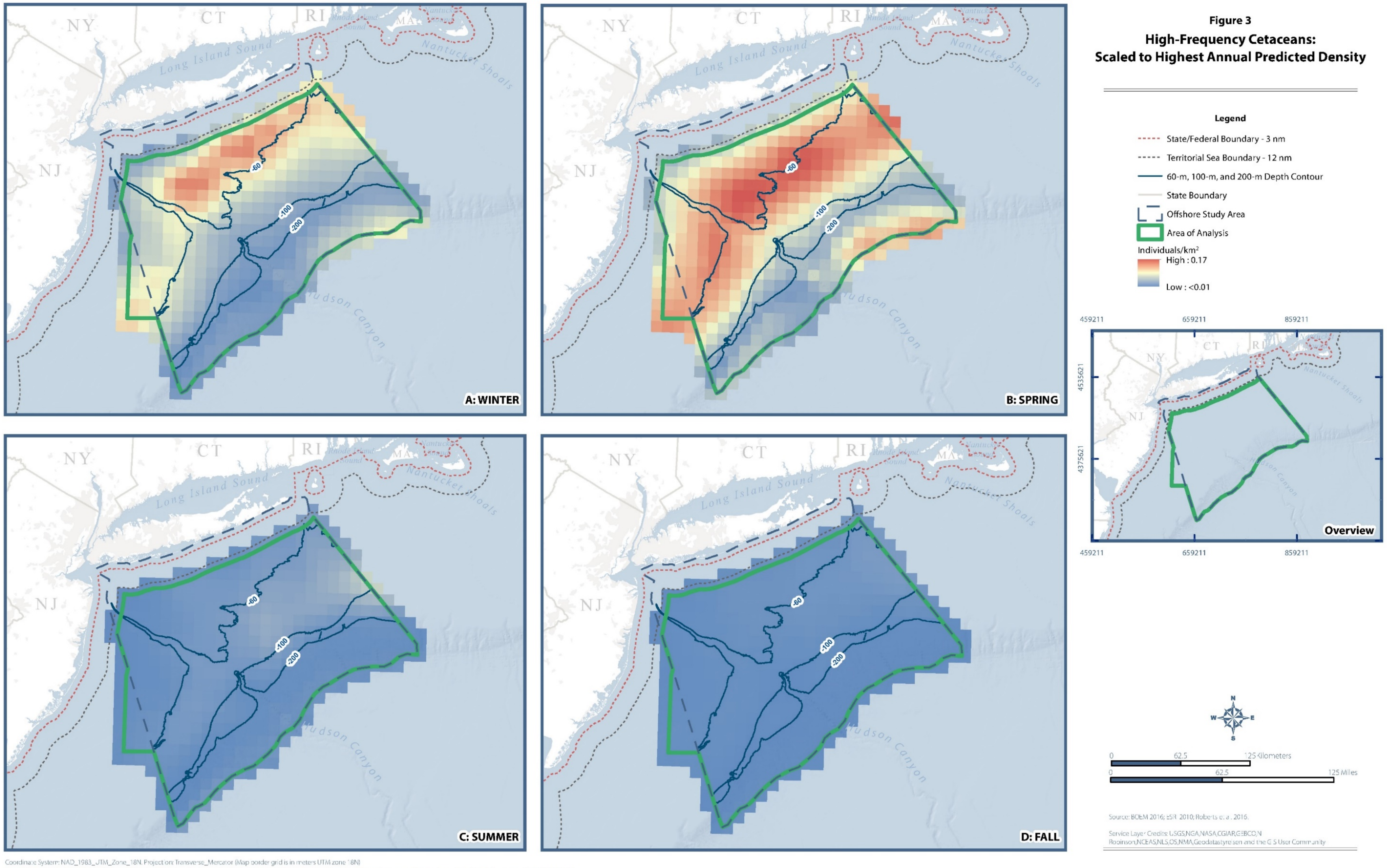


Figure 3. High-Frequency Cetaceans: Scaled to Highest Annual Predicted Density.

Source: BOEM 2016; ESRI 2010, Roberts et al. 2016



2.2.2 Mid-Frequency Cetaceans Distribution, Density, and Seasonal Patterns

The mid-frequency cetaceans are the sperm whales, beaked whales, and dolphins. Dolphins are members of the family Delphinidae, which includes animals that are sometimes referred to as "whales," including pilot whales, melon-headed whales, false killer whales, pygmy killer whales, and killer whales (Table 2). The Roberts et al. (2016) models overlaid to evaluate predicted mid-frequency cetacean seasonal densities in the AoA include monthly models for all species except the following:

- Clymene, melon-headed, and Fraser's dolphins (which were assumed to be absent from the AoA region).
- False killer whales and killer whales (for which two and four sightings respectively in the U.S. Atlantic EEZ were extrapolated to low densities across the entire EEZ).
- Pantropical spotted, spinner, and rough-toothed dolphins and bottlenose whales (for which densities were assumed to be zero on the continental shelf and constant values in slope and oceanic waters).
- White-beaked dolphins (for which density was assumed to be zero on the continental slope and oceanic waters with a constant density in the AoA on the continental shelf). The more common mid-frequency cetaceans in the AoA drove predicted high-density areas for this receptor group.

Mid-frequency cetaceans are predicted to gather in higher concentrations along the continental slope and Hudson Canyon and Valley in winter, summer, and fall and to spread out across the continental shelf in spring (Figure 4). Within the continental slope, the highest predicted densities occur along on the southeastern boundary of the AoA. Predicted densities are relatively low on the continental shelf.

Because the continental slope has the highest predicted mid-frequency cetacean densities, and because these areas would be logistically difficult for building a wind farm, the continental shelf was examined for patterns of mid-frequency cetacean use separate from the shelf slope. High use on the slope drowns out the nuance of shelf use patterns shown in Figure 4. Figure 5 shows predicted mid-frequency cetacean use patterns on the continental shelf in the AoA only. These predicted densities suggest that habitat use on the continental shelf in the AoA is highest along the Hudson Shelf Valley (Figure 5). This pattern persists year-round, though predicted densities decline in summer and fall.

Figure 4. Mid-Frequency Cetaceans: Scaled to Highest Seasonal Predicted Density.

Source:BOEM 2016; ESRI 2010; Roberts et al. 2016

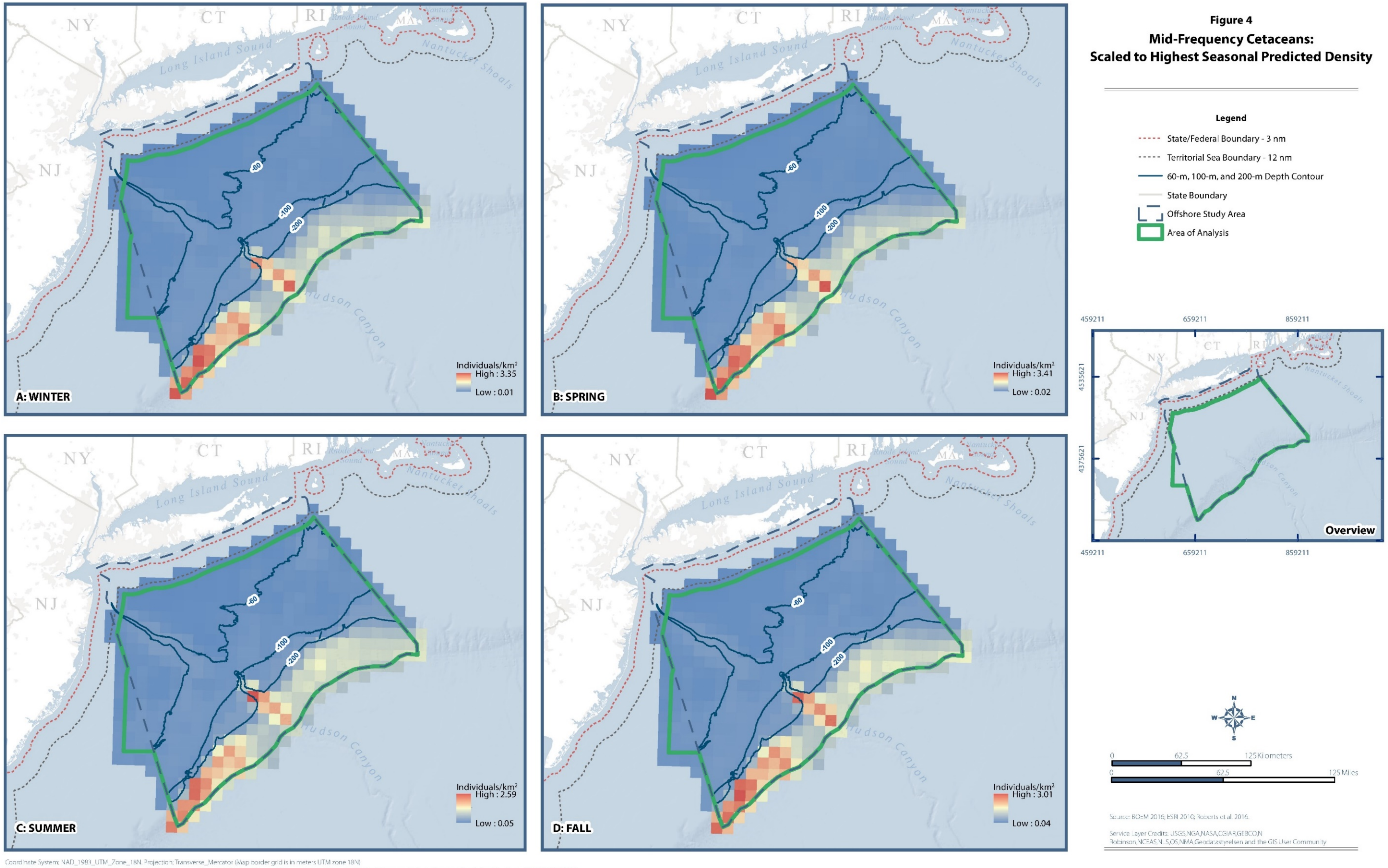
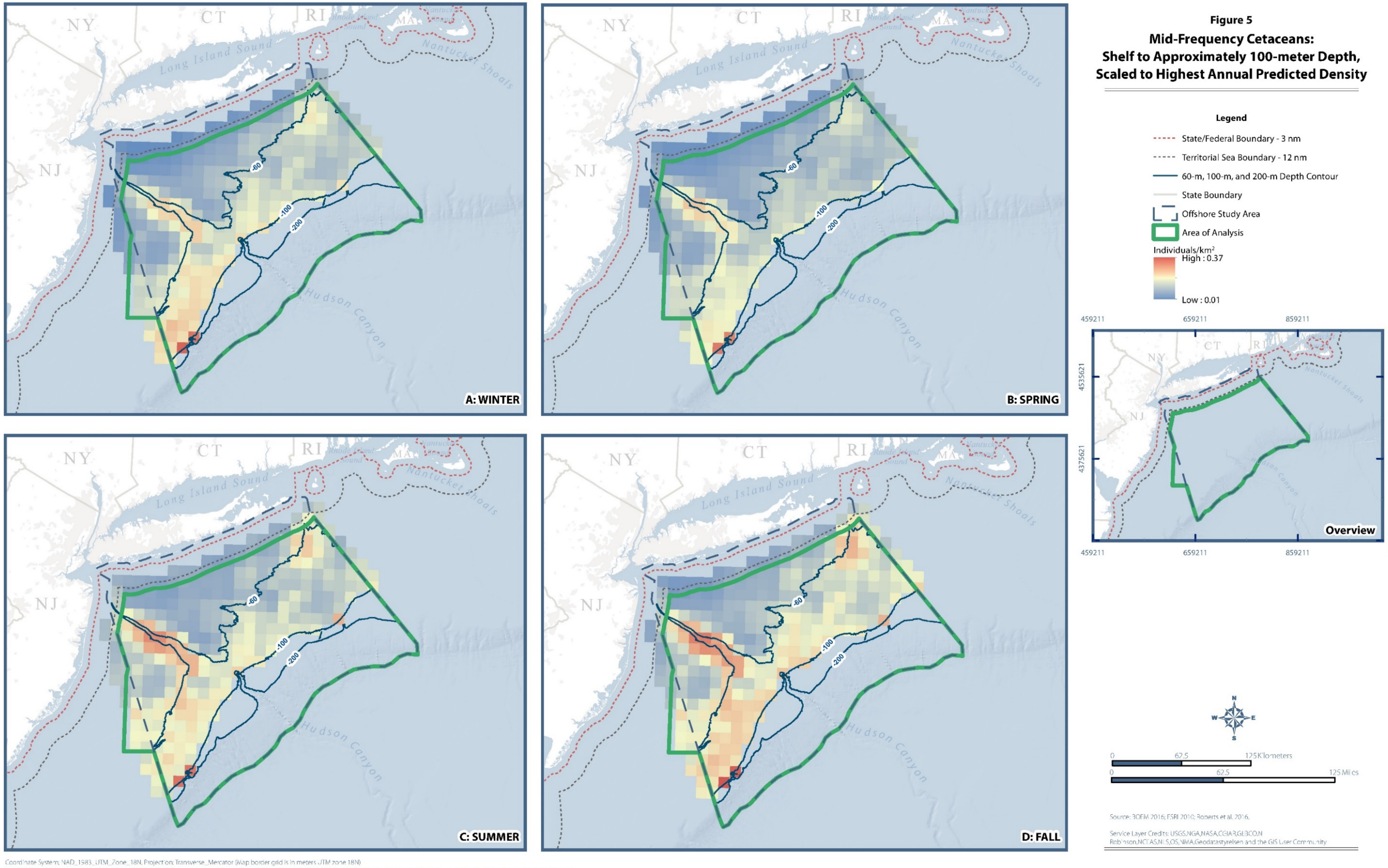


Figure 5. Mid-Frequency Cetaceans: Shelf to Approximately 100-meter Depth, Scaled to Highest Annual Predicted Density.

Source: Boem 2016; ESRI 2010; Roberts et al. 2016



2.2.3 Low-Frequency Cetaceans Distribution, Density, and Seasonal Patterns (excluding North Atlantic right whale)

The low-frequency cetaceans are the baleen whales. The Roberts et al. (2016) models overlaid to evaluate predicted low-frequency cetacean seasonal densities in the AoA include monthly models for minke, humpback, and fin whales; extrapolate eight sightings of blue whales to a constant density throughout the U.S. Atlantic EEZ; and assume that Bryde's whales are absent from the AoA. Roberts et al. (2016) predict the following:

- Fairly constant occurrence of fin whales in the AoA.
- Northward shift of humpback whales in July and August and a southward shift between December and March.
- Northward shift of minke whales between July and October and southward shift of minke whales between December and March.
- Occurrence of sei whales in the AoA mainly between April and July, with sei whales concentrating north of the AoA in other months.

In the AoA, predicted low-frequency cetacean density (not including North Atlantic right whales) was lower in fall (maximum 0.01 individuals/km^2) and winter (maximum 0.02 individuals /km^2) and higher in spring (maximum 0.04 individuals/km^2), with slightly higher density distribution in summer (maximum 0.03 individuals/km^2) than fall and winter (Figure 6). Predicted habitat-use patterns did not change much across seasons, with the greatest predicted occurrence on the shelf break and continental slope. Hudson Canyon was a predicted hotspot, and higher densities shifted north of the canyon on the slope in winter and along the entire slope in spring. Overall, predicted densities of low-frequency cetaceans are relatively low within the AoA, ranging from zero to a maximum of 0.04 individuals/km^2. To better visualize the relationship in density levels across seasons, maps of density scaled to the annual highest density value are provided in Figure 7. As shown, low-frequency cetaceans are predicted to be most abundant in the AoA in spring, followed by summer. While Figure 6 indicates predicted preferred habitat over the seasons, Figure 7 shows changes in predicted seasonal densities.

High predicted use of the shelf break and slope is driven in part by spring and fall humpback whale migration through this area, but it is also driven by predicted use of this region in spring by sei and minke whales and year-round use by fin whales. Although fin whales are predicted to use this area year-round, they have only been observed on the slope during summer surveys (Roberts et al. 2016). Summer is the most common time of year for surveys to take place, potentially biasing sighting results. Minke and sei whales have not been observed in this area of the AoA much at all, but they are predicted to occur.

Overall, the predictions indicate that low-frequency cetaceans are likely to be using the continental slope more than the shelf, and most species show increased spring use corresponding to migration, though similar increases are not apparent in fall, with the exception of humpback whales (Roberts et al. 2016). This use pattern for fin, sei, and minke whales may be, in part, an artifact of Roberts et al.'s assumptions associated with movement patterns of sei, fin, and minke whales by season (Roberts et al. 2016). Additional data related to baleen whale distribution patterns are provided in Appendix B.1.1.

Because the continental shelf break, slope, and oceanic regions have the highest predicted low-frequency cetacean use, and because this area would be logistically difficult for building a wind farm, the continental shelf was examined for patterns of low-frequency cetacean use separate from the shelf break, slope, and oceanic waters. High use on the slope drowns out the nuance of shelf use patterns in Figures 6 and 7. Figure 8 shows predicted low-frequency cetacean use patterns on the continental shelf only. These predicted densities suggest very little use of the continental shelf, with highest use near the shelf break (Figure 8).

Figure 6. Low-Frequency Cetaceans: Scaled to Highest Seasonal Predicted Density.

Source: BOEM 2016; ESRI 2010; Roberts et al. 2016

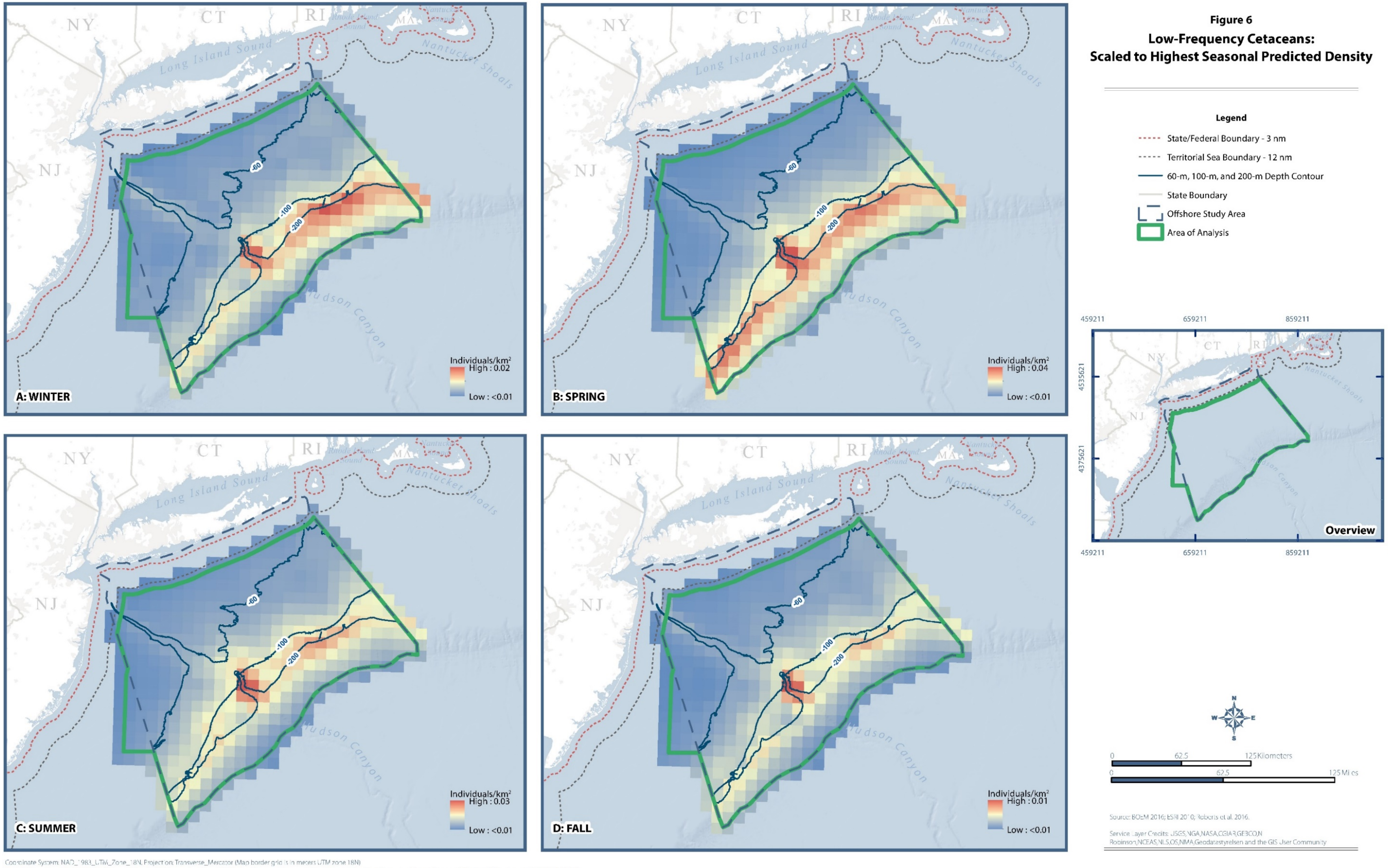


Figure 7. Low-Frequency Cetaceans: Scaled to Highest Annual Predicted Density.

Source: BOEM 2016; ESRI 2010; Roberts et al. 2016

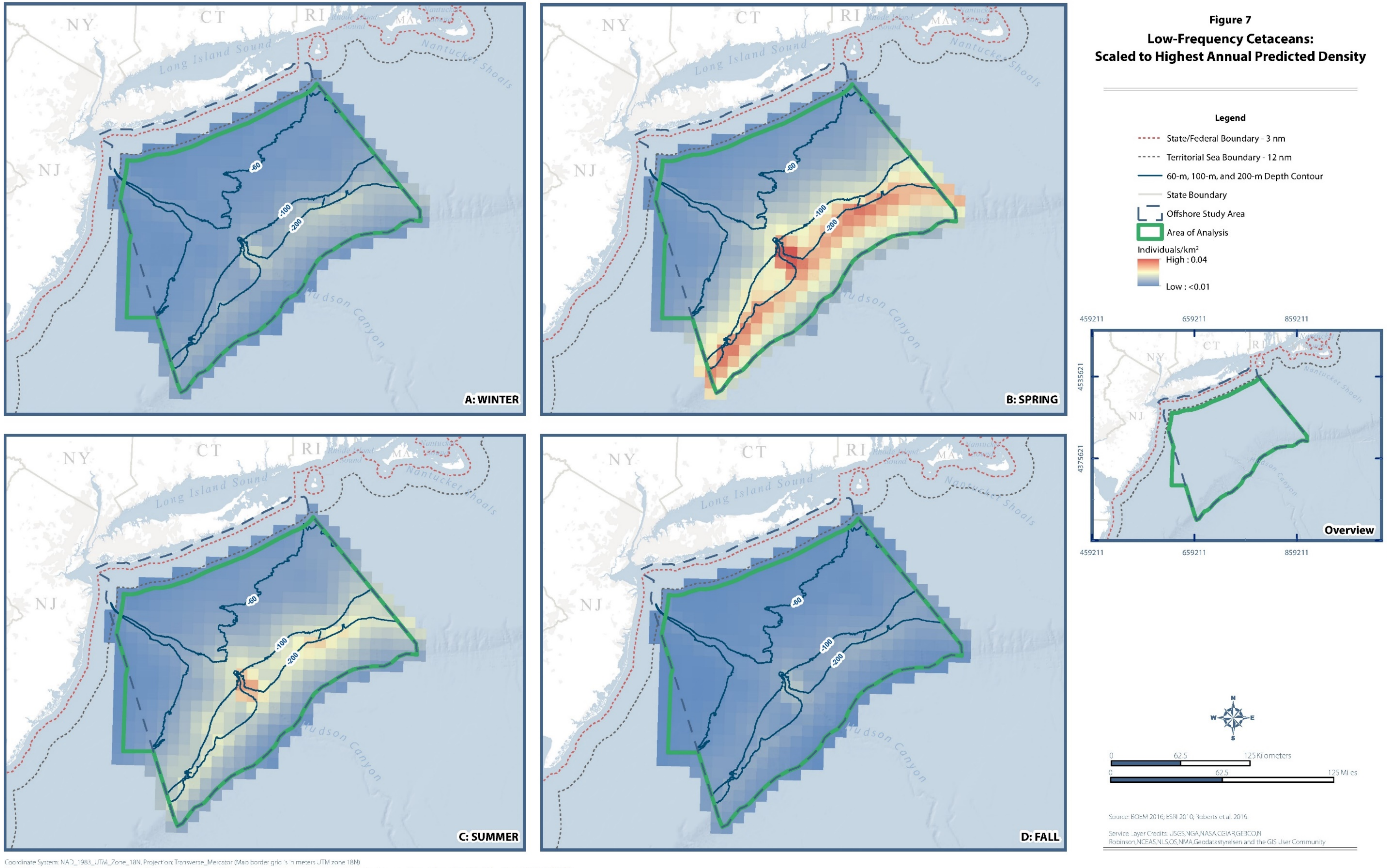
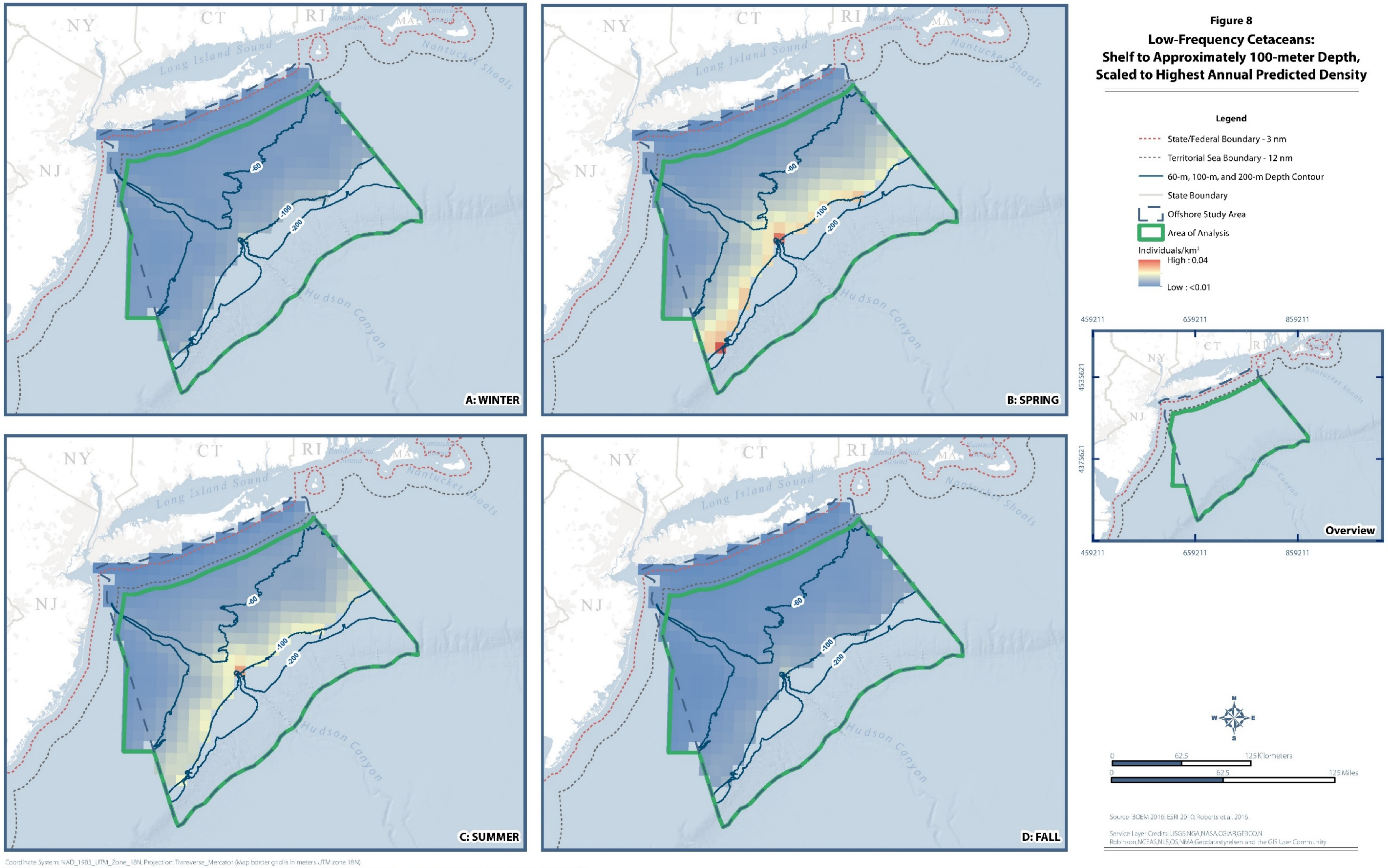


Figure 8. Low-Frequency Cetaceans: Shelf to Approximately 100-meter Depth, Scaled to Highest Annual Predicted Density.

