Wind Energy Research Lease on the Atlantic Outer Continental Shelf Offshore Maine Biological Assessment

For the National Marine Fisheries Service

April 2024

U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

Contents

List of Figures

List of Tables

List of Acronyms

Term	Definition
AIM	Acoustic Integration Model
AIS	Automatic Identification System
ALWTRP	Atlantic Large Whale Take Reduction Plan
AMAPPS	Atlantic Marine Assessment Program for Protected Species
ANSI	American National Standards Institute
ASMFC	Atlantic States Marine Fisheries Council
ASSRT	Atlantic Sturgeon Status Review Team
AUV	autonomous underwater vehicle
BIA	biologically important area
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation, and Enforcement
BRI	Biodiversity Research Institute
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
CETAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
CSA	CSA Ocean Sciences Inc.
CWA	Clean Water Act
DFO	Fisheries and Oceans Canada
DMA	Dynamic Management Area
DMR	Maine Department of Marine Resources
DNREC	Department of Natural Resources and Environmental Control
DOI	Department of the Interior
DPS	Distinct Population Segment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	environmental impact statement
EMF	electromagnetic field
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FDR	Facility Design Report
FHWA	Federal Highway Administration
FHWG	Fisheries Hydroacoustic Working Group

Term	**Definition**
FIR	Fabrication and Installation Reports
GAR	Greater Atlantic Region
GARFO	Greater Atlantic Regional Fisheries Office
GMRI	Gulf of Maine Research Institute
GPS	global positioning system
HDD	horizontal directional drilling
HRG	high-resolution geophysical
IHA	Incidental Harassment Authorization
IPF	impact-producing factor
ITA	Incidental Take Authorization
IUCN	International Union for Conservation of Nature
LAA	likely to adversely affect
LFC	low-frequency cetacean
LOA	letter of authorization
MBES	multibeam echosounder
MFC	mid-frequency cetacean
MMPA	Marine Mammal Protection Act
MOA	memorandum of agreement
MOTUS	MOTUS Wildlife Tracking System
NARW	North Atlantic right whale
NASA	National Aeronautics and Space Administration
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NLAA	not likely to adversely affect
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollution Discharge Elimination System
NPS	National Park Service
NRC	National Research Council
NROC	Northeast Regional Ocean Council
OCS	Outer Continental Shelf
OPR	Office of Protected Resources
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OSS	offshore substation
PAM	passive acoustic monitoring

Term	Definition
PATON	Private Aids to Navigation
PBR	potential biological removal
PIT	passive integrated transponder
PRD	Protected Species Division
PSO	protected species observer
PTOW	Pine Tree Offshore Wind
PTS	permanent threshold shift
RAP	Research Activities Plan
RHA	Rivers and Harbors Act
ROD	Record of Decision
SAG	surface active group
SAR	stock assessment report
SBP	sub-bottom profiler
SEFSC	Southeast Fisheries Science Center
SEL	sound exposure level
SMA	Seasonal Management Area
SPL	sound pressure level
SSS	side scan sonar
SVP	sound velocity profiler
TBD	to be determined
TEWG	Turtle Expert Working Group
TIMS	Technical Information Management System
TSS	total suspended solids
TTS	temporary threshold shift
UME	Unusual Mortality Event
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UXO	unexploded ordnance
WHOI	Woods Hole Oceanographic Institution
WTG	wind turbine generator

1 Introduction

In accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 United States Code [U.S.C.] §§ 1531 et seq.), this document transmits the Bureau of Ocean Energy Management's (BOEM's) Biological Assessment (BA) of the effects of the Proposed Action on ESA-listed species and designated critical habitat that occur within the Action Area.

The Proposed Action for this BA is the issuance of a wind energy research lease on the U.S. Outer Continental Shelf (OCS) in the Gulf of Maine in support of wind energy development to the State of Maine (i.e., the Lessee). The research lease would grant the State of Maine the exclusive rights to submit, for BOEM's potential approval, a research activities plan (RAP) for wind energy-related research activities offshore Maine. For the purposes of this BA, the duration of the research lease was assumed to be 5 years (February 2029) which corresponds to the maximum expected timeline to achieve RAP approval. The research lease would not authorize any development or construction activities on the OCS, but would authorize site assessment activities (i.e., placement of a meteorological ocean buoy) within the lease, and site characterization activities (i.e., geophysical, geotechnical, biological, and archeological surveys, and monitoring activities) in and around the research lease and potential future project easements. Information gathered from site assessment and site characterization activities would be used by the State of Maine to develop a RAP for potential future construction and operation of floating offshore wind turbines, installation of inter-array and export cables, and associated wind energy-related research facilities, which BOEM would evaluate in a subsequent environmental analysis after receiving the RAP. Through an Operator Agreement with the State of Maine, Pine Tree Offshore Wind (PTOW) will be the Designated Operator of the Project. Under this agreement, the State of Maine will coordinate and oversee the performance of the research lease activities while PTOW will advance the research framework and support the execution of certain research activities. PTOW will also be responsible for constructing, operating, maintaining, repairing, and replacing the Project in accordance with the terms of the commercial lease, which is outside the scope of this BA. The potential project easements would all be located within the Gulf of Maine and include corridors that extend from the lease area to the onshore energy grid.

Prior to the approval of RAP authorizing the construction and operation of wind energy-related research facilities, BOEM would prepare a plan-specific environmental analysis and would comply with all required consultation requirements.

BOEM is the lead federal agency for purposes of Section 7 consultation (50 Code of Federal Regulations [CFR] 402.07); the other action agencies participating in the review process include the Bureau of Safety and Environmental Enforcement (BSEE); the U.S. Coast Guard (USCG); the National Marine Fisheries Service's Office of Protected Resources (NMFS OPR); the U.S. Army Corps of Engineers (USACE); and the Federal Communications Commissions (FCC). Neither the State of Maine nor PTOW are applying for an OCS Air Permit or NPDES permit for the Proposed Action and no federal actions from the U.S. Environmental Protection Agency (USEPA) are expected for the Proposed Action. Therefore, the USEPA is not considered an action agency for this action.

In addition to the federal action agencies listed above, two state agencies will also be issuing permits or authorizations on the Proposed Action: the Maine Bureau of Parks and Lands, and Maine Department of Marine Resources (DMR).

2 Consultation History and Regulatory Authorities

2.1 Consultation History

The Energy Policy Act of 2005, Public Law 109-58, added Section 8(p)(1)(c) to the Outer Continental Shelf Lands Act. This section authorized the Secretary of the Interior to issue leases, easements, and Rights of Way (ROWs) in the OCS for renewable energy development, including wind energy. The Secretary delegated this authority to the former Minerals Management Service, and later to BOEM. Final regulations implementing this authority (30 CFR part 585) were promulgated on April 22, 2009.

On October 1, 2021, the State of Maine submitted an application for a research lease requesting 9,700 acres (3,925.5 hectares) on the U.S. OCS in a location more than 20 nmi (37 km) off the Maine coast. On August 19, 2022, BOEM published a Request for Competitive Interest for the Gulf of Maine in the *Federal Register* (*FR*) for a 45-day public comment period, and a separate Request for Interest was published on that same date. On January 19, 2023, BOEM announced its “Determination of No Competitive Interest” for a research lease proposed by the State of Maine. BOEM’s determination means that the bureau will move forward to process the state’s research application, which could be used to inform any future commercial offshore wind development in the Gulf of Maine. Subsequently, BOEM announced the publication of the Gulf of Maine’s Notice of Intent to prepare an Environmental Assessment (EA) for a wind energy research lease on the Atlantic OCS offshore Maine in the *FR* on May 3, 2023.

This BA supports BOEM’s request for ESA Section 7 consultation. The Federal action that is the subject of this request for Section 7 consultation is BOEM’s the issuance of a wind energy research lease to the State of Maine and the other Federal actions outlined below. BOEM issued the draft BA on July 21, 2023. The draft BA was reviewed by all applicable action agencies, and comments were received by BSEE and NMFS, which were incorporated into the final BA. The final BA was also revised to incorporate additional information provided by the State of Maine describing the Proposed Action. BOEM has ensured that the final BA was reviewed by the other action agencies, is based on the best available scientific information, and includes all the information required by 50 CFR 402.14(c).

2.2 Other Regulatory Authorities

2.2.1 Bureau of Safety and Environmental Enforcement

BSEE’s mission is to enforce safety, environmental, and conservation compliance with any associated legal and regulatory requirements during the proposed surveys and future activities. BSEE is responsible for verifying and enforcing compliance with any avoidance, minimization, and monitoring measures from this consultation for activities conducted on the OCS through 30 CFR 285/585, lease stipulations, and required mitigations associated with consultation. Additionally, BSEE will be involved with enforcement and compliance, as-placed anchor plats, Protected Species Observer (PSO) reporting, and decommissioning/site clearance reviews for any buoys installed under the Proposed Action.

2.2.2 United States Army Corps of Engineers

The USACE regulates discharges of dredged or fill material into U.S. waters and structures or work in navigable waters of the U.S. under Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act (RHA). On December 15, 2023, the USACE sent BOEM a letter outlining their jurisdiction for the Research Lease and agreed that BOEM would be the lead federal agency for the ESA consultation with NMFS. Some of the surveying activities within the lease area and within navigable waters and the placement of buoys would be subject to USACE Section 10 jurisdiction and require Department of the Army authorization. The USACE anticipates that most site characterization and site assessment activities would be covered by USACE Maine General Permit Numbers 13, 17, and/or 18, which may require self-verification notification or preconstruction notification to USACE. These general permits cover Land and Water-Based Renewable Energy Generation Facilities and Hydropower Projects (General Permit Number 13); Scientific Measurement Devices (General Permit Number 17); and/or Survey Activities (General Permit Number 18) which would cover activities associated with the deployment of the floating light detection and ranging (FLiDAR) buoy (**Section 3.1.1.1**), the high-resolution geophysical (HRG) surveys (**Section 3.1.2.2)**, the geotechnical surveys (**Section 3.1.2.3**), and the benthic surveys (**Section 3.1.2.4**). At the time of permit request submittal by the Lessee, the USACE will review these activities in accordance with permit application review procedures, and per the conditions of the General Permits, the USACE will conduct their own Section 7 consultation using the information provided in this BA. Additionally, under the Proposed Action a preconstruction notification to USACE is anticipated prior to installation of the FLiDAR buoy and MOTUS Wildlife Tracking System (**Section 3.1.2.10**); and prior to starting the HRG survey activities, the geotechnical survey, and benthic survey activities.

2.2.3 United States Coast Guard

The USCG administers the permits for Private Aids to Navigation (PATON) located on structures positioned in or near navigable waters of the U.S. All vessels operating under the Proposed Action will be required to comply with existing state and federal regulations related to ballast and bilge water discharge, including USCG ballast discharge regulations (33 CFR 151.2025). Additionally, the permits for PATON will be pursued by PTOW prior to installation of the FLiDAR buoy (**Section 3.1.1.1**) and MOTUS Wildlife Tracking System (**Section 3.1.2.10**).

2.2.4 National Marine Fisheries Service

The Marine Mammal Protection Act (MMPA), as amended, and its implementing regulations (50 CFR part 216) allow, upon request, the incidental take of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region. Incidental take is defined under the MMPA (50 CFR 216.3) as, "harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. This includes, without limitation, any of the following: the collection of dead animals, or parts thereof; the restraint or detention of a marine mammal, no matter how temporary; tagging a marine mammal; the negligent or intentional operation of an aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal; and feeding or attempting to feed a marine mammal in the wild." The "take" largely arises due to activities incidental to planned marine construction activities, such as underwater sound, and may include behavioral avoidance. For the Proposed Action, an Incidental Harassment Authorization (IHA) under the MMPA will be requested by the lessee for the HRG survey, geotechnical survey, and benthic survey activities which use equipment operating at frequencies <180 kHz (**Sections 3.1.2.2, 3.1.2.3,** and **3.1.2.4**). A draft application was submitted in fall 2023, and a revised application is planned for submission in summer 2024.

Additionally, the State of Maine will pursue a Letter of Acknowledgement from NMFS to acknowledge and confirm that the activities described under the Proposed Action in Section 3.1 would be considered scientific research activities which are therefore exempt from any regulations under the Magnuson-Stevens Fishery Conservation and Management Act. Obtaining a Letter of Acknowledgment serves as a convenience to the researcher, the vessel(s), NMFS, the National Oceanic and Atmospheric Administration (NOAA) Office of Law Enforcement, and the USCG, to establish that the activity is indeed exempt from the provisions of the Magnuson-Stevens Fishery Conservation and Management Act.

2.2.5 Federal Communications Commissions

The FCC regulates interstate and international communications by radio, television, wire, satellite, and cable in all 50 states, the District of Columbia and U.S. territories. In the Action Area (**Figure 3-3**), the FCC has jurisdiction out to 12 miles (19 kilometers) from shore. The shore-based radar stations used during the physical oceanographic monitoring activities described in **Section 3.1.2.6** will require a radar license from the FCC for the radar which will be applied for and issued through Woods Hole Oceanographic Institute.

2.2.6 Maine Bureau of Parks and Lands

The Maine Bureau of Parks and Lands under the Maine Department of Agriculture, Conservation, and Forestry is responsible for managing natural and cultural resources in Maine for preservation of recreational, cultural and historic, wildlife, and timber resources. Under the Proposed Action, deployment and use of the shore-based radar stations for the physical oceanographic monitoring activities described in **Section 3.1.2.6** will require a Special Activities Permit from the Maine Bureau of Parks and Lands which will be applied for and issued to DMR.