Source: BOEM 2016; ESRI 2010; Roberts et al. 2016



2.2.4 Deep-Diving Cetaceans Distribution, Density, and Seasonal Patterns

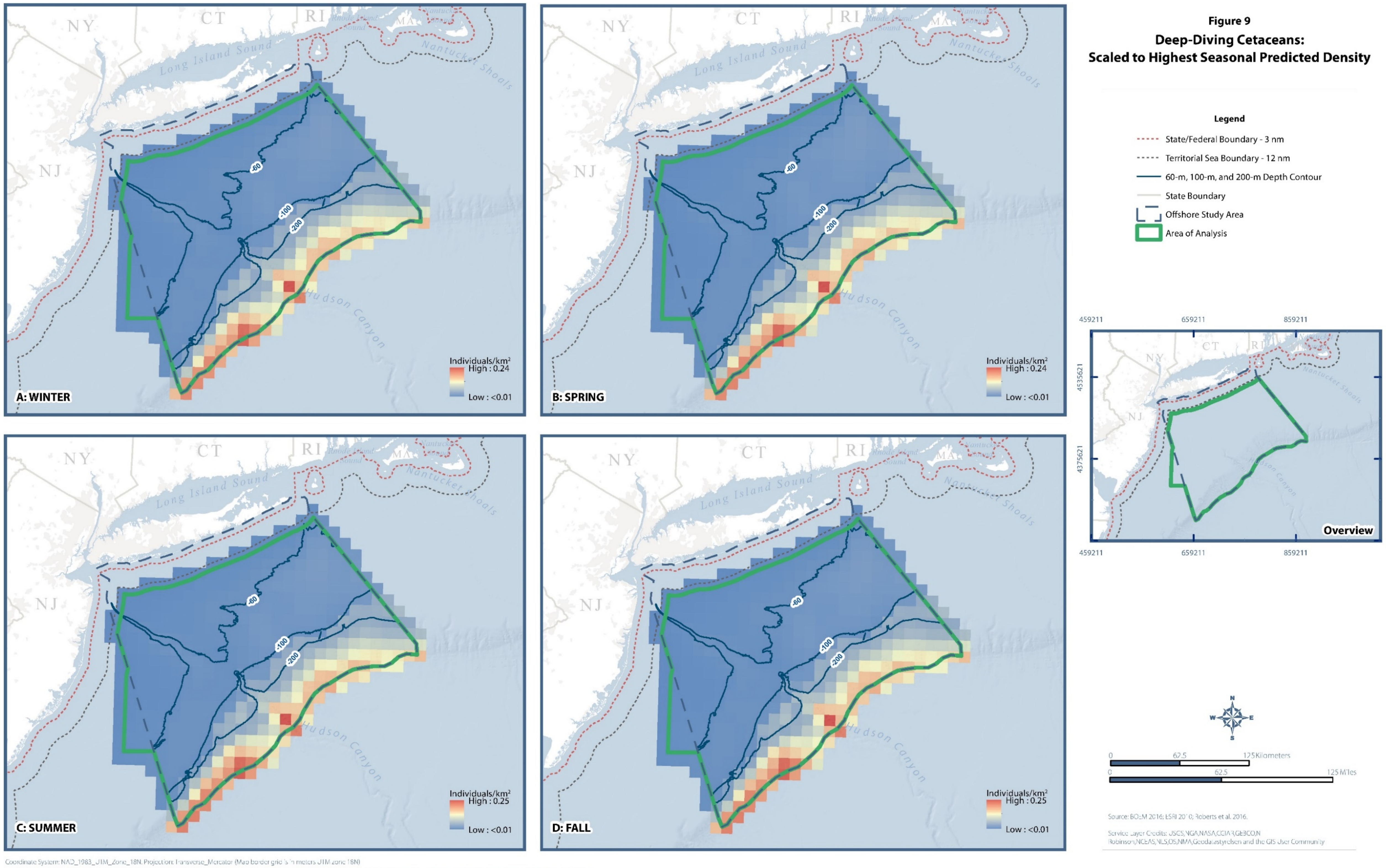
Along with generalized hearing groups, distribution of cetaceans was analyzed by generalized diving group (Table 3). This group consists of deep-diving and shallow-diving cetaceans. Deep-diving cetaceans use vertical habitat with a depth >200 m and spend significant time at these greater depths (NOAA NEFSC 2014).

Deep-diving cetaceans in the AoA include the sperm whale, beaked whales, pilot whales, spinner dolphin, and pygmy and dwarf sperm whales. The Roberts et al. (2016) models overlaid to evaluate predicted deep-diving cetacean seasonal densities in the AoA include monthly models for pilot whales, sperm whales, and beaked whales. Based on two sightings of spinner dolphins and 31 sightings of pygmy and dwarf sperm whales in the U.S. Atlantic EEZ, Roberts et al. (2016) assume these species are absent from the continental shelf and occur at constant densities elsewhere in the EEZ. Maps in Roberts et al. (2016) indicate some shift to higher predicted densities in the southern half of the range of sperm whales from June to October, possibly causing some increase in expected density in the AoA slope and oceanic areas. Beaked whales do not appear to show any strong seasonal trends in predicted density patterns, and predicted pilot whale densities suggest an increased concentration of pilot whales on the continental slope and oceanic area that includes the AoA from April to July (Roberts et al. 2016).

Deep-diving cetaceans as a group have almost identical predicted distributions and densities throughout all seasons within the AoA, ranging from a maximum of 0.24 individuals/km^2 in winter and spring to 0.25 individuals/km^2 in summer and fall (Figure 9). Deep-diving cetaceans are predicted to concentrate at the highest densities in the AoA along the continental slope and oceanic waters. Because predicted density distribution is similar among seasons, figures of densities scaled to the yearly maximum density are not provided. These maps were generated, but were found to have little utility for the visualization of density across seasons. Deep-diving cetaceans would be expected to frequent deep water areas, so figures were not generated removing slope and oceanic density predictions to examine use patterns specific to the continental shelf.

Figure 9. Deep-Diving Cetaceans: Scaled to Highest Seasonal Predicted Density.

Source: BOEM 2016; ESRI 2010; Roberts et al. 2016



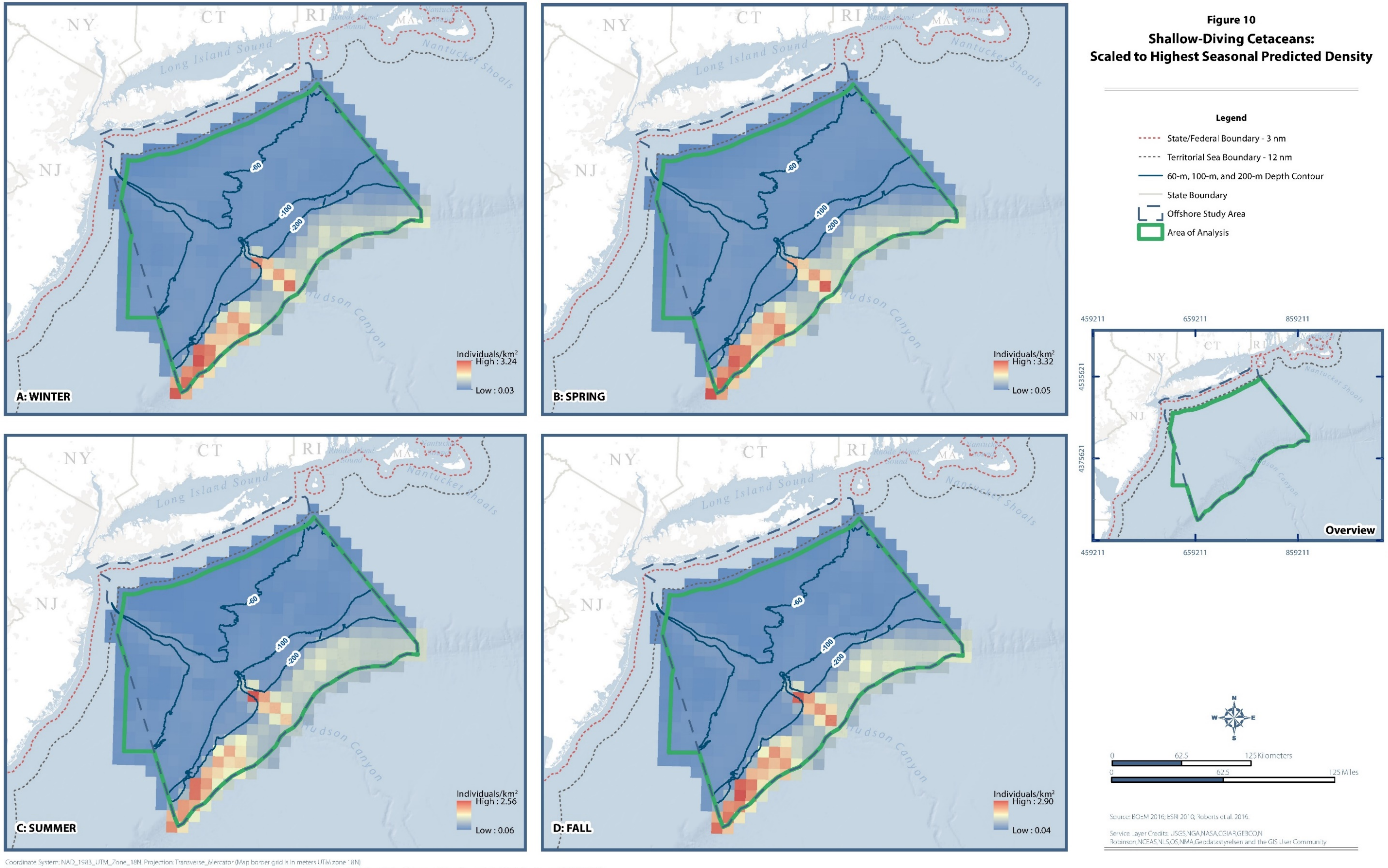
2.2.5 Shallow-Diving Cetaceans Distribution, Density, and Seasonal Patterns (excluding North Atlantic right whale)

Shallow-diving cetaceans (Table 3) spend a large majority of their lives (>75%) at depths of 200 m or shallower (NOAA NEFSC 2014). Shallow-diving cetaceans in the AoA include harbor porpoise, baleen whales (not including North Atlantic right whales, which are considered separately in Section 2.2.7), and most of the dolphins (except pilot whales and spinner dolphins).

The predicted distribution of shallow-diving cetaceans stays relatively consistent throughout seasons, with maximum densities in the AoA by season increasing from 2.56 to 3.32 individuals/km^2 from summer to spring. Figure 10 shows density predictions across the region that includes the AoA. This receptor group is predicted to concentrate on the continental slope and in Hudson Canyon. The majority of these species are mid-frequency cetaceans, so that receptor group likely drives the use patterns seen in shallow-diving cetaceans. Seasonal shifts or migrations by these species appear to be smoothed into a relatively consistent annual presence of shallow-diving cetaceans across seasons in the deep waters of the AoA. Despite this, as mentioned above, some species have predicted seasonal distributions and observed shifts in habitat-use through the year (see Appendix B, Section B.1). The predicted use of deep waters by shallow diving cetaceans may reflect the distribution of prey. With respect to distribution on the shelf, this should be driven mainly by mid-frequency cetaceans, as there is one high-frequency cetacean on the shelf (harbor porpoise), and low-frequency cetaceans tend to be predicted to occur on the shelf break and slope (see Section 2.2.3). Therefore, predicted use of the continental shelf would be expected to be similar to the mid-frequency cetaceans (see Section 2.2.2).

Figure 10. Shallow-Diving Cetaceans: Scaled to Highest Seasonal Predicted Density.

Source: BOEM 2016; ESRI 2010; Roberts et al. 2016



2.2.6 Endangered Cetaceans Distribution, Density, and Seasonal Patterns (excluding North Atlantic right whale)

The ESA-listed cetaceans known to occur in the AoA include sei, blue, fin, and sperm whales (for a discussion of the listed North Atlantic right whale, see Section 2.2.7). All of these species are low-frequency cetaceans except the sperm whale, which is a mid-frequency cetacean. Because predicted use of the AoA for sei and blue whales is low, predicted patterns for endangered species are mainly driven by fin whales and sperm whales, which are not similar in their life histories but are both managed under the ESA.

The predicted distribution of endangered cetaceans within the AoA varies slightly throughout the seasons; however, animals generally concentrate near and on the continental slope (Figure 11). This is not surprising given that sperm whales are deep divers and the maps of low-frequency cetaceans indicate a preference for continental slope waters (Section 2.2.3). Roberts et al. (2016) also predict that the slope is the highest use area for fin whales, though the shelf is expected to be more commonly used by this species than by sperm whales. The predicted distribution shifts to the oceanic side of the slope in the fall and moves back toward the shelf break in the spring, likely correlating to predicted sperm whale movements. Hudson Canyon is predicted to be a high-use area throughout the year. Predicted densities of endangered cetaceans are generally low and increase from a maximum density of 0.03 whales/km^2 in fall and winter to a high of 0.07 whales/km^2 in the spring. To better visualize the relationship in density levels across seasons, maps of density scaled to the highest density value (0.07/km^2) are provided (Figure 12). These indicate that endangered cetaceans are predicted to be most abundant in the AoA in spring. Figure 11 indicates predicted preferred habitat over the seasons, and Figure 12 shows changes in predicted seasonal densities.

Figure 11. Endangered Cetaceans: Scaled to Highest Seasonal Predicted Density.

Source: BOEM 2016; ESRI 2010; Roberts et al. 2016

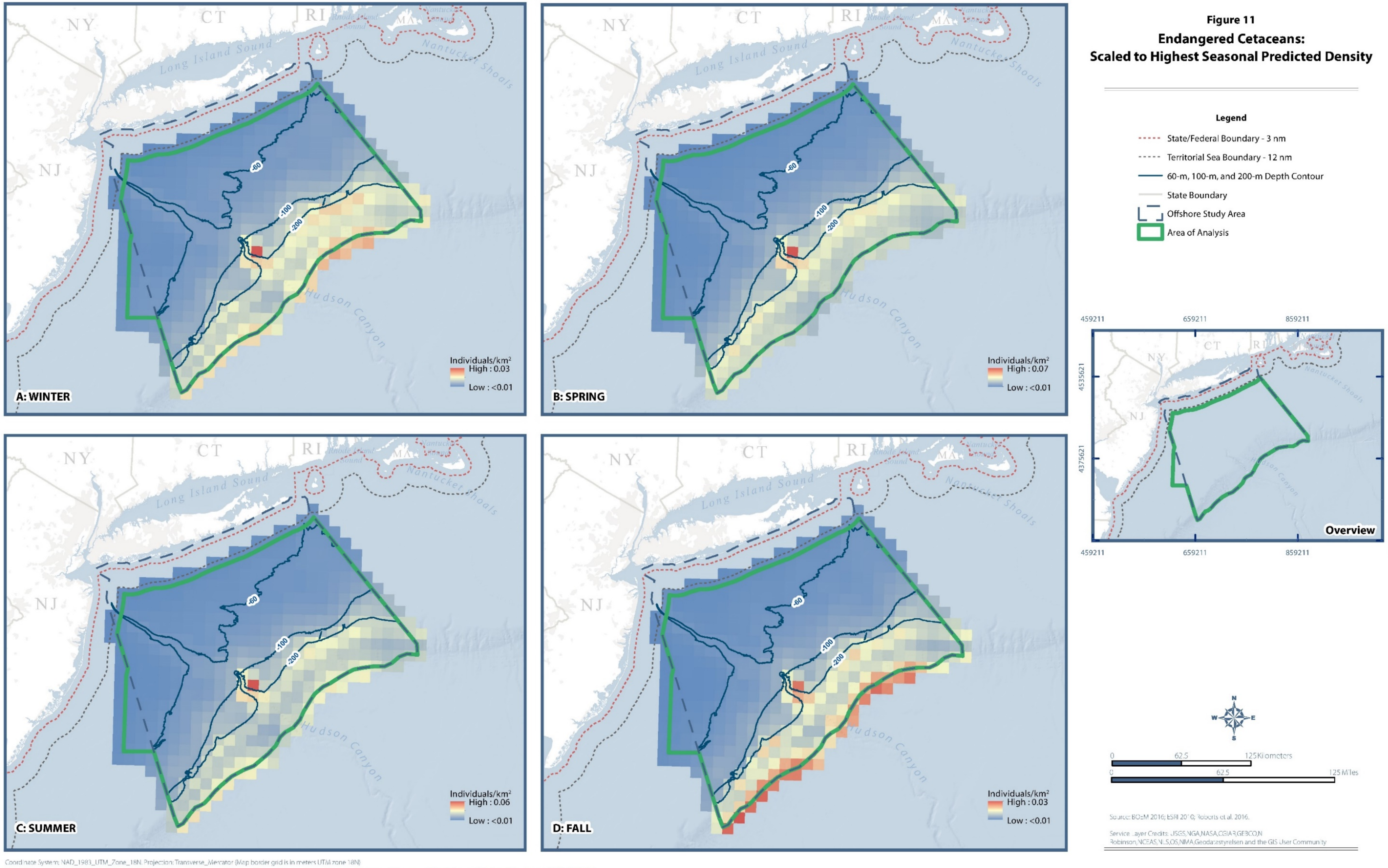
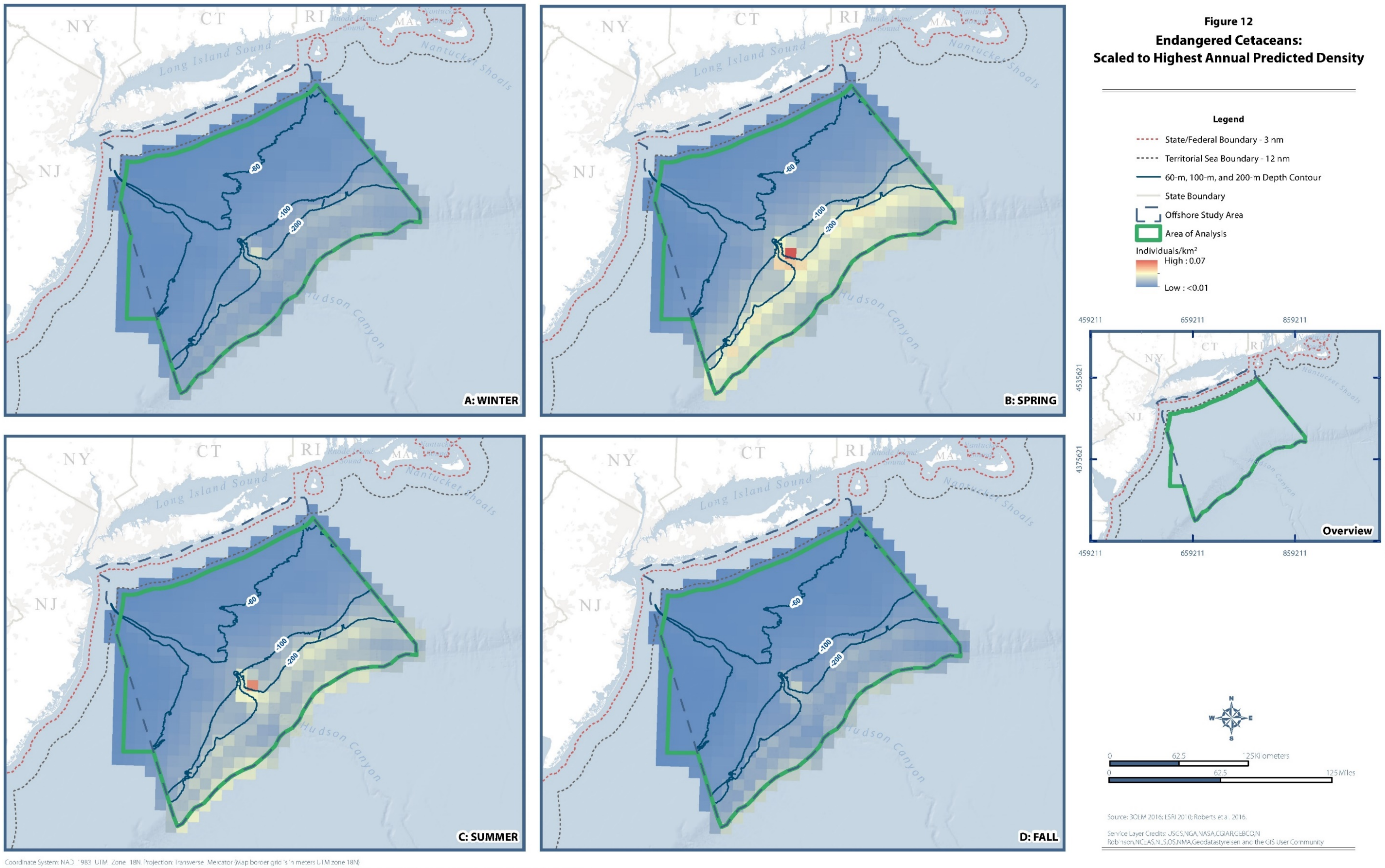


Figure 12. Endangered Cetaceans: Scaled to Highest Annual Predicted Density.

Source: BOEM 2016; ESRI 2010; Roberts et al. 2016



2.2.7 North Atlantic Right Whale Fine-Scale Distribution, Density, and Seasonal Patterns

Because of the interest in North Atlantic right whale conservation, a variety of studies have focused on gathering data specifically related to this species and its distribution, density, and seasonal movement patterns (Section 2.1).

During winter, the highest predicted density of North Atlantic right whales is along the northern, nearshore boundary of the AoA, with little predicted use of waters further offshore (Figure 13A). During spring, predicted right whale distribution concentrates in the northeast corner of the AoA (Figure 13B). Predicted density in the AoA reaches a high of 0.004 right whales/km^2 in the northeastern corner in spring, with lower densities predicted along the coastal boundary of the AoA and the continental shelf break and slope (Figure 13B). During summer, right whales are predicted to concentrate along the continental slope, with some diffuse use of the continental shelf as well (Figure 13C). During fall, right whale distribution is predicted to shift to the northeast on the continental shelf in the AoA, with some high-density areas also along southeastern Long Island (Figure 13D).

The models of North Atlantic right whales in Roberts et al. (2016) are monthly predictions of right whale density and distribution. These models predict a low level of right whale density along the northern nearshore boundary of the AoA in January and February, with right whales starting to move down from the north toward the tip of Long Island in March. Density increases in the area near Long Island in April, driving the spring increase in density in the northeastern corner of the AoA. In May, right whales in the AoA are predicted to diffuse outward toward the continental break and slope, with densities growing along the slope and declining on the shelf through June and July. In August, right whales in the AoA are predicted to be limited again to the northeastern area off the coast of Long Island, and almost no presence is predicted in the AoA in September and October, with movement back into the northern, nearshore boundary region in November and December.

To better visualize the relationship in density levels across seasons, maps of density scaled to the highest density value are provided (Figure 14). Within the AoA, maximum density was 0.004km^2. These maps make it clear that right whales are predicted to be most abundant in the AoA in spring. Figure 13 indicates predicted preferred habitat over the seasons, and Figure 14 shows changes in predicted seasonal densities.

Figure 13. North-Atlantic Right Whales: Scaled to Highest Seasonal Predicted Density.

Source: BOEM 2016; ESRI 2010; Roberts et al. 2016

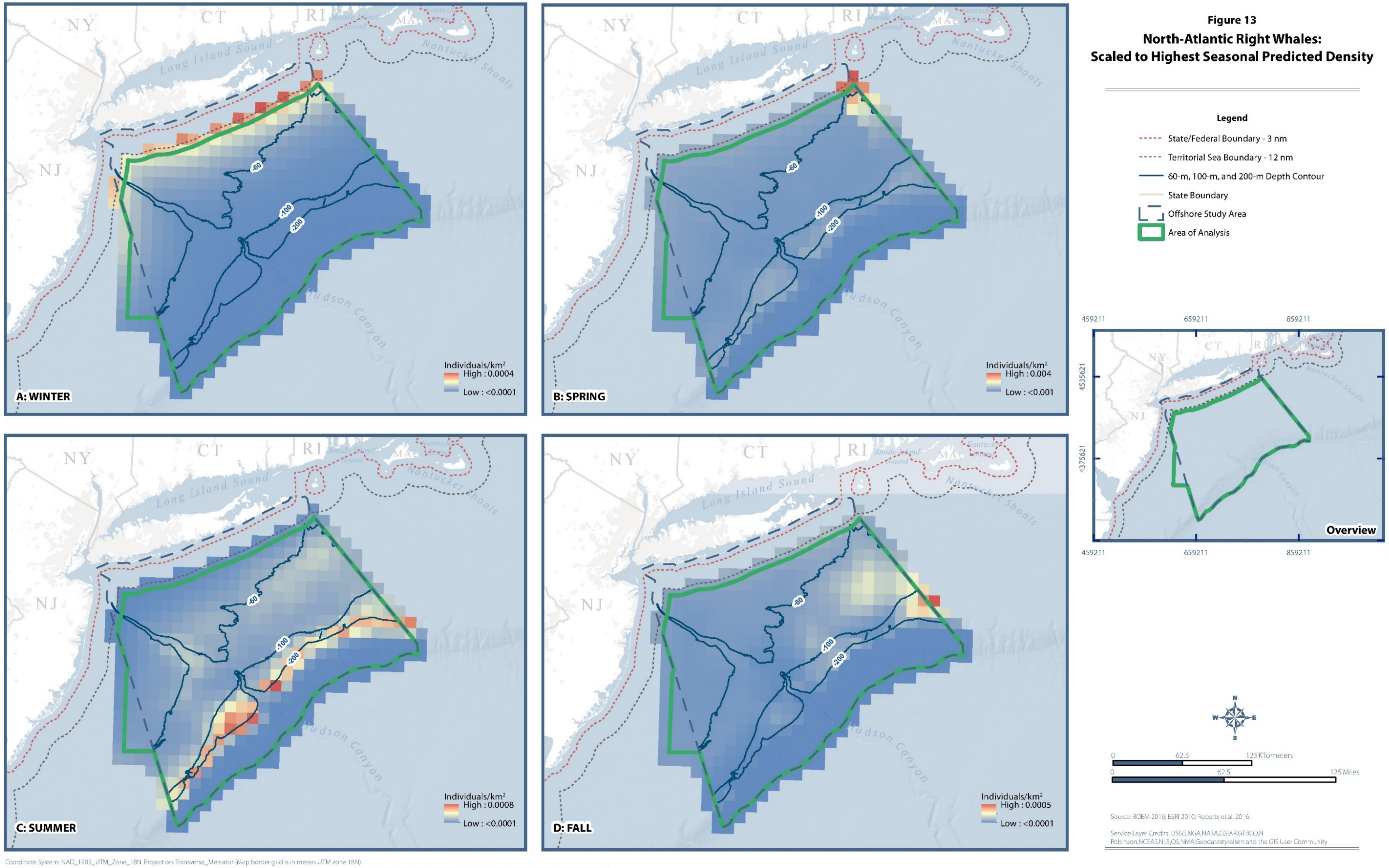
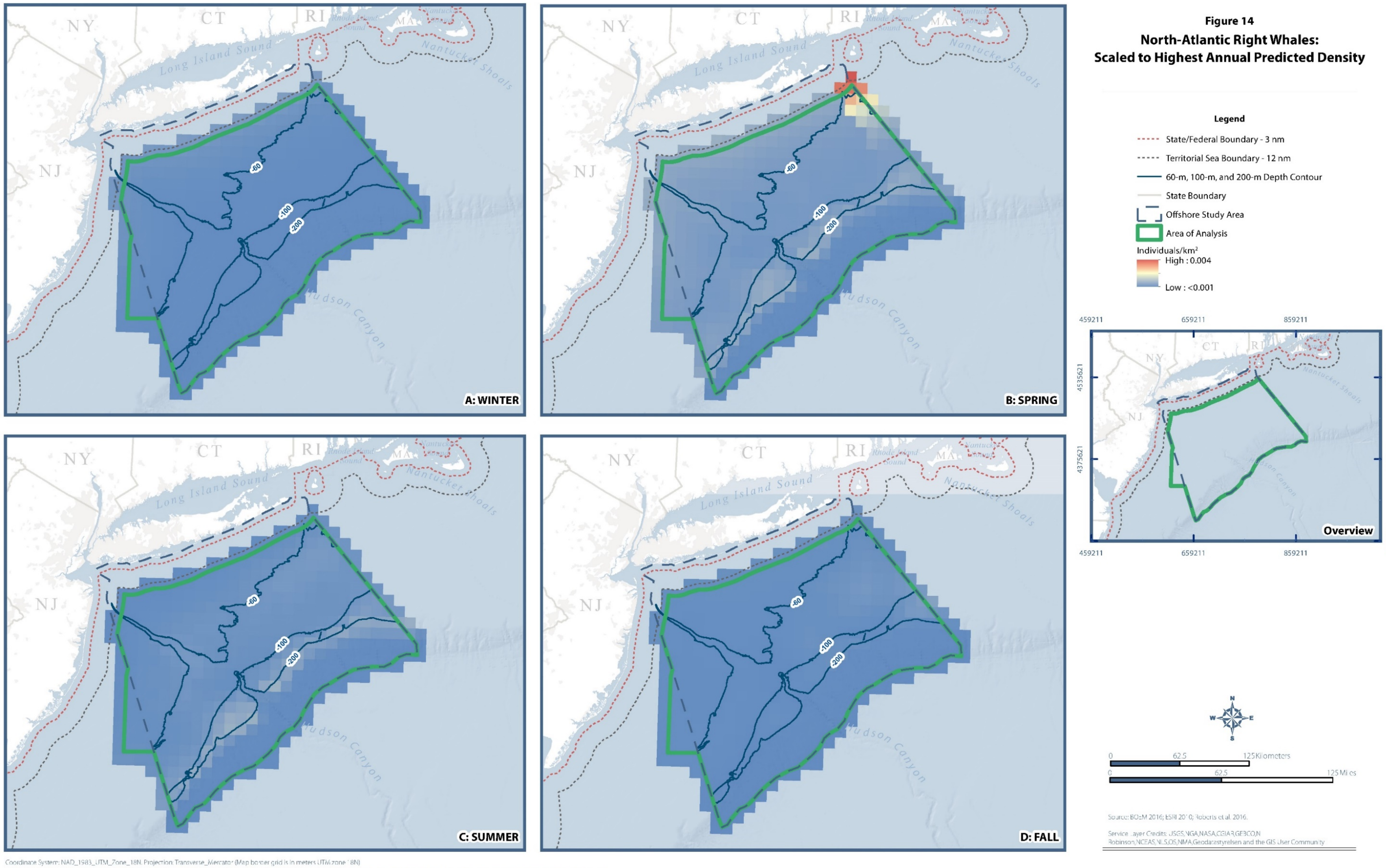


Figure 14. North-Atlantic Right Whales: Scaled to Highest Annual Predicted Density.

Source: BOEM 2016; ESRI 2010; Roberts et al. 2016



2.2.8 Seals Distribution, Density, and Seasonal Patterns

Seals are another receptor group of marine mammals analyzed within the AoA. Seals spend time both at sea and on land and produce sounds in both water and air. The most abundant species of seal found in the AoA is the harbor seal (Appendix B, Section B.2). Roberts et al. (2015) developed preliminary habitat-based seal density maps for the U.S. Atlantic EEZ based on 842 observations of seals at sea during cetacean aerial and vessel surveys. Seals are generally easier to observe on land, so they are The densities of seals predicted by the Roberts et al. (2015) models may not be accurate predictions of actual density, and Roberts et al. (2015) is an unpublished report of preliminary results. However, density predictions in Navy (2007) do not address predicted habitat use by seals (i.e., Navy [2007] spreads seals in equal density across the entire AoA and beyond, which is not helpful for evaluating where they might be at most risk from offshore wind development in the AoA). Thus, Roberts et al. (2015) provide the only model available to examine potential use pattern of seals in the AoA, even though the densities used in the model do not necessarily reflect the actual absolute densities of seals.

The distribution of seals within the AoA is presented in two figures based on the combination of data provided by Roberts et al. (2015); Figure 15A combines the fall, winter, and spring seasons (September to May), and Figure 15B shows summer (June to August). For the fall, winter, and spring season dataset, the highest predicted densities of seals in the AoA are concentrated in the nearshore northeast corner and decrease in more offshore regions of the AoA toward the south. In summer, seals are predicted to shift northward in their distribution, with highest densities shifting closer to the southeastern shoreline of Long Island. Predictions in Roberts et al. (2015) did not consider distance from major haul-out or rookery (breeding) areas in the region in evaluating predicted habitat-based distribution. Overall, these modeled results are consistent with the literature suggesting a distribution of harbor seals near coastal areas that shifts northward of the AoA in the summer (see Appendix B, Section B.2).

In addition to evaluating the Roberts et al. (2015) general seal predictions, Navy (2007) models for harbor seals and gray seals were also analyzed. Navy (2007) is often the source of density data for harbor seals and other seals used in estimating "take"[1] for MMPA permits. Navy (2007) provides seasonal density predictions for harbor and gray seals. However, in analyzing Navy (2007) data, the density predictions for harbor seals are not fine-scale enough to result in any differences in predicted

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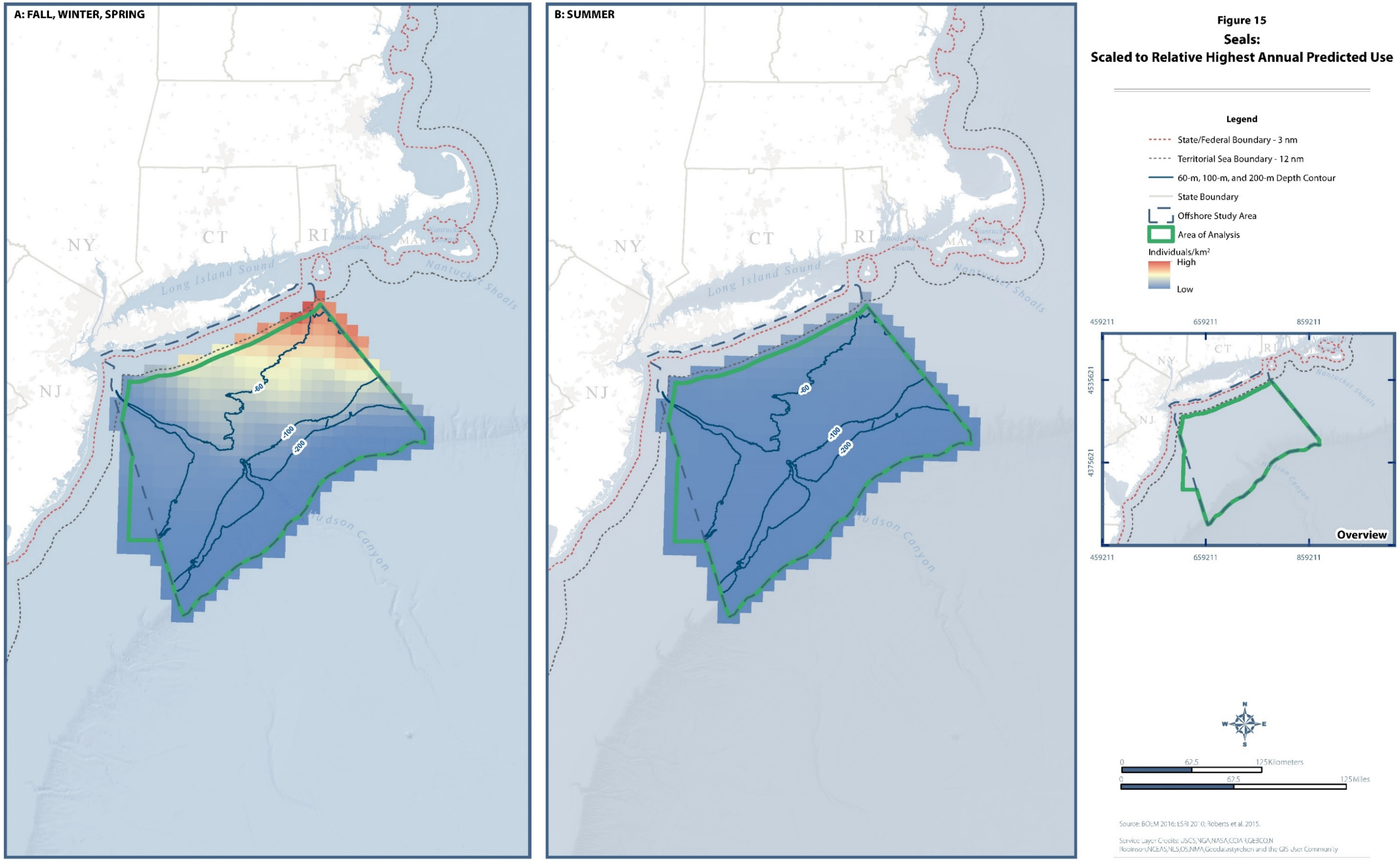
1 "Take" is defined in the Marine Mammal Protection Act as "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" and in the Endangered Species Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."

distribution across the AoA. Navy (2007) extends harbor seal presence uniformly across the entire continental shelf of the AoA; therefore, this model has limited utility for predicting high-use areas within the AoA. The Navy (2007) models do not predict any changes in density across seasons, except no harbor seals are predicted to be present in the AoA in summer. For gray seals, presence is only predicted in the western half of the AoA, with no differences among seasons. The Navy (2007) models suggest that gray seals may be more common in the eastern half of the AoA, but they are not fine-scale enough to provide much information about risk to gray seals in the AoA, though they indicate low densities in the region.

Figure 15. Seals: Scaled to Relative Highest Annual Predicted Use.

Source: BOEM 2016; ESRI 2010; Roberts et al. 2015



Coordinate System: NAD_1983_UTM_Zone_18N. Projection: Transverse_Mercator (Map border grid is in meters UTM zone 18N)
Path: M:\New_York_City\NYSERDA_Offshore\Maps\MXD\Masterplan_figures\3_Marine_Mammals\Seasonal_Maps\Figure15_Seals_Relative_Highest_Annual_Predicted_Use.mxd 10BP17A.0034.01

2.2.9 Sea Turtles Distribution, Density, and Seasonal Patterns

The sea turtle species known to occur in the AoA are loggerhead, leatherback, Kemp's ridley, and green. The general distribution of sea turtles within the AoA is predicted to be relatively consistent through each season based on overlaying Navy (2007) models (Figure 16). These models do not include green sea turtles, for which data were not found on any data portals, though "hardshell" turtles are discussed in Navy (2007). Navy (2007) does not provide any data for sea turtle distribution on the continental slope or oceanic regions of the AoA.

The highest concentration of sea turtles is predicted to occur in the southwestern corner of the AoA near the shelf edge, just above where the Hudson Canyon cuts into the shelf slope. Sea turtle occurrence is predicted to be lower throughout the remainder of the AoA. However, this high concentration of sea turtles at the Hudson Canyon is driven by an anomalously high density, an order of magnitude higher than others. This high density is predicted for Kemp's ridley turtles in one grid square of the model across all seasons. When the seasonal models are considered with the data removed from this square, there is no change in the pattern of distribution (Figure 16). Because this distribution is mainly driven by the Kemp's ridley turtles, and because loggerhead turtles are the most common and widespread turtle in the AoA, a map was also generated with only loggerhead turtle densities to evaluate their predicted distribution on the continental shelf. The results of this mapping indicate that loggerhead turtles tend to be most abundant in the southwestern third of the AoA with highest densities in summer (Figure 17).

Figure 16. Sea Turtles: Scaled to Highest Annual Predicted Density.

Source: BOEM 2016; ESRI 2010; Navy 2007, 2012

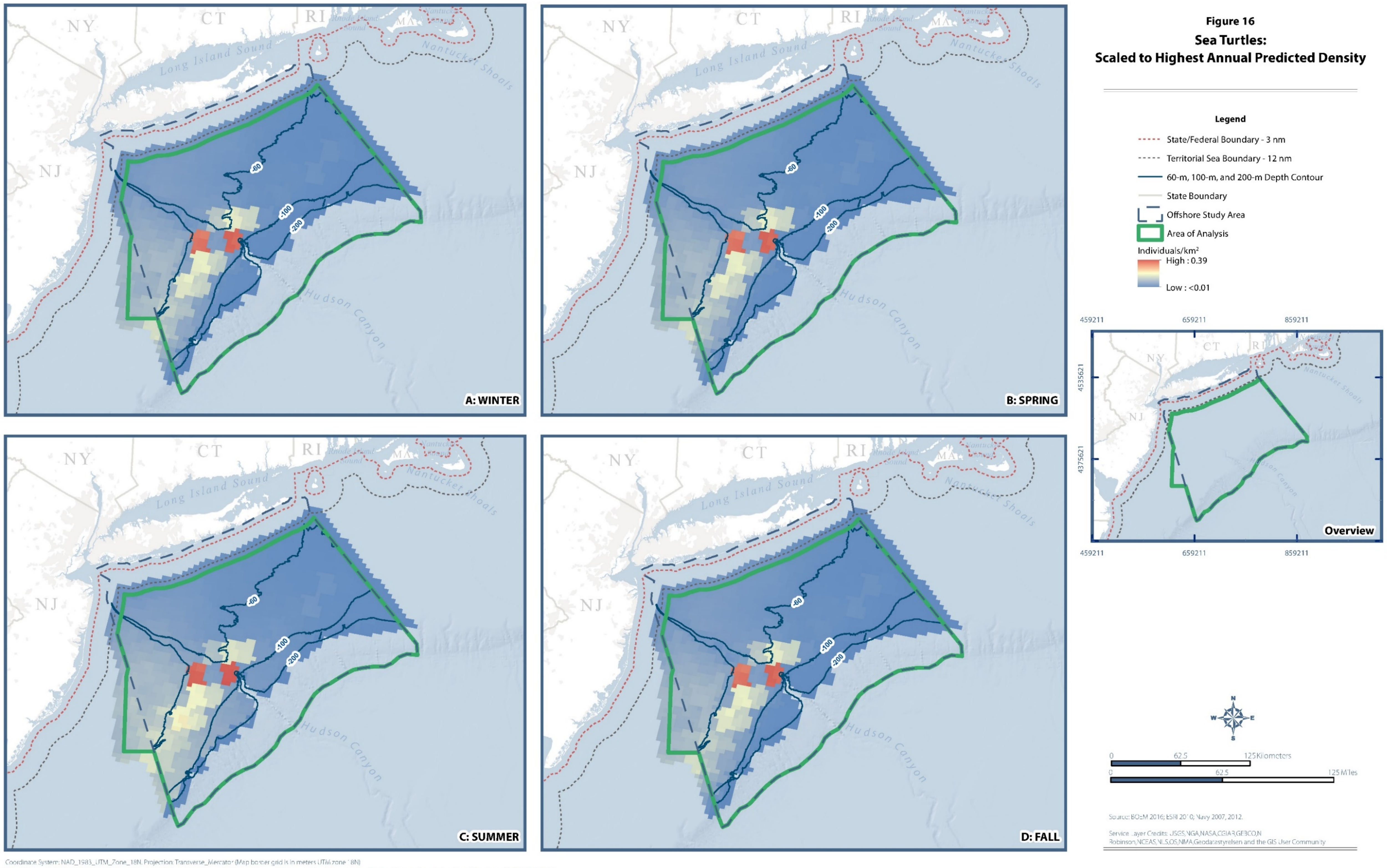
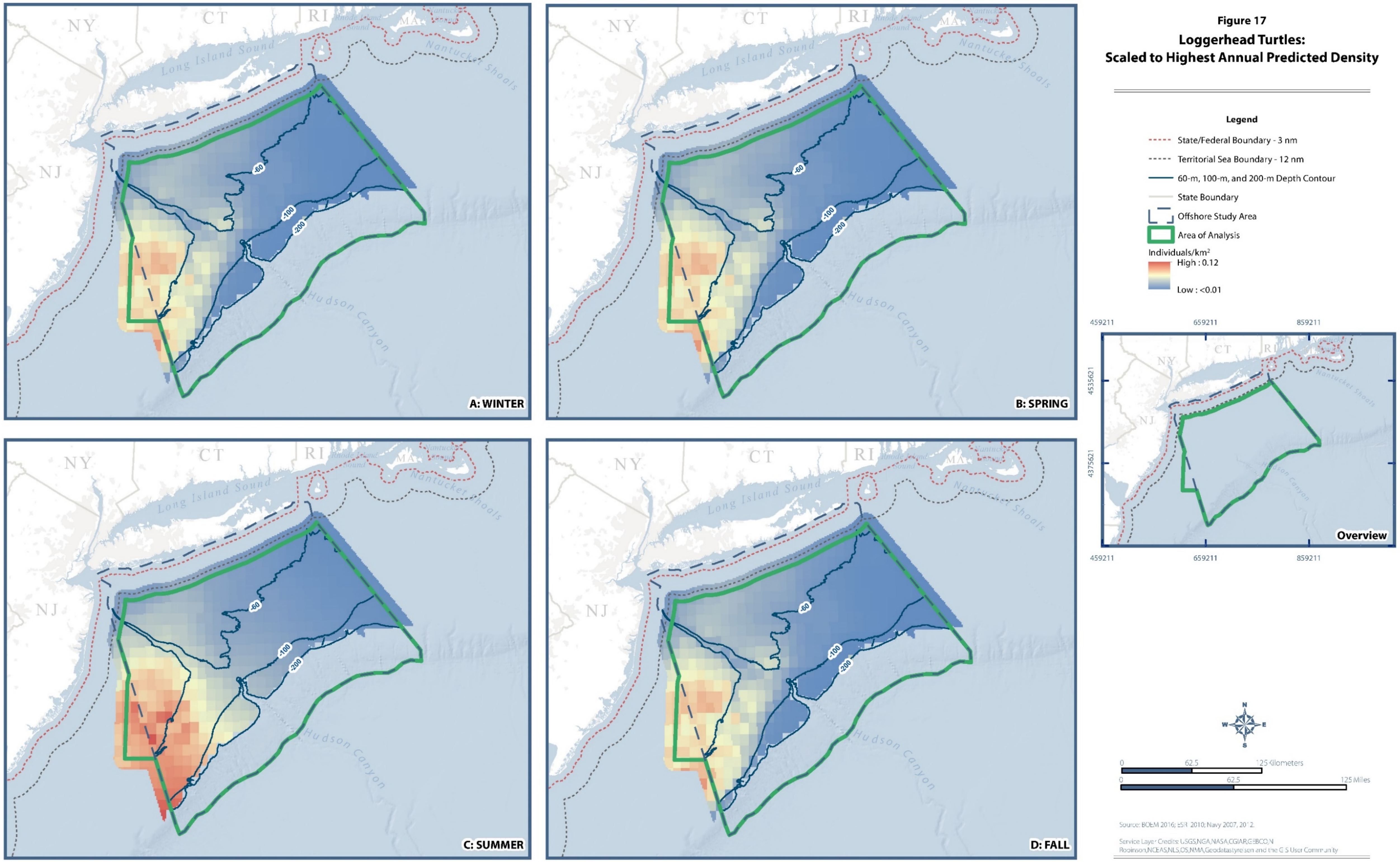


Figure 17. Loggerhead Turtles: Scaled to Highest Annual Predicted Density.

Source: BOEM 2016; ESRI 2010; Navy 2007, 2012



Coordinate System: NAD_1983_UTM_Zone_18N. Projection: Transverse_Mercator (Map border grid is in meters UTM zone 18N)
Path: M:\New_York_City\NYSERDA_Offshore\Maps\MXD\Masterplan_figures\3_Marine_Mammals\Seasonal_Maps\Figure17_Loggerhead_Turtles_Highest_Annual_Predicted_Density.mxd 10BP17A.0034.01

3 Potential Sensitivity and Risks

One objective of this Study is to identify sensitive receptors and potential risks associated with potential stressors from future offshore wind farm development in the AoA, including pre-construction (e.g., geophysical surveys), construction (e.g., pile driving), and post-construction/operation activities (e.g., collision risk from re-routed vessels; permanent structures in water). Based on the literature review, the main potential stressors associated with offshore wind development would be noise, changes in types/numbers of vessels, and permanent structures in the water. Noise and changes in types/numbers of vessels are mainly associated with construction and periodic maintenance, and so are temporary in nature. Permanent structures in the water would be a long-term, constant potential stressor. The main potential risks from these stressors include increased vessel collision, disruption to behavior patterns, physiological injury (e.g., hearing loss), and displacement. Different types of marine mammals and sea turtles vary in their potential sensitivity to these risks. The following sections provide an overview of potential stressors, and risks and sensitivity of marine mammals and sea turtles in the AoA to these stressors, based on the best available science (see Section 2 and Appendix B). BMPs that may be applied to avoid, minimize, and mitigate impacts to marine mammals and sea turtles during pre-construction, construction, and post-construction/operation activities are described in Section 6. Table 6 describes these BMPs by potential stressors and receptor groups.

3.1 Noise

3.1.1 Overview of Potential Effects of Noise on Marine Mammals and Sea Turtles

Marine mammals are especially known for their reliance on auditory signals. For example, studies have identified dolphin sounds specific to social interaction, courtship, travel, and foraging (Dudzinski 1996; Herzing 1996; Díaz López 2011). The songs of large whales play a role in mating (Payne and McVay 1971; Croll et al. 2002; Smith et al. 2008; Johnson et al. 2015). Odontocetes (toothed whales) rely on echolocation to find prey, avoid predators, and navigate. There is growing evidence that noise affects marine mammals and sea turtles both directly and indirectly.

Human-induced noise in the marine environment can cause physical injury or alter behavior in marine mammals and sea turtles. Noise can directly and indirectly interfere with the ability of these animals to communicate; detect prey, mates, and predators; and respond to their environment. Noise can mask environmental sounds and communication and echolocation signals. Noise can also prompt marine mammals to become displaced away from the noise source (Nowacek et al. 2007; Southall et al. 2007).

Recent publications have described noise exposure thresholds for PTS and/or TTS and behavioral responses of marine mammals and sea turtles (Southall et al. 2007; Popper et al. 2014; Finneran 2016). These thresholds can be used to identify types of receptors, such as low-, mid-, and high-frequency cetaceans, that may be sensitive to certain types of underwater noise. NOAA Fisheries released new guidance on TTS and PTS thresholds for marine mammals in July 2016 (NOAA NMFS 2016a) (Table 5). PTS is considered “Level A harassment” under the MMPA. NOAA NMFS (2016a) does not address “Level B harassment.” Because the new guidance does not address “Level B harassment,” NOAA Fisheries uses an interim sound threshold guideline of 160 dB rms re 1µPa for pulsed sound and 120 dB rms re 1µPa received level for continuous sound (see Section 1.3.2 for definitions of “harassment” under the MMPA). NOAA NMFS (2016a) uses a dual metric of peak sound pressure and cumulative sound level to evaluate thresholds for PTS for impulsive noise (Table 5).

Table 5. Summary of Generalized Hearing Ranges and PTS Thresholds of Marine Mammals

Source: NOAA NMFS 2016a

Hearing Group	Generalized Hearing Range	PTS Impulsive Noise[a]	PTS Non-impulsive Noise[a]
Low-frequency cetaceans (LF)	7 Hz–35 kiloHertz (kHz)	$dB_{pk,flat}$: 219 dB $Sel_{cum,LF,24h}$: 183 dB	$Sel_{cum,LF,24h}$: 199 dB
Mid-frequency cetaceans (MF)	150 Hz–160 kHz	$dB_{pk,flat}$: 230 dB $Sel_{cum,LF,24h}$: 185 dB	$Sel_{cum,LF,24h}$: 198 dB
High-frequency cetaceans (HF)	275 Hz–160 kHz	$dB_{pk,flat}$: 202 dB $Sel_{cum,LF,24h}$: 155 dB	$Sel_{cum,LF,24h}$: 173 dB
Seals (in water) (PW)	50 Hz–86 kHz	$dB_{pk,flat}$: 218 dB $Sel_{cum,LF,24h}$: 185 dB	$Sel_{cum,LF,24h}$: 201 dB

[a] Peak sound pressure (dB_{pk}) has a reference value of 1 µPa, and cumulative sound exposure level (SEL_{cum}) has a reference value of 1 micropascal squared-seconds ($1 \mu Pa^2 s$). The subscript “flat” is included to indicate that peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The subscript associated with Sel_{cum} thresholds indicates the designated marine mammal auditory weighting function (low-, mid-, and high-frequency cetaceans and phocid seals in water) and that the recommended accumulation period is 24 hours.

Popper et al. (2014) reported that the general hearing range of sea turtles based on review of the literature may be between 50 to 1,200 Hertz (Hz) with sensitivity to sound declining above 400 Hz. Dow Piniak et al. (2016); Dow Piniak, Eckert, et al. (2012); Lavender et al. (2014); Lenhardt (1994); Martin et al. (2012); O’Hara and Wilcox (1990); and Ridgway et al. (1969) support Popper et al. (2014)’s reported hearing range for sea turtles. Dow Piniak, Mann, et al. (2012) reported that sea turtles are able to detect slightly higher frequencies in water than in air. Popper et al. (2014) concluded that sea turtles may be protected from pile driving and other impulsive noise because of their rigid external shell, potentially referring to protection for organs inside the shell area. PTS for impulsive and non-impulsive noise has not been measured for sea turtles.

3.1.2 Pre-Construction, Construction, and Operation-related Noise Sources in the Offshore Study Area

Pre-Construction: Geophysical Surveys. Typically, multibeam echo sounders (MBES) are used to conduct pre-construction geophysical surveys to evaluate and confirm geological, geotechnical, and benthic characteristics of the seafloor. Echo sounders emit a short pulse of sound and "listen" to reflected energy from the seabed. Single beam echo sounders are commonly used by vessels and are essential for safe navigation. This type of echo sounder directs sound vertically downward to measure depths under the keel. Multibeam systems operate with multiple beams of sound at frequencies typically above 12 kHz, with deep water systems usually using frequencies below 20 kHz (SCAR 2002). Due to the low power and selective directivity of MBES beams (i.e., sound is directed in relatively narrow beams rather than spreading spherically away from the source), geophysical surveys using this method a re unlikely to cause injury to marine mammal hearing, but may temporarily affect their behavior (Lurton and DeRuiter 2011; Quick et al. 2016). Potential effects of MBES are relative to the frequencies, beam shape, and power of equipment; see Section 3.1.1 and Table 5 for information on hearing frequencies of marine mammals and sea turtles. Any equipment used for geophysical and geotechnical survey work that emits sounds that result in the potential for marine mammals or sea turtles to experience received sound levels exceeding NOAA's injury or harassment thresholds would be a potential risk and require consideration in mitigation and permitting of pre-construction activities.

Construction: Pile driving. Noise levels would be highest during the wind farm construction period. The primary source of noise related to offshore wind farm construction in the AoA would be pile driving. Construction would involve installation of wind turbine generators using monopile or jacket foundations attached to the seabed (DOI MMS 2009), depending on water depth. Monopile foundations would be installed in shallow water using an impact or vibratory pile driver. Jacket foundations would be installed in deep water using an impact pile driver. 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 than monopiles (Norro et al. 2013).

Pile driving, particularly impact pile driving, is one of the noisiest construction-related activities undertaken in marine environments today (Madsen et al. 2006; Erbe 2009). Impulsive (pulsed) sound waves generated by the hammer striking the pile travel very quickly over long distances in water, air, and the seafloor; have low attenuation; contain low and high frequencies; and can radiate back into the water column from the seafloor even at great distances from the pile (Illingworth and Rodkin 2007; Erbe 2009). Pile driving associated with construction of an offshore wind farm has the potential to cause behavioral changes, TTS, and even PTS in marine mammals and sea turtles, depending on their distance from the work area (see Section 3.1.5 for details regarding potential pile-driving risks to marine mammals and sea turtles during construction).

For a 96-inch steel pile driven by an impact hammer, Illingworth and Rodkin (2007) measured an unattenuated sound pressure within 10 m at a peak of 220 dB. Brandt et al. (2011) measured noise from wind farm pile driving in the Danish North Sea. This study found that for a pile driven with 449 blows over 30 minutes (the time needed to install one pile), the peak dB at 720 m from the source was 196 dB. The threshold used for evaluating behavioral "take" of marine mammals is 160 dB root mean square (rms). The rms levels were not measured in Brandt et al. (2011). The spectral maximum was between 80 and 200 Hz, which is audible to low-frequency cetaceans. These studies suggest that although the majority of the energy in pile driving is at low frequencies, a low-frequency cetacean would need to be relatively close (less than 720 m) to the source to potentially experience PTS. Behavioral impacts may occur at further ranges, and behavioral avoidance may differ among individuals relative to received sound levels and behavior state. For example, Wood et al. (2012) provide a probabilistic step function related to behavioral responses for which 10%, 50%, and 90% of individuals exposed are expected to exhibit a behavioral response. Overall, low-frequency cetaceans are likely to hear pile-driving noise at greater distances than high- and mid-frequency cetaceans, but they are likely less sensitive to acute exposure to noise than high-frequency cetaceans because the peak energy of noise must be higher for low-frequency cetaceans to experience threshold shift.

Dominant spectral features of the noise generated by pile driving will be dependent on the frequency of the pile-driving device; for example, vibratory pile drivers typically have a frequency of 15 to 35 Hz (Dahl et al. 2015). In a study of underwater pile driving in California, for a diesel impact hammer, most acoustic energy was measured at frequencies between 250 and 1,000 Hz, and for a drop impact hammer, between 250 and 2,000 Hz (Illingworth and Rodkin 2007). However, noise is generated at higher frequencies as well (Illingworth and Rodkin 2007). Underwater pile driving recorded by Erbe et al. (2009) showed very broadband sound near the source (40 Hz to >40 kHz), but at long ranges, only <400 Hz remained.

Operation. Noise associated with future wind farm operation is likely to pose low risk. There is some noise associated with operation of wind turbines, but it does not much exceed ambient noise levels (Madsen et al. 2006). For example, Tougaard, Henriksen, et al. (2009) found that noise from three different wind turbine types in European waters was only measurable above ambient noise levels at frequencies below 500 Hz with sound pressure levels from 109 to 127 dB rms re 1 μPa at distances from 14 to 20 m from the foundations. At these levels, Tougaard, Henriksen, et al. (2009) found that audibility was low for harbor porpoise (about 20 to 70 m away) and for harbor seals (less than 100 m to a few kilometers away). General seal hearing range overlaps with the low-frequency receptor group (baleen whale) hearing range, though baleen whales hear at lower frequencies as well (NOAA NMFS 2016a). Low-frequency cetaceans within a few kilometers of a wind farm may hear noise associated with operation at low levels depending on sound-propagation conditions and ambient noise levels, but these low levels are unlikely to cause injury to marine mammal hearing (Madsen et al. 2006).

Rice et al. (2014) examined low-frequency (<1,000 Hz) noise along the east coast of the U.S. and found highest ambient noise levels off New Jersey and New York relative to other areas, with most noise below 500 Hz. Tyack (2008) reported that motorized shipping noise is mainly in the 20 to 200 Hz frequency band and has increased ocean noise 10- to 100-fold over natural ambient sound. Cornell Lab of Ornithology (2010) measured ambient sound in baleen whale hearing ranges in the New York Bight and found that New York Harbor and areas off Long Island had elevated background noise at as high as 100 to 140 dB levels for parts of the day in the range of North Atlantic right whale (77 to 224 Hz) and blue/fin whale (11 to 28 Hz) vocalizations. This noise was attributed to commercial shipping.

3.1.3 Physical Effects of Noise

Noise has the potential to physically injure marine mammals. Necropsies of beaked whales stranded following a military exercise using mid-frequency sonar showed that the whales had suffered hemorrhages related to sound-induced air bubble formation in their tissues (decompression sickness) (Jepson et al. 2003; Cox et al. 2006). Various authors have described potential mechanisms for deaths of beaked whales associated with mid-frequency active Navy sonar (e.g., Saunders et al. 2010; Fernández et al. 2005; Crum et al. 2005; Potter 2004). However, physical injury or mortality from pile-driving noise has been more commonly documented in fish (Caltrans 2004, 2009, 2010) than in marine mammals, seals, or sea turtles. A more common injury associated with noise is noise-induced hearing loss in the form of TTS or PTS. To date, studies have not included exercises to induce PTS in marine mammals or sea turtles for purposes of measuring thresholds, so thresholds are extrapolated from other data (see Southall et al. 2007; Finneran 2016).

Studies have shown that noises at levels similar to those produced by pile driving (via playback studies) can cause TTS in harbor porpoises (Kastelein, Hoek, et al. 2013) and seals (Kastak and Schusterman 1999). Studies have also shown that harbor porpoises are more likely to be injured by high sound levels at close proximity to the source (i.e., within 100 m) (Bailey et al. 2010) and when exposed to multiple-strike sounds rather than single-strike sounds (Kastelein, Hoek, et al. 2013). Data on the effects of noise on sea turtles are lacking (Popper et al. 2014). Popper et al. (2014) concluded that sea turtle shells may reduce risk of internal injury from pile-driving noise.

3.1.4 Behavioral Effects of Noise

Displacement. Marine mammals' behavioral responses to noise range from no response, to mild aversion, to panic and flight (Southall et al. 2007). Short- and long-distance displacement can occur in seals and cetaceans in response to noise. Underwater noise can drive seals from the water (Verboom and Kastelein 2005). Numerous studies have shown that harbor porpoises (Verboom and Kastelein 2005; Bailey et al. 2010; Brandt et al. 2011; Dähne et al. 2013), killer whales (Morton and Symonds 2002; Williams et al. 2014), and harbor seals (Verboom and Kastelein 2005) may temporarily leave an area in response to noise. Humpback whales, green sea turtles, and loggerhead sea turtles have been reported to travel away from underwater seismic noise (McCauley et al. 2000).

While it is unlikely that MBES would injure marine mammal hearing (Lurton and DeRuiter 2011), a recent study on the effect of echo sounders has shown that pilot whales exposed to echo sounder beams changed direction more frequently (Quick et al. 2016).