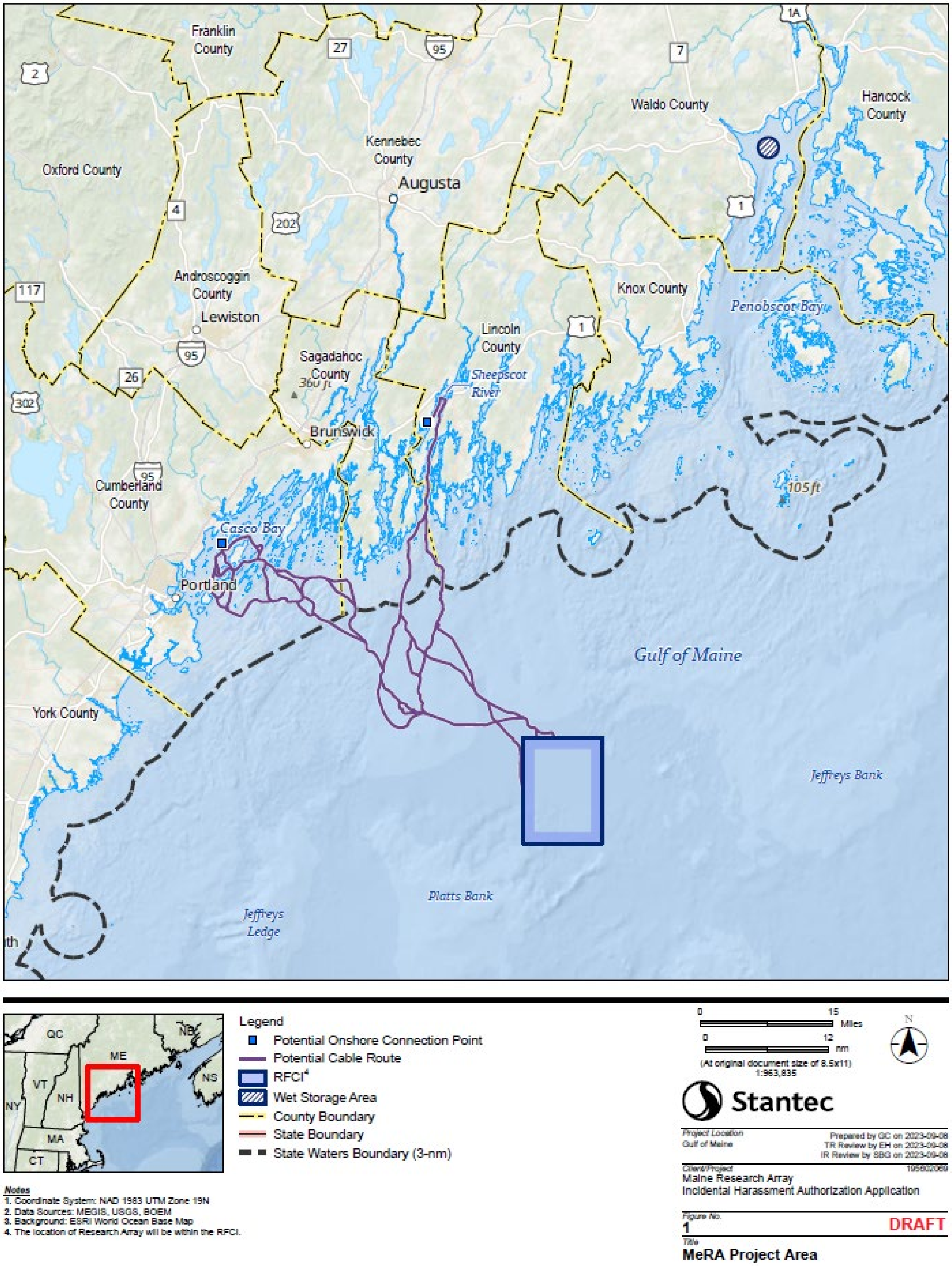
2.2.7 Maine Department of Marine Resources

DMR was established to conserve and develop marine and estuarine resources; to conduct and sponsor scientific research; to promote and develop the Maine coastal fishing industries; to advise and cooperate with local, state, and federal officials concerning activities in coastal waters; and to implement, administer, and enforce the laws and regulations necessary for these purposes. This agency receives Federal financial assistance from the U.S. Fish and Wildlife Service. Under the Proposed Action, the bottom trawl surveys described in **Section 3.1.2.12** and the lobster trap surveys described in **Section 3.1.2.14** will require a Maine Special License from DMR for non-commercial fishing activities prior to commencement.

3 Description of the Proposed Action and Action Area

Under the ESA, “action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the U.S. or upon the high seas (50 CFR 402.02). The Proposed Action considered in this BA is the issuance of a lease and the associated Federal actions identified above in **Section 2**. The activities that are planned as a result of the research lease issuance include site assessment activities and site characterization activities on the lease, and potential Project easements. The activities that are part of the Proposed Action area described in **Section 3.1**. The Action Area is defined in **Section 3.2**. Finally, all monitoring and mitigation measures that are part of the Proposed Action are presented in **Section 3.3**.

Unless otherwise noted, the region in which all site assessment and site characterization surveys (e.g., benthic, fisheries, biological, geophysical reconnaissance, HRG, aerial) will occur encompasses the Research Lease Area, potential cable routes, and the wet storage area in Penobscot Bay (**Figure 3-1**). All vessel transits will originate from ports along coastal Maine except for the vessel used for deployment, maintenance, and decommissioning of the FLiDAR buoy (**Section 3.1.1.2**) which may originate from Boston, Massachusetts or Portland, Maine.



From: Stantec Consulting Services, Inc. (2023)

Figure 3-1. Location of the Research Lease Area, potential cable routes, and wet storage area

3.1 Description of Activities

The Proposed Action is the issuance of a research lease by BOEM and associated State and Federal authorizations and permits proposed by BSEE, USACE, USCG, NMFS OPR, FCC, Maine Bureau of Parks and Lands, and DMR; and include the resultant site assessment activities and site characterization activities on the lease and potential Project easements (**Figure 3-1**). Proposed site assessment activities include the temporary placement of a meteorological ocean buoy. Proposed site characterization activities include geophysical, geotechnical, biological, and archeological surveys and monitoring activities. An overview of the timing and duration of each of these proposed survey activities is provided in **Table 3-1**, and the following subsections provide more detail regarding the activities considered in this BA. The timing of the site assessment and site characterization activities shown in **Table 3-1** is based on the most recent estimates provided by the State of Maine and reported in the EA but is subject to change based on procurement processes, vessel availability, permitting processes, and other factors.

Table 3-1. Summary of the timing and duration of survey activities under the Proposed Action

Activity	Timing	Duration
FLiDAR buoy deployment, maintenance, and decommissioning	Quarter 2 2024 through Quarter 2 2026	24 months
Geophysical reconnaissance surveys	September through November 2024	15 multi-day trips for 24-hour operations spanning 7 to 14 days each and 60 single-day trips for daytime[1] only operations over a 3-month period
HRG surveys	March through May 2025	15 multi-day trips for 24-hour operations spanning 7 to 14 days each and 60 daily trips for daytime only operations over a 4-month period
Geotechnical surveys	March through May 2025 and August through November 2025	30 multi-day trips spanning 7 to 14 days each of 24-hour operations over a 3- and 4-month period
Benthic surveys	September through November 2024	30 multi-day trips spanning 7 to 14 days each of 24-hour operations over a 3- month period
Seafloor habitat characterization surveys	Quarter 1 2023[3] through February 2029[2]	Surveys conducted once annually over a 5-year duration
Physical oceanographic monitoring	July 2023[3] through February 2029[2]	Installation of radar stations began in 2023, and test glider deployments to work out logistics began in July 2023. Data collection glider deployments will begin in July 2024, and would occur at least every other month (depending on data needs) over the 5-year duration
Digital aerial surveys	May 2023[3] to March 2025 (possible extension to March 2026)	Four flights conducted quarterly from May 2023 through March 2024; thereafter monthly flights will be conducted from April 2024 through March 2025

Activity	Timing	Duration
Visual wildlife surveys	Quarter 4 2022[3] through February 2029[2]	Test surveys began in 2022 to work out logistics. Data collection surveys will begin in April 2024, after which monthly surveys are anticipated over a 5-year duration[4]
PAM for marine mammals, ambient noise, and large pelagic and benthic fish	PAM data collected between June 2024 and February 2029[2] Fish data collected between Quarter 3 2022 and February 2029[2]	PAM equipment deployed over a 5-year period Fish tagging began in Quarter 3 2022, and receivers will be deployed continuously beginning in June 2024. Both activities will continue over a 5- year period
MOTUS tracking	Quarter 2 2024 through Quarter 2 2026	24-months
Active acoustic surveys	Quarter 4 2022[3] through February 2029[2]	Test surveys to work out logistics began in 2022. Data collection surveys will begin in April 2024. Two 12-hour vessel trips[1] per month, every other month are anticipated over a 5-year duration
Bottom trawl surveys	Quarter 4 2024 through February 2029[2]	1 to 6 vessel trips seasonally (up to 24 trips monthly)
Plankton and larval lobster surveys	Quarter 4 2023[3] through February 2029[2]	Test surveys to work out logistics began in Quarter 4 2023. Data collection surveys will begin in April 2024. During the first year after lease issuance, 1 or 2 vessel trips per month are anticipated. Monthly trips are anticipated in subsequent years over 5- year duration, but the number will depend on contracted vessels. Vertical tows will be conducted monthly year-round over 5-year duration. Neuston net tows will be conducted monthly from April through November over 5-year duration.
Lobster trap surveys	September 2024 through February 2029[2]	Six trips by 12-hour vessel[1] per season[5] over 5-year duration

FLiDAR = floating light detection and ranging buoy; HRG = high-resolution geophysical; PAM = passive acoustic monitoring.

[1] For the purposes of this analysis, 12-hour surveys are assumed to be daytime only, defined as 1 hour after civil sunrise to 1.5 hours before civil sunset.

[2] The February 2029 end date is based on the estimated timing of RAP approval, which was conservatively estimated to occur within 5 years of lease issuance, or February 2029.

[3] Surveys with start dates that pre-date the publication of this BA are assumed in the assessment to have already started.

[4] Visual wildlife surveys will be conducted on the same vessel as the active acoustic surveys so these activities would co-occur.

[5] The Proposed Action includes mitigation which restricts gear from being set in the Lobster Management Area 1 restricted area between October 1 and January 31, so any seasonal deployment of the lobster traps would occur outside of these months.

3.1.1 Site Assessment Activities

Site assessment activities part of the Proposed Action will include deployment of a FLiDAR buoy and associated vessel activity for its deployment, maintenance, and retrieval as described in the following subsections.

3.1.1.1 Floating Light Detection and Ranging Buoy Deployment

PTOW will deploy a Fugro SEAWATCH Wind FLiDAR buoy in the Research Lease Area (**Figure 3-1**) to collect and transmit information on wind, waves, currents, sea level, and other meteorological parameters in real time, providing both project data and also alerting the project to the need for maintenance if systems appear to be collecting erroneous information (or no information at all). The FLiDAR will be equipped with an independent tracker and dual global positioning system (GPS) to allow for real-time position monitoring. Power to the FLiDAR will be supplied and charged by solar panels and the backup buoy power system. Backup energy needed to operate the requested sensors autonomously will be provided by methanol fuel cells in the hull. The FLiDAR buoy will be deployed for a total of 24-months between Quarter 2 of 2024 and Quarter 2 of 2026 (**Table 3-1**).

The FLiDAR buoy diameter is 9.5 ft (2.9 m), with an overall height of 23 ft (6.8 m), and approximate weight of 5,512 lb (2,500 kg). The buoy will be deployed within the Research Lease Area and moored with a 0.75-inch (19-mm) diameter chain attached to a single gravity-based anchor, which is estimated to weigh approximately 6,000 lb (2,722 kg) and is not expected to exceed a spatial footprint of 32 ft^2 (3 m^2). The buoy anchor is a gravity-based anchor that will be installed by being laid on the seafloor and allowing gravity to pull the weight down and settle. An overview of the FLiDAR buoy parameters is provided in **Table 3-2**.

Decommissioning is essentially the reverse of the deployment process. Equipment recovery would be performed with the support of a vessel equivalent in size and capability to that used for deployment. Typically for a buoy like the proposed FLiDAR buoy, a crane-lifting hook would be secured to the buoy, and a water/air pump system would de-ballast the buoy, causing it to tip into the horizontal position. The mooring chain and anchor would then be recovered to the deck using a winching system and transported to shore. Buoy decommissioning is expected to be completed within 1 to 2 days.

Table 3-2. Summary of key components of the FLiDAR buoy system under the Proposed Action

Parameter	Details
FLiDAR buoy dimensions	Diameter = 9.5 ft (2.9 m) Height = 23 ft (6.8 m) Weight = 5,512 lb (2,500 kg)
Anchor	6,000 lb (2,722 kg) bottom anchor
Anchor type	0.74-inch (19-mm) diameter chain attached to a single gravity-based anchor[1]
Maximum seafloor disturbance	32 ft^2 (3 m^2)
Timing of deployment	April 2024 through April 2026

FLiDAR = floating light detection and ranging buoy

[1] A gravity-based anchor is a type of mooring in which the anchor is laid on the seafloor and settles due to gravity pulling the weight down.