Displacement due to noise may cause marine mammals and sea turtles to move more frequently into areas of higher vessel traffic, such as shipping corridors. Depending on where and how far an animal displaces, it may be more susceptible to vessel collision or predation, or have difficulty finding prey or a mate. The species that are at a higher risk of vessel collision in general include humpback whales, which are currently experiencing an unusual mortality event in the North Atlantic that appears to be related to larger than usual numbers of vessel collisions (NOAA 2017a) and North Atlantic right whales, for which vessel collision is considered a significant factor affecting recovery of the species (Knowlton and Kraus 2001; Rolland et al. 2016). NOAA Fisheries also declared an unusual mortality event for North Atlantic right whales on August 25, 2017, though it has not been determined what may be driving this event (NOAA 2017b).

Behavior state has been shown to affect response to noise for some marine mammals (Ellison et al. 2012; Goldbogen et al. 2013; Southall et al. 2016). For example, Goldbogen et al. (2013) found that blue whales feeding on deep prey were more likely to change diving behavior when exposed to simulated sonar than blue whales feeding at shallow depths. They concluded that response to sonar with temporary avoidance appears to abate quickly after the exposure. In addition to behavior state, other contexts can be important as well. Southall et al. (2016) state that factors like behavior state can interact with exposure variables such as received level, and orientation of sound and receiver. For example, gray whales exposed to simulated low-frequency sonar during their southward migration avoided the source when it was located in the migratory path, but not when it was located farther offshore, despite similar received sound levels (Buck and Tyack 2000). This suggests that there are factors beyond received sound level and behavior state that affect marine mammal responses to sound. The studies of the relationship of response to behavior state and other factors have focused on sonar rather than noise anticipated from wind farms, but they provide some context for consideration of the influence of these factors. Southall et al. (2016) suggest that it may be unrealistic to attempt to address these factors during operations as part of mitigation (i.e., determine behavior states or the relationship in space of all sounds and receivers in situ), but they could inform quantifiable criteria like acoustic guidelines.

Masking. Because marine mammals rely on sounds for communication and for sensing their environment, marine noise has the potential to interfere with their ability to send and receive acoustic signals, and thus their ability to communicate, interact socially, forage, and navigate (e.g., David 2006). This interference is known as masking. The susceptibility of a marine mammal to masking depends on the frequency at which they send and receive auditory signals and the frequency, loudness, and other attributes of the background noise (e.g., David 2006). Low-frequency cetaceans such as baleen whales may be most vulnerable to masking by low-frequency noise (Richardson et al. 1995), such as vessel traffic noise (Redfern et al. 2017).

David (2006) reported that pile-driving noise may be perceived by bottlenose dolphins over 10 kilometers (km) from the source and may mask whistles up to 40 km and echolocation clicks up to 6 km, but risks associated with masking are likely limited due to directional hearing and the pulsed nature of the noise source. Noise from pile driving was found to temporarily silence harbor porpoise during wind farm construction in the Danish North Sea and caused multi-day drops in their levels of vocal activity (Brandt et al. 2011). Brandt et al. (2011) found a decrease in harbor porpoise vocal activity out to a mean of 17.8 km from the noise source, but an increase in porpoise vocal activity at 22 km. Harbor porpoise have been relatively well-studied because of their proximity to European offshore wind farms (e.g., Carstensen et al. 2006; Tougaard, Carstensen, et al. 2009). Acoustic monitoring in the Baltic Sea indicated that time between harbor porpoise echolocation detections increased to six times longer during wind farm construction (Carstensen et al. 2006). Tougaard, Carstensen, et al. (2009) also found increased intervals between detected harbor porpoise sounds during wind farm-related pile driving in the North Sea. Such changes in vocalization and echolocation detection may be related to displacement or behavioral disturbance, but they may also reflect masking of sound, in that harbor porpoise may choose not to use sound in an environment too noisy for sound to be effective.

3.1.5 Potential Risk of Noise-related Injury or Behavior Change in Marine Mammals and Sea Turtles during Construction

A primary noise-related risk to marine mammals and sea turtles associated with construction of an offshore wind farm within the AoA could potentially result from pile driving. While behavioral effects have been documented in marine mammals after exposure to MBES, it is not anticipated that pre-construction geophysical and geotechnical surveys would result in injury to marine mammals or sea turtles and any behavioral effects will likely be short-term and limited to a small area around the vessel (see Section 3.1.2). Operational noise is unlikely to exceed ambient noise (see Rice et al. [2012] for measures of ambient noise off the New York and New Jersey coasts) and is not as loud or acute as pile-driving noise. Therefore, the following discussion focuses on pile-driving risk.

High-Frequency Cetaceans. The potential risk of noise-related injury, behavioral changes, or displacement from noise may be highest for high-frequency cetaceans due to their sensitivity to loud, high-frequency noise generated by pile driving. Although the majority of the energy in pile-driving noise is relatively low-frequency (Illingworth and Rankin 2007; Dahl et al. 2015; Brandt et al. 2016), there are high-frequency components, and high-frequency cetaceans are expected to have lower received energy thresholds for PTS than other marine mammal hearing groups (NOAA Fisheries 2016).

Studies suggest that harbor porpoises may experience temporary displacement from pile-driving noise (Verboom and Kastelein 2005; Bailey et al. 2010; Brandt et al. 2011; Dähne et al. 2013), further supporting their potential sensitivity to this stressor. Brandt et al. (2016) studied harbor porpoise responses to pile-driving noise for eight wind farms built from 2009 to 2013 in the German Bight. In this study, harbor porpoise vocalization detections declined by 93% at noise levels above 170 dB. This decline became smaller as noise level decreased, reaching a 25% decline at 145 to 150 dB. Decline of 50% was at 150 to 160 dB. Distance also was a factor, with vocalization detection rates declining by 68% at 0 to 5 km but only 26% from 10 to 15 km. Detection declines varied significantly by wind project, and this difference may have been, in part, related to differing weather and ocean conditions that affect sound propagation. Decreased detections within 2 km of piling sites lasted a mean of 20 hours. In addition, Brandt et al. (2016) reported decreased detections out to as far as 10 km from piling sites in the 24 hours prior to starting pile driving, suggesting other activities near the sites may have affected harbor porpoise vocalization rates or presence. Brandt et al. (2016) did not find any evidence of habituation or sensitization of harbor porpoises. All of the wind farms studied by Brandt et al. (2016) used seal scarers prior to piling as a deterrence measure.

Dähne et al. (2017) evaluated the effect of using a bubble curtain to reduce high-frequency noise from pile driving in the German Bight. Seal scarers were used prior to pile driving in this project as well. Dähne et al. (2017) concluded that, when bubble curtains attenuated sound about 1 kHz between 7 and 12 dB, harbor porpoise echolocation sound decreased out to 12 km from the pile driving, which is less than some studies measuring changes in harbor porpoise vocal activity as far as 18 to 25 km from pile driving. They also found that the seal scarer caused sufficient reaction to suggest it may have surpassed the displacement impact of the pile driving with bubble curtains, calling this approach into question as a mitigation measure when combined with bubble curtains.

Three species of high-frequency cetaceans are found in the AoA: pygmy and dwarf sperm whales and harbor porpoise. Habitat-based density models from Roberts et al. (2016) that extrapolate to predicted use patterns of these species in the AoA and other data sources (see Appendix B) were used to evaluate when these sensitive species may be expected to be seasonally present in the AoA (see Table 2 in Section 2.1.1, and Appendix B). As described in Section 2.2.1, the harbor porpoise is the driver of high-frequency cetacean seasonal patterns in the analysis of high-frequency cetacean density in the AoA (Figures 2 and 3) because of the low occurrence of pygmy and dwarf sperm whales. Harbor porpoise hearing (e.g., Kastelein et al. 2012) and TTS (e.g., Lucke et al. 2009) have been directly studied, rather than estimated by proxy, and research has indicated that harbor porpoise may perceive pile-driving noise from wind farm construction at distances as much as tens of kilometers from the construction site (e.g., Tougaard, Carstensen, et al. 2009; Kastelein, van Heerden, et al. 2013). These results suggest potential for risk of construction noise-related disturbance to this receptor.

Mid-Frequency Cetaceans. Mid-frequency cetaceans are less likely to overlap in the most sensitive parts of their hearing range, with the loudest sounds associated with pile driving. The loudest sounds produced during pile driving tend to be low-frequency sounds, usually below 1 kHz (Brandt et al. 2016). This is in the lower part of the generalized hearing range of mid-frequency cetaceans (150 Hz to 160 kHz; NOAA

Fisheries 2016) and not concentrated in the most sensitive range of hearing. For example, bottlenose dolphins have been measured to have most sensitive hearing at about 45 kHz (Popov et al. 2007), belugas at 32 to 108 kHz (Klishin et al. 2000), killer whales at 15 kHz (Hall and Johnson 1971), striped dolphins at 64 kHz (Kastelein et al. 2003), and false killer whales at 16 to 64 kHz (Thomas et al. 1988). They also are less likely to overlap with the low-frequency sounds associated with vessel traffic.

Studies of bottlenose dolphins suggest that they can detect pile-driving noise as much as 40 to 50 km away, but risks of masking may be limited and changes in behavior are hard to attribute to sound versus other variables (David 2006; Bailey et al. 2010). Detection of sound does not necessarily equate to disturbance by sound, and mid-frequency cetaceans are known to approach and bow-ride on vessels conducting seismic surveys, which produce relatively loud sounds (e.g., Barkaszi 2012).

Low-Frequency Cetaceans. Low-frequency cetaceans are the baleen whales. Each species of low-frequency cetacean exhibits some seasonality in the AoA (see Table 2 in Section 2.1.1, and Section B.1 in Appendix B). As a group, they tend to be predicted to occur in deep water along the continental slope and Hudson Canyon, with some indication of slightly higher predicted densities in the Hudson Shelf Valley than other areas of the continental shelf (Figures 6, 7, and 8). Blue, sei, and Bryde's whales are rare in the AoA. Observations and predicted densities suggest that minke whales are likely less common than humpback, fin, and right whales in the AoA, though they are present throughout most of the year based on acoustic detections (Risch et al. 2012). Humpback whales migrate through the area in spring and fall and have been observed feeding in coastal areas of the AoA June to November (Sieswerda et al. n.d.); fin whales may be most common and may use the northeastern corner of the AoA for feeding (see Appendix B, Section B.1). Fin and humpback whales occur along the coastal region of the AoA and form the basis of a whale watching industry in that area (Antunes et al. 2015). Due to their occurrence pattern, fin and humpback whales are probably the low-frequency cetaceans most vulnerable to noise disturbance (aside from North Atlantic right whales discussed below).

Low-frequency cetaceans may be at risk for masking by lower frequency construction-related vessel traffic, but vessel traffic is not uncommon in the AoA in general (U.S. Coast Guard Navigation Center 2016). With respect to pile driving, most energy in pile-driving noise is at low frequencies, less than 1 kHz, which attenuate relatively slowly (Illingworth and Rankin 2007; Dahl et al. 2015; Brandt et al. 2016). The frequency range estimated to be the range of maximum sensitivity of humpback whales is 2 to 6 kHz (Houser et al. 2001), but sensitivity of low-frequency cetaceans has not been tested directly on animals. Sound may be perceived by baleen whales at large distances from pile-driving activities, but shipping and other ambient low-frequency noise is also typically present in the environment (Rice et al. 2014; Risch et al. 2012). The amount of energy estimated to potentially cause TTS or PTS for low-frequency cetaceans is lower than mid-frequency cetaceans but higher than high-frequency cetaceans (NOAA Fisheries 2016). As such, noise at low frequencies would need to maintain eceived levels of approximately a peak of 219 dB or a 24-hour continuous received level of 183 dB to potentially cause PTS in low-frequency cetaceans (NOAA Fisheries 2016).

North Atlantic Right Whales. Right whales in the AoA may be less at risk from noise due to the way their population shifts within the AoA throughout the year. Right whales are predicted to occur in high concentrations close to shore in winter (Figure 13A), be largely absent from the AoA in spring (Figure 13B), and congregate in deep water beyond the continental shelf in summer (Figure 13C). Because the highest concentrations of right whales occur along the margins of the AoA, this species may avoid noise-related risks from construction, depending on siting decisions. However, right whales are endangered, so it is difficult to assess their habitat use patterns, and disturbance may be a bigger risk when a population is small and declining.

Seals. Seals are generally coastal and spend part of their time on land, reducing their vulnerability to in-water construction noise. Thompson et al. (2013) developed a complex framework for evaluating the risks of pile driving for wind farm development on harbor seals in Moray Firth. They concluded that the noise should not result in reduction of population-level fitness. Kastelein, Gransier, et al. (2013) reported that the behavior of harbor seals exposed to playbacks of pile-driving sounds suggested that harbor seals may hear pile driving up to hundreds of kilometers from pile-driving sites, but distance of audibility would be affected by actual sound propagation conditions and masking from ambient noise.

Sea Turtles. It is difficult to determine the vulnerability of sea turtles to noise. Popper et al. (2014) speculated that the physiology of sea turtles may put them at lower risk to internal injury from pulsed sounds, like those associated with pile driving. Given their low-frequency hearing, masking from MBES and pile driving may be a larger concern if auditory environmental cues are used for migration or feeding in the AoA.

The U.S. Army Corps of Engineers (1997) evaluated the response of loggerhead sea turtles to a fixed sound source designed to repel sea turtles from dredges. They tested this sound source in the York River, and tested tone bursts of 250, 500, and 750 Hz. They conducted a tank version of the study as well. In the York River, there was no significant difference between avoidance and approach of the sound source by loggerhead sea turtles. In another experiment, 10 loggerhead sea turtles in the York River were exposed to seismic sound to evaluate behavioral responses (USACE 1997). Naïve sea turtles showed a significant avoidance response, but this response did not continue for multiple exposures, suggesting habituation. McCauley et al. (2000) conducted two trials in which captive green and loggerhead sea turtles were approached with a single operating seismic source. They found that the sea turtles "noticeably" increased swimming activity when the seismic source was 166 dB that and sea turtles spent increasingly more time swimming when the source level increased. Although seismic sound is not directly comparable to pile-driving noise, and seismic sources typically are part of moving towed arrays rather than stationary construction activities, the lack of experiments using pile-driving sound to evaluate sea turtle responses makes studies of seismic responses potentially informative. The applicability of these seismic studies should also be considered in the context of responses of sea turtles constrained in areas by cages or nets, which is not similar to normal environmental conditions.

3.2 Changes in Vessel Types/Numbers

3.2.1 Vessel Activity in the Offshore Study Area

Prior to construction, geophysical and geotechnical survey vessels will be used to evaluate potential wind development sites. During construction, vessel traffic to and from existing port facilities in New York State will likely include a wide variety of vessel types (e.g., working barges, jack-up barges, tugs) and sizes (90 to 400 feet) (DOI MMS 2009; Navigant Consulting, Inc. 2013). For example, large vessels (up to 400 feet) may be used to deliver shipments of blades to onshore assembly facilities. Barges may also be used to transport materials like monopiles to the offshore work sites (DOI MMS 2009; Navigant Consulting, Inc. 2013). The vessels delivering construction materials travel at approximately 10 knots (19 km/hour) (DOI MMS 2009). During construction activities (e.g., pile driving), vessels would likely be intermittently stationary or slow-moving barges and tugs conducting or supporting the installation (DOI MMS 2009). Additionally, smaller vessels (16 to 49 feet) may be used for light work or to transport crews, and these vessels may reach up to 35 knots (DOI MMS 2009; ESS Group 2016). During operation (post-construction), vessel traffic associated with maintenance would likely be infrequent. Based on onshore and offshore experience, maintenance is typically scheduled twice a year per turbine, with unscheduled maintenance occurring approximately three times per year (DOI MMS 2009; ESS Group 2016). This would involve far fewer vessels (e.g., two per working day) than during construction (DOI MMS 2009).

3.2.2 Potential Vessel Collision Risk to Marine Mammals and Sea Turtles

Collisions with vessels are a potential threat to a number of marine mammal and sea turtle species, especially large, shallow-diving whales. The more time a species spends at the water surface, the more time is available to interact with vessels. Thus, shallow-diving cetaceans may be more vulnerable to collision than deep-diving cetaceans, which spend less time at the surface, though vulnerability to vessel collision is influenced by other factors as well.

Marine mammals and sea turtles are more likely to be struck and to die as a result of injuries when a vessel is large (i.e., 80 m or longer) (Laist et al. 2001), traveling at high speed (Laist et al. 2001; Jensen and Silber 2004; Hazel et al. 2007; Kite-Powell et al. 2007; Vanderlaan and Taggart 2007; Vanderlaan et al. 2009; Work et al. 2010; Conn and Silber 2013), or located in a geographic bottleneck such as a narrow strait (Williams and O'Hara 2010). Laist et al. (2001) reviewed vessel collision data and concluded that mortality was more likely when vessels were traveling at 14 knots or faster. Jensen and Silber (2004) reported that, in 292 cases, most vessels reported collision with whales at vessel speeds of 13 to 15 knots. Hazel et al. (2007) concluded that sea turtles fled only rarely as vessel speeds reached about 10 knots, potentially making them more vulnerable to collision from higher speed vessel. The vessel used in this experiment was a 6 m aluminum boat, so it would not be comparable to offshore wind construction and maintenance vessels. Modeling right whale evasion behavior suggested that vessels traveling at 15 knots or faster toward a right whale are likely to collide with the whale even if the whale takes evasive action (Kite-Powell et al. 2007). Based on modeling related to pre- and post-speed restrictions in SMAs for right whales on the east coast, Conn and Silber (2013) estimated that mortality risk from vessel collision was reduced by 80–90%. Small cetaceans also collide with vessels (e.g., Wells and Scott 1997), but as for sea turtles and seals, the literature on collisions is mainly limited to small craft rather than the types of ships associated with wind farm development.

Vessel collisions are most likely to occur in areas with high numbers of ships (i.e., shipping routes) or concentrations of whales (e.g., Biologically Important Areas [BIAs]) (Douglas et al. 2008; Berman-Kowaleski et al. 2010). Behavior state may affect vulnerability to vessel collision. For example, Horwood (1981) reported that minke whales that were feeding were easy to approach and typically ignored the vessel, while the behavior of other minke whales was "skittish," but these reactions were taking place one day after whaling vessels left the area.

Whale species vary in their susceptibility to vessel collision. Laist et al. (2001) reviewed 407 stranding deaths of seven large whale species from 1975 to 1996 along the U.S. Atlantic Coast (Maine to Florida). The review indicated that 67% of sei whale, 33% of fin whale, 33% of North Atlantic right whale, 8% of humpback whale, 5% of minke whale, and zero sperm and Bryde's whale stranding deaths included signs of vessel collision (Laist et al. 2001). In 2016 and through October 31, 2017, there were 57 humpback whale strandings on the U.S. Atlantic coast, and of the 20 cases examined, 10 had injuries consistent with vessel collision (NOAA 2017a). This is six times the 16-year average of 1.5 humpback whales with signs of vessel collision, and NOAA Fisheries has declared an ongoing, unusual mortality event for humpback whales in the North Atlantic (NOAA 2017a). The critically endangered North Atlantic right whale is particularly vulnerable to population-level risks from vessel collision because its current population may number at fewer than 500 individuals (Hayes et al. 2017). There is also a recently declared (as of August 25, 2017) unusual mortality event for North Atlantic right whales, though it is not clear what role vessel collision may play in this event (NOAA 2017b). As of October 31, 2017, 16 right whales were documented dead since June 7, 2017. Vessel collision is considered an important factor in the lack of recovery for this critically endangered species (Knowlton and Kraus 2001; Kraus et al. 2005; Silber and Bettridge 2010).

Based on the susceptibility to vessel collision described in Laist et al. (2001), the species most susceptible to vessel collision in the AoA are likely the North Atlantic right whale and fin whale, though the recent increase in humpback whale vessel collision may suggest higher risk for this species than indicated by the data reviewed in Laist et al. (2001). In winter, when the right whale population moves closer to shore (Figure 13A), they would be most at risk from large shipping vessels entering the port in New York City and large vessels traveling between work areas and the shore at high speeds (though within required seasonal speed limits). In fall and spring, when right whales are present in the AoA in lower concentrations and tend to congregate at the northern boundary of the AoA (Figures 13B and 13D), and in summer, when the right whale population moves offshore beyond the continental shelf (Figure 13C), risk of vessel collision would decrease for this species. Fin whale observations and recordings are more frequent in the spring and summer, with a few observations relatively close to the Long Island shore in the summer (see Appendix B, Section B.1). Humpback whale observations in the AoA are limited and typically restricted to summer and fall, and they may migrate through the area further offshore than the AoA (see Appendix B, Section B.1).

Moore et al. (2013) describe signs of sharp trauma indicative of injuries associated with vessel collision in stranded seals. Vessel collision associated with sea turtles, seals, and cetaceans smaller than the large baleen and sperm whales tends to focus on sharp force trauma, such as propeller injury (Moore et al. 2013; NMFS and USFWS 2008). As such, vessel collision with the large vessels associated with wind farm construction and maintenance may be less likely for these species due to surface behavior, deep diving, maneuverability, and/or vessel aversion, though it is difficult to know how many small, surfacing animals are injured or killed by large vessels without stranding onshore or being observed at sea. Shallow-diving animals may be more susceptible to vessel collision risk than deep-diving animals due to more availability at the surface. (See Table 3 for a list of deep- and shallow-diving cetaceans.)

Sea turtles may be deep divers as well. For example, leatherback sea turtles have been recorded diving to depths greater than 1,000 m (Eckert et al. 1988), but data are sparse with respect to sea turtle diving habits at sea and little is known about them in the AoA. James et al. (2005) tagged leatherback turtles in Nova Scotia and followed their movements throughout the North Atlantic for over a year; they recorded dive depths of greater than 400 m, though most dives were 250 m and less. The most common seal in the AoA is the harbor seal (see Appendix B, Section B.2). Harbor seals are generally shallow divers (Lesage et al. 1999).

Vessel collision is considered a threat to the recovery of loggerhead (NMFS and USFWS 2008), Kemp's ridley (NMFS et al. 2011), and green turtles (NMFS and USFWS 1991) in the Western Atlantic. This threat is not explicitly mentioned in the leatherback turtle recovery plan, though increases in vessel traffic are described as a threat (NMFS and USFWS 1992). NMFS and USFWS (2008) reported that unpublished data from NMFS indicated that propeller and collision injuries from boats and ships were found on 14.9% of stranded loggerheads in the U.S. Atlantic and Gulf of Mexico from 1997 to 2005, with an increasing trend from the late 1980s to early 2000s, though some injuries may have been post-mortem.

3.3 Permanent Structures in the Water

In addition to temporary, short-term potential stressors such as noise associated with pile driving and additional vessels on the water for construction, wind turbines, as relatively permanent structures in the water, are a potential stressor. While numerous empirical studies have evaluated marine mammal displacement as a result of noise in the marine environment (see Section 3.1.5), data on the potential for habitat fragmentation or displacement caused by offshore wind structures themselves are generally lacking. The few studies that do exist present contradictory results. For example, a study of a wind farm in the Baltic Sea documented 89% fewer harbor porpoises inside the wind farm during construction and 71% fewer 10 years later compared to baseline levels (Teilmann and Carstensen 2012). However, a similar study found a significant increase of 160% in the presence of harbor porpoise within an operating wind farm in the Dutch North Sea (Scheidat et al. 2011).

Harwood (2001) points out that highly mobile marine species, in theory, can use other suitable areas to compensate for habitat loss and fragmentation, but cautions that major barriers to migration or loss of critical habitat could affect species. Hardwood (2001) also notes that marine mammals may spend more time travelling between critical areas than actually in those areas, which means they are vulnerable to risks outside of critical areas. He also states that critical areas can be difficult to identify. Fragmentation of habitat may require additional energy expenditure (Harwood 2001), such as increased migration effort to circumvent a wind farm, potentially affecting fitness. It is also possible for displacement to cause marine mammals or sea turtles to increase use of areas with higher risk of threats, such as shipping lanes. Harwood's conclusions suggest that marine mammals and sea turtles may use habitat in dynamic ways that vary inter-annually depending on ocean conditions that drive prey distribution. In addition, climate change may affect preferred habitats and distribution over the lifetime of a wind farm (Harwood 2001). Known areas of concentrated feeding, breeding, and migration in the AoA for marine mammals and sea turtles may be considered sensitive to the risks associated with permanent structures.

Based on this information, these receptors generally appear to have higher risk from structures in the water in certain locations in the AoA, such as the northeastern corner, the eastern boundary near the coast, the Hudson Shelf Valley area, and the shelf break and slope regions.

3.4 Environmental Sensitivity and Permitting Risk Analysis

The data presented in this Study were incorporated into a larger modeling study that evaluates locations of various types of potential environmental sensitivities within the AoA. The objective of the modeling study is to develop a weighting system and map products that allowed for a comparative analysis of the potential risks to marine resources during pre-construction, construction and operation of offshore wind farms. Risks were evaluated for receptors (e.g., marine mammals), and with consideration of seasonal differences in site use by migratory organisms (as data allowed), which could be relevant to pre-construction, construction, and operational-phase sensitivities. Differences among potential risk from stressors (e.g., pile driving, new structures in the water) were captured in this exercise, and the outputs of the mapping reflected these differences in risk.

These relative risks were captured in the sensitivity modeling exercise in three separate series of maps: pre-construction, construction, and operation, with each including seasonal and annual maps. The density data of Roberts et al. (2016) for cetaceans, Roberts et al. (2015) for seals, and Navy (2007) for sea turtles were used in the modeling study because these data most clearly reflected the relative trends as described above. The resulting maps were used, along with other tools, to identify the relative potential for biological sensitivity among areas of the AoA, as well as areas to propose to BOEM for further analysis. The maps also inform developers about areas of biological importance, potentially reducing the uncertainty and costs of future proposals.

4 Conclusions/Synthesis

This Study reviews the best available science, including distribution and habitat-use information from a thorough survey of the existing literature and habitat-based density estimates based on extensive survey work in the Mid-Atlantic over the last 22 years, as presented in Appendix B and Section 2, respectively. Though more data, such as those being collected by Normandeau Associates, Inc. (Normandeau) and APEM, Inc. (APEM), and by the DEC (Schlesinger and Bonacci 2014; Tetra Tech and Smultea Environmental Sciences 2017) (see Appendix A), will help refine understanding of local distribution and occurrence of marine mammals and sea turtles in the AoA, existing data can be used to begin identifying areas that BOEM should consider for future offshore wind development in the AoA.

Noise and vessels associated with future wind farm development are potential temporary stressors; wind turbines in the water are a potential long-term stressor. Noise that may affect marine mammals or sea turtles is temporary and mainly associated with MBES and other bottom surveys that use sound during pre-construction and with pile driving during construction. Noise may cause injury, displacement, and/or changes in behavior. Increased frequency and changes in vessel traffic associated with pre-construction surveys, wind farm construction, and post-construction maintenance may increase risk of vessel collisions with marine mammals and/or sea turtles. Permanent structures in water during and after construction may result in longer-term displacement or loss/fragmentation of important habitat. Displacement that pushes animals into higher traffic areas, like shipping channels, may increase vessel collision risk. Loss of important habitat may reduce fitness by increasing energy expenditures or reducing access to prey or mates.

Noise has been a focus of much attention and study in the last decade (e.g., Williams et al. 2015; Forney et al. 2017). Although the understanding of hearing in marine mammals tends to be based on studies of a few individuals of several species used as proxies for the remaining species (Southall et al. 2007; Finneran 2016), NOAA Fisheries has integrated the existing data to evaluate the potential for TTS and PTS at different peak sound pressures and cumulative sound levels for different hearing groups of marine mammals. NOAA Fisheries has used this information to establish policy associated with thresholds for injury (NOAA NMFS 2016a). Less is known about sea turtle hearing and thresholds (Popper et al. 2014). Behavioral responses of marine mammals and sea turtles to noise can be even more difficult to evaluate than hearing impacts of noise. Behavioral changes are context-dependent (Ellison et al. 2012; Goldbogen et al. 2013; Southall et al. 2016), and population-level consequences are unclear, although some efforts have been made to evaluate these consequences using expert elicitation frameworks

(King et al. 2015). The data suggest that some species may be more vulnerable to noise, such as harbor porpoise (Dähne 2013), beaked whales (Cox et al. 2006), and melon-headed whales (Southall et al. 2006). North Atlantic right whales are also potentially more vulnerable than some other species because of their endangered status.

With respect to noise, harbor porpoise, North Atlantic right whales, and other baleen whales are likely to have the highest potential for disturbance based on studies of harbor porpoise near European wind farms, studies of baleen whale responses to noise, and the hearing frequencies and sensitivities of these species. All of these species are predicted to occur at greatest densities in the northeastern area of the AoA. There is also evidence of humpback and fin whales using areas near the coast of Long Island along the northwestern and southwestern borders of the AoA (Antunes et al. 2015; Sieswerda et al. n.d.). The fluctuation in predicted density and observed use patterns over seasons suggests that limiting noise during certain seasons may reduce potential risks for these receptors. Right whales have the highest predicted densities in the northeastern area of the AoA in spring. Although total densities are predicted to be low, right whales tend to be predicted along the coastal boundary of the AoA in winter, along the continental slope in summer, and back toward the northeastern area of the AoA in fall. However, research off the New Jersey coast suggests that North Atlantic right whales can occur year-round in coastal New Jersey and may use the area for feeding and migration (Whitt et al. 2013).

If a wind farm were proposed toward the northeastern part of the AoA, the spring season would likely present the greatest risk to marine mammals due to noise from pile driving. If the wind farm is closer to the Long Island coast, winter may be a higher risk for pile driving for to North Atlantic right whales, though other seasons may be riskier for fin and humpback whales. Seals are more common along the Long Island coast in spring, fall, and winter than in summer, and sea turtles tend to move northward into the AoA and along the coast in warmer seasons. Thus, coastal development must balance seasonal mitigation according to greatest potential for impacts to particular species.

Based on monthly predictions, harbor porpoise are unlikely to occur in the OSA in July through September. Rhode Island University (1982) surveys suggested harbor porpoise shift distribution out of the OSA in winter, but more recent surveys in 2010–2015 documented harbor porpoise in the OSA and in Long Island Sound in winter (NOAA NEFSC and SEFSC 2011a). Normandeau and APEM (2016, 2017) surveys support a lack of harbor porpoise presence in summer. Overall, harbor porpoise have most vulnerability to impacts from sound if noise-generating activities occur in fall, winter, or spring in areas with high sightings and predicted distribution in the northeastern area of the AoA. The baleen whales (not including North Atlantic right whales) are less common in the AoA, with the exception of humpback and fin whales. Low-frequency noise that travels long distance may affect these receptors. Fin whales feed in the very northeastern corner of the AoA such that they are included in a feeding BIA (see Appendix B Section B.1.1.1). Feeding in the north would likely be mainly a summer activity. Humpback whales migrate through the AoA, and largest densities are expected to be present along the slope area during spring and fall seasons. Fin and humpback whales have also been documented feeding in areas near the Long Island coast (Antunes et al. 2015; Sieswerda et al. n.d.), and vocalizations since June 2016 have been detected from humpbacks mainly March to June. Fin whale vocalizations peaked November to March (Baumgartner et al. 2017). Depending on location and anticipated low-frequency noise propagation, seasonal noise mitigation may be appropriate, but it will require site-specific consideration.