3.1.1.2 Vessels and Potential Ports

Deployment of the FLiDAR buoy (**Section 3.1.1.1**) may require up to four total vessel trips for deployment (one trip), maintenance (two trips), and decommissioning (one trip). The buoy deployment is anticipated to be 24-months (Quarter 2 2024 through Quarter 2 2026), including all maintenance trips and decommissioning. An overview of the vessel activities associated with the proposed site assessment activities is provided in **Table 3-3**. Estimates of vessel speeds during transiting and survey activities are provided based on available information from BOEM (2021b) or based on the type of survey activities proposed for each vessel; however, all vessels in **Table 3-3** included under the Proposed Action will adhere to the vessel strike avoidance measures provided in **Section 3.3**, so actual vessel speeds may differ based on mitigation requirements during the surveys. It was estimated that the vessel would cover a distances of approximately 200 nmi (370 km) during one round trip between the Research Lease Area and the home port in Boston, Massachusetts, the vessel would cover a distances of approximately 100 nmi (185 km) during one round trip between the Research Lease Area and the home port in Portland, Maine.

Table 3-3. Estimated Proposed Action vessel use during site assessment activities

Vessel Type	Vessel Length	Home Port	Number of Vessels	Number of Round Trips per Year			Approx. Vessel Transit Speed (knots)[1]	Approx. Vessel Survey Speed (knots)[2]
				2024	2025	2026		
Crew Boat	200 ft (61 m)	Boston, MA or Portland, ME	1	1	2	1	22.1	12

[1] Vessel speeds during transit were sourced from Table A-4 of BOEM (2021b). The modeled vessel types from USEPA (2022a) were compared to representative vessel types from BOEM (2021b), respectively, as follows: “Crew and Supply” as “Crew,” “Tugboat” as “Tug,” “Workboat” as “Research/survey,” and “Fishing C1/C2” as “Research/survey”.

[2] Vessel speeds during survey activities were assumed based on project information from Section 2.2 of the Final EA or appropriate estimates specific to each survey or monitoring activity. Vessel speeds during survey activities were assumed to be 12 knots for FLiDAR buoy-based acoustic monitoring.

3.1.2 Site Characterization Activities

Site characterization activities that are part of the Proposed Action would occur within the Research Lease Area and areas immediately surrounding it, potential cable routes, and the wet storage area in Penobscot Bay identified in the State of Maine’s research lease application (**Figure 3-1**), which all fall within the Action Area defined in **Figure 3-3**. Site characterization activities include geophysical reconnaissance surveys; HRG surveys; geotechnical surveys; benthic surveys; seafloor habitat characterization sampling and surveys; physical oceanographic monitoring; digital aerial surveys; visual wildlife surveys; passive acoustic monitoring (PAM) of marine mammals, ambient noise, and large pelagic and benthic fish; MOTUS tracking; active acoustic surveys, environmental DNA (eDNA) sampling of marine fish and invertebrates; bottom trawl surveys for marine fish and invertebrates; plankton and larval lobster surveys; lobster trap surveys; and associated vessel traffic. The State of Maine requested to conduct lobster trap surveys, which would include the use of vertical lines, in their site characterization activities. However, BOEM is not proposing that activity as part of the Proposed Action and requiring the lessee to acknowledge that the issuance of the lease does not covey coverage under the ESA Section 7(a)(2) for the use of fixed fishing gear vertical lines (i.e., lines between the bottom fishing gear and surface marking/retrieval buoys) that pose a risk of entanglement to large whales. BOEM’s ESA biological assessment and consultation with NMFS includes only lobster trap surveys that utilize ropeless gear technology. A description of these activities is provided in the following subsections.

3.1.2.1 Geophysical Reconnaissance Surveys

PTOW will conduct geophysical reconnaissance surveys within the Research Lease Area, export cable routes, and wet storage area in Penobscot Bay (**Figure 3-1**). Reconnaissance surveys are designed to cover a broader area and collect relatively lower resolution data than HRG surveys (**Section 3.1.2.2**) in order to identify specific locations for the subsequent HRG surveys. The surveys will utilize hull-mounted multibeam echosounder (MBES) with backscatter measurement (proxy for seafloor hardness) and a parametric sub-bottom profiler (SBP). The selected equipment specific to the geophysical reconnaissance survey scope will have operational frequencies greater than 180 kHz or operate at amplitudes and beamwidths such that an IHA for marine mammals will not be required (discussed further in **Section 6.3.2**). A summary of the equipment proposed for both the geophysical reconnaissance surveys and the HRG surveys is provided in **Table 3-4**.

Table 3-4. Proposed geophysical survey equipment for the geophysical reconnaissance and HRG surveys[1]

Equipment Category	System	Vessel Type(s)	Activity Using Equipment	Operating Frequency (kHz)	Source Level (SPL, dB re 1 µPa m)	Source Level (Lpk, dB re 1 µPa m)[2]	Beam Width (degrees)	Pulse Duration (ms)	Pusle Repetition (Hz)
MBES	Norbit Winghead	XO-450 XOCEAN USV	Geophysical reconnaissance surveys	400 and 200	180	220	400khz = 0.5°×0.9 200khz = 1.0°×2.0	0.5	<60
MBES	R2 Sonic 2024	Deepwater, shallow water	HRG surveys	170–450	191	221	<2	0.015–1.115	Up to 50
MBES	Kongsberg EM 2040	Deepwater, shallow water	HRG surveys	200 – 700	187[3]	NR	<2	1.5–12	Up to 50
MBES	Reason T50	Shallow water	HRG surveys	200–400	216[4]	220 to 223[4]	2	Up to 10	Up to 50
Parametric SBP	Innomar Medium	XO-450 XOCEAN USV	Geophysical reconnaissance	100	<243	247	+/- 1°	0.7–1.0	6–15
Parametric SBP	Innomar SES-2000 Medium-100	Deepwater, shallow water	HRG surveys	85–115	241[5]	247	2	0.7–2	Up to 40
Sound Velocity Profiler	Valeport SWiFT	XO-450 XOCEAN USV	Geophysical reconnaissance survey	N/A	N/A	N/A	N/A	N/A	N/A
SSS	Edgtech 4200	Deepwater, shallow water	HRG survey	300/600	206	212	140	5–10	NR
SSS	EdgeTech 4205	Deepwater, shallow water	HRG survey	300/600	NR	NR	50[6]	NR	NR
USBL	Sonardyne Mini-Ranger 2[7]	Shallow water	HRG survey	19–34	194	NR	90	5	1
USBL	IxBlue GAPS[8]	Shallow water	HRG survey	20–30	191	194	180	1	10

Equipment Category	System	Vessel Type(s)	Activity Using Equipment	Operating Frequency (kHz)	Source Level (SPL, dB re 1 µPa m)	Source Level (Lpk, dB re 1 µPa m)[2]	Beam Width (degrees)	Pulse Duration (ms)	Pusle Repetition (Hz)
SBP	GeoMarine Geospark 2000 (400 tip)[8]	Deepwater	HRG survey	0.25–5	206	214	180	2.8	1

dB = decibels; HRG = high-resolution geophysical; Hz = hertz; kHz = kilohertz; Lpk = peak sound pressure level; µPa = micropascal; MBES = multibeam echosounder; N/A = not applicable; NR = not reported; re = referenced to; SBP = sub-bottom profiler; SPL = root-mean-square sound pressure level; SSS = side-scan sonar; USBL = ultra-short baseline.

[1] Information for each source was obtained from the manufacturer.

[2] Source levels provided are in-beam.

[3] Source level from 78 FR 47495.

[4] Source levels are based on the measurements of Reason T20P frequency modulated waveforms from Crocker and Fratantonio (2016).

[5] The SPL source level is assumed to be the Lpk source level minus 6 dB based on average measurements of sub-bottom profilers from Crocker at Fratantonio (2016).

[6] Vertical beam width.

[7] System details from 87 FR 61575, except beam width, which is assumed to be 90° based on Sonardyne Ranger 2 details in 87 FR 33730.

[8] Source level and operating parameters from 88 FR 50117.

Geophysical reconnaissance surveys will occur between September and November 2024 and will include both 24-hour (i.e., daytime and nighttime) and 12-hour (i.e., daytime only) operations. It is anticipated that the 24-hour survey operations will require a total of 15 multi-day trips that would each last for approximately 7 to 14 days per trip depending on many factors, including weather downtime, vessel replenishment, and crew changes. The 12-hour operations will require 60 daily vessel trips during the 3-month survey period.

3.1.2.2 HRG Surveys

PTOW will conduct HRG surveys in the Research Lease Area, potential export cable routes, and wet storage area in Penobscot Bay (**Figure 3-1**). The surveys would collect bathymetrical (seafloor depth), morphological (topography), and geological data to inform various charting, interpretation, analyses, and reporting efforts for the State of Maine's research project, including assessment of archeological resources.The HRG surveys will utilize MBES, side-scan sonar (SSS), ultra-short baseline (USBL) equipment, parametric SBP, and a sparker SBP source. A summary of the equipment proposed for the HRG surveys is provided in **Table 3-4**.

Surveys will occur between March and May 2025 and will include both 24-hour (i.e., daytime and nighttime) and 12-hour (i.e., daylight only) operations. As summarized in **Table 3-6**, HRG surveys would only be conducted from up to two vessels concurrently: one for the 24-hour and one for the 12-hour operations. It is anticipated that the 24-hour survey operations will require 15 multi-day trips that would each last for approximately 7 to 14 days per trip depending on many factors, including weather downtime, vessel replenishment, and crew changes throughout the 4-monthy survey period. The 12-hour operations will require 60 daily vessel trips during the 4-month survey period between March and May 2025.

3.1.2.3 Geotechnical Surveys

PTOW will conduct geotechnical surveys of the Research Lease Area, potential export cable routes, and wet storage area in Penobscot Bay (**Figure 3-1**) to sample or test seabed characteristics to inform design specifications of and locations suitable for placement of anchors for future floating wind turbine foundations and cable infrastructure. Equipment used for these surveys will include shallow geotechnical coring (piston or vibracores) on the order of 6 to 12 inches (15 to 30 cm) in diameter, and cone penetration testing to depth of approximately 82 ft (25 m). The exact scope of these surveys has not yet been determined but it is anticipated that several hundred vibracores and cone penetration testing samples will be required throughout the survey area and survey period. Each sample would result in minimal seafloor disturbance, on the order of a few square meters in disturbance area. PTOW is preparing a full G&G survey plan which will define this information and will be reviewed and approved by BOEM and NMFS prior to the start of these surveys in 2025. It is anticipated that the surveys will be conducted using 24-hour operations (i.e., daytime and nighttime) and will require 30 multi-day trips that would each last for approximately 7 to 14 days per trip, depending on many factors, including weather downtime, vessel replenishment, and crew changes. Surveys will occur over a 3-month period between March and May 2025, and a 4-month period between August and November 2025.

3.1.2.4 Benthic Surveys

PTOW will conduct detailed benthic surveys to characterize seafloor habitats of the Research Lease Area, export cable routes, and wet storage area identified in the State of Maine's research lease application (**Figure 3-1**). The surveys will utilize benthic grabs (Hamon grab or Van Veen grab), frame-mounted sediment profile imaging/plan view cameras, and underwater video. The underwater video data will be used to meet the same survey goals of the geophysical reconnaissance survey scope (**Section 3.1.2.1**) and will be deployed with the benthic grabs and sediment profile imaging/plan view cameras during the benthic surveys.

The exact scope of these surveys has not yet been determined but it is anticipated that several hundred benthic samples will be required throughout the survey period. Each sample would result in minimal seafloor disturbance, on the order of several square meters in disturbance area. PTOW is preparing a full G&G survey plan which will define this information and will be reviewed and approved by BOEM and NMFS prior to the start of these surveys. It is anticipated that the benthic survey vessel will conduct 24-hour operations (i.e., daytime and nighttime) and will undergo up to 30 multi-day trips that would each last for approximately 7 to 14 days per trip, depending on many factors, including weather downtime, vessel replenishment, and crew changes. Surveys will occur over a 3-month between September and November 2024. Benthic surveys will be conducted from the same vessels planned for the geophysical reconnaissance surveys in **Section 3.1.2.1**.

3.1.2.5 Seafloor Habitat Characterization Surveys

DMR will conduct seafloor habitat characterization surveys of the Research Lease Area, potential export cable routes, and wet storage area in Penobscot Bay (**Figure 3-1**) to characterize seafloor habitat and benthic infauna species composition. Data collected would include water column profiles; average seafloor values for temperature, pH, chlorophyll, dissolved oxygen, and salinity; surficial sediment information; seafloor video; benthic species composition; bathymetry; and backscatter.

Water column profiles will be collected in concert with the Maine Coastal Mapping Initiative's (MCMI's) sonar mapping efforts (DMR 2022a) and will utilize a sound velocity profiler (SVP) to collect the water column profiles. In shallow water and in areas where topographic breakpoints in the seafloor are observed, SVP casts are taken every hour. During continuous vessel operations in offshore locations without much topographic variation, SVP casts may be taken every 3 hours to adequately characterize the water column based on physical characteristics. The surface sound velocity will be continuously monitored for any deviations, and new casts will be taken at a shorter interval if deviations are observed. When MCMI is grab sampling, water column samples will be taken with an Exo or SeaBird conductivity, temperature, and depth (CTD) instrument mounted on the sampling frame.