Changes in types or numbers of vessels may increase the potential for vessel collision with marine mammals. Vessel collision is a higher risk for North Atlantic right whales, fin whales, and humpback whales than for other species. Sei whales may also have high risk for vessel collision in general, but this species is rare in the AoA and found mainly north of the AoA. Seasonal avoidance of North Atlantic right, fin, and humpback whale high-use areas by vessels would help reduce this risk. Right whales change their habitat use pattern seasonally (Figures 13 and 14), so appropriate seasons for wind farm construction would depend on siting. Avoiding the fin whale BIA may reduce risk of vessel collisions with fin whales. Humpback whales migrate through the AoA. Therefore, summer and winter seasons may pose lower risk to humpback whales in the slope area. Humpback and fin whales have also been observed along the Long Island and New Jersey coastal areas in spring, summer, and fall (Antunes et al. 2015; Sieswerda et al. n.d.), including observations of feeding (Sadove and Cardinale 1993; Sieswerda et al. n.d.). Right whales tend to use coastal areas more in winter, so choices about seasonal construction may involve trade-offs relative to the vulnerability of particular baleen whale species. Vessel collision risk is also reduced by following laws associated with vessel speed and other mitigations. Any displacement associated with increased vessel traffic is likely to be temporary.

With respect to noise, ship traffic is common in the AoA, and vessel noise will likely be within ambient noise levels. Some information on ambient noise levels in the New York Bight is provided in Risch et al. (2012), and Rice et al. (2014) reported highest ambient noise levels below 1,000 Hz off New Jersey and New York relative to other areas off the U.S. East Coast, with the majority of this noise concentrated below 500 Hz.

Permanent structures in the water leading to potential displacement and habitat loss/fragmentation is a potential long-term consequence of wind farm development in the AoA. It is difficult to predict whether marine mammals and/or sea turtles may be displaced, as it would be possible for these species to inhabit the area within a wind farm. In the case of displacement, if there were suitable nearby habitat and displacement did not cause undue energy expenditure, populations may not be affected. Risk of displacement can be reduced by siting future wind farms in areas that are not considered important feeding, breeding, or migratory areas and by avoiding areas close to shipping lanes, as displacement into shipping lanes could increase risk of collisions with vessels.

The general distributions and predicted densities of marine mammals and sea turtles described in Sections 1 and 2, as well as the occurrence data described in Appendix B, suggest the following:

- Fin whales may have important feeding habitat in the northeastern section of the AoA.
- Right whales, humpback whales, fin whales, and minke whales migrate through the AoA.
- Right whales have highest predicted densities in the northeastern area of the AoA in spring.
- Right whales are predicted along the coastal boundary of the AoA in winter, along the continental slope in summer, and back toward the northeastern area of the AoA in fall.
- Right whales use the New Jersey coast year-round and may use coastal areas of the New York Bight for both feeding and migration.
- Humpback and fin whales feed (mainly spring through fall) in coastal areas of the AoA along Long Island and New Jersey.
- Seals are predicted to be most abundant in coastal waters and shift their distribution north of the AoA in summer.
- Sea turtles are predicted to occur mainly in the southern part of the AoA, but they have been observed and stranded in northern areas of the AoA, and recent surveys suggest high occurrence of loggerheads throughout the continental shelf area in summer.
- Green turtles are rare in the AoA, and leatherbacks occur in small numbers across the shelf
- Most receptor groups are predicted to have concentrated use of the continental shelf break and slope and Hudson Canyon, potentially extending along the Hudson Shelf Valley during at least part of the year.
- Mid-frequency cetaceans (mainly the dolphins) are predicted to use the southwestern area of the continental shelf near the Hudson Shelf Valley more than other locations on the shelf.
- Harbor porpoise are predicted to distribute across the continental shelf in winter and spring and concentrate more in the northeastern area of the AoA in summer and fall.

In the context of offshore wind development in the AoA, siting wind farms in the middle continental shelf area may help reduce potential risks overall. With respect to marine mammals and sea turtles, this central area is where most species are observed less often (versus coastal and slope observations) and habitat-based use predictions usually indicate lowest use, though Lagueux et al. (2010) show some local patterns on the shelf based on sightings per unit effort analysis. The Hudson Canyon and Valley are predicted to have higher use than the main body of the shelf for most species, and this prediction is supported by Sadove and Cardinale's (1993) descriptions of local surveys in the New York Bight.

Potential displacement or behavioral responses to noise associated with wind farm development are likely to be temporary, limiting the likelihood of population-level consequences, but cumulative and aggregative risks should be considered in siting and mitigation. The highest risk locations for a future wind farm relative to marine mammals and sea turtles may be in the northeastern corner of the AoA, the continental shelf break and slope, and the areas closest to the coast where North Atlantic right whales, humpback whales, fin whales, and harbor seals frequently use habitat nearshore. However, recent surveys in 2016 and 2017 (Normandeau and APEM 2016, 2017; Tetra Tech and Smultea Sciences 2017) indicate that sea turtles are common across the shelf in summer and that potential preference for the slope or coastal areas does not mean that species are not present on the shelf.

In considering the conclusions associated with risk reduction described above, the actual presence, use patterns, and sensitivity of particular receptor groups or species should be considered in the context of attempting to limit effects of potential stressors. For example, North Atlantic right whales are highly vulnerable to vessel collision and are endangered, so special attention could be paid to reducing stressors that may lead to potential increased vessel collision risk in areas or seasons with high right whale use. Another example might be prioritizing risk reduction associated with pile-driving noise for high- and low-frequency cetaceans. The conclusions provided here highlight the receptors with known high sensitivity and risk. Lack of data makes it difficult to draw conclusions about potential risks and sensitivities for rare and cryptic receptors that are difficult to study, such as some high-frequency cetaceans, or are understudied at sea, such as sea turtles and seals. Further, site- and project-specific mitigation can address some of the potential risks, and some potential BMPs associated with such mitigation are discussed in Section 6.

5 Agency and Stakeholder Engagement

Agency and stakeholder feedback was an important element of this Study in identifying marine mammal and sea turtle use within the AoA and informing recommended guidelines and BMPs to site, construct, and operate offshore wind farms in the AoA in a responsible manner. This Study was updated to reflect agency and stakeholder feedback; however, it does not necessarily reflect the commenters' opinions.

The State of New York provided a first draft of this Study to 15 entities for review, including State and federal regulators, environmental NGOs, and other stakeholders on August 11, 2017, and afforded these stakeholders the opportunity to submit written comments on the draft's contents. In addition, the State hosted a webinar on August 21, 2017, in which the Study's authors gave an overview of the document and fielded questions and concerns from participating State and federal agencies and environmental NGOs. In total, the State received 113 written and verbal comments.

The State considered all comments and, when appropriate, made changes to the Study in response to the comments. In some cases, comments required only a written response, whereas others required edits to the text, figures, maps, or formatting of the Study. In general, most comments fell into one or more of the following categories:

- Requests to include discussion of data gaps.
- Requests to include more discussion of uncertainty in scientific information.
- Requests to clarify discussions of background.
- Requests to add data from unreported sources and reconsider some conclusions based on additional data.
- Comments on figures.
- General editorial comments.

Comment responses and/or edits to the Study often fell into one or more of the following updates or outcomes:

- Clarification of text in the Study.
- Addition of information from new sources.
- Restating clearly the scope of the Study and how the data were used to draw conclusions.

6 Guidelines and Best Management Practices

This section provides examples of guidelines and BMPs that developers can use to reduce potential risks to marine mammals and sea turtles. Table 6 summarizes guidelines and BMPs from various sources. While this section provides general BMPs, these are not offered as mitigation measures, which outline specific actions to ease the severity of specific stressors for a specific project. These BMPs will instead provide general options that can be tailored to specific projects. 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. Developers should consult the State, NOAA, and BOEM for up-to-date regulatory recommendations or requirements at the time of project planning and development. 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 next steps, including an approach to develop guidelines.

Table 6. Wind Farm Development Guidelines and BMPs Related to Marine Mammals and Sea Turtles

Receptor (Species/Group)	Potential Guideline/BMP	Reference
Stressor: Increased Vessel Presence/Change in Types of Vessels Present in AoA Risks: Vessel-collision, displacement		
All cetacean receptor groups[a], seals, and sea turtles	Vessel operators and crews keep vigilant watch for all marine mammals and sea turtles.	NOAA 2008 (Vessel Strike Avoidance Measures); BOEM 2014; NOAA GARFO n.d. (GARFO Section 7 Guidance)
All cetacean receptor groups,[a] seals, and sea turtles	Train vessel crews in protected species identification, laws, regulations, vessel collision information, and behavior and distribution information	NOAA 2008
All cetacean receptor groups,[a] seals, and sea turtles	Establish designated traffic lanes for construction, maintenance, and decommissioning vessels.	DOI MMS 2009
All cetacean receptor groups,[a] seals, and sea turtles	Keep vessel traffic to a minimum during construction and decommissioning.	DOI MMS 2009
All cetacean receptor groups[a], seals, and sea turtles	Year-round, the vessel maintains a predetermined minimum separation distance to all other marine mammals and sea turtles.	NOAA 2008; BOEM 2014
All cetacean receptor groups,[a] seals, and sea turtles	Establish seasonal restrictions for construction schedules when appropriate.	USACE 2014; NOAA GARFO n.d.
All cetacean receptor groups,[a] seals, and sea turtles	Speed limits for vessels	NYSERDA 2015; NOAA GARFO n.d.
All cetacean receptor groups,[a] seals, and sea turtles	Minimize changes in vessel traffic where at-risk species are likely to occur in area	NOAA GARFO n.d.

Table notes are at the end of the table.

Table 6 continued

Receptor (Species/Group)	Potential Guideline/BMP	Reference
All cetacean receptor groups[a]	Vessel operators and crew familiarize themselves with NOAA's regional viewing guidelines and ways to minimize encounters with cetaceans.	DOI MMS 2009
Shallow-diving cetaceans	If small cetaceans are sighted (e.g., bowriding) attempt to remain parallel to animals' course and avoid excessive speed or abrupt changes in direction.	NOAA 2008
Endangered cetaceans	Year-round, when ESA-listed whales are sighted, vessels maintain a predetermined minimum separation distance.	NOAA 2008; BOEM 2014
Endangered cetaceans	If an ESA-listed whale is observed in the path of the vessel, the operator reduces speed and shifts engines to neutral.	NOAA 2008; BOEM 2014
North Atlantic Right Whale	Maintain a distance of 500 m away from North Atlantic right whales.[b]	50 CFR § 224.103 (c)(1)(i)
North Atlantic Right Whale	If within 500 m of a right whale and underway, steer clear of the whale and immediately leave the area at a slow safe speed.[b]	50 CFR § 224.103 (c)(2)(i)
North Atlantic Right Whale	Vessels 65 feet or larger are restricted to traveling at 10 knots or less in the period of November 1 to April 30 each year in SMAs, including Ports of New York/New Jersey.[b]	50 CFR § 224.105
Stressor: Noise Risks: Physical injury, displacement, behavior alteration		
All cetacean receptor groups,[a] seals, and sea turtles	Establish a predetermined exclusion and monitoring zone radius around acoustically active project components.[c]	DOI MMS 2009; USACE 2014; NYSERDA 2015; Carduner 2017; Morin 2017; BOEM 2017
All cetacean receptor groups,[a] seals, and sea turtles	A third party Protected Species Observer monitors the exclusion zone for a designated length of time prior and subsequent to each pile-driving event, and during the entirety of the pile-driving activity.	USACE 2014; NYSERDA 2015
All cetacean receptor groups,[a] seals, and sea turtles	Under safe conditions, apply ramp up/soft-start procedures for noise-producing equipment used in pile driving.	USACE 2014; NOAA GARFO n.d.; Carduner 2017
All cetacean receptor groups,[a] seals, and sea turtles	Pile-driving start avoided during periods of low visibility (i.e., during fog conditions or at night).	JNCC 2010; NYSERDA 2015
All cetacean receptor groups[a], seals, and sea turtles	Establish seasonal restrictions for construction schedules when appropriate.	USACE 2014; NYSERDA 2015; NOAA GARFO n.d.
All cetacean receptor groups,[a] seals, and sea turtles	Use noise reduction technologies during pile driving to reduce the sound levels in water.	Lucke et al. 2011; NYSERDA 2015; NOAA GARFO n.d.; Carduner 2017; Philipp 2017; Dähne et al. 2017

Table notes are at the end of the table.

Table 6 continued

Receptor (Species/Group)	Potential Guideline/BMP	Reference
All cetacean receptor groups,[a] seals, and sea turtles	Limit amount of time spent pile driving in a 24 hour period	NOAA GARFO n.d.
All cetacean receptor groups,[a] seals, and sea turtles	Adequate zone of passage maintained throughout action area	NOAA GARFO n.d.
All cetacean receptor groups,[a] seals, and sea turtles	Noise remains below relevant species thresholds	NOAA GARFO n.d.
All cetacean receptor groups,[a] seals, and sea turtles	Geographic and/or seasonal restrictions to limit exposure and reduce behavioral harassment	Carduner 2017
All cetacean receptor groups,[a] seals, and sea turtles	Displace animals from areas of high noise levels by means of Soft start or deterrence devices; i.e., Pinger, Seal Scarer	Philipp 2017
All cetacean receptor groups[a]	Conduct passive acoustic monitoring baseline study for ambient noise and cetacean vocalizations during pre-construction surveys to assist in siting	Kraus et al. 2016; BOEM 2017; Van Parijs 2017
All cetacean receptor groups[a]	Designate passive acoustic monitoring operators during the piling process to assist in detecting cetaceans in the area.	JNCC 2010; NYSERDA 2015
North Atlantic Right Whale	Prohibition on pile driving (met tower) in the period of November 1 to April 30	Morin 2017; BOEM 2017
North Atlantic Right Whale	All sub-bottom profiling and pile driving stops within 24 hours of Dynamic Management Area establishment	Morin 2017; BOEM 2017
Sea turtles	To the extent practicable, restrict human activities that could seriously affect sea turtles, especially during the periods of reproduction, nesting and migration.	IAC 2001
Stressor: Permanent Structures in the Water Risks: Displacement, Avoidance		
All cetacean receptor groups,[a] seals, and sea turtles	Careful siting to avoid biological hotspots and areas that might displace animals into shipping lanes	NYSERDA 2015
All cetacean receptor groups,[a] seals, and sea turtles	Structures do not create any impairment of normal behaviors or block passage	NOAA GARFO n.d.

[a] Cetacean receptor groups include high-, mid-, and low-frequency, shallow- and deep-diving, and endangered cetaceans (Table 3).

[b] This BMP represents a published federal regulation and must be followed as written.

[c] Permits often require exclusion and monitoring zones. Any mitigation included as a permit condition becomes a requirement rather than a voluntary BMP

In addition to BMPs and potential mitigation, there are legal requirements with respect to protection of North Atlantic right whales which are universally in effect unless the regulations are changed (Table 7).

Table 7. Regulations Associated with North Atlantic Right Whale Protection

Requirement	Regulation
Maintain a distance of 500 m away from North Atlantic right whales.	50 CFR § 224.103 (c)(1)(i)
If within 500 m of a right whale and underway, steer clear of the whale and immediately leave the area at a slow, safe speed	50 CFR § 224.103 (c)(2)(i)
Vessels 65 feet or larger are restricted to traveling at 10 knots or less in the period of November 1 to April 30 each year in SMAs, including Ports of New York/New Jersey and Block Island Sound.	50 CFR § 224.105;

Deepwater Wind, Energy Management, Inc. (Deepwater Wind) and Bluewater Wind Delaware LLC, along with nine NGOs that advocate for environmental protection, reached an agreement in December 2012 with respect to mitigation to protect North Atlantic right whales during offshore wind farm site assessment and characterization in the Mid-Atlantic Wind Energy Areas (Grybowski et al. 2012). Deepwater Wind reached a similar agreement with seven of these organizations in 2014 to implement additional mitigations in the Rhode Island-Massachusetts (RI/MA) Wind Energy Area (Grybowski et al. 2014). The mitigations agreed to by these developers are summarized below in Table 8. The developers have agreed to these mitigations for site assessment and characterization regardless of whether they would be otherwise required by law or permit conditions. These are not mitigations necessarily required by BOEM, NOAA, or any other permitting or implementing agency, and they may or may not be applicable or advisable for any particular future offshore wind development in the AoA. No agreements are currently in place for construction of wind facilities, and none are in place for New York State.

Table 8. Mitigation Measures for North Atlantic Right Whale in Agreements between Offshore Wind Developers and Nongovernmental Organizations

Mitigation Measures	Period Applicable (RI/MA Wind Energy Area)[a]	Summary (RI/MA Wind Energy Area)[a]	Period Applicable (Mid-Atlantic Wind Energy Areas offshore NJ, DE, MD, VA)[b]	Summary (Mid-Atlantic Wind Energy Areas offshore NJ, DE, MD, VA)[b]
Seasonal Restrictions on Sub-bottom Profiling and Pile Driving for Meteorological Tower	May 15–October 31 for pile driving, and May 15–December 31 for sub-bottom profiling	Activities can occur in accordance with the RI/MA Revised EA and additional mitigation measures contained in this agreement, as applicable.	May 1—October 31, for pile driving and sub-bottom profiling	Activities can occur in accordance with the mitigation requirements specified in the mid-Atlantic EA and additional mitigation measures contained in this agreement, as applicable.
	May 1–May 14, for pile driving, and January 1 – January 31 and May 1 –May 14 for sub-bottom profiling	Same as Green Period, provided that the Developer completes a site-specific risk assessment that includes: • An assessment of the potential for right whale activity during period of survey. • An acoustic assessment of the specific equipment to be used. • A site-specific Marine Mammal Harassment Avoidance Plan The risk assessment shall be made available to BOEM, NMFS, and to the NGO parties of this agreement prior to commencement of activities.	March 22—April 30 and November 1—November 22, for pile driving and sub-bottom profiling	Same as Green Period, provided that the developer completes a site-specific risk assessment that includes: • An assessment of the potential for right whale activity during period of survey. • An acoustic assessment of the specific equipment to be used. • A site-specific Marine Mammal Harassment Avoidance Plan. The risk assessment shall be made available to BOEM, NMFS, and to the NGO parties of this agreement prior to commencement of activities.
	November 1–April 30 for pile driving, and February 1–April 30 for sub-bottom profiling	Activities cannot occur during this period.	November 23–March 21, for pile driving and sub-bottom profiling	Activities cannot occur during this period.
Vessel Speed Restriction	Any Yellow Period and any Red Period	A 10-knot speed limit restriction during these periods on all vessels of any length associated with site assessment surveys and site characterization activities, including survey vessels as well as support vessels, operating in and transiting to and from the wind energy area (WEA).	November 1–April 30	A 10 knot speed limit restriction during these periods on all vessels of any length associated with site assessment surveys and site characterization activities, including survey vessels, as well as support vessels, operating in and transiting to and from the WEA.
Use of Noise Attenuation and Source Level Reduction Technology to Reduce Sound during Meteorological Tower Construction	The Yellow Period for pile driving	The developer shall use the best commercially available technology, such as bubble curtains, cushion blocks, temporary noise attenuation pile design, vibratory pile drivers, and/or press-in pile drivers, to reduce the pile-driver source levels and horizontal propagation, unless such technology is prohibitively expensive for the project. The developer will employ engineering expertise to determine the best available technology for each pile-driving site (or this may be done programmatically for a series of sites), and the engineering analysis and cost analysis shall be made available.	March 22–April 30 and November 1–November 22	The developer shall use the best commercially available technology, such as bubble curtains, cushion blocks, temporary noise attenuation pile design, vibratory pile drivers, and/or press-in pile drivers, to reduce the pile-driver source levels and horizontal propagation, unless such technology is prohibitively expensive for the project. The developer will employ engineering expertise to determine the best available technology for each pile-driving site (or this may be done programmatically for a series of sites), and the engineering analysis and cost analysis shall be made available.
Establishment of Exclusion Zone	All periods	**Sub-bottom profiling:** A minimum 500 m (1,640-foot) radius exclusion zone for all marine mammals and sea turtles shall be established around the sub-bottom profiler, with an exception for dolphins that, in the determination of the visual observers, are approaching the vessel at a speed and vector that indicates voluntary approach to bow-ride. The presumed 500 m exclusion zone should be confirmed using sound source validation before sub-bottom profiling begins, and the exclusion zone should be enlarged for the duration of site characterization activity if the 160 dB isopleth extends beyond 500 m from the source. For sound source validation, developers will conduct in-field empirical measurements of the distances in the broadside and endfire directions at which broadband received levels (for boomer sources) or each operating frequency (for chirp sources) below 22 kHz reach 180 and 160 dB rms re 1 μPa for the sub-bottom profiling source that will be employed. Results will be reported to BOEM and NMFS and made available within five days.	All periods	**Sub-bottom profiling:** A minimum 500 m (1,640-foot) radius exclusion zone for all marine mammals and sea turtles shall be established around the sub-bottom profiler, with an exception for dolphins that, in the determination of the visual observers, are approaching the vessel at a speed and vector that indicates voluntary approach to bow-ride. The presumed 500 m exclusion zone should be confirmed using sound source validation before sub-bottom profiling begins, and the exclusion zone should be enlarged for the duration of site characterization activity if the 160 dB isopleth extends beyond 500 meters from the source. For sound source validation, developers will conduct in-field empirical measurements of the distances in the broadside and endfire directions at which broadband received levels (for boomer sources) or each operating frequency (for chirp sources) below 22 kHz reach 180 and 160 dB rms re 1 μPa for the sub-bottom profiling source that will be employed. Results will be reported to BOEM and NMFS and made available within five days.

Table notes are at the end of the table.

Table 8 continued

Mitigation Measures	Period Applicable (RI/MA Wind Energy Area)[a]	Summary (RI/MA Wind Energy Area)[a]	Period Applicable (Mid-Atlantic Wind Energy Areas offshore NJ, DE, MD, VA)[b]	Summary (Mid-Atlantic Wind Energy Areas offshore NJ, DE, MD, VA)[b]
Establishment of Exclusion Zone	All except as extended through Yellow Period	**Pile driving:** Commitment to shutting down if a North Atlantic right whale is observed within the 160 dB rms re 1 µPa isopleth around the pile-driving source. This provision should not be construed, however, to modify the visual monitoring requirements established by BOEM.	None	None
Real-time Monitoring Effort	May 15–October 31, for pile driving, and May 15–December 31, sub-bottom profiling	**Sub-bottom profiling**: Provide 2 dedicated, qualified NMFS-approved observers (1 on/1 off) at each sub-bottom profiling site to effectively maintain a steady watch during the course of the sub-bottom profiling. **Pile driving during meteorological tower installation:** Provide a minimum of 4 dedicated, qualified NMFS-approved observers (2 on/2 off, with each observer covering 180 degrees from bow to stern) at each pile-driving site to effectively maintain a steady watch during the course of the pile-driving activity and to provide effective monitoring in all directions around the sound source	May 1—October 31	**Sub-bottom profiling**: Provide 2 dedicated, qualified NMFS-approved observers (1 on/1 off) at each sub-bottom profiling site to effectively maintain a steady watch during the course of the sub-bottom profiling. **Pile driving during meteorological tower installation:** Provide a minimum of 4 dedicated, qualified NMFS-approved observers (2 on/2 off, with each observer covering 180 degrees from bow to stern) at each pile-driving site to effectively maintain a steady watch during the course of the pile-driving activity and to provide for effective monitoring in all directions around the sound source
Real-time Monitoring Effort	January 1–January 31 and May 1–14, the Yellow Period for sub-bottom profiling	**Sub-bottom profiling:** Provide a minimum of 2 dedicated, qualified NMFS-approved observers (1 on/1 off) at each sub-bottom profiling site to effectively maintain a steady watch during the course of the sub-bottom profiling. Four dedicated, qualified NMFS-approved observers (2 on/ 2 off) shall be provided if the source vessel is of sufficient size to accommodate the two additional personnel. Observers employed during the Yellow Period for sub-bottom profiling shall have at least 1 year of experience as professional marine mammal observers or equivalent academic experience. **Visibility for sub-bottom profiling:** Sub-bottom profiling can take place at night if the site-specific risk assessment shows acceptable results during night conditions. If the exclusion zone is obscured by fog, activity must be stopped until the zone is visible for 30 minutes.	March 22–April 30, and November 1–November 22	**Sub-bottom profiling:** Provide a minimum of 2 dedicated, qualified NMFS-approved observers (1 on/1 off) at each sub-bottom profiling site to effectively maintain a steady watch during the course of the sub-bottom profiling. Four dedicated, qualified NMFS-approved observers (2 on/ 2 off) shall be provided if the source vessel is of sufficient size to accommodate the two additional personnel. Observers employed during the Yellow Period shall have at least 1 year of experience as professional marine mammal observers or equivalent academic experience. **Pile driving during meteorological tower installation:** Provide a minimum of 4 dedicated, qualified NMFS-approved observers (2 on/2 off, with each observer covering 180 degrees from bow to stern) at each pile-driving site to effectively maintain a steady watch during the course of the pile-driving activity and to provide effective monitoring in all directions around the sound source. Observers employed during the Yellow Period shall have at least 1 year of experience as professional marine mammal observers or equivalent academic experience. **Visibility:** Sub-bottom profiling can take place at night if the site-specific risk assessment shows acceptable results in night conditions. Pile driving will not take place at night. Developers will not start driving a pile unless, under normal circumstances, the pile can be completed during daylight hours. In the event that a developer begins driving a pile with the plan to achieve full penetration during daylight hours, but a situation arises that jeopardizes pile penetration if the drive is not completed, the developer may continue driving the pile into nighttime hours to protect human health, the environment, or completion of the drive. If the exclusion zone is obscured by fog, no sub-bottom profiling or pile-driving activity, including ramp-up, will be initiated until the exclusion zone is visible for 30 minutes. **Aerial surveys:** During only the March 22–April 30 portion of the Yellow Period: During pile driving, in order to focus effort on detecting right whales as they approach the source on their northward migration, aerial surveys will be conducted on the south side of the acoustic source. During aerial surveys, the developer will maintain a partially extended exclusion zone for North Atlantic right whales, shutting down if any right whale is observed within the smaller of the 120 dB isopleth or 30 km radius around the south side of the source.

Table notes are at the end of the table.

Table 8 continued

Mitigation Measures	Period Applicable (RI/MA Wind Energy Area)[a]	Summary (RI/MA Wind Energy Area)[a]	Period Applicable (Mid-Atlantic Wind Energy Areas offshore NJ, DE, MD, VA)[b]	Summary (Mid-Atlantic Wind Energy Areas offshore NJ, DE, MD, VA)[b]
	May 1–14, the Yellow Period for pile driving	**Pile driving during meteorological tower installation:** Provide a minimum of 4 dedicated, qualified NMFS-approved observers (2 on/2 off, with each observer covering 180 degrees from bow to stern) at each pile-driving site to effectively maintain a steady watch during the course of the pile-driving activity and to provide for effective monitoring in all directions around the sound source. Observers employed during the Yellow Period for pile driving shall have at least 1 year of experience as professional marine mammal observers or equivalent academic experience. **Visibility for pile driving:** Pile driving will not take place at night. Developers will not start driving a pile unless, under normal circumstances, completion of the pile can be achieved during daylight hours. In the event that a developer begins driving a pile with the plan to achieve full penetration during daylight hours, but a situation arises that jeopardizes pile penetration if the drive is not completed, the developer may continue driving the pile into the nighttime hours to protect human health, the environment, or completion of the drive. If the exclusion zone is obscured by fog, no pile-driving activity, including ramp-up, will be initiated until the exclusion zone is visible for 30 minutes. **Additional monitoring for pile driving:** The developer will conduct aerial monitoring and/or real-time passive acoustic monitoring sufficient to detect aggregations of foraging North Atlantic right whales within at least a 20 km radius of the pile-driving source. The developer will maintain an extended exclusion zone for North Atlantic right whales, shutting down if any right whale is observed within the smaller of the 120 dB isopleth or 20 km radius around the source.		
Adaptive Management Review	All Periods	The parties believe that the survey efforts underway in the MA WEA and RI/MA WEA should continue for at least three years in each area. Yearly, or at any time if requested by one of the parties, the parties agree to review the scientific data on North Atlantic right whales that have been collected as part of the above-mentioned survey efforts, along with any other available data, including sightings and information on new technologies or practices that have become available, and the agreed-upon measures may be revised to reflect the new data and information. The parties also reserve their rights to consider again existing technologies or practices, which, although not warranted at the time this agreement was signed, may need to be reconsidered in the view of new data.	All periods	
Other Regulatory Requirements	All periods	In reaching this agreement, the developer and the environmental NGOs are aware that BOEM, NMFS, or other agencies have prescribed additional measures for the protection of North Atlantic right whales and other marine species. In the event of any disagreement between these measures and those prescribed by federal or state agencies, the more protective measures will apply. The parties agree that these mitigation measures will remain in place for at least four years unless revisions are made at any earlier date pursuant to the adaptive management review provision above. After four years, the mitigation measures may also be revised to reflect new information and best practices that have become available. To reiterate, the agreement is only applicable to site characterization and site assessment activities in the RI/MA WEA. It does not apply to any other WEA, including the MA WEA, or project development site. It does not apply to the construction and operations phases, nor does it imply or suggest what measures may be appropriate at the construction and operations phases. Construction and Operations Plans will be subject to a separate environmental review, permitting, and approval process by the federal government.	All periods	We agree that these mitigation measures will remain in place for at least four years. At that time, they may be revised to reflect new information and best practices that have become available. To reiterate, this agreement is only applicable to site characterization and site assessment activities in the mid-Atlantic WEAs. It does not apply to the construction and operations phases, nor does it imply or suggest what measures may be appropriate at the construction and operations phases. Construction and Operations Plans will be subject to a separate environmental review, permitting and approval process by the federal government.