Seafloor sampling and surveys will utilize benthic grab equipment and MBES. The benthic grab equipment will include a young-modified Van Veen grab sampler with dimensions of 160 mm × 320 mm × 6 liters, or a Ponar dredge with dimensions of 229 mm × 229 mm × 8.2 liters. The anticipated area of seafloor disturbance for this equipment is <22 ft^2 (<2 m^2) for each grab sampling location, including the direct impact from the sampling frame, and all grab samples will be processed using MCMI existing protocols:

- The sediment surface is photographed with scalebar;
- 500 ml of well-mixed sediment is transferred into sampling bags and wet sediment color is determined using Munsell color charts. Field estimates of sediment grain size distribution is made according to the Coastal and Marine Ecological Classification Standard (CMECS) classification scheme;
- The sediment samples are placed in a cooler on ice packs until they can be stored in the lab refrigerator;
- The sediment samples are kept refrigerated or frozen to prevent geochemical reactions, growth of organic material, or evaporation. Sediment samples are wet sieved for grain size analysis and percentage of gravel, sand, silt, and clay is measured using net dry weight of each size fraction; and
- The benthic fauna samples are collected from grab samples by sieving animals and associated sediments down to a 500-micron size fraction and preserving sieved materials with 95% non-denatured ethanol. Collected fauna are processed in the lab by removing specimens from any remaining associated sediment and sorting by phylum. Specimens are then identified to family level (or lowest taxonomic level practicable) and counted to obtain abundance and diversity measures. Benthic fauna survey data are used to classify seafloor habitats in accordance with the CMECS.

MCMI protocols also include collecting three minutes of high-definition video of the seafloor at every grab sampling site using grab-framed mounted cameras. Videos are analyzed to characterize benthic epifaunal communities and identify mobile fauna (e.g., fish, crabs, zooplankton, etc.). Seafloor video survey data are used to classify benthic habitats using the CMECS framework.

The MBES equipment proposed for the seafloor habitat characterization surveys is summarized in **Table 3-5**.

Table 3-5. Proposed multibeam echosounder equipment that will be used for the seafloor habitat characterization surveys

	Existing MCMI Equipment[1]	Anticipated for 2024 and After[2]
Type	Kongsberg EM 2040C	Kongsberg EM 2042
Operating Frequency	300 kHz (200-400 kHz supported)	300 kHz (150-700 kHz supported)
Source Level (Lpk)	205 dB re 1 µPa m	211 dB re 1 µPa m
Source Level (SPL)	194 dB re 1 µPa m	198 re 1 µPa m

dB = decibels; Hz = hertz; kHz = kilohertz; µPa = micropascal; Lpk = peak sound pressure level; MCMI = Maine Coastal Mapping Initiative; re = referenced to; SPL = root-mean-square sound pressure level.

[1] The type of equipment used for this survey scope is based on the information provided in DMR (2022b), and the source information comes from the manufacturer.

[2] The type of equipment selected for this survey scope is based on personal communication with DMR staff scientists, and the source information provided in this table comes from the manufacturer.

These surveys will be conducted once per year beginning in the Quarter 1 of 2023 and continuing until the RAP is approved. For the purposes of the assessment in this BA, it was conservatively assumed that the RAP would be approved within 5 years of lease issuance, or approximately February 2029. The total number of trips per annual survey will depend on the expected range of the contracted vessel, but for the purposes of this BA it was assumed a total of 10 vessel trips would be required each year for the annual surveys.

3.1.2.6 Physical Oceanographic Monitoring

DMR will conduct monitoring to characterize the physical oceanographic conditions and surface wind conditions in and around the Research Lease Area (**Figure 3-1**). Above-water and surface data will be collected from existing shore-based radar stations with 3.1-mi (5-km) resolution operated by the State of Massachusetts; two additional radar stations with 1.2-mi (2-km) resolution will also be installed along the Maine coast in the first year after lease issuance. In following years, one to three additional radar stations may be installed. Subsurface water data on water column temperature, salinity, chlorophyll-a concentration, and suspended particulate concentration would be collected with a single Slocum glider. The glider length is 4.9 ft (1.5 m), and the hull diameter is 9 inches (22 cm). The average speed of the glider is 1 knot with thruster speeds up to 2 knots. Initial deployment will take place south of Mount Desert Island and transit to the west across the Maine Coastal Current. These initial legs will help to better understand the ocean conditions upstream of the Research Lease Area. The glider will then make repeated circuits through and around the Research Lease Area before returning to the north and being recovered offshore of the Damariscotta River. If the transit time from Mount Desert Island to the Research Lease Area is too long, DMR will either use a more direct pathway or deploy the glider from near the Damariscotta River.

Monitoring from the shore-based radar stations would occur continuously, while the glider would be deployed approximately every other month, and each would operate for approximately a one-month period. No samples are collected by the glider, rather it will measure the desired parameters of the water in-situ. Installation of the shore-based radar stations began in 2023, and test glider deployments to work out logistics began in July 2023 which required a total of three vessel trips. Data collection deployments will begin in July 2024 and continue until the RAP is approved, which was conservatively estimated for this BA to occur within 5 years of lease issuance, or approximately February 2029. Vessel transits for physical oceanographic monitoring activities may be required every other month for deployment of the underwater glider; however, deployment of the glider may occur less frequently based on data needs. For the purposes of this BA, it was assumed one vessel trip for deployment every other month would be required between 2024 and 2028, with only one vessel trip required for 2029 since RAP approval is anticipated in February of that year.

3.1.2.7 Digital Aerial Surveys

PTOW will work with HiDef and Biodiversity Research Institute (BRI) to conduct high-definition digital aerial surveys of the Action Area (**Figure 3-3**) to sample and map seasonal occurrence and activity of birds (as well as bats, marine mammals, sea turtles, and large fish). Surveys will also document the number of individuals, distribution, behaviors (e.g., foraging, flying, resting), and flight height and direction (if applicable). The surveys will use high-resolution digital video cameras mounted on a fixed-wing aircraft flying at an altitude of approximately 1,312 ft (400 m) and ground speed of approximately 120 knots, providing imagery at 0.6 inches (1.5 cm) ground sample distance. Initially, surveys would cover the entire 68,320-acre (276-km^2) Research Lease Area, but may be reduced to cover the 9,728-acre (39.4-km^2) State of Maine's requested lease area plus a 2.5-mi (4-km) buffer (**Figure 3-4**).

BOEM has funded four broad digital surveys (once per season) conducted by HiDef and BRI that started in the Spring of 2023. To meet BOEM's Avian Survey Guidelines, PTOW aims to continue this work and conduct a total of four flights per quarter in the Action Area starting May 2023 through March 2024. Thereafter, monthly flights will be conducted from April 2024 through March 2025, with a possible extension through March 2026. Four surveys will be flown alongside the BOEM-funded surveys being conducted by HiDef and BRI, and eight will be standalone surveys. By flying additional interlaced transects, spaced evenly between the existing BOEM transects, these surveys will provide approximately 15% cover of the Research Lease Area, plus a 3-mi (4-km) buffer. The BOEM Guidelines require greater than 10% coverage, and due to the small survey area, and the limited flexibility in transect spacing, this coverage represents the most efficient way to accomplish this objective.

3.1.2.8 Visual Wildlife Surveys

Vessel-based visual wildlife surveys will be conducted by BRI, in cooperation with the Gulf of Maine Research Institute (GMRI) to assess marine mammal, bird, and sea turtle species utilization of the Research Lease Area (**Figure 3-1**), with emphasis on endangered and threatened species listed under the ESA. The surveys will also assess information variability and uncertainty associated with baseline surveys. All observers will document species identification, location, group size, distance and bearing from vessel, flight height for birds, and behavior for each sighting as well as sea state, time of day, glare, and fishing activity in the area. Surveys will be conducted by two bird observers, trained by the Maine Department of Inland Fisheries and Wildlife for protected species and bird observations, and four marine mammal observers, trained as protected species observers. The visual wildlife surveys will be conducted from the same vessel used for the active acoustic surveys described in **Section 3.1.2.11**, which will require up to two 12-hour (i.e., daytime only) vessel survey days per month. Test surveys to work out logistics began in Quarter 4 of 2022, and data collection surveys will begin in April 2024 through approval of the RAP, which was conservatively estimated in this BA to occur within 5 years of lease issuance, or approximately February 2029. The vessels would follow fixed transects and would not deviate to intercept marine mammals. Vessel speeds will not exceed 10 knots during the transects and all vessels associated with these surveys will adhere to all vessel strike avoidance measures described in **Section 3.3**.

3.1.2.9 PAM for Marine Mammals, Ambient Noise, and Large Pelagic and Benthic Fish

DMR will conduct passive acoustic monitoring to characterize marine mammal utilization of the Research Lease Area and vicinity to quantify ambient noise levels. The mooring suites would be spaced across the Research Lease Area and 12 nmi (22 km) buffer (in all directions) to incorporate into the larger PAM network across the Gulf of Maine. Under the Proposed Action, DMR will also opportunistically tag fish caught by rod and reel fishing with acoustic transmitter tags to characterize seasonal distribution, movement patterns, and habitat use of highly migratory (e.g., tuna, sharks) and benthic (e.g., cod, hake, haddock, redfish, dogfish) fishes. Opportunistic tagging will focus on highly migratory species, and no ESA-listed fish have been caught using this method by DMR in adjacent areas to date. Pop-up satellite archival tags (PSATs) may be used in future years for longer range monitoring of larger species such as basking sharks. Receivers capable of detecting the presence of tagged fish would be deployed in a grid across the Research Lease Area with a few additional receivers placed adjacent to the Research Lease Area in areas of high species abundance.

Acoustic data for marine mammals and ambient noise levels will be collected using nine SoundTrap ST600 hydrophones equipped with F-POD devices. Recorded data will be analyzed for all whale calls, especially the presence of North Atlantic right whale (NARW) calls, with a primary focus on their 100 to 300 Hz upcalls. The hydrophones will sample at a rate of 48 kHz which equates to an effective analysis range of up to 24 kHz. The F-PODs enable detection of odontocete (toothed whale) species with core detection bands generally under 140 kHz. There is no surface connection to the SoundTrap systems; all equipment is bottom mounted using a 100 lb, 4-ft (1.2-m) long steel beam used as an anchor that sits on the seafloor with no vertical lines to the surface. This anchoring method was selected to be consistent with the mooring design and anchor used by NOAA's Passive Acoustic Group.

For the large pelagic and benthic fish monitoring, 15 Vemco VR2AR Receivers will be moored within the Research Lease Area and 12 nmi (22 km) buffer (in all directions) using spectra rope anchored to 100 lb, 4-ft (1.2-m) long steel beams; the receivers will be floated approximately 50 ft (15 m) above the anchor to detect the acoustic transmitter tags. Each receiver would be equipped with an acoustic release, eliminating the use of surface buoys that require vertical lines extending through the water column that may pose entanglement risks to marine mammals and sea turtles. PSATs do not require detection by the acoustic array and would pass data via a satellite link at a pre-selected time.

The SoundTrap hydrophones for marine mammal and ambient noise data collection will be deployed from one 45-ft (14-m) research vessel starting in June 2024 and continue through RAP approval, which was conservatively estimated in this BA to occur within 5 years of lease issuance, or approximately February 2029. Tagging of large pelagic and benthic fish began in Quarter 3 of 2022 and will continue through RAP approval; the Vemco receivers used for the large pelagic and benthic fish monitoring will be deployed beginning in June 2024 and will operate continuously through RAP approval (approximately February 2029). It is anticipated that the Vemco receivers will require a single vessel trip to deploy the equipment, a single vessel trip to retrieve the equipment, and a single trip once per year to change out the batteries on all units. Tagging activities required 8 round trips per year in 2022 and 2023 which are included in the total number of trips provided in **Table 3-6**. The SoundTrap hydrophones will need to be serviced every 3 to 4 months, but all nine hydrophones can be serviced during a single vessel trip, so it is anticipated that deployment and retrieval of this equipment will require one vessel trip each, and up to four vessel trips per year would be required for servicing the equipment between 2024 and 2029.

3.1.2.10 MOTUS Tracking

MOTUS is an international collaborative network established by researchers that have tagged birds and bats with automated radio telemetry tags. A MOTUS Wildlife Tracking System-compatible receiver station will be deployed on the FLiDAR buoy (**Section 3.1.1.1**) to provide data on the occurrence of tagged birds or bats in the Research Lease Area coupled with information on the season, time of day, and weather conditions. MOTUS data are limited to the birds or bats that are tagged and occur in the Action Area during the FLiDAR buoy offshore deployment. The receiving station will operate at a common frequency compatible with other MOTUS installations in the region. Additionally, the Project would also fund deployment of up to two new MOTUS receivers on coastal islands in the Action Area. Deployment of the additional MOTUS receivers would be performed by vessels already scheduled to transit to these areas, so no additional vessel traffic beyond what is described in **Section 3.1.2.15** would be required. It is expected that all the MOTUS tracking systems will be deployed for 24-months (Quarter 2 of 2024 through Quarter 2 of 2026) as part of the FLiDAR buoy deployment period.

3.1.2.11 Active Acoustic Surveys and eDNA Sampling of Marine Fish and Invertebrates

GMRI, under contract from the State of Maine, would conduct active acoustic surveys along fixed transects in the Research Lease Area and vicinity to evaluate marine fish, particularly small pelagic species, and invertebrate species and taxon abundance and distribution in the water column and in proximity to the benthos. A Simrad EK60 echosounder system with three split-beam transducers (38, 120, and 200 kHz) will be utilized for these surveys.

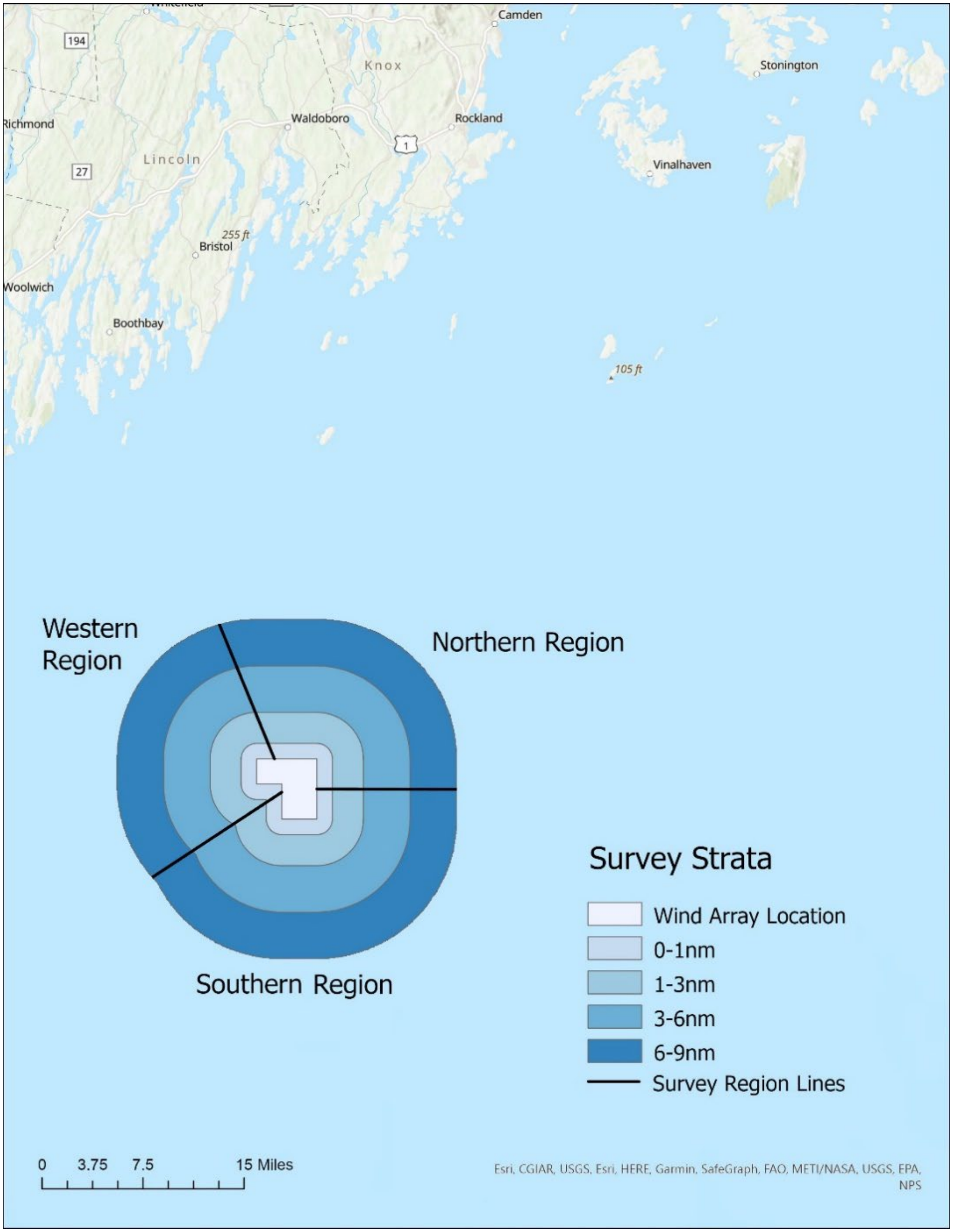
Water samples will be collected with a 5 L General Oceanics Niskin Water Sampler, then immediately transferred to 1 L Nalgene bottles and run through eDNA analysis to ground truth the acoustic data. The proposed Niskin Water Sampler is comprised of a non-metallic free-flushing sampling bottle that is 27.2 inches (69.2 cm) in length and 8.5 lbs in weight. Selection of the sampling locations will depend on the locations of the future wind turbines, which will be identified after lease issuance.

It is anticipated that these surveys will require two 12-hour (i.e., daytime only) vessel trips per month. Test surveys to work out logistics began in Quarter 4 of 2022, and data collection surveys will begin in April 2024 to approval of the RAP, which was conservatively estimated in this BA to occur within 5 years of lease issuance, or approximately February 2029.

3.1.2.12 Bottom Trawl Surveys for Marine Fish and Invertebrates

DMR would conduct bottom trawl surveys to evaluate marine fish and invertebrate species composition in proximity to the benthos. The goal of these surveys is to sample out from the Research Lease Area in three stratified regions that cover different areas of high use by marine fish and invertebrate species identified during the siting process. The innermost strata for the survey is in the Research Lease Area; the next strata extends over 1 nmi (1.9 km) out from the edge of the Research Lease Area; the next strata extends 1 to 3 nmi (1.9 to 5.6 km) from the Research Lease Area; the next strata extends 3 to 6 nmi (5.6 to 11.11 km) from the Research Lease Area; and the final strata extends 6 to 9 nmi (11.11 to 16.67 km) from the Research Lease Area (**Figure 3-2**). There are three regions of the survey: a northern region, western region, and southern region (**Figure 3-2**). The total survey area is approximately 512 mi^2 (1,326 km^2) and ranges in depth from 269 to 610 ft (82 to 186 m). The sampling area encompasses portions of several significant geomorphic features, such as Three Dorys Ridge, the Mistaken Ground area, and parts of Platts Bank. It is anticipated that 30 to 38 bottom trawls would be conducted seasonally in the following windows, with a total of 120 to 152 trawls expected each year:

- Winter = January 1st to March 1st
- Spring = April 1st to May 31st
- Summer = July 1st to August 31st
- Fall = September 26th to October 31st



Source: Maine DMR's Bottom Trawl Survey Plan for Maine's Offshore Research Array

Figure 3-2. Proposed survey design for the bottom trawl survey for marine fish and invertebrates. The edge of the survey area is about 18 mi (29 km) from Boothbay Harbor

Surveys would not be conducted under regular commercial fishing permits and protocols, and as discussed in **Section 2.2.4,** DMR will pursue a Letter of Acknowledgement from NMFS. The proposed survey area shown in **Figure 3-2** would not overlap with the area surveyed by the Maine-New Hampshire Inshore Trawl Survey as the outer boundary of that survey extends approximately 12 mi (19 km) off the coast, which ends 6 mi (9 km) before outer edge of the bottom trawl survey area.

The gear for the survey will utilize the same gear as the Maine-New Hampshire Inshore Trawl Survey (Sherman et al. 2005). Survey equipment will consist of a modified shrimp net with 2 in polyethylene stretched mesh and a 1-in cod end liner. The net has 60-ft (18-m) top legs that are 7/16th inch wire and 58-ft (17-m) bottom legs that include two feet of 5/8th inch chain at the end where the wings attach to the bottom leg for a total of 60 ft (18 m). The ground gear for this net is a roller frame which has 6-inch rubber discs with 4-inch rubber disc spacers between each 6-inch disc on the 29-ft (9-m) wing sections and a 10-ft (3-m) section of 8-inch rubber discs with 4-inch cookies to maintain spacing in the middle. The roller frame has equally spaced toggles to attach to a 7/16th inch wire which is then attached to the 70 ft (21 m) footrope which is made of 5/8th inch Rander's Combination Wire Rope. The 58 ft (17 m) headline has twenty-eight deep-sea net floats on 5/8th inch polyethylene float line. The doors being used for this survey are type 25 Thyboron THYson trawl doors, weighing about 606 lb (275 kg) each and approximately 21 ft^2 (2 m^2) in size. Simrad net sensors will be monitoring the net performance during every tow to evaluate door spread, wind spread, headline height, and bottom contact to ensure the net is fishing consistently between tows. The net will be towed at a speed of 2.5 knots for up to 20 minutes in duration for each tow.

It is anticipated that one to six vessel trips will be conducted seasonally, beginning in Quarter 4 of 2024 and continuing until the RAP is approved, which was conservatively estimated in this BA to occur within 5 years of lease issuance, or approximately February 2029.

3.1.2.13 Plankton and Larval Lobster Surveys

DMR would conduct vertical and neuston tows to characterize the zooplankton community, examine aggregation patterns throughout the water column, and quantify abundance and seasonal timing of lobster and other crustacean larvae. Tows would be conducted within and up to 3 nmi (5.6 km) outside of the Research Lease Area. Surveys would not be conducted under regular commercial fishing. Vertical tows will follow the Department of Fisheries and Oceans Canada (DFO) Atlantic Zone Monitoring Program protocols (Mitchell et al. 2002) and the neuston tows will follow DMR's larval survey protocol (DMR 2022c). The neuston net used for this survey would be 3 ft (1 m) wide and towed for up to 15 minutes for each tow, while the vertical tows will be deployed for approximately 2-3 minutes for each tow. The neuston tows would sample the top 1.6 ft (0.5 m) of the water column using a 500 µm mesh, and the vertical tows would sample at 33 ft (10 m) and >492 ft (>150 m) water depth using a 200 µm mesh.

Selection of survey locations will consider seasonal wind patterns in order to establish a baseline to examine potential impacts on stratification downstream from potential future turbine installations. It is anticipated that there will be a maximum of 10 sample stations, four of which will be considered the core stations and 6 the intermediate stations. At each station, DMR will conduct one >492 ft (>150 m) vertical tow; three 1-km long neuston tows; a CTD cast; and a chlorophyll-a content measurement at three water depths. Additionally, at each core station DMR will conduct one 33 ft (10 m) vertical tow and a zooplankton chlorophyll-a content measurement in the upper 33 ft (10 m) of the water column.

Test surveys to work out logistics began in Quarter 4 of 2023. Data collection surveys will begin in April 2024 and continue until the RAP is approved, which was conservatively estimated to occur within 5 years of lease issuance, or approximately February 2029. During the first year after lease issuance, one or two vessel trips per month are anticipated following the deployment timing of the neuston and vertical tows described above. In subsequent years, the port and number of trips per month would depend on the contracted vessel, but as indicated in **Table 3-6**, it was assumed up to two vessel trips per month will be required for the 5-year duration of these surveys. The vertical tows will be conducted monthly year-round, and the neuston tows will be conducted monthly between the months of April and November during the survey period. For each monthly vessel trip, up to 10 vertical tows at the >492 ft (>150 m) water depth will be conducted; up to four vertical tows at the 33 ft (10 m) water depth will be conducted; and up to three neuston tows will be conducted.

3.1.2.14 Lobster Trap Surveys

DMR would conduct lobster trap surveys to characterize the lobster population, including the presence of large egg-bearing and oversized lobsters, to assess movement patterns of lobsters, and to test ropeless fishing gear. As described in **Section 2.2.4**, DMR will be pursuing a Letter of Acknowledgement from NMFS for these activities. Twenty-five trawl strings, each consisting of 12 individual lobster traps, including both vented and ventless trap types, will be set during each sampling period (see below for deployment frequency). All traps set within and up to 12 nmi (22 km) outside the Research Lease Area. Each trawl string will utilize ropeless fishing gear, thereby eliminating the need for any vertical buoy lines. All rope or lines used (i.e., between pots in a set) would follow the requirements of the commercial Atlantic Large Whale Take Reduction Plan (ALWTRP) Risk Reduction Rules, including use of sinking groundlines and 1,700 lb weak points (**Section 3.3.9**).

The twenty-five trawl strings will be deployed three times per season each year in winter (February), spring (April-May), and summer (July-August). As noted in **Section 3.3.9**, no gear can be set under the Proposed Action in the Lobster Management Area 1 restricted area between October 1 and January 31 (NMFS 2023a), so no traps will be deployed during these months. Each survey will consist of transporting and hauling the strings of traps three times over six trips per season. The target soak time will be one week each, weather-dependent. Details of the six trips are as follows:

- The first trip would transport and set nine trawl strings comprising 108 traps for a week-long soak;
- The second trip would transport and set eight new trawl strings comprising 96 traps and would haul and replace the first nine trawl strings for a total of 204 traps in the water for a week-long soak;
- The third trip would transport and set eight new trawl strings comprising 96 traps and would haul and replace the first 17 trawl strings for a total of 300 traps in the water for a week-long soak;
- The fourth trip would haul all 25 trawl strings comprising 300 traps, but would transport nine of the trawl strings to shore leaving a total of 192 traps in the water column for a week-long soak;
- The fifth trip would haul the remaining 16 trawl strings (comprising 192 traps), but would transport eight of the trawl strings to shore leaving a total of 96 traps in the water column for a week-long soak; and
- The sixth trip would haul and transport the remaining 8 trawl strings to shore to be stored on land, completing this deployment.

The six trips described above would be repeated three times each swinter, spring, and summer. These surveys are anticipated to begin in September 2024 and continue until approval of the RAP, which was conservatively estimated to occur within 5 years of lease issuance, or approximately February 2029.

3.1.2.15 Vessels and Potential Ports

The potential types, number of transits, home ports, and potential speeds for vessel activities associated with the proposed site characterization activities described in the previous subsections is summarized in **Table 3-6**. Estimated distances that vessels are expected to travel during transit between the home ports and the Research Lease are provided in **Table 3-7**. The information in this table represents the best estimate of potential vessels transiting throughout the Action Area for the site characterization surveys included under the Proposed Action. Estimates of vessel speeds during transiting and survey activities are provided based on available information from BOEM (2021b) or based on the type of survey activities proposed for each vessel; however, all vessels in **Table 3-6** included under the Proposed Action will adhere to the vessel strike avoidance measures provided in **Section 3.3**, so actual vessel speeds may differ based on mitigation requirements during the surveys.