[a] Source: Grybowski et al. 2014

[b] Source: Grybowski et al. 2012

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Appendix A. Data Sources

Sources of data used for density analyses are described in Section A.1. These data sources were used as described in Section 2.1 to generate maps of predicted habitat-based densities of receptor groups within the AoA. Some additional sources of data used to describe known occurrence and distribution of individual species and receptor groups in Appendix B are described in Section A.2. The list in Section A.2 is not exhaustive but provides some of the most significant references for marine mammal and sea turtle occurrence and existing planning efforts in the AoA.

A.1 Data Sources for Density Analysis

Sources of data used to evaluate density of marine mammals and sea turtles in order to determine seasonal distribution in Section 2 of the report are described below.

A.1.1 Duke University Habitat-Based Density Models (Roberts et al. 2015, 2016)

Duke University Habitat-Based Cetacean Density Models (Roberts et al. 2016) combine data from 15 aerial and shipboard surveys covering 895,000 km of trackline in the Western Atlantic over 22 years from 1992 to 2014. Using data across multiple years allows for analysis of rare and cryptic species, for which there would be insufficient data for analysis in any given survey, and smooths interannual variation for a general prediction over time. This modeling assumes relatively similar population sizes and habitat preferences over time. In cases in which data were sufficient, monthly density predictions were made. If data were not sufficient to assess density by month, an average annual estimate was made. The Roberts et al. (2016) models do not include the 2010–2015 Atlantic Marine Mammal Assessment Program for Protected Species (AMAPPS) data (NOAA NEFSC and SEFSC 2010, 2011a, 2012, 2013, 2014, 2015), so as those data represent the latest surveys by NOAA a nd BOEM, they are considered separately. Roberts and his colleagues are adding AMAPPS data to their cetacean models and anticipate new density models that include these data (Roberts 2017). They have provided access to a preliminary density model for seals in water in the Western Atlantic (Roberts et al. 2015). Roberts et al. (2015) provide seasonal density estimates for seals as a group, but Roberts (2017) cautions that the models may overestimate density in some pixels and do not consider distance to known haul-out locations as a co-variate, among other caveats. However, the relative densities predicted across the region provide some insight into potential preferred seasonal habitats for seals based on observations of seals at sea during the same surveys used for cetacean density mapping (total seals observed was 842).

The surveys upon which the Roberts et al. (2015, 2016) models are based include the following, which do not all include the AoA but include the larger EEZ region in which these species occur:

- NEFSC Aerial Surveys 1995–2008.
- NEFSC North Atlantic Right Whale Sighting Survey Harbor Porpoise Survey 1999–1999.
- NEFSC North Atlantic Right Whale Sighting Survey 1999–2013.
- NEFSC Shipboard Surveys 1995–2004.
- NJDEP Aerial Surveys 2008–2009.
- NJDEP Shipboard Surveys 2008–2009.
- SEFSC Atlantic Shipboard Surveys 1992–2005.
- SEFSC Mid Atlantic Tursiops Aerial Surveys 1995–2005.
- SEFSC Southeast Cetacean Aerial Surveys 1992–1995.
- University of North Carolina at Wilmington (UNCW) Cape Hatteras Navy Surveys 2011–2013.
- UNCW Early Marine Mammal Surveys 2002–2002.
- UNCW Jacksonville Navy Surveys 2009–2013.
- UNCW Onslow Navy Surveys 2007–2011.
- UNCW Right Whale Surveys 2005–2008.
- Virginia Aquarium Aerial Surveys 2012–2014.

A.1.2 Navy Operating Area Density Models in OBIS-SEAMAP (Navy 2007)

OBIS-SEAMAP (Halpin et al. 2009) provides density models prepared by the Navy in 2007 (Navy 2007) and updated in 2012 (Navy 2012). The cetacean density estimates are outdated and less comprehensive than the Roberts et al. models prepared by Duke University in 2016. However, the Navy Operating Area Density Estimates models suggest approaches for modeling species of seals, which are not modeled to species by Roberts et al. (2015). Harbor seal and gray seal density was estimated by Navy (2012) using SMRU Ltd. (2012) models that include seasonal dynamic environmental variables using NOAA Fisheries survey data. For other seals found occasionally in the AoA, there were not sufficient sightings to create seasonal or habitat-based models, so basic models using abundance divided by area were used in Navy (2007) and Navy (2012). This approach does not allow for predicting high-density areas of these species. SMRU Ltd. (2012) also cautions that empirical data, such as photo identification, should be used in addition to predicted densities for seals because many of the data did not fit the model approach and had to be excluded.

A.2 Data Sources for Surveys and Tracking

Main sources of survey and tracking data for marine mammals and sea turtles are described below. Other sources were also cited.

A.2.1 State of the World's Sea Turtles Models in OBIS-SEAMAP

Sea turtle tracking data in the AoA presented in State of the World's Sea Turtles (SWOT) model for the U.S. Atlantic coast originate with the Virginia Aquarium (Coyne and Godley 2005; Halpin et al. 2009; Lockhart 2016, 2017a, 2017b; Mansfield 2017). Data represent track logs of telemetered wild-caught and by-caught loggerhead and Kemp's ridley turtles between 2013 and 2015. The goal for the project underlying the data is to compare rehabilitated and wild turtles, develop a fine-scale abundance estimate, and understand how nearshore an offshore population interacts and uses habitat.

A.2.2 Cetacean and Turtle Assessment Program (Rhode Island University 1982)

For 39 months from November 1978 to January 1982, aerial surveys were conducted in the Mid- and North Atlantic with the goal of characterizing marine mammals and sea turtles in the region. This comprehensive report describes sightings and provides maps and abundance estimates. This report remains one of the best integrated descriptions of marine mammal and sea turtle occurrence in the region and is important for comparing with data that are more current.

A.2.3 Atlantic Marine Assessment Program for Protected Species (NOAA NEFSC and SEFSC 2010, 2011a, 2012, 2013, 2014, 2015)

AMAPPS surveys represent the newest available survey data (NOAA NEFSC and SEFSC 2010, 2011a, 2012, 2013, 2014, 2015). AMAPPS survey results as reported in NOAA NEFSC and SEFSC 2010–2015 were reported here relative to sightings in the AoA. AMAPPS data are not yet publicly available aside from what is provided in NOAA NEFSC and SEFSC (2010, 2011a, 2012, 2013, 2014, 2015) and a few resulting reports (e.g., Palka 2012). AMAPPS surveys also included observations of sea turtles. AMAPPS data are more recent than those in Navy (2007) and Roberts et al. (2016) and are not included in those models, so it is useful to consider them in case they indicate any deviations from predicted seasonal habitat use in recent years. Further, the abundance estimates used by NOAA Fisheries for many of the marine mammals in the AoA are based on the 2011 AMAPPS surveys (Palka 2012; Hayes et al. 2017). The AMAPPS aerial surveys in 2015 were designed to include the AoA, and the boundaries of the AoA are included in the maps in this report (NOAA NEFSC and SEFSC 2015). AMAPPS surveys are ongoing.

A.2.4 Remote Marine and Onshore Technology Surveys (Normandeau and APEM 2016, 2017)

New York State is currently supporting fine-scale aerial surveys in the AoA that use high-resolution digital photography to create a baseline of marine wildlife observations to be used to better understand the distribution and use patterns of marine wildlife in the AoA, including marine mammals and sea turtles. Two initial reports that include taxonomic summaries of sightings are available for summer and fall of 2016 (Normandeau and APEM 2016, 2017).

A.2.5 Marine Mammal Stock Assessment Reports (Hayes et al. 2017)

Every year, NOAA Fisheries releases Stock Assessment Reports (SARs) for marine mammals that occur in the U.S. EEZ as required under the 1994 amendments to the MMPA. NOAA Fisheries works with regional offices to develop the technical reports by revising older SARs as new data become available. Not all species' SARs are updated each year; the MMPA requires that NOAA Fisheries revise strategic stocks annually and non-strategic stock at least every three years. These reports must contain specified information such as broadly described geographic range, serious injury and mortality estimates, abundance estimates, stock status, and observed fisheries bycatch. In addition, when possible, the reports determine a minimum population estimate, maximum bet productivity rate, population trend, and an estimate of the potential biological removal (maximum number of animals that may be removed from a marine mammal stock) for each species. Note that the number of SARs changes over time as stocks, and their definitions, shift.

A.2.6 Other Sources for Finer-Scale and/or Older Data and Data Portals

Many sources of sightings for marine mammals and sea turtles are not included; specifically, scientific surveys not included in the models and reports cited in Appendix B, anecdotal reports, informal citizen science opportunistic observations, stranding reports, acoustic monitoring, and newer surveys (e.g., DEC unpublished data—see Schlesinger and Bonacci [2014] and Tetra Tech and Smultea Environmental Sciences [2017]). There have also been prior efforts to assess marine mammal and sea turtle patterns in other potential offshore wind development areas nearby (e.g., Kraus et al. 2016), and data portals have been created to house and serve data (e.g., Mid-Atlantic Ocean Data Portal). These data provide supplemental information to density, distribution, and abundance estimates provided by the data sources described in Appendix A, allowing, in some cases, for finer scale spatial and/or temporal/seasonal evaluation of use patterns. The following list is likely not exhaustive but provides sources of data available on marine mammal and sea turtle observations associated with the AoA. This list is based on sources suggested by stakeholders, though some are not published or publicly available at this time. These data were used and cited as appropriate in Sections 2 through 6 and Appendix B of this Study and are captured here as examples of information in addition to the main sources of distribution, migration patterns, and density described above. Not every possible source can be described in detail in this Study, but the references below are potential sources of data for further analysis of marine mammal and sea turtle use of the AoA. Many of these sources continue to accrue and report on data in the New York Bight.

- **North Atlantic Right Whales.**
  - North Atlantic Right Whale Consortium Database. (http://www.narwc.org/pdf/consortium_database.pdf).
  - NOAA NEFSC Interactive North Atlantic Right Whale Sightings Map (https://www.nefsc.noaa.gov/psb/surveys/).
- **Whales.**
  - DEC Surveys and Acoustic Monitoring for Large Whales (Schlesinger and Bonacci 2014, Tetra Tech and Smultea Sciences 2017).
  - Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles (Kraus et al. 2016; https://www.boem.gov/RI-MA-Whales-Turtles/) (Note that these surveys did not occur in the AoA).
  - Gotham Whale (https://www.gothamwhale.org/).
  - Status Reviews and 5-year reviews of ESA-listed whales.
- **Cetaceans.**
  - Autonomous Real-time Marine Mammal Detections New York Bight Buoy (http://dcs.whoi.edu/nyb0616/nyb0616.shtml) (Baumgartner and Rosenbaum 2016).
  - Cetacean High Use Habitats of the Northeast U.S. Continental Shelf (based on Cetacean and Turtle Assessment Program study sightings by Rhode Island University 1982) (Kenney and Winn 1986).
- **Seals.**
  - Coastal Research and Education Society of Long Island (http://cresli.org/).
  - Riverhead Foundation (http://www.riverheadfoundation.org/researchmethods/).
- **Sea Turtles.**
  - Sea Turtle Stranding Network Database. (https://www.sefsc.noaa.gov/species/turtles/strandings.htm).
  - Status Reviews and 5-year reviews of ESA-listed turtles.
  - Offshore Atlantic Seabird Compendium database, which includes some observations of sea turtles, particularly the opportunistic surveys organized by R. Viet (https://catalog.data.gov/dataset/atlantic-offshore-seabird-dataset-catalog) (see Brown-Saracino et al. 2013).

- **Management and Use Planning.**
  - Rhode Island Ocean Special Area Management Plan Volumes 1 and 2 (Rhode Island Coastal Resources Management Council 2010).
  - Rhode Island Assessment of the Ocean Special Area Management Plan (Mulvaney 2013).
  - Department of the Navy Marine Resources Assessment for the Northeast Operating Areas (Navy 2005).
  - NJDEP Ocean/Wind Power Ecological Baseline Studies (Geo-Marine, Inc. 2010).
  - DEC and DOS New York Ocean Action Plan (2017–2027) (DEC 2017).
  - DOS Offshore Atlantic Ocean Study (DOS 2013).
  - Biodiversity Research Institute Mid-Atlantic Baseline Studies (http://www.briloon.org/mabs/mid-atlantic).
  - Technical Report for the Spatial Characterization of Marine Turtles, Mammals, and Large Pelagic Fish to Support Coastal and Marine Spatial Planning in New York (Lagueux et al. 2010).
  - Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals (NAS 2017).
- **Regulatory Documents.**
  - Final Report on Best Management Practices Workshop for Atlantic Offshore Wind Facilities and Marine Protected Species. March 7–9, 2017. Silver Spring, Maryland. Report pending.
  - BOEM Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New York (BOEM 2016).
  - ESA Section 7 Consultation Biological Opinion for Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf in Massachusetts, Rhode Island, New York and New Jersey Wind Energy Areas (NMFS 2013).
  - New York City Department of Environmental Protection Water Quality Monitoring.
  - U.S. Environmental Protection Agency Helicopter Water Quality Monitoring of the New York Bight (EPA 2005)
  - General.
  - High-resolution Aerial Imaging Surveys of Marine Birds, Mammals, and Turtles (Gordon et al. 2013).
  - Literature Search and Data Synthesis for Marine Mammals and Sea Turtles in the U.S. Atlantic from Maine to the Florida Keys (Waring et al. 2012).
  - Map of New York artificial reef sites (http://www.dec.ny.gov/outdoor/71702.html).
  - DEC Surfclam GIS layers.
- **Data Portals Housing Datasets from Above Studies and/or Other Sources.**
  - Mid-Atlantic Ocean Data Portal (http://portal.midatlanticocean.org).
  - Northeast Ocean Data Portal (http://www.northeastoceandata.org).
  - Marine Cadastre (https://marinecadastre.gov/).
  - DataBasin (www.DataBasin.org).
  - Mid-Atlantic Regional Association Coastal Ocean Observing System (www.maracoos.org).
  - Cetacean and Sound Mapping (http://cetsound.noaa.gov/cetsound).
  - Mid-Atlantic Regional Ocean Assessment (http://roa.midatlanticocean.org/).

A.3 References

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Appendix B. Seasonal and Behavioral Use of the AoA by Marine Mammals and Sea Turtles

General seasonal distribution and use of the AoA by marine mammals and sea turtles is described below. Information about distribution is limited by location and season of data collection. In the AoA itself, relatively comprehensive seasonal surveys took place from 1979 to 1981 (Rhode Island University 1982), and more recently, aerial surveys targeting the AoA occurred in 2015 (NEFSC and SEFSC 2015). The DEC is currently conducting a three-year baseline monitoring study focused on endangered large whale species: humpback, fin, sperm, sei, blue, and North Atlantic right whales. The program employs two methods of surveys: a monthly aerial line transect survey and continuous passive acoustic monitoring. Opportunistically, sea turtles and other cetacean species are also recorded. In addition, Normandeau and APEM (2016, 2017) are conducting thorough seasonal aerial surveys of the AoA using high-resolution digital photography to improve identification and enumeration of marine mammals and sea turtles in the area. See Appendix A for more information about data sources.

For sources in which seasonality data are available, a thorough description of occurrence and migration patterns, as evidenced by surveys over decades, is provided below. Waring et al (2012) also provides detailed descriptions of all marine mammal and sea turtle species in the U.S. Atlantic from Maine to the Florida Keys. When a species is rare or uncommon in the AoA, numbers of sightings and locations of sightings in or near the AoA during different surveys are described, and conclusions are drawn regarding whether species may use the AoA for feeding, breeding, or migration (or more than one of these purposes). For non-migratory common species, any pattern of distribution within the AoA indicated by surveys is described. See Table 2 in Section 2.1.1 for a summary of abundance and distribution information for all species potentially occurring in the AoA. Further, in Section 2.2, density maps from models based on existing survey data are used to estimate hotspots for particular species groups. Density maps assume the use of particular types of habitats by species and are useful for predicting species occurrence based on habitat parameters; however, Sections B.1 to B.3 describe the general distribution and use patterns directly observed during surveys.

B.1 Cetaceans

B.1.1 Mysticetes (Baleen Whales)

Most of the baleen whales in the western North Atlantic exhibit a pattern of using the northern part of their range in spring and summer for feeding and the southern part of their range in fall and winter f or breeding (Leatherwood et al. 1976). The following sections describe general seasonal patterns, occurrence, and use within and near the AoA by mysticetes.

B.1.1.1 Endangered Mysticetes

The following species of Mysticetes found in the AoA are listed as endangered under the ESA: blue (*Balaenoptera musculus musculus*), sei (*B. borealis borealis*), fin (*B. physalus physalus*), and North Atlantic right whales (*Eubalaena glacialis*). Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of endangered baleen whales in the New York Bight. Sightings per unit effort is not the same as predicted density, which uses line-transect theory to evaluate effective strip widths, detection functions, and correction factors for perception and availability biases associated with sightings and effort; however, it provides a visual representation that considers the amount of trackline surveyed relative to the number of sightings. Because of the biases inherent in the ability to observe marine mammals and sea turtles at sea, sightings per unit effort should be considered in the context that sighting rates are affected by parameters like sea state, species behavior, etc. That said, Lagueux et al. (2010) reported that endangered baleen whales exhibited highest sightings per unit effort in the AoA in summer and indicated a relatively large rate of observation across the shelf from the southwestern border up to the Long Island coast in summer. This analysis included humpback whales because they were listed under ESA at that time.

Blue Whale. Blue whales tend to be found north of the AoA (Leatherwood et al. 1976). During surveys conducted in the western North Atlantic from 1979 to 1981, blue whales were observed twice (Rhode Island University 1982). These sightings were approximately 70 miles southeast of Cape Sable, Nova Scotia. Sadove and Cardinale (1993) reported that blue whales were rarely observed in the New York Bight during 15 years of studies and surveys.

More recently, annual surveys by NOAA NEFSC and SEFSC from 2010 to 2015 resulted in three observations of blue whales: one sighting off the Nova Scotian Shelf in late summer of 2010 (NOAA NEFSC and SEFSC 2010), one near the 100 m depth contour off of Massachusetts in summer 2013 (NOAA NEFSC and SEFSC 2013), and one in the same area of the 100 m depth contour off

Massachusetts in spring 2015 (NOAA NEFSC and SEFSC 2015). The SAR for the western North Atlantic blue whale stock cites personal communications from R. Sears describing year-round Canadian distribution (Hayes et al. 2017). Leatherwood et al. (1976) report that blue whales have been observed off Long Island and Ocean City, Maryland, but abundance is greatest further north on the Nova Scotian Banks, the St. Lawrence Gulf, and other northern locations. Roberts et al. (2016) used records of eight sightings in the western North Atlantic over 22 years and 895,000 km of surveys to estimate density of blue whales in the western North Atlantic; three of these sightings were at the latitude of Long Island but well east of the AoA. One blue whale was observed in the AoA on the continental slope in fall 2016 aerial surveys (Normandeau and APEM 2017). No blue whales were observed in the AoA during March, April, May, June, and July 2017 surveys by the DEC (Tetra Tech and Smultea Sciences 2017).

Cornell Lab of Ornithology (2010) monitored vocalizations of baleen whales in the New York Bight February 2008 to March 2009. Blue whales were recorded for short periods in March 2008 and January/February 2009 (detected on 28/258 days). Blue whales were only detected at recorders in the offshore area and not at recorders near Long Island coast and New York Harbor. Blue whales have not been reported in the real-time autonomous recordings in 2016 and 2017 in the New York Bight (Baumgartner et al. 2017).

Given that blue whales are rare in the AoA, this area is unlikely to be an important feeding, breeding, or calving ground for this species.

Fin Whale. Leatherwood et al. (1976) described fin whales as the most widely distributed large whale in the western North Atlantic. They report that fin whales tend to summer from below the latitude of Cape Cod, MA up to the Arctic Circle. They can be found between New York and Bermuda in summer. Fin whales may also approach close to shore, with concentrations between shore and the 1,000-fathom isobaths (Leatherwood et al. 1976). During winter, fin whales may move farther offshore and spread southward as far as Florida and the Greater Antilles offshore, but they are not common in tropical waters (Leatherwood et al. 1976).

Fin whales were the most commonly observed large whales in surveys from 1979 to 1981 (Rhode Island University 1982). The data from these surveys suggested that fin whales have higher abundance off the Delmarva Peninsula in winter and spring, with a shift to higher abundance in New England in summer and fall; however, evidence of migrational shifts elsewhere is lacking. A study conducted by Sadove and Cardinale (1993) in the New York Bight found that fin whales were the most common baleen whale in the region and were typically within 30 miles of land from April through August. They reported that fin whales moved offshore near the 200 m contour during September to early December, but come within 1 mile of eastern Long Island to feed January to March. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that fin whales were across the continental shelf in summer, with lower occurrence in fall, winter, and spring.

More recent data show observations of fin whales in the northeastern part of the AoA near the 50 m depth contour during NOAA NEFSC and SEFSC surveys in late summer of 2010 (NOAA NEFSC and SEFSC 2010), in the southwestern corner of the AoA near the 100 m depth contour in summer of 2013 (NOAA NEFSC and SEFSC 2013), on the eastern side of the AoA near the 100 m depth contour in spring of 2014 (NOAA NEFSC and SEFSC 2014) and winter of 2014/2015 (NOAA NEFSC and SEFSC 2015). The SAR for fin whale provides a map of sightings from 11 surveys from 1995 to 2011 (which includes 2010 and 2011 AMAPPS surveys). This map indicates sightings of fin whales relatively close to shore down through Massachusetts with a tendency to be a little farther offshore south of that area, though sightings were made near the tip of Long Island and in the southern region of the AoA (Hayes et al. 2017). Fin whales were also observed southward down to Cape Hattaras, North Carolina.

Greene et al. (2010) reports the highest sighting rate per unit of effort in the AoA region during spring and summer. Five fin whales were observed in the AoA during aerial surveys in fall 2016, and 10 were observed in the AoA in summer 2016 (Normandeau and APEM 2016, 2017). Six of the summer sightings were on the shelf break, and two were relatively close to Long Island shore; three of the fall sightings were on the break and slope, and one sighting was on the shelf (Normandeau and APEM 2016, 2017). Two fin whales were observed in the AoA during March 2017 surveys by the DEC (Tetra Tech and Smultea Sciences 2017); one sighting was nearshore, the other was near the Hudson Shelf Valley on the shelf. Surveys in April 2017 resulted in no observations of fin whales, but surveys in May 2017 resulted in observations of nine groups totaling 16 fin whales. These observations were mainly near the shelf break and slope, but one sighting was near coastal Long Island (Tetra Tech and Smultea Sciences 2017). Fin whales in May were observed lunge feeding (Tetra Tech and Smultea Sciences 2017). No large whales were observed during June 2017, and one fin whale was observed in July 2017 near the Hudson Canyon.

Fin whales were recorded in the New York Bight from late August through mid-May in 2008 and 2009 (recordings were not made May 17 to August 26), though exact location of vocalizing fin whales is unknown (Morano et al. 2012). Fin whales were identified on all 266 days of recording in the New York Bight. Differences in fin whale vocalizations were noted between the seasons of September to January, coinciding with the winter reproductive season, and March to May (Morano et al. 2012). Cornell Lab of Ornithology (2010) monitored vocalizations of baleen whales in the New York Bight February 2008 to March 2009. Fin whales were recorded on all days of the study (256/256), and were recorded at some point at all 10 buoy locations. They were recorded on 64% and 33% of days at the two buoys nearest shore by Long Island. Cornell Lab of Ornithology (2010) concluded that fin whales likely occur in higher density farther offshore, but they were recorded near-shore as well.

The Woods Hole Oceanographic Institute and Wildlife Conservation Society New York Bight acoustic buoy (deployed June 23, 2016) collects and provides real-time recording data (Baumgartner et al. 2017). Time series data provided on the buoy website (http://dcs.whoi.edu/nyb0616/nyb0616.shtml) show that the majority of detections are of fin whales, with decreased detections April to July. Largest peaks in 2016 were November to March, though September peaks in 2017 were higher than in 2016, suggesting some interannual variation or just general variation resulting from random changes in vocal behavior at any given time. These data support potential year-round occurrence with an increase in vocal activity in fall and winter, which may correspond to the reproductive season as suggested by Morano et al. (2012). Further data continue to be collected via the U.S. Northeast Passive Acoustic Sensing Network (Van Parjs et al. 2015).

There is evidence that New England waters are an important feeding ground for fin whales (Agler et al. 1993), and Hain et al. (1992) reported that calving likely occurs from October to January in the Mid-Atlantic region, though the specific location is unknown. LaBrecque et al. (2015) suggested that an area just east of Long Island off Montauk Point, including a small part of the northeastern section of the AoA, is a biologically important feeding area for fin whales from March to October. Fin whales are seasonally seen during whale watching activities along the Long Island coast, and spatial modeling that considers presence/absence and some environmental co-variates suggests they may prefer certain locations along that coastal stretch (Antunes et al. 2015). These data complement the density predictions of Roberts et al. (2016), particularly in that they include nearshore areas not included in Roberts et al.'s models. Analyses of whale watching data are ongoing, and Ricardo Antunes (Wildlife Conservation Society) and his colleagues are in the process of publishing their results.

Sei Whale. Sei whales tend to be found north of the AoA (Leatherwood et al. 1976), as indicated by the stock designation "Nova Scotia stock" (Hayes et al. 2017). During surveys conducted in the western North Atlantic from 1979 to 1981, three sightings of sei whales in July were just south of Montauk Point and Block Island and there were two "probable" sightings east of the Delmarva Peninsula and east of North Carolina respectively, also in July (Rhode Island University 1982). Feeding sei whales were observed north of the AoA and mainly along the continental shelf edge (Rhode Island University 1982). Sadove and Cardinale (1993) reported that sei whales were seen frequently in the New York Bight in the early 1980s but were infrequently sighted after that time.

More recently, annual surveys by NOAA NEFSC and SEFSC from 2010 to 2015 resulted in sightings of sei whales north of the AoA, with the exception of a sighting of a sei whale in the southeast corner of the AoA near the 2000 m depth contour in winter of 2011 (NOAA NEFSC and SEFSC 2011a) and spring 2014 (NOAA NEFSC and SEFSC 2014) and a sighting in the southeast corner of the AoA near the 100 m depth contour in fall of 2012 (NOAA NEFSC and SEFSC 2012). The SAR for sei whales provides a map of sightings from 10 surveys from 1995 to 2011 (which includes 2010 and 2011 AMAPPS surveys). This map indicates one sighting of sei whales in the southeast corner of the AoA and one near that area, with all other sightings north of the AoA (Hayes et al. 2017). Greene et al. (2010) reports the highest sighting rate per unit of effort in the AoA region during spring and summer. No sei whales were observed in the AoA in fall and summer aerial surveys in 2016 (Normandeau and APEM 2016, 2017). No sei whales were observed in the AoA during March–July 2017 surveys by the DEC (Tetra Tech and Smultea Sciences 2017).

Time series data provided on the website for the Woods Hole Oceanographic Institute and Wildlife Conservation Society New York Bight acoustic buoy show very few detections of sei whales, with most of the detections in April of 2017 (http://dcs.whoi.edu/nyb0616/nyb0616.shtml).

Given that sei whales are uncommon in the AoA, this area is unlikely to be an important feeding, breeding, or calving ground for this species.

North Atlantic Right Whale. Leatherwood et al. (1976) described North Atlantic right whales as potentially historically abundant from the Davis Straits to the Carolinas and extending to Bermuda. The more recent distribution described by Leatherwood et al. (1976) is from Iceland south to Florida, with right whales moving north along the eastern Florida coast from January to March. Right whales pass through New England in spring and reach as far north as Nova Scotia (Leatherwood et al. 1976).

During surveys conducted in the western North Atlantic from 1979 to 1981, North Atlantic right whales were noted to aggregate in spring in the Great South Channel off Massachusetts, with scattered sightings along the coast from North Carolina to Cape Cod and further north (Rhode Island University 1982). Summer sightings were mainly in the Bay of Fundy and Browns Bank (Rhode Island University 1982). Feeding was observed during the 1979–1981 study in regions north of the AoA. This is consistent with Merrick et al. (2001)'s analysis of right whale aggregation areas that could serve as SMAs. Merrick et al. (2001) found that there were core aggregation areas in spring near Cape Cod and Great South Channel and identified additional areas in the Georges Bank/Gulf of Main region where right whales congregate in spring. Rhode Island University (1982) summarizes right whale movements as a wintering period off Georgia and Florida, migration to the Great South Channel area in spring, and migration to Bay of Fundy and Browns Bank in summer, followed by migration in fall to spend winter in the Florida/Georgia region. Such a migratory route would suggest highest concentrations of right whales in the AoA in spring and fall during migrations between more northern feeding grounds and more southern breeding/calving areas. Overall, Rhode Island University (1982) reported a few sightings of right whales on the continental shelf in the AoA, most of which occurred during spring and fall.

Whitt et al.'s (2013) analysis of right whale distribution and seasonal occurrence in nearshore waters off New Jersey found that these waters serve as a migratory corridor between feeding grounds in the northeast and calving grounds in the southeast. Whitt et al. (2013) also found that right whales are present off the New Jersey coast throughout the year and not only during typical migratory periods. Right whales of various age and sex classes (adult females, cow-calf pairs, and juvenile males) use the nearshore waters off the New Jersey coast as part of a right whale migratory corridor. The nearshore waters may also be a feeding habitat for the species. Right whale peak acoustic detections were made in March through June. Sadove and Cardinale (1993) reported that, in the New York Bight, right whales were mainly observed along the south shore of Long Island, with sightings concentrated March through June. They report observations of feeding but conclude that the New York Bight functions mainly as a migratory area for right whales with some opportunistic feeding. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that right whales were mainly absent from the AoA in fall and winter, with concentrations near the southern Long Island coast in spring and summer and additional concentration by the middle of the shelf break near Hudson Canyon in spring.

Knowlton et al. (2002) reported that surveys and tagging studies indicated right whales off New York in February, April, June, August, and September, but there was no detectable pattern of movement past the port of New York.

More recently, annual surveys by NOAA NEFSC and SEFSC from 2010 to 2015 resulted in sightings of right whales north and east of the AoA, with the exception of a sighting in the southeast corner of the AoA near the 100 m depth contour in summer of 2013 (NOAA NEFSC and SEFSC 2013) and a sighting in the northwest area of the AoA in spring of 2014 (NOAA NEFSC and SEFSC 2014). The SAR for North Atlantic right whale in the Western Atlantic provides a map of sightings from NOAA Fisheries surveys conducted from 2007 to 2011 (which includes 2010 and 2011 AMAPPS surveys). This map indicates a sighting in the northeastern corner and one in the northwestern corner of the AoA. Right whale sightings tend to be coastal or on the continental shelf, differentiating them from sei whales, which tend to be near the shelf break and slope, and fin whales, which are distributed across the shelf out to the edges of oceanic waters (2,000 m depth contour). Fin whales and humpback whales have also been reported to frequent and feed in coastal areas of the AoA region (Antunes et al. 2015). Greene et al. (2010) report very low sightings per unit effort in the AoA in winter and effectively zero sightings per unit effort in other seasons. No right whales were observed in the AoA in fall and summer aerial surveys in 2016 (Normandeau and APEM 2016, 2017). Two groups totaling three right whales were observed in the AoA during March 2017 surveys by the DEC (Tetra Tech and Smultea Sciences 2017); one group was at the shelf break and one was on the shelf closer to the break than to shore. In April 2017, three groups totaling five right whales were observed in continental shelf waters, and none were observed in May, June, and July 2017 (Tetra Tech and Smultea Sciences 2017).

In addition to surveys, North Atlantic right whales have been tracked with satellite tags into the AoA (e.g., Baumgartner and Mate 2005). Cornell Lab of Ornithology (2010) monitored vocalizations of baleen whales in the New York Bight February 2008 to March 2009. North Atlantic right whales were recorded on 53 of 258 days (21%), with most detections occurring in spring. Detections at the New York Harbor buoys were relatively rare compared to buoys off Long Island. Davis et al. (2017) reported on acoustic recordings of North Atlantic right whales from 324 recorders along the U.S. East Coast, including several recorders in the New York Bight, from 2004 to 2014. This study suggested that North Atlantic right whales are present year-round throughout their range. This study also concludes that North Atlantic right whales have shifted their distribution from a heavy reliance on northern grounds, like the Bay of Fundy, to spending more time in the Mid-Atlantic region. In addition, the

Woods Hole Oceanographic Institute and Wildlife Conservation Society New York Bight acoustic buoy shows that right whale vocalizations were detected mainly October to January with a small additional peak in March (Baumgartner et al. 2017).

Pace et al. (2017) reported that photo-identification data indicate a 99.99% probability that the North Atlantic right whale population declined about 1% per year from 2010 to 2015, despite increases in population of about 2.8% per year from 1990 to 2010. Overall, males declined just under 4% and females approximately 7% from 2010 to 2015.

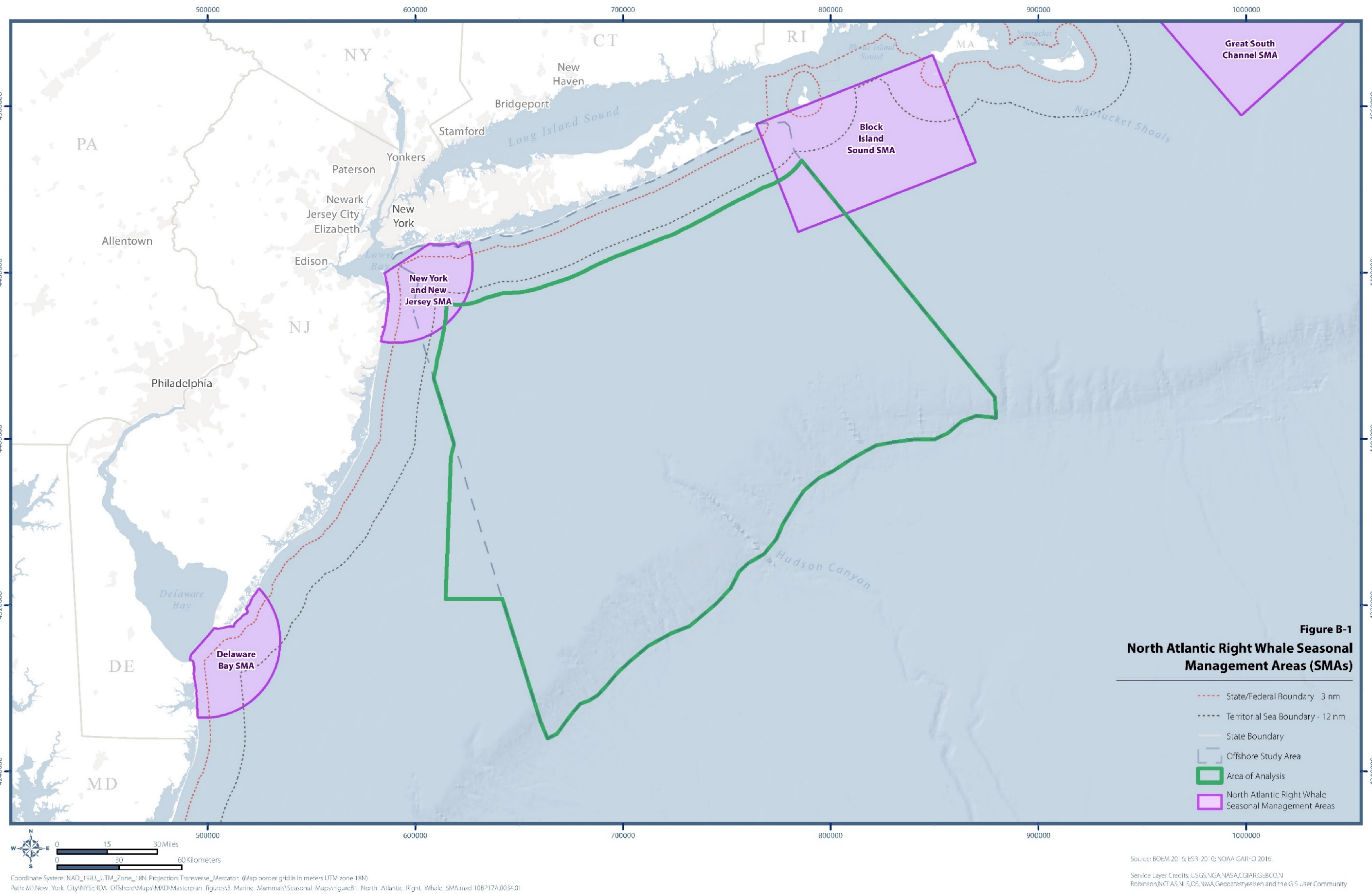
There is an SMA for North Atlantic right whales November 1 to April 30 in the AoA to protect migrating whales in the area (Figure B-1). This SMA covers the ports of New York and New Jersey and so is in the northwest corner of the AoA; it is drawn as a 20-nautical-mile-radius circle around 40º29'42.2"N, 073º55'57.6"W (excluding land). Given the seasonal distribution of North Atlantic right whales, the AoA is likely part of the migratory corridor between feeding and breeding areas. LaBrecque et al. (2015) describe a migratory BIA for North Atlantic right whales along the U.S. East Coast, including the entire AoA, in November and December and in March and April.

B.1.1.2 Other Mysticetes

Aside from endangered blue, fin, sei, and North Atlantic right whales, minke (*Balaenoptera acutorostrata*) and humpback (*Megaptera novaeangliae*) whales are also found in the AoA. Humpback whales were split into 14 DPSs under the ESA in 2016, and the West Indies DPS was not listed (81 FR 62260). This DPS corresponds to the Gulf of Maine humpback whale stock managed under the MMPA, so humpback whales in the AoA are no longer listed under the ESA. Minke whales are also not listed. Bryde's whales have been observed extremely rarely in the Western Atlantic, and the species is assumed to be absent north of the Gulf Stream (including the AoA) in density models developed by Roberts et al. (2016). NOAA Fisheries has not developed an SAR for this species in the region (Hayes et al. 2017).

Figure B-1. North Atlantic Right Whale Seasonal Management Areas (SMAs).

Source: BOEM 2016; ESRI 2010; NOAA GAR-O 2016



Humpback Whale. Humpback whales are widely distributed in the Atlantic, ranging from Iceland and Greenland south to Venezuela and the islands of the West Indies (Leatherwood et al. 1976). Humpback whales are managed as a feeding stock in the Gulf of Maine under the MMPA (Hayes et al. 2017) and as a breeding population in the West Indies under the ESA (81 FR 62260). In summer, humpback whales are found in the northern parts of their range at least from New England north to the pack ice, with concentrations of feeding in these northern regions (Leatherwood et al. 1976). In winter, humpback whales migrate south to areas like Bermuda, the Bahamas, and the West Indies to breed and calve (Leatherwood et al. 1976). During surveys conducted in the western North Atlantic from 1979 to 1981, humpback whales were regularly observed north of the AoA (Rhode Island University 1982).

In the AoA, sightings from 1979 to 1981 included small concentrations of feeding humpback whales east and southeast of Montauk Point, Long Island in spring and summer. Rhode Island University (1982) reported that, in general, humpback whales were observed commonly in shallower, inshore areas, and feeding was typically observed during spring and summer, with very few whales observed in winter. A study conducted by Sadove and Cardinale (1993) in the New York Bight found that humpback whale abundance fluctuated annually. They observed humpbacks in shallow bays, along the southern shore of Long Island, and into New York Harbor, with greatest abundance in June to September. Sadove and Cardinale (1993) report feeding activity by humpback whales, including during December and January. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that humpback whales have hotspots along the continental slope, with additional occurrence on the shelf. Most sightings occurred in the AoA in spring, and most sightings in fall were concentrated near the southern Long Island coast.

Humpback whales are seasonally seen during whale watching activities along the Long Island coast, and spatial modeling that considers presence/absence and some environmental co-variates suggests they may prefer certain locations along that coastal stretch (Antunes et al. 2015). These data complement the density predictions of Roberts et al. (2016), particularly in that they include nearshore areas not included in Roberts et al.'s models. Analyses of whale watching data are ongoing, and Ricardo Antunes (Wildlife Conservation Society) and his colleagues are in the process of publishing their results. Sieswerda et al. (n.d.) anecdotally reported that Gotham Whale has identified 19 humpback whales, with re-sightings from known Gulf of Maine whales since 2011 in the New York Bight. Sightings occurred between June and November, and feeding was documented during some sightings, though whether this feeding has been observed in all or only some months is not specified (Sieswerda et al. n.d.).

More recent annual surveys conducted by NOAA NEFSC and SEFSC from 2010 to 2015, resulted in no sightings of humpback whales within the AoA (NOAA NEFSC and SEFSC 2011a, 2012, 2013, 2014, 2015). The SAR for humpback whales in the Gulf of Maine stock provides a map of sightings from 10 NOAA Fisheries surveys conducted from 1995 to 2011 (which includes 2010 and 2011 AMAPPS surveys). This map indicates a sighting in the southwestern corner of the AoA and shows humpback whale sightings in the Mid-Atlantic to be mainly along the continental shelf break. Greene et al. (2010) report very few sightings per unit effort in the AoA in summer and fall and effectively zero sightings per unit effort in other seasons. One humpback whale was observed in the AoA in fall and another in summer aerial surveys in 2016 (Normandeau and APEM 2016, 2017). Two groups totaling three humpback whales were observed in the AoA during March 2017 surveys by the DEC (Tetra Tech and Smultea Sciences 2017); one group was near the coast and one was at the shelf break. In April 2017, one humpback was observed on the shelf; in May 2017, five groups totaling six humpbacks were observed spread along the outer-shelf near the break; none was observed in June and July 2017 (Tetra Tech and Smultea Sciences 2017).

Time series data provided on the Woods Hole Oceanographic Institute and Wildlife Conservation Society New York Bight acoustic buoy website (http://dcs.whoi.edu/nyb0616/nyb0616.shtml) shows that humpback whales were detected mainly from March to June, though there were a few detections in October 2017. This potentially corresponds to migration in the AoA.

Given the seasonal distribution of humpback whales, it is possible feeding near Montauk Point may extend into the AoA, but humpback whales likely use most of the AoA as a migratory area or migrate further offshore than the AoA to travel between areas north of the AoA and their breeding grounds in tropical islands in the south. LaBrecque et al. (2015) did not suggest that a BIA exists in or near the AoA; a feeding BIA is described north of the AoA.

Minke Whale. Leatherwood et al. (1976) reported that minke whales range from polar to tropical waters in the North Atlantic, though they are most abundant in colder waters north of New York State. Leatherwood et al. (1976) noted that this species often approaches close to shore and enters river mouths, inlets, and estuaries but is also found in deep, oceanic waters. During surveys performed in the western North Atlantic from 1979 to 1981, minke whales were observed in the AoA in spring and summer, with reduced presence in fall, and were mainly absent in winter (Rhode Island University 1982). In the AoA, sightings from 1979 to 1981 tended to be on the continental shelf, with the highest concentration of observations in an area extending from Montauk Point northward in a “U” shape. In three years, there was only one sighting in the fall and none in winter that were south of Long Island. Rhode Island University (1982) reported that feeding was typically observed inside the 100 m contour. Near the AoA, feeding was observed east of Montauk Point. Sadove and Cardinale (1993) reported that minke whales were the second most abundant baleen whale in the New York Bight, occurring year-round with a peak in summer. This report stated that minke whales tended to be found within 30 miles of the coast, mainly on the continental shelf. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that minke whales were observed less often in fall and winter, with hotspots near the shelf break and slope in spring and summer, but occurrence across the continental shelf in spring shifting further offshore in summer.

More recent annual surveys by NOAA NEFSC and SEFSC from 2010 to 2015 resulted in no sightings of minke whales within the AoA from 2010 to 2014, but there were three sightings in the southeastern part of the AoA on the continental slope in spring of 2014 (NOAA NEFSC and SEFSC 2014). The SAR for minke whales in the Canadian Eastern Coastal stock provides a map of sightings from ten NOAA Fisheries surveys conducted from 1995 to 2011 (which includes 2010 and 2011 AMAPPS surveys) and a survey conducted in Canadian waters in 2007. This map indicates that most sightings of minke whales are north of the AoA, but a small number of sightings occurred on the southeastern edge of the AoA on the continental slope and on the western side of the AoA on the continental shelf (Hayes et al. 2017). Greene et al. (2010) reports very low sightings per unit of effort in the AoA in spring and summer and effectively zero sightings per unit effort in other seasons. One minke whale was observed in the AoA in summer aerial surveys in 2016 (Normandeau and APEM 2016). Three minke whales were observed in the AoA during March 2017 surveys by the DEC (Tetra Tech and Smultea Sciences 2017); one was on the continental slope, and the other two were near the Hudson Valley on the shelf. None was observed in April 2017; one was observed in May 2017 offshore of the eastern tip of Long Island; and in July 2017, one was observed on the continental slope (Tetra Tech and Smultea Sciences 2017).

Risch et al. (2014) analyzed data from acoustic recordings in 2004, 2005, and 2008 through 2012 from 16 sites in the North Atlantic, including a site near Long Island. The Long Island recordings suggested that minke whales were present mainly in the southeastern area of the AoA near the shelf break. Frequency of recordings during seasons supported the visual data, indicating that minke whales occur in the northern part of their range in the summer with decreases in detections north of 40^{o} latitude (about the middle of the AoA) in fall and increases in detections further south in winter with movement back toward the north in spring (Risch et al. 2014). Risch et al. (2014) stated that one of the most surprising results of their study was the relative lack of detections near New York in the fall. Given the seasonal distribution of minke whales, it is possible feeding near Montauk Point may extend into the AoA, but minke whales likely use most of the AoA as a migratory area or migrate further offshore than the AoA to travel between areas north of the AoA and their breeding grounds in the south. LaBrecque et al. (2015) did not suggest a BIA exists in or near the AoA; a feeding BIA is described north and to the east of the AoA.

B.1.2 Odontocetes (Toothed Whales)

In addition to baleen whales, toothed whales occur in the AoA. These include sperm whales (*Physeter macrocephalus*), dwarf and pygmy sperm whales (*Kogia* spp.), dolphins (Delphinidae), harbor porpoise (*Phocoena phocoena*), and beaked whales (*Mespolodon* spp. and *Ziphius cavirostris*). Some of these species exhibit some seasonal shifts in distribution, but most are found year-round in the AoA.

B.1.2.1 Endangered Odontocetes (Toothed Whales)

Sperm whales are found in the AoA and are listed as endangered under the ESA.

Sperm Whale. Sperm whales range widely in the oceanic regions of the North Atlantic from Venezuela to at least the Davis Straits (Leatherwood et al. 1976). Distribution differs between adult males and females/immature males, with adult males ranging farther north (Leatherwood et al. 1976). Migration for males and females is northward in spring to summer and southward to temperate and tropical areas in fall to winter (Leatherwood et al. 1976). Rhode Island University (1982) reported that surveys conducted from 1979 to 1981 indicated that sperm whales occur in continental shelf waters south of New England in spring, summer, and fall. The main distribution of sperm whales is along the shelf break/slope and oceanic waters, concentrating at approximately 1,000 m depth; however, sperm whales have been observed inshore of the 100-m depth contour in an area south of Block Island, Martha’s Vineyard, and Nantucket from May to November (Rhode Island University 1982).

A study conducted by Sadove and Cardinale (1993) in the New York Bight found that sperm whales were also seen regularly south of Montauk Point in less than 18 m of water May to June and again in October. Kenney and Winn (1986) found that sperm whales are one of the primary species of the continental shelf edge. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that highest occurrence of sperm whales was on the slope and in oceanic waters, with some increased observations in the AoA in summer.

Although there is a southward shift in distribution in winter, sperm whales may occur in the AoA year-round with highest concentration likely in summer at the shelf break and beyond, though observations in the AoA itself are rarely reported based on a review of survey sightings over the last several decades (Rhode Island University 1982; Greene et al. 2010; NEFSC and SEFSC 2010, 2011a, 2012, 2013, 2014, 2015; Hayes et al. 2017). Feeding was not commonly observed by Rhode Island University (1982), but the peak in summer and the year-round presence suggests the slope and oceanic areas of the AoA may include feeding areas for sperm whales. In surveys conducted in fall and summer of 2016 in the AoA, one sperm whale was observed on the continental slope in fall (Normandeau and APEM 2016, 2017). One sperm whale was observed in the AoA during March, 2017 surveys by the DEC (Tetra Tech and Smultea Sciences 2017); this whale was on the continental slope. No sperm whales were observed in April, May, and June 2017 surveys, but three individuals were observed on the slope during July 2017 surveys (Tetra Tech and Smultea Sciences 2017).

B.1.2.2 Other Odontocetes (Toothed Whales)

In addition to endangered sperm whales, a variety of dolphins, pygmy and dwarf sperm whales, beaked whales, and harbor porpoise are found in the AoA.

Pygmy and Dwarf Sperm Whales. Generally, pygmy and dwarf sperm whales are difficult to observe and to distinguish at sea (Bloodworth and Odell 2008). Because of this, stock assessments combine the two species for management purposes (Hayes et al. 2017). There was only one sighting of a pygmy sperm whale during surveys conducted from 1979 to 1981; this sighting was in the southern part of the AoA in 2,560 m of water (Rhode Island University 1982). Sadove and Cardinale (1993) reported few sightings in the New York Bight, with those that occurred near significant features like Hudson Canyon; however, they noted that pygmy sperm whales strand relatively often comparative to the few observations of live animals. The SARs for pygmy and dwarf sperm whales in the Western North Atlantic stocks provide a map of sightings from NOAA Fisheries surveys conducted in 2004 and 2011. This map indicates most sightings of pygmy and dwarf sperm whales are along the continental slope and in oceanic waters (Hayes et al. 2017).

There can be difficulty in detecting these species in aerial surveys, which are the type of survey typically conducted over the continental shelf. The density models provided in Roberts et al. (2016) assumed these species are not present on the continental shelf. However, there were no vessel surveys on the shelf in the AoA or on the shelf north of the AoA to about 43.5ºN used in the model, so the assumption that pygmy and dwarf sperm whales are not present on the shelf in that region is predicated on their lack of use of the shelf elsewhere. Because pygmy and dwarf sperm whales are cryptic (i.e., hard to see), with quiet surface behavior and small groups (e.g., mean group size was 1.9 based on data from NOAA NEFSC and SEFSC 2011a, 2012, 2013, 2014), their distribution and use of shelf waters in the AoA is unlikely to be determined using aerial survey techniques. Sightings in the NOAA NEFSC and SEFSC surveys occurred during vessel surveys from 2011 to 2014 and place dwarf and pygmy sperm whales in deep water. The data described above suggest that pygmy and dwarf sperm whales are most likely found mainly on the continental slope and oceanic waters, which are on the southwestern side of the AoA. Based on these patterns, pygmy and dwarf sperm whales are found year-round in the slope and oceanic areas of the AoA and may feed and breed within that area of the AoA. No pygmy or dwarf sperm whales were observed in surveys of the AoA in summer and fall of 2016 (Normandeau and APEM 2016, 2017).

Beaked Whales. Generally, beaked whales prefer deep-water habitats (e.g., MacLeod and Zuur 2005) and can dive for over an hour to depths greater than 1,400 m (Baird et al. 2006). Because they spend little time at the surface, they can be difficult to detect in surveys, particularly aerial surveys. *Mesoplodon* species are often lumped together because they are difficult to distinguish at sea, and in the SARs (Hayes et al. 2017) and Roberts et al. (2016) models, Mespolodonts and Cuvier's beaked whale (*Ziphius cavirostris*) are combined for abundance and density estimates. The northern bottlenose whale is also in the family of beaked whales, but this species appears to be extremely rare, with only four sightings in 895,000 km of surveys used in Roberts et al. (2016). In surveys conducted from 1979 to 1981, there were 15 sightings of Mesoplodont beaked whales, with two occurring within the AoA on the continental slope. All sightings during these surveys were in slope and oceanic waters. Cuvier's beaked whales were observed six times and bottlenose whales were sighted twice during these surveys. These species of beaked whales were also seen mainly along the slope and oceanic area, with one sighting of Cuvier's and one sighting of bottlenose whales in the AoA (Rhode Island University 1982).

The SARs for Mesoplodont and Cuvier's beaked whales in the Western North Atlantic stocks show a map of sightings for 10 surveys conducted from 1995 to 2011. This map indicates that Mesopldont and Cuvier's beaked whales were mainly observed on the slope and in oceanic waters during these surveys as well; however, some were observed on the shelf, with one of those shelf sightings just off the coast of

Long Island in the AoA (Hayes et al. 2017). A map of six aerial surveys from 1998 to 2007 appears in the SAR for bottlenose whales. Bottlenose whales were sighted infrequently and mainly in deep water (Hayes et al. 2017). Like pygmy and dwarf sperm whales, beaked whale behavior makes them difficult to detect, particularly in aerial surveys, so their occurrence on the shelf may be higher than surveys suggest. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested beaked whales were mainly found on the slope and in oceanic waters. However, there is a small hotspot in the middle of the shelf in the AoA in fall. Given the rarity of observations of these species, the identification of the hotspot could be based on a single sighting, which may not indicate higher risk in that location of the shelf.

Beaked whales were also observed in all seasons during the NOAA NEFSC and SEFSC 2010–2015 surveys, mainly in slope and oceanic waters, including deep waters of the AoA (NOAA NEFSC and SEFSC 2010, 2011a, 2012, 2013, 2014, 2015). During surveys in late summer of 2010, a beaked whale sighting occurred in approximately 50 m of water off the tip of Long Island in the AoA. Based on these patterns, beaked whales are found year-round in the slope and oceanic areas of the AoA and may feed and breed within that area of the AoA. In surveys of the AoA in summer and fall 2016, 12 beaked whales were observed (Normandeau and APEM 2016, 2017).

Dolphins. Dolphins are a diverse group of marine mammals. There are 20 species of the family Delphinidae (the dolphins) that may occur in the AoA, but nine of those species are extremely rare in the AoA (see Table 2 in Section 2.1.1), as indicated by a lack of sightings during survey efforts in the Western Atlantic (see Hayes et al. 2017, Roberts et al. 2016). Dolphin species do not typically exhibit the extreme migrations of baleen whales, but some species do have seasonal shifts in distribution, possibly associated with shifts in prey species. For example, pilot whales tend to move northward along the continental slope in late winter and spring, with distribution more widespread throughout the shelf in late summer and fall; from May to December long- and short-finned pilot whales (*Globicephala melas* and *G. macrorhynchus* respectively) form two distinct northward clusters in the Great South Channel/Georges Bank area and the Mid-Atlantic, south of 38°30'N respectively (Payne and Heinemann 1993).

Sadove and Cardinale (1993) reported that pilot whales in the New York Bight were distributed in two bands: one inshore band at 30 to 40 fathoms, and one offshore band along the 100-fathom contour at Hudson Canyon, the Dip and Block Canyon. They reported a peak in pilot whales in spring, with few in summer, and a shift to the offshore band area in fall. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that pilot whales were most commonly observed in the AoA in spring, with concentrations mainly along the southeastern and northeastern borders of the AoA but spreading onto the mid-shelf area. One group of 40 long-finned pilot whales was observed on the slope in July during surveys from March to July 2017 (Tetra Tech and Smultea Sciences 2017).

A critical review of short-beaked common dolphin (*Delphinus delphis*) reports concluded that this species is found primarily from North Carolina northward and shifts its distribution onto the Scotian Shelf in summer to fall (Jefferson et al. 2009), suggesting a reduction in occurrence in the AoA during that time of year. In surveys from March to July 2017, common dolphins were observed on the shelf and slope in May, June, and July, with a tendency to be observed more commonly on the shelf than the slope in July. (Tetra Tech and Smultea Sciences 2017). Sadove and Cardinale (1993) reported that common dolphins in the New York Bight were present mainly in depths of greater than 10 m with closest approach to shore March to June and affinity for submarine canyons. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that common dolphins tend to be observed near the shelf break and slope in spring and summer, with more diffuse sightings in fall and winter on the shelf.

Risso's dolphins (*Grampus griseus*) show a tendency for concentration of their range into the Mid-Atlantic Bight (which includes the AoA) in winter, with broader distribution in other seasons (Rhode Island University 1982). Sadove and Cardinale (1993) reported year-round presence of Risso's dolphins in the New York Bight, with a preference for deep water (>50 m), though occasional sightings in Long Island Sound and bays of Long Island. They also reported that Risso's dolphins tended to be observed around submarine features, such as Hudson and Block Canyons. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that Risso's dolphins mainly occur in shelf break and slope waters, but sightings occurred on the shelf as well, with most sightings per unit effort in summer and fall. Tetra Tech and Smultea Sciences (2017) reported 10 sightings totaling 41 Risso's dolphins on the continental slope of the AoA during aerial surveys in March 2017. In April 2017, 16 groups totaling 135 individuals were observed, mainly on the slope and over Hudson Canyon. In May 2017, seven groups totaling 15 individuals were observed on the slope. In June 2017, three groups totaling 14 individuals were observed on and near the slope. In July 2017, 21 groups totaling 176 individuals were observed on the shelf break and slope (Tetra Tech and Smultea Sciences 2017).

Rhode Island University (1982) concluded that striped dolphins (*Stenella coeruleoalba*) are found year-round in the Mid-Atlantic Bight, but there is a concentration of this species along the shelf edge in that region in spring. No striped dolphins were specifically observed in surveys from March to July 2017, though unidentified *Stenella* sightings occurred in March and April (Tetra Tech and Smultea Sciences 2017). Sadove and Cardinale (1993) recorded striped dolphins in late winter and early spring in deep water (>100 m). Sadove and Cardinale (1993) described spotted dolphins as seasonal in the New York Bight, occurring mainly in late spring and summer, with shallow water observations mainly south of Montauk Point and the Hudson Canyon shelf. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that striped dolphins were mainly absent from the AoA, with highest occurrence along deep slope and oceanic waters in summer.

Offshore bottlenose dolphins (*Tursiops truncatus truncatus*) tend to shift southward in winter out of the AoA (Rhode Island University 1982). A corresponding increase in bottlenose dolphins was documented in areas of North Carolina in winter, providing further evidence of a southward shift in winter (Torres et al. 2005). Sadove and Cardinale (1993) reported that bottlenose dolphins were common in waters near Long Island. Five groups totaling 47 bottlenose dolphins were observed in coastal waters in July during aerial surveys March to July 2017 (Tetra Tech and Smultea Sciences 2017). Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that offshore bottlenose dolphins were concentrated along the shelf break and slope of the AoA, with some decrease in occurrence in winter.

Pilot whales, short-beaked common dolphins, Risso's dolphins, striped dolphins, and offshore bottlenose dolphins are the most common delphinid species in the AoA, though their distribution differs spatially across the area (See Table 2 in Section 2.1.1). The species of dolphins identified thus far in ongoing surveys of the AoA by Normandeau and APEM (2016, 2017) are striped dolphins, pilot whales, common bottlenose dolphins, Risso's dolphins, and short-beaked common dolphins, further supporting the general conclusion that these species are the most common delphinids in the AoA based on the larger-scale, lower-resolution studies described above. Sadove and Cardinale (1993) also reported that Atlantic white-sided dolphins were common in the New York Bight year-round, with a peak from March to July and a tendency to prefer less than 70 m of water, though they are also observed near submarine canyons. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data s uggested that white-sided dolphins are mainly seen in slope and northeastern areas of the AoA, with declines in occurrence in summer and fall.

Sadove and Cardinale (1993) reported that presence of white-beaked dolphins in the New York Bight tends to fluctuate annually, with the species generally seen on the shelf in winter and spring when present. This species highest concentrations are found north of the AoA, and NOAA surveys have rarely observed them south of about 40.5ºN (Hayes et al. 2017). Killer whales are rare in the New York Bight (Sadove and Cardinale 1993) and larger east coast EEZ (Hayes et al. 2017).