Table 3-6. Estimated Proposed Action vessel use during site characterization activities

Vessel Type	Approx. Vessel Length	Approx. Vessel Draft	Home Port	Destination	Number of Vessels	Timing	Total Number of Round Trips[1]	Frequency of Transits	Approx. Vessel Transit Speed (knots)[2]	Approx. Vessel Survey Speed (knots)[3]
Geophysical reconnaissance 24-hour vessel	164 ft (50 m)	11.8 ft (3.6 m)	Portland, ME	Research Lease Area, export cable routes, wet storage area	1	September through November 2024	15	Every 7 to 14 days	11.5	4.5
Geophysical reconnaissance 12-hour vessel	49 ft (15 m)	10 ft (3 m)	Portland, ME	Research Lease Area, export cable routes, wet storage area	1	September through November 2024	60	Daily	11.5	4.5
HRG survey 24-hour vessel	164 ft (50 m)	11.8 ft (3.6 m)	Portland, ME	Research Lease Area, export cable routes, wet storage area	1	March through May 2025	15	Every 7 to 14 days	11.5	4.5
HRG survey 12-hour vessel	49 ft (15 m)	10 ft (3 m)	Portland, ME	Research Lease Area, export cable routes, wet storage area	1	March through May 2025	60	Daily	11.5	4.5
Geotechnical survey vessel	246–262 ft (75-80 m)	12.8 feet (3.9 m)	Portland, ME	Research Lease Area, export cable routes, wet storage area	1	August through November 2025	30	Every 7 to 14 days	11.5	4.5
Research vessel for seafloor habitat characterization surveys	45 ft (14 m)	10 ft (3 m)	Boothbay, ME	Research Lease Area, export cable routes, wet storage area	1	Q1 2023 – RAP approval[4]	70	Annual	12.5	4.5

Vessel Type	Approx. Vessel Length	Approx. Vessel Draft	Home Port	Destination	Number of Vessels	Timing	Total Number of Round Trips[1]	Frequency of Transits	Approx. Vessel Transit Speed (knots)[2]	Approx. Vessel Survey Speed (knots)[3]
Research vessel for physical oceanographic monitoring	45 ft (14 m)	10 ft (3 m)	Boothbay, ME	Research Lease Area	1	July 2023 – RAP approval[4]	34	Every other month[5]	12.5	12.5
R/V *Merlin* for visual wildlife surveys and active acoustic surveys and eDNA sampling for visual wildlife surveys[6]	65 ft (19 m)	11 ft (3.4 m)	Portland, ME	Research Lease Area	1	Q4 2022 – RAP approval[4]	232	Monthly	22.1	10
Research vessel for PAM surveys for marine mammals, ambient noise, and large pelagic and benthic fish	45 ft (14 m)	10 ft (3 m)	Boothbay, ME	Research Lease Area	1	June 2024 – RAP approval[4]	112	Every 3 months[7]	12.5	10
Stern rigged single screw bottom trawler for bottom trawl surveys	70 ft (21 m)	11 ft (3.4 m)	Boothbay, ME	Research Lease Area	1	Q4 2024 – RAP approval[4]	108	Seasonally[8]	12.5	2.5
Research vessel for plankton and larval surveys for plankton and larval lobster surveys	45 ft (14 m)	10 ft (3 m)	Boothbay, ME	Research Lease Area	1	Q4 2023 – RAP approval[4]	130	Monthly[9]	12.5	2.5

Vessel Type	Approx. Vessel Length	Approx. Vessel Draft	Home Port	Destination	Number of Vessels	Timing	Total Number of Round Trips[1]	Frequency of Transits	Approx. Vessel Transit Speed (knots)[2]	Approx. Vessel Survey Speed (knots)[3]
Commercial lobster boat, single screw for lobster trap surveys	50 ft (15 m)	10 ft (3 m)	Bristol, ME	Research Lease Area	1	September 2024 – RAP approval[4]	110	Quarterly	12.5	2.5

[1] A round trip was assumed to include the vessel transiting from the home port to the destination (depending on the survey for which the vessel is operating) as well as the vessel transiting from the destination back to the home port.

[2] Vessel speeds during transit were sourced from Table A-4 of BOEM (2021b). The modeled vessel types from USEPA (2022a) were compared to representative vessel types from BOEM (2021b), respectively, as follows: “Crew and Supply” as “Crew,” “Tugboat” as “Tug,” “Workboat” as “Research/survey,” and “Fishing C1/C2” as “Research/survey”.

[3] Vessel speeds during survey activities were assumed based on project information from Section 2.2 of the Final EA or appropriate estimates specific to each survey or monitoring activity. Vessel speeds during survey activities were assumed to be 4.5 knots for G&G surveys, 12.5 knots for physical oceanographic monitoring, 10 knots for visual wildlife surveys, 10 knots for acoustic surveys and monitoring, and 2.5 knots for fish and trawl surveys.

[4] This BA makes the conservative assumption that the RAP would be approved within 5 years of lease issuance, or approximately February 2029.

[5] Vessel transits for physical oceanographic monitoring activities may be required every other month for deployment of the underwater glider; however, deployment of the glider may occur less frequently based on data needs. For the purposes of this BA, the maximum-case scenario of one deployment every other month was assumed in the determination of effects in **Section 6**.

[6] The visual wildlife surveys will be conducted from the same vessel used for the active acoustic surveys and therefore these activities were combined in this table.

[7] Number and frequency of transits for the PAM surveys will differ depending on the equipment being serviced, but it is anticipated that the SoundTrap hydrophones will be serviced every 3 months, while the Vemco recievers will be serviced once each year, and tagging activities will be oppotrunistic. Therefore, the frequency of the transits provided for this vessel is based on the equipment requiring the most frequent vessel transits, which is the SoundTrap hydrophones.

[8] Bottom trawl surveys may include one to six vessel trips per season depending on final port location and vessel availability; therefore, for the purposes of this BA, the maximum number of potential trips assuming six vessel trips per season was used in the analysis.

[9] During the first year of plankton and larval surveys after lease issuance, one or two vessel trips per month is anticipated, and in subsequent years, the number of tips will depend on contracted vessels. For the purposes of this BA, it was assumed up to two vessel trips per month will be required for the duration of these surveys.

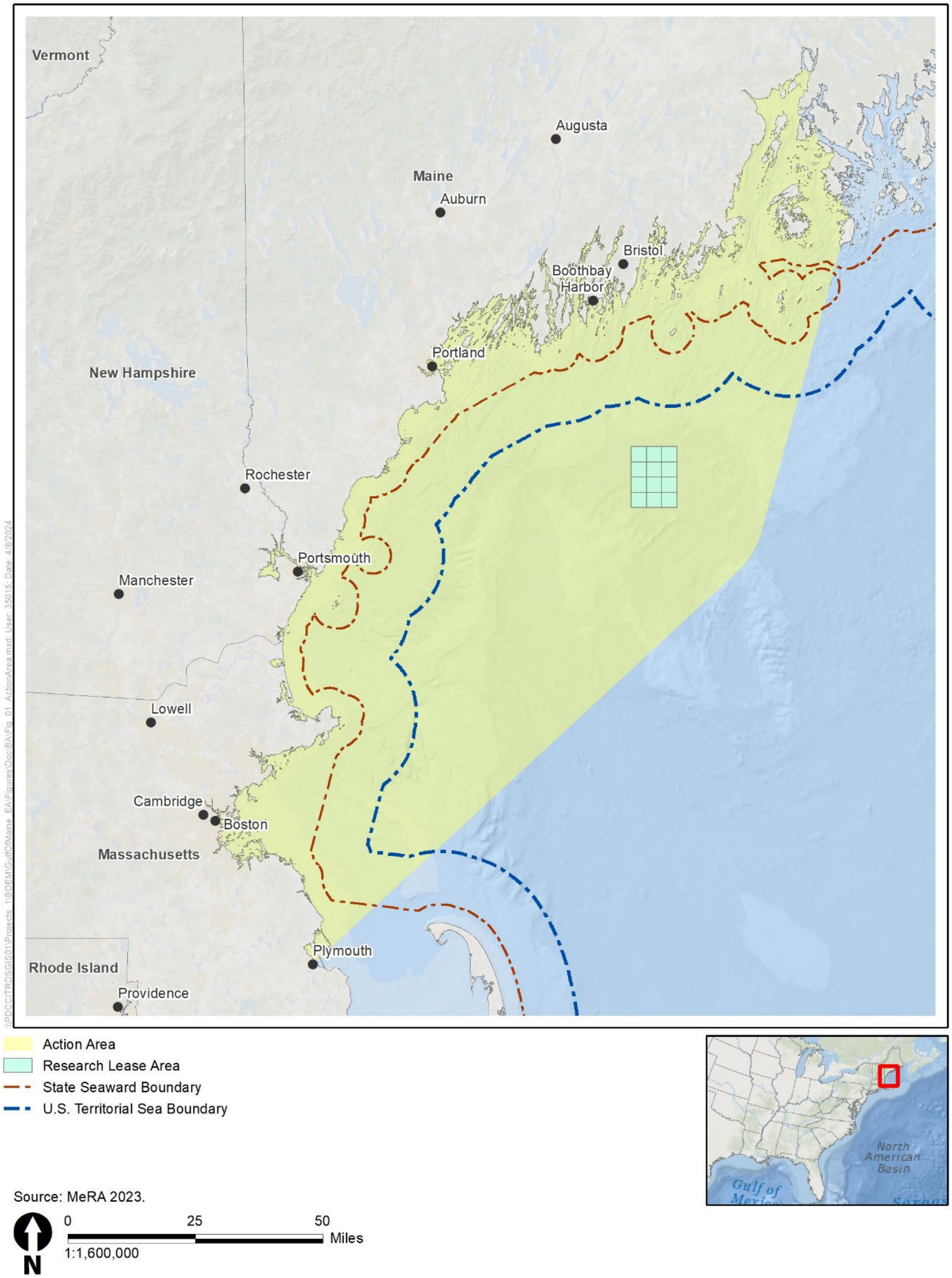
Table 3-7. Estimated distances project vessels would travel from the Research Lease Area to the nearest ports (nautical miles) for all ports and vessels included under the Proposed Action

Home Port	One-way Trip[1]	Round Trip[1]
Boothbay, ME	40	80
Boston, MA	100	200
Bristol, ME	45	90
Plymouth, MA	110	220
Portland, ME	50	100

[1] One-way trip distances outside the Research Lease Area were approximated by measuring the distance from each port to the farthest corner of the Research Lease Area. This distance was doubled to estimate roundtrip distance.

3.2 Action Area

The Action Area (**Figure 3-3**) is defined by 50 CFR 402.02 as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.” The Action Area for this consultation is a broad region that encompasses the area where all Project activities will occur, inclusive of all site assessment and site characterization surveys (e.g., benthic, fisheries, biological, geophysical reconnaissance, HRG, aerial) as well as all vessel transit routes for all Project-related activities. The Action Area as defined includes the entire Research Lease Area, the area encompassing all potential cable routes, the wet storage area in Penobscot Bay (**Figure 3-1**), and ports located in Boston, Massachusetts; Portland, Maine; Boothbay, Maine; and Bristol, Maine. No vessel transits from ports outside of this region are considered under the Proposed Action. Further, no upriver vessel transits are planned under the Proposed Action. A geographic overview of the Action Area is provided in **Figure 3-3**. The State of Maine’s requested lease area (9,728 acres [39.4 square kilometers]) falls within the narrowed area of interest (34,596 acres [140 square kilometers]) and broader Research Lease Area (68,320 acres [276 square kilometers]); these defined areas are identified in **Figure 3-4**.



Source: MeRA 2023.