Harbor Porpoise. Harbor porpoise in the AoA are part of a stock described as the Gulf of Maine/Bay of Fundy stock, indicative of their northern distribution (Hayes et al. 2017). Rhode Island University (1982) reported that harbor porpoise distribution shifts from spring to summer, with numerous sightings east and southeast of Cape Cod in spring, with high occurrence in the northern Gulf of Maine and at the entrance to the Bay of Fundy. However, in summer, harbor porpoise continue to frequent the northern Gulf of Maine but are mainly absent from the western Gulf of Maine and Cape Cod. Reduced observations of harbor porpoise in the winter in the Mid- and North-Atlantic led Rhode Island University (1982) to speculate that the population may shift south in winter. During the Rhode Island University (1982) study, harbor porpoise were only observed within the AoA in spring. Sadove and Cardinale (1993) reported that observations of harbor porpoise in the New York Bight were mainly from December to June. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that harbor porpoise were present across the continental shelf in spring, with lower occurrence in summer, fall, and winter. More recent annual surveys by NOAA NEFSC and SEFSC from 2010 to 2015 resulted in four sightings of harbor porpoise within the AoA and several sightings in Long Island Sound in winter of 2011; harbor porpoise were concentrated much farther north above 42ºN in summer surveys in the same year (NEFSC and SEFSC 2011a). Harbor porpoise were observed east of the AoA in spring and fall of 2012 and spring of 2014 (NEFSC and SEFSC 2012, 2014). Harbor porpoise tend to be observed in coastal or continental shelf areas, but there was an observation of a harbor porpoise on the continental slope in summer of 2013 (NEFSC and SEFSC 2013). Two sightings of harbor porpoise also occurred off the southern tip of New Jersey in spring of 2014 (NEFSC and SEFSC 2014). The SAR for harbor porpoise in the Gulf of Maine/Bay of Fundy stock provides a map of sightings from ten NOAA Fisheries surveys conducted from 1995 to 2011 (which includes 2010 and 2011 AMAPPS surveys) and a survey conducted in Canadian waters in 2007. No observation of harbor porpoises are noted in the AoA on this map (Hayes et al. 2017). Without attribution, Hayes et al. (2017) reports that harbor porpoise are widely dispersed from New Jersey to Maine in fall and spring, and lower densities are found off New York in winter. Four harbor porpoise were observed in the AoA during fall but not during summer surveys in 2016 (Normandeau and APEM 2016, 2017).

B.2 Seals

In addition to cetaceans, seals occur in the AoA. The most common species of seal in and near the AoA are harbor seals (Hayes et al. 2017). Gray seals also occur in the region, and harp seals have been observed and stranded as far south as New Jersey more often in recent years (RFMRP 2014; Hayes et al. 2017). Roberts et al. (2015) models predicted relative densities for seals in the AoA region, but densities of seals in water can be difficult to evaluate, in part, because these species also spend time on land. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of seals in the New York Bight. They reported that these data suggested that seals were sighted mainly near the southern Long Island coast, with no sightings in the AoA in fall. Summer sightings were further north than spring and winter sightings.

Harbor Seals. Based on observations of harbor seals (*Phoca vitulina concolor*) during surveys from 1995 to 2011, maps provided in Hayes et al. (2017) indicate that harbor seals occur in coastal areas in and near the AoA from September to May. Sadove and Cardinale (1993) reported harbor seal occurrence in the Long Island region year-round, with largest numbers November to May. Payne and Schneider (1984) studied harbor seal occurrence at Stage Point, Massachusetts. They describe harbor seals as present from late October to May, moving north to Maine for the pupping season, which occurs mid-May to mid-June. Hayes et al. (2017) reported that anecdotal reports suggest that harbor seals may also pup at some high-use areas off Manomet, MA. Sadove and Cardinale (1993) report four pupping events at Fishers Island, Great Gull Island, and Wading River Creek. Harbor seal use of the region that includes the AoA is seasonal, with increasing numbers from October to March and a peak in mid-March (Hoover et al. 2013). Occurrences may be increasing specifically in New York waters, given increased numbers of stranded animals and increases in observations during aerial, ship, and land-based surveys (DiGiovanni et al. 2015). Harbor seals have stranded along the New York and New Jersey coasts in recent years. Between 2010 and 2014, 70 harbor seals stranded in New York and 44 stranded in New Jersey (Hayes et al. 2017). During 2013, 17 harbor seals stranded along the Long Island coast, mainly on the southern side of Long Island (RFMRP 2014).

The Riverhead Foundation for Marine Research and Preservation (RFMRP) (2017) describes its research on seals in New York, Rhode Island, and Connecticut. Seal haul outs studied by this group in New York include Shinnecock, Montauk, Fisheries Island, and Gull Islands (RFMRP 2017). The RFMRP conducted 77 aerial surveys for seals in New York from 2001 to 2015 and tagged 28 harbor seals that were rehabilitated and released in New York waters (DiGiovanni et al. 2015). The RFMRP website provides links to see tracks of individual seals, but no comprehensive analysis of tracking and/or aerial surveys appear to be available. Another group observing seals in the New York region is the Coastal Research and Education Society of Long Island, Inc. (CRESLI). This organization monitors s eals at Cupsogue Beach and reports that this haul-out site has a catalog of 179 identifiable harbor seals as of May 2017 (CRESLI 2017a). Data collected opportunistically at Cupsogue Beach from 2002 to 2016 do not include any sightings of seals between May 25 and November 11 in any year.

Surveys for seals are typically conducted at haul-out or rookery sites on land, and counts are used to evaluate trends or can be extrapolated with corrections for seals in water to help evaluate local abundances (see Hayes et al. 2017 for examples). However, seals can be observed at sea.

Recent annual surveys conducted by NOAA NEFSC and SEFSC from 2010 to 2015 resulted in one sighting of unidentified seals within the AoA in winter of 2011; more unidentified seals observed in Long Island Sound (NEFSC and SEFSC 2011a); one sighting of harbor seals in Long Island Sound in fall of 2012 (NEFSC and SEFSC 2012); and one sighting of an unidentified seal in the Sound in winter of 2015 (NEFSC and SEFSC 2015). NOAA NEFSC and SEFSC (2011a, 2012) reported that telemetry and abundance surveys from Maine to Massachusetts would result in updated harbor seal abundance estimates and more information about habitat preferences. Abundance estimates in Western North Atlantic have been updated to reflect these data (Hayes et al. 2017). During more recent aerial surveys, 14 unidentified seals were observed in the AoA in fall of 2016 and none were observed in summer of 2016 (Normandeau and APEM 2016, 2017).

Gray Seals. Based on observations of gray seals (*Halichoerus grypus*) during surveys from 1995 to 2011, maps provided in Hayes et al. (2017) indicate that gray seals occur in coastal areas in and near the AoA from September to May. Sadove and Cardinale (1993) reported gray seals appearing in the New York Bight in January and remaining through April, with a peak in February and March. Gray seals pup in areas north of the AoA in winter (Wood et al. 2007); however, CRESLI (n.d.) reported that there is a probable gray seal rookery on Little Gull Island in Long Island Sound. Harbor seal use of the region that includes the AoA is seasonal, with increasing numbers from October to March and a peak in mid-March (Hoover et al. 2013). Occurrences may be increasing specifically in New York waters given increased numbers of stranded animals and increases in observations during aerial, ship, and land-based surveys (DiGiovanni et al. 2015). Gray seals have stranded along the New York and New Jersey coasts in recent years. Between 2010 and 2014, 62 dead harbor seals stranded in New York and 32 stranded in New Jersey (Hayes et al. 2017). During 2013, 35 gray seals stranded along the Long Island coast, mainly along the southern side of Long Island (RFMRP 2014).

RFMRP (2017) describes the RFMRP's research on seals in New York, Rhode Island, and Connecticut. Seal haul outs studied by this group in New York include Shinnecock, Montauk, Fisheries Island, and Gull Islands (RFMRP 2017). The RFMRP conducted 77 aerial surveys for seals in New York from 2001 to 2015 and tagged 32 gray seals that were rehabilitated and released in New York waters (DiGiovanni et al. 2015). The RFMRP website provides links to see tracks of individual seals, but no comprehensive analysis of tracking and/or aerial surveys appears to be available. Another group observing seals in the New York region is CRESLI. This organization monitors seals at Cupsogue Beach (CRESLI 2017b). Data collected opportunistically at Cupsogue Beach from 2002 to 2016 do not include any sightings of seals between May 25 and November 11 in any year.

Surveys for seals are typically conducted at haul-out or rookery sites on land, and counts are used to evaluate trends or can be extrapolated with corrections for seals in water to help evaluate local abundances (see Hayes et al. 2017 for examples). However, seals can be observed at sea. Recent annual surveys by NOAA NEFSC and SEFSC from 2010 to 2015 resulted in one sighting of unidentified seals within the AoA in winter of 2011, with more unidentified seals observed in Long Island Sound (NEFSC and SEFSC 2011a) and another sighting of an unidentified seal in the sound in winter of 2015 (NEFSC and SEFSC 2015). Gray seals were tagged during the 2011-2015 AMAPPS surveys (NEFSC and SEFSC 2013, 2014, 2015). During more recent aerial surveys, 14 unidentified seals and two gray seals were observed in the AoA in fall of 2016 and none were observed in summer of 2016 (Normandeau and APEM 2016, 2017).

Harp Seals. Harp seals (*Pagophilus groenlandicus*) are considered to have a distribution north of the AoA (Hayes et al. 2017), but they have been occasionally observed at Cupsogue Beach and Montauk Point (CRESLI 2017b). Sadove and Cardinale (1993) reported that harp seals were sighted and stranded more often in the New York Bight in the late 1980s and early 1990s than in prior years. Stranded harp seals have also been observed along the New York and New Jersey coasts in recent years. Between 2010 and 2014, 59 harp seals stranded in New York and 45 stranded in New Jersey (Hayes et al. 2017).

During 2013, eight harp seals stranded along the Long Island coast, mainly on the southern side of Long Island (RFMRP 2014). Another group observing seals in the New York region is CRESLI. This organization monitors seals at Cupsogue Beach and reported eight observations of harp seals from 2002 to 2017 (CRESLI 2017b). These observations occurred from January to May. Data collected opportunistically at Cupsogue Beach from 2002 to 2016 do not include any sightings of seals between May 25 and November 11 in any year.

Surveys for seals are typically conducted at haul-out or rookery sites on land and counts are used to evaluate trends or can be extrapolated with corrections for seals in water to help evaluate local abundances (see Hayes et al. 2017 for examples). However, seals can be observed at sea. Recent annual surveys by NOAA NEFSC and SEFSC from 2010 to 2015 did not result in any observations of harp seals in the AoA region, though not all seals were identified to species (NEFSC and SEFSC 2010, 2011a, 2012, 2013, 2014, 2015). During more recent aerial surveys, 14 unidentified seals were observed in the AoA in fall of 2016 and none were observed in summer of 2016 (Normandeau and APEM 2016, 2017).

B.3 Sea Turtles

Four species of sea turtles are found within the AoA: loggerhead, leatherback, Kemp's ridley, and green turtles. These sea turtles are all ESA-listed and share a similar life history. Females lay eggs on coastal beaches, and hatchlings emerge and swim offshore, where they feed until returning at a larger size to nearshore coastal habitats (e.g., NMFS et al. 2011).

Surveys of recreational angler sea turtle sightings, fisheries bycatch records, aerial surveys of the Atlantic coast, stranding records, tagging, and mark-recapture studies have determined that sea turtles exhibit seasonal migration patterns directed northward and inshore in the spring and early summer as waters warm along the Atlantic coast. The pattern reverses in the late summer and early fall (e.g., Henwood 1987; NMFS and USFWS 1991; Morreale et al. 1992; Schmid 1995; Witzell and Azarovitz 1996; Braun-McNeill and Epperly 2002; Renaud and Williams 2005; NOAA NEFSC and SESFC 2010, 2011a, 2012, 2013, 2014, 2015). Coastal waters of New York may provide important developmental habitat for Kemp's ridleys, loggerheads, and green turtles during their early life stages (Morreale and Standora 1998). Recent aerial surveys in the AoA from March to July by Tetra Tech and Smultea Sciences (2017) include observations of occasional unidentified sea turtles, with a sudden jump in sightings across the AoA to 52 unidentified sea turtles (and four identified leatherback turtles) in July.

Loggerhead Sea Turtle. The loggerhead turtle (*Caretta caretta*) occurs throughout temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans, with the majority of nesting sites for this species occurring on the Atlantic coast of the U.S. and the western Indian Ocean (NMFS and USFWS 2008). In the U.S., the largest aggregation of nesting females occurs in South Florida, with the next largest aggregation occurring between Georgia and North Carolina (NMFS and USFWS 2008). In offshore waters, adult loggerheads primarily inhabit continental shelf waters from New York to Florida (Schroeder et al. 2003).

Critical nearshore reproductive habitat for loggerheads is designated along the coast from Florida's Atlantic coast to Onslaw Bay, north of Wilmington, North Carolina (79 FR 39755). Critical migratory habitat is designated along the eastern and southern coasts of Florida to the Florida Keys, and off the northern coast of North Carolina (79 FR 39855). Critical *Sargassum* spp. habitat is designated off the coast of central Florida, and critical wintering habitat is designated off the northern coast of North Carolina within Onslaw Bay and Pamlico Sound (79 FR 39855).

The loggerhead is the most common sea turtle species observed during marine turtle aerial surveys year-round in the Northwestern Atlantic (e.g., Rhode Island University 1982; NOAA NEFSC and SESFC 2010, 2011a, 2012, 2013, 2014, 2015). Year-round aerial surveys undertaken from 1979 to 1981 by Rhode Island University (1982) documented loggerheads within the AoA, in highest concentrations west of the continental shelf break, with the highest numbers reported during the summer. Almost no loggerheads were observed in winter, and those that were observed were located south of the AoA and in oceanic waters (Rhode Island University 1982). Aerial surveys in summers of 1998, 1999, 2002, 2004, and 2006 resulted in regular sightings of loggerheads in the AoA (NOAA NEFSC n.d.). Sadove and Cardinale (1993) reported loggerheads in the New York Bight as early as May. They concluded that juveniles were in bays and Long Island Sound and a wider range of age classes were found up to 40 miles offshore. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that loggerhead turtles are mainly absent from the AoA in winter and spring, with greatest occurrence in summer across the southern half of the AoA and up into coastal waters near New Jersey and Long Island.

Aerial surveys undertaken by NOAA NEFSC and SESFC documented loggerhead turtles within the AoA in late summer of 2010, summer of 2011, and fall of 2012 (NOAA NEFSC and SEFSC 2010, 2011a, 2012). These aerial surveys also confirm this species' seasonal migration patterns, showing high loggerhead concentrations in coastal waters of southeastern states in summer (NOAA NEFSC and SEFSC 2010, 2011a, 2012, 2013, 2014) and fewer occurrences in northern waters in winter, with only one observation in the AoA in winter of 2015 in the northeastern corner of the AoA near the tip of Long Island (NOAA NEFSC and SEFSC 2011a, 2013, 2015). In fall and summer of 2016, surveys of the AoA resulted in observations of 395 loggerhead turtles in summer and six observations in fall (Normandeau Associates and APEM 2016, 2017). Summer observations tended to be densest closer to shore (Normandeau and APEM 2016). Rhode Island University summer sightings were sparser on the eastern area of the AoA than Normandeau and APEM (2016) sightings, but had a similar trend of being denser closer to shore. Year-round, the highest densities of loggerheads recorded during Navy surveys occurred off the coast of Florida, North Carolina, and Virginia (Navy 2007). Data from Greene et al. (2010) depicted on northeastoceandata.org indicate that sightings per unit effort of loggerhead sea turtles in the AoA are higher in summer than spring and loggerheads are observed relatively often across the AoA in summer. Data from AMAPPS surveys were used to estimate a preliminary abundance of 588,000 loggerhead turtles in summer in the northwestern Atlantic (NOAA NEFSC and SEFSC 2011b).

Sea turtle tracking data in the AoA presented in the SWOT model for the U.S. Atlantic coast originate with the Virginia Aquarium (Coyne and Godley 2005; Halpin et al. 2009; Lockhart 2016). Data represent track logs of telemetered wild-caught and by-caught loggerhead turtles between 2013 and 2015. Within the four Virginia Aquarium studies included on SWOT, loggerhead turtles only entered the AoA in the Lockhart (2016) study. These data show satellite tracks of loggerheads within the AoA, with highest use just west of the AoA's western boundary, off the New Jersey coast (Lockhart 2016). Barco et al. (2013) reports on Virginia Aquarium tagging in 2012 and 2013. This report provides maps of tracklines of six tagged loggerheads, with northernmost tracks extending along the coast up to about 41^{o}N, or about halfway up the New Jersey coast. Satellite tags were deployed on loggerhead turtles during AMAPPS surveys as well, but maps of tracklines did not extend into the AoA (NOAA NEFSC and SEFSC 2010, 2011a, 2012, 2013, 2014, 2015). Ongoing tracking data from AMAPPS are available at http://www.seaturtle.org/tracking/?project_id=537.

Likewise, sightings of loggerheads during scallop fishery observations were all south of 40^{o}N despite quite a bit of fishery effort and observation within the rest of the AoA (Murray 2004, 2015). Maps published by Murray (2004) indicate much higher numbers of loggerhead observations than detected by Murray (2015), with sightings at or below 39^{o}N in August, September, and December (other months not observed). Possibly, the higher number of sightings reported by Murray (2004) is a result of more/slightly different observation months; this study covers July to October and resulted in

22 sightings versus four sightings reported by Murray (2015). The largest number of sightings reported by Murray (2004) occurred in October (10 sightings). These observations were concentrated along the 50 m isobath, but that may be an artifact of fishing effort, as there was little effort in deeper waters off New Jersey. However, there was considerable effort in the AoA with no sightings beyond the ones mentioned above. Reynolds and Sadove (1997) evaluated sea turtles captured incidentally in pound nets near Long Island from 1986 to 1996. Loggerheads were the dominant species captured.

Leatherback Sea Turtles. Leatherback sea turtles (*Dermochelys coriacea*) nest along temperate coastlines throughout the world, with the largest concentration of nesting females occurring on the Pacific coast of Mexico (NMFS and USFWS 1992). Until recently, this species rarely nested along the U.S. Atlantic coast. Until the 1980s, the northernmost extent of this species' nesting range was northeastern Florida (Caldwell et al. 1956; Caldwell 1959; Nichols and Du Toit 1983; Seyle 1985). As of the mid-2000s, the nesting range had extended northward into North Carolina (Rabon et al. 2003). This species moves into cooler waters during warmer months (NMFS and USFWS 1992).

Adult leatherbacks migrate greater distances than any other species in the family Cheloniidae (Morreale et al. 1996; Hughes et al. 1998; Hays and Scott 2013), sometimes up to 11,000 km from their breeding areas (Benson et al. 2011). Migration patterns differ by region and are driven by oceanographic processes (NMFS and USFWS 2013). Critical habitat for this species has been designated in the U.S. Virgin Islands (44 FR 17710) and the Pacific coast of the U.S. (77 FR 4170), but not on the Atlantic coast of the U.S.

Leatherbacks are expected to occur within the AoA. During year-round aerial surveys conducted from 1979 to 1981, leatherbacks were most often observed in northern waters near Long Island in summer, and were the second-most common turtle species encountered during the surveys after loggerheads (Rhode Island University 1982). Leatherbacks were seen in the Mid-Atlantic once in the AoA in spring, twice in fall, and zero times in winter (Rhode Island University 1982). Aerial surveys in the summers of 1998, 1999, 2002, 2004, and 2006 resulted in a few (approximately seven) sightings of leatherbacks in t he southern to western continental shelf area of the AoA (NOAA NEFSC n.d.). Sadove and Cardinale (1993) reported that leatherbacks were one of the most abundant species of sea turtle in the New York Bight, suggesting they were observed more often than green, Kemp's ridley, and hawksbill sea turtles. They stated that the leatherback is predominantly a pelagic species but reported observations along the south shore of Long Island and in Long Island Sound. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that leatherback turtles are mainly absent from the AoA in spring and winter, with occurrence across the continental shelf and in oceanic waters, as well as coastal areas in summer and fall.

Leatherbacks were not observed within the AoA during aerial surveys by NOAA NEFSC and SEFSC in 2010, 2013, 2014, but were observed within the AoA during summer 2011 and fall 2012 aerial surveys (NOAA NEFSC and SEFSC 2011a, 2012). This species was more commonly observed in the southeastern U.S. during these surveys (NOAA NEFSC and SEFSC 2010, 2014, 2015). In fall and summer of 2016, aerial surveys of the AoA resulted in observations of nine leatherback turtles in summer and six observations in fall (Normandeau and APEM 2016, 2017). Tetra Tech and Smultea Sciences (2017) reported observations of four leatherback turtles (two on the shelf, one on the shelf break, and one on the slope) during July 2017 aerial surveys. The highest densities of leatherbacks recorded during year-round Navy surveys occurred off the coasts of Georgia and South Carolina (Navy 2007). Data from Greene et al. (2010) depicted on northeastoceandata.org indicate sightings per unit effort of leatherback sea turtles in the AoA are higher in summer than spring, and observations have occurred across the AoA.

Eckert (2002) reported that juvenile leatherbacks occur only in waters warmer than 26 degrees Celsius. Satellite and radio tracking studies of leatherbacks are less common than those of loggerheads in the U.S. North Atlantic region. In the five-year review of leatherbacks, NMFS and USFWS (2013) cite seven tracking studies, none of which occurred in the U.S. North Atlantic or tracked leatherbacks to that region. The World Wide Fund for Nature (n.d.) has conducted tagging and tracking of leatherbacks in the North Atlantic, and one trackline moves up the U.S. East Coast from the Caribbean into coastal/shelf waters in North Carolina and continues north to southern New Jersey. The tracklines in this study appear to indicate very long distance movements of this species across entire ocean basins. James et al. (2005) used satellite tracking of leatherback turtles tagged off Nova Scotia and entanglement records of leatherback turtles to evaluate habitat use. They found that leatherback turtles have some previously unrecognized high-use areas in continental shelf and slope waters, with high use areas in the AoA near the northern slope area. Some tagged leatherback turtles traveled into coastal shelf waters in the AoA (James et al. 2005). Reynolds and Sadove (1997) evaluated sea turtles captured incidentally in pound nets near Long Island from 1986 to 1996. No leatherbacks were captured.

Green Turtle. Green turtles (*Chelonia mydas*) inhabit tropical and subtropical waters of the U.S. Virgin Islands, Puerto Rico, and continental U.S. from Texas to Massachusetts (Groombridge 1982). Green turtles are highly migratory, and their complex movements throughout different habitats are a prominent feature of their life history (Musick and Limpus 1997; Morreale and Standora 1998).

Juvenile green turtles use estuarine waters along the U.S. Atlantic coast as summer developmental habitat as far north as Long Island Sound (Epperly et al. 1995; Musick and Limpus 1997). Important feeding areas include several locations in Florida, including the Indian River Lagoon, Florida Keys, and Crystal River. Major green turtle nesting colonies in the Atlantic occur on Acension Island, Aves Island, Costa Rica, and Suriname. On the U.S. Atlantic coast, green turtles nest in small numbers on the east coast of Florida (NMFS and USFWS 1991). Critical habitat for this species is designated at Culebra Island in Puerto Rico (63 FR 46693).

In aerial surveys from 1979 to 1981, in the Mid-Atlantic, only seven green turtles were observed, one of which was observed in the coastal area near the port of New York off New Jersey (Rhode Island University 1982). Given they are temperature-limited, green turtles would be less likely to be in northerly areas when water temperatures are cold (Rhode Island University 1982). Aerial surveys in the summers of 1998, 1999, 2002, 2004, and 2006 resulted in no sightings of green turtles in the AoA; all sightings were to the south (NOAA NEFSC n.d.). Sadove and Cardinale (1993) reported that green turtles had lower occurrence in the New York Bight than other species of sea turtles and that they were typically found in shallow water bays and Long Island Sound from June to October, with cold-stunned individuals extending into December.

Green turtles were observed within the AoA during NOAA NEFSC and SESFC northeast aerial surveys in summer of 2010 and summer of 2011 (NOAA NEFSC and SESFC 2010, 2011a). Green turtles were also observed during aerial surveys in the southeastern U.S. in summer of 2010 and winter of 2011, with fewer sightings recorded in winter 2011 than in summer 2010 (NOAA NEFSC and SESFC 2010, 2011a). Surveys conducted in 2013, 2014, and 2015 did not record this species. Green turtles are most likely to occur within the AoA during the summer, but could occur year-round. In fall and summer of 2016, surveys of the AoA resulted in an observation of one green turtle in summer and none in fall (Normandeau and APEM 2016, 2017). The highest densities of hardshell (green and hawksbill) turtles recorded during year-round Navy surveys occurred off the coast of Florida, with moderate densities occurring between North Carolina and Long Island (Navy 2007).

RFMRP (n.d.[a]) provides a map of trackline from a green turtle tagged in Long Island Sound in 2016 that moved along the north coast of Long Island within the Sound for 56 days. Reynolds and Sadove (1997) evaluated sea turtles captured incidentally in pound nets near Long Island from 1986 to 1996. A mean of six green turtles per year were captured from 1985 to 1996 during this study. In winter, five cold-stunned green turtles were collected on Long Island eastern beaches and bays (not ocean beaches) from 1985 to 1987 (Morreale et al. 1992).

Kemp's Ridley. Kemp's ridley sea turtles (*Lepidochelys kempii*) inhabit waters of the Gulf of Mexico and northwest Atlantic Ocean as far north as the Grand Banks (Watson et al. 2004) and Nova Scotia (Bleakney 1955). The Kemp's ridley has a restricted population distribution. Nesting is essentially limited to beaches of the western Gulf of Mexico. In the U.S., nesting occurs regularly in south Texas and infrequently in several other U.S. States (NMFS et al. 2011). On the Atlantic coast, nests have been observed as far north as Georgia (Williams et al. 2006) and North Carolina (Marquez et al. 1996). No critical habitat has been designated for this species.

Kemp's ridley presence and seasonal distribution in U.S. waters is dependent on water temperature, with occurrences on the Atlantic coast more common during the summer months (Renaud and Williams 2005). In a study of cold-stunned sea turtles along Long Island, Morreale et al. (1992) found that Kemp's ridley turtles made up 75% of cold-stunned sea turtles collected, and the relatively small size suggested that New York waters are used by this species during early developmental stages. Sadove and Cardinale (1993) reported this species was found in the New York Bight June to October, though cold-stunned individuals occurred through December. They also found that the region was important for juvenile development, describing some individual areas of potentially important habitat. During this species' post-hatching, oceanic life stage, it may rely on *Sargassum* spp. for food and shelter, similar to loggerhead and green sea turtles (NMFS et al. 2011), though Sadove and Cardinale (1993) reported feeding on spider and green crabs. Lagueux et al. (2010) analyzed several surveys from 1978 to 2006 to evaluate sightings per unit effort of cetaceans and sea turtles in the New York Bight. They reported that these data suggested that Kemp's ridley turtles were only observed in summer in the AoA and were mainly present in the southwestern corner, though some were observed near the south shore of Long Island and along the northeastern boundary.

In aerial surveys conducted in the Mid-Atlantic from 1979 to 1981, only six Kemp's ridley turtles were observed, three of which were in the AoA (Rhode Island University 1982). Aerial surveys in the summers of 1998, 1999, 2002, 2004, and 2006 resulted in observations of Kemp's ridleys in the very southeastern corner of the AoA, with only two sightings north of that area (east of Long Island) (NOAA NEFSC n.d.). Kemp's ridleys were not observed within the AoA during any NOAA NEFSC and SESFC aerial surveys between 2010 and 2015. All Kemp's ridley observations documented during these surveys occurred between Florida and southern North Carolina (NOAA NEFSC and SEFSC 2010, 2011a, 2012, 2014, 2015). These surveys confirm the limited distribution of this species on the U.S. Atlantic coast. In fall and summer of 2016, surveys of the AoA resulted in observations of 18 Kemp's ridley turtles in summer and one observation in fall (Normandeau and APEM 2016, 2017). The highest densities of Kemp's ridleys recorded during year-round Navy surveys occurred off the coast of New Jersey, south of the AoA (Navy 2007).

Reynolds and Sadove (1997) evaluated sea turtles caught incidentally in pound nets near Long Island 1986 to 1996. Sea turtle tracking data in the AoA presented in the SWOT model for the U.S. Atlantic coast originate with the Virginia Aquarium (Coyne and Godley 2005; Halpin et al. 2009;Lockhart 2016). Data represent track logs of telemetered wild-caught and by-caught Kemp's ridley turtles between 2013 and 2015. Within the four Virginia Aquarium studies included on SWOT, Kemp's ridley turtles did not enter the AoA during tracking (Lockhart 2016, 2017a, 2017b; Mansfield 2017). RFMRP (n.d.[b]) provides a map of trackline from a tagged Kemp's ridley turtle in 2015 that followed the coast north along New Jersey and along the southern side of Long Island.

B.4 Extremely Rare or Extralimital Marine Mammals and Sea Turtles

Although Roberts et al. (2016) include density models for all of the following listed species (except pygmy killer whales), these species are not likely to be susceptible to risk from offshore wind development activities in the AoA due to their extreme rarity (see Hayes et al. 2017 and sighting totals in Roberts et al. 2016). As they are so rare, population centers are likely not within the U.S. Atlantic EEZ, and offshore wind development would not be expected to pose a risk to any of these species.

- Bryde's whales (*Baleanoptera edeni*).
- Northern bottlenose whales (*Hyperoodon ampullatus*).
- Killer whales (*Orcinus orca*).
- False killer whales (*Psuedorca crassidens*).
- Fraser's dolphins (*Lagenodelphis hosei*).

- Spinner dolphins (*Stenella longirostris*).
- Pantropical spotted dolphins (*S. attenuata*).
- Clymene dolphins (*S. clymene*).
- Melon-headed whales (*Peponocephala electra*).
- White-beaked dolphins (*L. albirostris*).
- Pygmy killer whale (*Feresa attenuata*).

Bryde's whales are rare enough that Hayes et al. (2017) do not define a Western North Atlantic stock of this species. Only four sightings occurred in the 15 surveys over 22 years used in Roberts et al. (2016). Likewise, although DEC (n.d.) and RFMRP (n.d.[c]) state that ringed seals (*Pusa hispida*) occur on rare occasion in New York waters, Hayes et al. (2017) does not define a stock in the Western North Atlantic. Organizations opportunistically observing seals in the New York region have observed occasional harp seals and, in rare cases, ringed seals and hooded seals (*Cystophora cristata*) (e.g., CRESLI 2017b). Sadove and Cardinale (1993) reported that hooded seals and ringed seals were observed in the New York Bight but were likely extralimital. In addition, Rhode Island University (1982) reports four sightings of beluga whales (*Delphinapterus leucas*) along the southern coast of Long Island in the AoA and one sighting on the continental slope off New Jersey. They report that extralimital straying of individuals occurs on occasion in the Mid-Atlantic region as far southward as New Jersey. Sadove and Cardinale (1993) also mention extralimital occurrence of beluga whales in the New York Bight region. They also note that a hawksbill sea turtle was recorded in Long Island Sound shortly after a hurricane in 1938, suggesting this species may also rarely occur extralimitally in the AoA region.

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