Figure 3-3. Action Area for the Proposed Action

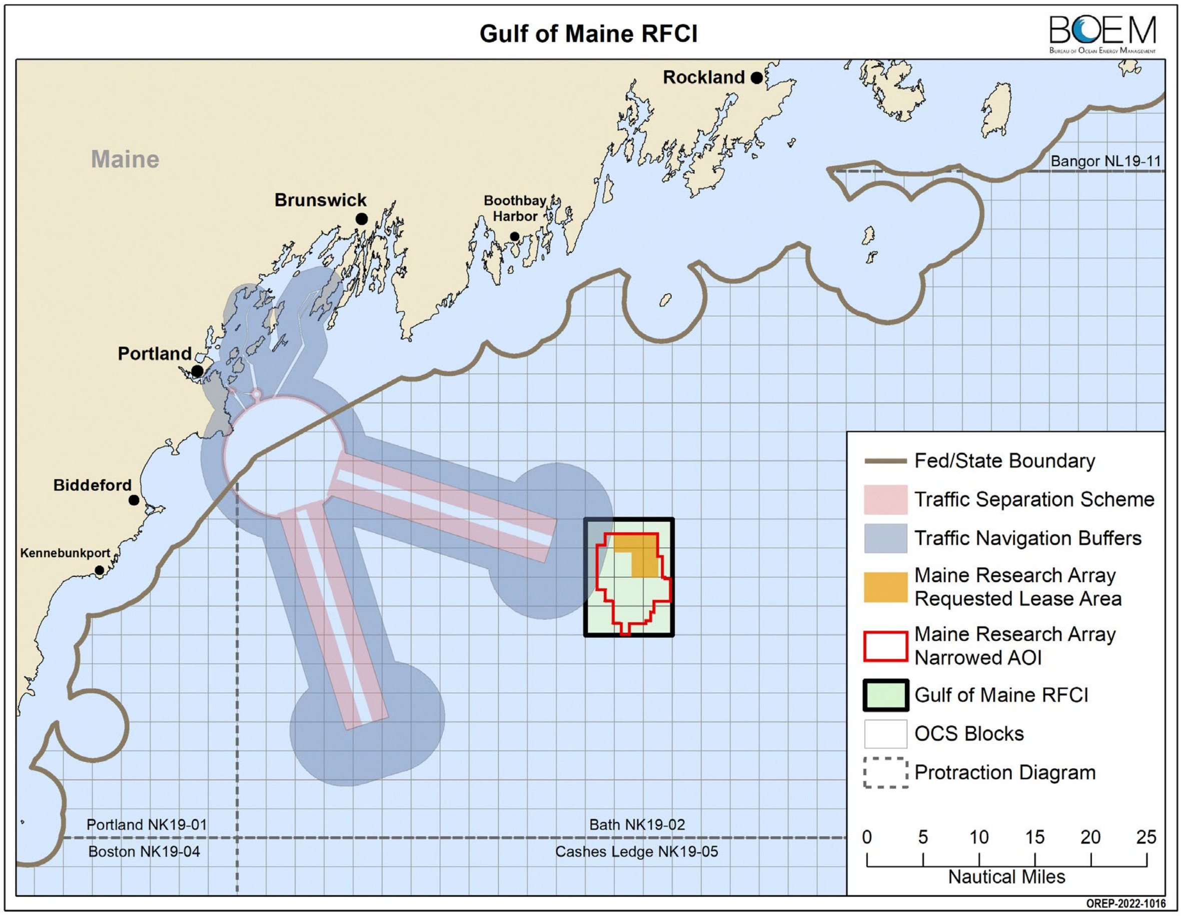


Figure 3-4. State of Maine's requested lease area

3.2.1 Environmental Baseline Conditions Within the Action Area

3.2.1.1 Physical and Biological Features

The Gulf of Maine is the northernmost component of the Northeast Large Marine Ecosystem. It is considered a semi-enclosed sea encompassing 36,000 mi^2 (93,240 km^2) and is bounded by Maine, New Hampshire, Massachusetts, New Brunswick, and Nova Scotia. Its complex geological, bathymetric, oceanographic, and hydrological features support high levels of primary and secondary productivity, making it one of the most productive regions of all the world's oceans (Thompson 2010). Cold and nutrient-dense Scotian Shelf waters from the Labrador Current enter the Gulf of Maine through the Northeast Channel, which sets up a generalized counterclockwise circulation that is bounded by Georges Bank to the south; Maine Coastal Current waters exit via the Great South Channel (Thompson 2010). Tidal-driven mixing is pronounced in the Gulf of Maine, especially in the Bay of Fundy. Additionally, freshwater influx from 60 rivers enters the Gulf of Maine. Together, these features sustain high levels of biodiversity in the Gulf of Maine, with waters that are used seasonally and year-round by a number of ESA-listed marine mammals, sea turtles, and fish, as well as other species of commercial, economic, and cultural value; over 3,000 marine species and birds utilize habitat within the Gulf of Maine. However, the Gulf of Maine's biological diversity is particularly vulnerable to rapidly changing physical and chemical conditions as a result of global climate change, as discussed in **Section 3.2.1.9**.

3.2.1.2 Seabed Conditions

Sediment from the coastline of the Action Area to roughly 295 ft (90 m) water depth is generally rocky with sand and gravel deposits. Muddy sediment deposits are also observed over large areas. High relief features exist beyond 9 nmi (16.7 km) from the coastline (Burgess 2022). The predominant sediment type within the Research Lease Area is silt (0.002 to 0.06 mm). The seabed in the Research Lease Area is generally flat with depressions and slopes, with water depths ranging from 518 to 620 ft (158 to 189 m) (Pentony 2022).

The Maine Coastal Mapping Initiative routinely conducts surveys within the Gulf of Maine since 2015 (Benson and Enterline 2021; Dobbs 2017). The surveys conducted in 2015 and 2016 encompassed or were nearby to the Research Lease Area and covered approximately 57 mi^2 (148 km^2) of the seafloor, along with benthic samples taken at 54 locations (Dobbs 2017). Dobbs (2017) found that sand was the most common sediment type found, with 83% of the samples containing more than 20% sand and 51% predominantly sand, according to Folk classifications. The samples nearshore at a depth of 164 ft (50 m) or less generally had the greatest sand concentration (Dobbs 2017). Gravel-sized particles were also common in the southern and eastern regions of the author's survey area in depths ranging from 98 to 164 ft (30 to 50 m) and comprised an average of 11% by weight in all the samples (Dobbs 2017).

Nearshore habitats include shallow water estuaries and bays which are mostly soft bottom sediments but also include shellfish beds and submerged aquatic vegetation (SAV). These various habitats provide food and shelter for high trophic species and boost local biodiversity, while also serving as nursery grounds for local fish species (Stevenson et al. 2014; Kritzer et al. 2016). Stevenson et al. (2014) evaluated the importance of these nearshore habitats for 16 of the most common commercially important species and their prey. Their analysis showed that sand and gravel/cobble habitats are used by the majority of species and life stages, followed by mud, eelgrass, macroalgae, boulder, salt marsh channels, and shell (mussel) beds. Shallow water habitats in the Gulf of Maine provide valuable ecological services for a variety of species.

3.2.1.3 Water Column Conditions

The Maine Department of Environmental Protection, Marine Environmental Monitoring Program was established in 1991 to monitor the "extent and effect of industrial contaminants and pollutants on marine and estuarine ecosystems and to determine compliance with and attainment of water quality standards" (38 Maine Revised Statutes 410-F). The State has three water quality classes for marine and estuarine waters—SA, SB, and SC—listed in order from highest to lowest quality (38 Maine Revised Statutes 465-B). Classification is based on monitoring of ambient water quality, nutrients, and eutrophication indicators. The majority of marine and coastal waters are classified as SB (mid-quality), with intermittent areas along less-developed portions of the Gulf of Maine coastline and islands classified as SA (highest quality); and localized areas at the outlets of industrialized or nutrient-rich watersheds classified as SC (lowest quality) (Maine Department of Environmental Protection 2024.

Water quality in the Gulf of Maine is affected by contaminants entering the marine environment through a variety of sources, including runoff, sewage, and industrial discharges. The presence of contaminants in coastal and marine waters acts as a stressor to biological communities and poses health risks to humans from exposure to contaminated shellfish and water. The effects of human activity on water quality in the Gulf of Maine increased after European colonization and subsequent expansion of fishing and logging activity in the late 1700s and were further intensified with growth in coastal populations and development of industries such as logging operations, sawmills, fish processing plants, private septic systems, municipal sewage plants, pulp mills, and agricultural drainage and aquaculture operations. There are an estimated 2,024 active point sources of contaminants in the Gulf of Maine region, including 378 wastewater treatment plants and 93 power plants (Gulf of Maine Association 2023).

The contaminants of greatest concern for the Gulf of Maine region are sewage, nutrients, mercury, and microbial pathogens (bacteria, viruses, and protozoa) (Jones 2011; Harding and Burbidge 2013).

3.2.1.4 Underwater Noise

Ambient noise in the Gulf of Maine based on a recorder deployed offshore Bar Harbor, Maine from August 1 to 31, 2008, was estimated to have some of the lowest overall noise levels compared to the other recording sites along the U.S. East Coast (Rice et al. 2014). The long-term spectral averages showed regular low-frequency pulses throughout the recording period which were thought to be related to tidal flow noise (Rice et al. 2014). The highest sound energy was reported between 10 and 200 Hz with cumulative equivalent sound levels, calculated as the variation in sound levels as a function of time, for the entire recording period exceeded 105 decibels (dB) referenced to (re) 1 micropascal (μ Pa) less than 1% of the time, whereas 50% of the data throughout the recording period only exceeded a median of 84 dB re 1 μPa (Rice et al. 2014). On average, sound levels in the Gulf of Maine during this one month recording period exceeded 120 dB re 1 μPa, the behavioral disturbance threshold for marine mammals in response to non-impulsive continuous sources (**Section 6.3.1.1**), less than 10% of the time (Rice et al. 2014).

NOAA's NEFSC has deployed multiple recorders within the Gulf of Maine including a moored SoundTrap 500 located in 61 m water depth just south of the island of Monhegan, Maine, offshore Muscongus Bay in the northern part of the Action Area, which collected data between February and December 2021; multiple marine acoustic recording units (MARU) deployed over Tillies Bank and Jeffreys Ledge just north of Stellwagen Bank National Marine Sanctuary in 60 to 133 m water depth which collected data between December 2007 and March 2010; and multiple MARU deployed within Stellwagen Bank National Marine Sanctuary in 25 to 81 m water depth which collected data between September 2008 and November 2009 (NOAA National Centers for Environmental Information [NCEI] 2023). Most of these studies collected animal detection information, with no ambient noise levels reported from any of these recorders, though raw data files are available that could be mined for ambient noise levels (NOAA NCEI 2023).

Haver et al. (2018) used data from recorders deployed by NOAA and the National Park Service (NPS) around the U.S., one of which was deployed off the Northeastern U.S. along the continental shelf edge (outside of the Action Area) in approximately 2,953 ft (900 m) water depth. Data collected from July 2014 to March 2015 showed sound spectrum levels ranging from approximately 60 dB re 1 $\mu Pa^2/Hz$ at 1,000 Hz to 100 dB re 1 $\mu Pa^2/Hz$ at 18 Hz. The peaks in sound levels observed around 18 Hz were thought to be indicative of fin and blue whale vocalizations in the data (Haver et al. 2018). The patterns in the ambient noise levels at all sites analyzed by Haver et al. (2018) were thought to reflect proximity to populated port cities and shipping lanes which influenced the level of vessel traffic in the region. However, it is worth noting that this analysis focused on data in deep water beyond the shelf edge and outside the Action Area, which cannot be interpreted as representative of ambient noise conditions in the Action Area.

Haver et al. (2019) used data from similar recorders analyzed by Haver et al. (2018) but focused specifically on comparison of underwater soundscapes for U.S. National Parks and Marine Sanctuaries, including Stellwagen Bank National Marine Sanctuary, which falls within the Action Area. Results of this analysis showed sound levels in the 50 Hz to 1.5 kHz frequency band were lower in Stellwagen Bank between June through August compared to November through May, which were thought to be correlated with lower wind speeds during the summer. The data collected in this area also showed numerous, high-noise transient events thought to be vessel passages through the area (Haver et al. 2019). The 90th, 5th, and 10th percentiles of the sound levels all peaked at 20 Hz with sound levels ranging from approximately 70 to 105 dB re 1 $\mu Pa^2/Hz$ at this frequency (Haver et al. 2019).

Haxel et al. (2022) deployed a hydrophone in a free drifting configuration at a 25-kW rated tidal turbine at the University of New Hampshire's Living Bridge Project in Portsmouth, New Hampshire. This project uses existing infrastructure of the Memorial Bridge connecting motor vehicle and pedestrian traffic between Portsmouth, New Hampshire, and Kittery, Maine, over the tidal Piscataqua River in Great Bay Estuary, roughly 4 km upriver from the river mouth. Data were collected between 21 and 23 July 2021 with the hydrophone deployed 1.6 m below the water's surface. The deployment method and timing were selected to align with the large possible range of the tidal turbine's generator outputs (Haxel et al. 2022). SPL ranged from approximately 105 to 125 dB re 1 µP but the authors noted that a comparisons of measured sound levels with proximity to the turbine did not reveal any clear patterns in noise levels associated with the turbine, nor was any repeated, characteristic turbine signal observed above the background ambient acoustic conditions (Haxel et al. 2022). Increases in SPL observed approximately 50 to 60 m downstream of the tidal turbine were thought to be attributed to passing vessels or noise related to the bridge from which the tidal turbine is deployed (Haxel et al. 2022).

3.2.1.5 Electromagnetic Field

The marine environment continuously generates ambient electromagnetic field (EMF) effects. The motion of electrically conductive seawater through Earth's magnetic field induces voltage potential, thereby creating electrical currents. Surface and internal waves, tides, and coastal ocean currents all create weak, induced EMF effects. Their magnitude at a given time and location depends on the strength of the prevailing magnetic field, site, and time-specific ocean conditions. Other external factors such as electrical storms and solar events can also generate variable EMF effects. The strength of Earth's direct current (DC) magnetic field is approximately 517 milligauss (mG) (51.7 microteslas [µT]) in the vicinity of the Research Lease Area (NOAA n.d.). This is the static magnetic field of Earth oriented to magnetic north at a declination of approximately 15 degrees west (NOAA n.d.). As ocean currents and organisms move through this DC magnetic field, a weak DC electric field is produced. For example, the electric field generated by the movement of the ocean currents through Earth's magnetic field is reported to be approximately 0.075 millivolts per meter (mV/m) or less (CSA Ocean Sciences Inc. and Exponent 2019). Wave action would also induce electrical and magnetic fields at the water surface on the order of 10 to 100 µV/m and 1 to 10 mG (0.1 to 1 µT), respectively, depending on wave height, period, and other factors. Although these effects dissipate with depth, wave action would likely produce detectable EMF effects up to 185 ft (56 m) below the surface (Slater et al. 2010). Petereit et al. (2019) found that tide-induced magnetic fields in the Gulf of Maine varied by approximately 0.68 nanoteslas (nT) between seasons, which was the largest seasonal difference found among the areas studied in this report.

Submarine transmission or communication cables can also contribute to EMF levels in an area. Electrical telecommunications cables are likely to induce a weak EMF in the immediate area along the cable path. Gill et al. (2005) observed electrical fields on the order of 1 to 6.3 µV/m within 3.3 ft (1 m) of a typical cable of this type. The heat effects of communication cables on surrounding sediments are likely to be negligible given the limited transmission power levels involved. Currently, there are two submarine cables which intersect partially with the Action Area (Northeast Regional Ocean Council 2024), installed between 1998 and 2005.

3.2.1.6 Artificial Light

Vessel traffic and navigational safety lights on buoys are the only artificial lighting sources in the open-water portion of the Action Area. Land-based artificial light sources become more predominant approaching the Maine, New Hampshire, and Massachusetts shorelines, especially in the vicinity of larger cities (i.e., Boston, Massachusetts; Portsmouth, New Hampshire; Portland, Maine).

3.2.1.7 Vessel Traffic

In 2021, state and federally licensed commercial fishers made 392,000 trips, mostly by lobster license holders, although other fisheries such as groundfish, scallop, and tuna are also active and contribute to the varied and extensive vessel traffic in the Gulf of Maine throughout the year (Burgess 2022). While fishing vessels are the most prevalent vessel type, cargo vessels, very large crude carriers, cruise vessels, container vessels, towing vessels, barges, and military vessels also transit the Gulf of Maine. Recreational vessel traffic includes private motorboats, fishing boats, and sailboats. Most commercial vessel traffic, excluding fishing vessels, tend to travel within established vessel traffic routes. There are four principal ports within the Action Area: Searsport, Maine; Portland, Maine; Portsmouth, New Hampshire; and Boston, Massachusetts (USACE 2023).

The Research Lease Area is located outside of existing designated routing measures; the western edge is located approximately 2.5 nautical miles (4.6 km) east of the Eastern Approach Traffic Separation Scheme entering and exiting the port of Portland, Maine. USCG's Marine Planning Guidelines recommend a 5-nautical mile (9.3-km) buffer zone of a Traffic Separation Scheme entry and exit area (as depicted in **Figure 3-4**) as the minimum distance necessary to enable vessels to detect one another visually and by radar where vessels are converging and diverging from multiple locations and for a large vessel to maneuver in an emergency. Approximately 9,856 acres (40 square kilometers) or 14 percent of the Research Lease Area are located within the buffer zones of the Eastern Approach Traffic Separation Scheme. The USCG has proposed the addition of six shipping safety fairways within the Gulf of Maine due to planned or potential offshore development, changes in fishery management and species distribution, and port expansion in order to preserve the unobstructed transit of densely traveled routes and port approaches by mariners (USCG 2023).

In 2023, USCG completed the Approaches to Maine, New Hampshire, and Massachusetts Port Access Route Study (MNMPARS), which used multiple sources of data, such as the Automated Identification System (AIS), Vessel Monitoring System (VMS) traffic, commercial fishing statistics, public comments, and partner agency submissions to determine if routing measure revisions are necessary to improve navigation safety (USCG 2023). AIS vessel transit[1] counts in 2022 are presented in **Figure 3-5**; AIS and VMS data from 2019 through 2021 are shown in **Table 3-8**. These data provide a broad overview of the amount and type of vessels present in the MNMPARS study area (i.e., the Gulf of Maine), including general vessel traffic volume, patterns, and commonly trafficked routes for the Gulf of Maine. The number of vessel transits and unique vessel counts intersecting with the State of Maine's requested lease area is presented in **Table 3-9** based on AIS and VMS data from 2019 through 2021. AIS and VMS data sources can capture the presence of unique fishing vessels; however, not all vessels are required to use AIS transceivers, therefore if there was a discrepancy between the AIS and VMS data, the higher vessel quantity is shown in **Tables 3-8** and **3-9** (USCG 2023).

---

[1] A vessel transit is considered a single one-way vessel passing.

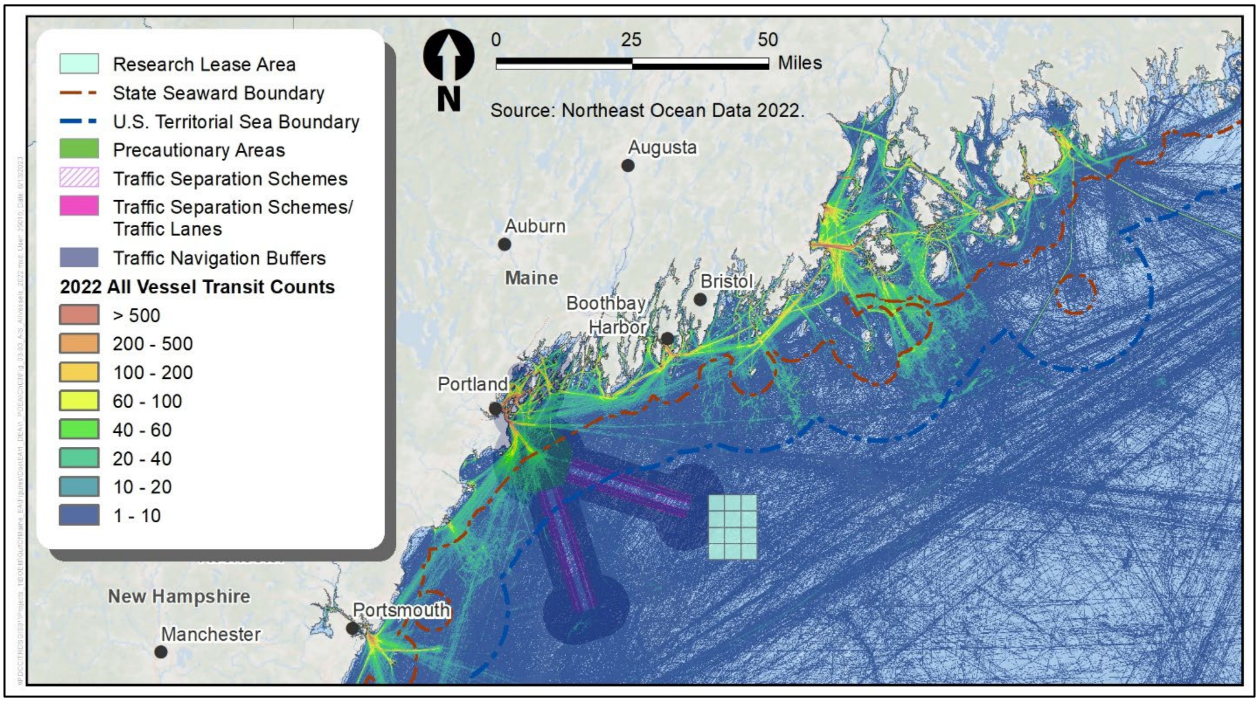


Figure 3-5. Automatic Identification System vessel transit counts for 2022 relative to the Research Lease Area

Table 3-8. Vessel transit and unique vessel counts by type for the Gulf of Maine (2019–2021)

Vessel Type	Vessel Transit Counts (in thousands)				Unique Vessel Counts			
	2019	2020	2021	Average	2019	2020	2021	Average
Pleasure/Sailing	12.1	13	12.5	12.4	1,916	1,933	2,087	1,979
Not available	4.2	1.5	6.2	4.0	470	94	763	442
Fishing	12.1	12[1]	13.1[1]	12.4[1]	266	269[1]	316[1]	283[1]
Cargo	1	0.8	0.8	0.9	254	225	207	229
Tug/Tow	3.5	2.1	1.9	2.5	161	133	135	143
Tanker	1	1	1.2	0.7	140	124	151	138
Other	2.2	1.9	2	2	99	105	102	102
Passenger	5.3	3	4.3	4.2	126	79	78	94
Military	0.1	< 0.1	< 0.1	< 0.1	12	6	11	10
Total	**41.5**	**35.3**	**42**	**39.2**	**3,444**	**2,968**	**3,844**	**3,419**

Source: USCG 2023

[1] VMS data used. All other data from AIS

Table 3-9. Vessel transit and unique vessel counts by type intersecting the State of Maine's requested lease area[1] (2019–2021)

Vessel Type	Vessel Transit Counts				Unique Vessel Counts			
	2019	2020	2021	Average	2019	2020	2021	Average
Pleasure/Sailing	67	67	68	67	58	64	65	62
Fishing	65	62[2]	47[2]	58[2]	22	24[2]	15[2]	20[2]
Tanker	29	25	27	27	15	17	17	16
Cargo	22	27	13	21	10	9	5	8
Not available	24	6	23	18	19	4	19	14
Passenger	40	0	2	14	25	0	2	9
Tug/Tow	8	6	6	7	5	3	2	3
Other	4	7	4	5	2	6	3	4
Military	0	0	1	0.3	0	0	1	0.3
Total	**259**	**200**	**191**	**217**	**156**	**127**	**129**	**137**

Source: USCG 2023.
[1] The State of Maine's requested lease area is a 9,700-acre area within the Research Lease Area and is depicted in **Figure 3-1**.
[2] VMS data used. All other data from AIS.

Overall, the data indicate that the Gulf of Maine is heavily trafficked, with an average of 39,200 yearly transits recorded during the MNMPARS study period (2019 through 2021). The majority of vessel transits were conducted by fishing and recreational vessels, though these vessel categories are likely underrepresented in the data. Given its smaller area (i.e., 9,700 acres), fewer vessels intersect with the State of Maine's requested lease area (**Table 3-9**). Pleasure craft/sailing traffic, fishing vessels, and tankers were the most common vessel types transiting through the requested lease area, with an average of 217 vessel transits per year, including 67 pleasure craft/sailing transits, 58 fishing transits, and 27 tanker transits per year.

An AIS transponder is only required on commercial vessels with a length of 65 feet (19.8 meters) or longer. Although some recreational and commercial fishing vessels smaller than 35 feet (10.7 meters) in length may choose to have a transponder, AIS is not mandatory on these vessels. VMS is also not mandatory on vessels. Therefore, these categories of vessels are underreported within the data presented above. When considering this limitation, the analysis of baseline vessel traffic for the Action Area as presented in this BA is likely an underestimate of actual ongoing vessel traffic.

3.2.1.8 Commercial and Recreational Fishing

Multiple commercial and recreational fishing grounds and banks are located within the Gulf of Maine. Fisheries within the Action Area are managed at both the Federal and regional level. At the Federal level, there are two councils designated by the Magnuson Fishery Conservation and Management Act of 1976 (later renamed the Magnuson-Stevens Fishery Conservation and Management Act): New England Fishery Management Council (NEFMC) for Connecticut, Massachusetts, Maine, New Hampshire, and Rhode Island. The commercial and recreational fishing within the Action Area is located entirely within the jurisdiction of the NEFMC. At the regional level, the 15 Atlantic states form the Atlantic States Marine Fisheries Commission. Species managed at the Federal level include sea scallop, Atlantic salmon, Atlantic herring by the NEFMC and Atlantic bluefish by the Mid-Atlantic Fishery Management Council (MAFMC); both councils jointly manage monkfish and spiny dogfish. Species managed at the regional level include American lobster, black drum, red drum, tautog, and weakfish. Black sea bass, spiny dogfish, scup, and summer flounder are managed at both the Federal and regional level.

NMFS maintains landings data for commercial and recreational fisheries based on year, state, and species. Commercial fisheries that utilize the waters in the potential activity area to the greatest extent include the American lobster, menhaden, and Atlantic sea scallop fisheries. The American lobster fishery accounts for approximately 49.5% of the total fishing revenue from Maine, New Hampshire, and Massachusetts waters, and 77.8% of revenue when considering Maine alone based on 2021 landings data (NMFS 2021a). Additional fisheries include menhadens, haddock, seaweed/rockweed, shortfin squid, and others.

There are multiple recreational fishing areas located within the Action Area, many of which are along the shoreline (DMR 2023a). There are also numerous charter and head boats available in Maine which target a variety of species including striped bass, bluefin tuna, mackerel, sharks, bluefish, and others (DMR 2023b). In 2022, the fisheries with the highest landings included Atlantic mackerel striped bass, pollock and other cods/hakes, each with over one million pounds landed. Additionally, the Action Area (**Figure 3-2)** overlaps with Lobster Management Areas 1 and 3, and the Outer Cape Lobster Management Area (GARFO 2020), and Fisheries Statistical Areas 512, 513, 514, 515, and 521 (GARFO 2023a).

3.2.1.9 Climate Change

NMFS and the United States Fish and Wildlife Service (USFWS) list long-term climate change as a threat for almost all marine species (Hayes et al. 2020, 2022, 2023; NMFS 2022a, USFWS 2023a,b,c,d). Climate change is known to increase temperatures, alter ocean acidity, change ocean circulation patterns, raise sea levels, alter precipitation patterns, increase the frequency and intensity of storms, and increase freshwater runoff, erosion, and sediment deposition. These effects can alter habitat, modify species' use of existing habitats, affect migration and movement patterns, and affect an organisms' physiological condition (Albouy et al. 2020; Lettrich et al. 2023; Love et al. 2013; USEPA 2022b; Gulland et al. 2022; National Aeronautics and Space Administration [NASA] 2023).

An increase in ocean acidity has numerous effects on ecosystems, fundamentally resulting in a reduction in available calcium carbonate that many marine organisms use to build shells (Doney et al. 2009). This could alter the distribution and abundance of marine mammal and sea turtle prey items and result in feeding shifts within food webs (Love et al. 2013; USEPA 2022b; NASA 2023). For example, between 1982 and 2018, the average center of biomass for 140 marine fish and invertebrate species along U.S. coasts shifted approximately 20 mi (32 km) north (USEPA 2022b). These species also migrated an average of 21 ft (6.4 m) deeper (USEPA 2022b). This effect is especially profound off the northeast U.S., where American lobster, red hake, and black sea bass have shifted, on average, 113 mi (182 km) north since 1973 (USEPA 2022b).

Climate change could affect the incidence or prevalence of infection and the frequency, severity, and magnitude of epizootics (Burge et al. 2014). Of the 72 established unusual mortality events identified for marine mammals between 1991 and 2022 in U.S. waters, 14 percent are attributed to infectious disease, though this has not been directly correlated with climate change (Hayes et al. 2023). However, infectious disease outbreaks are predicted to increase as a result of climate change (Burek et al. 2008).

Over time, climate change and coastal development will alter existing habitats, rendering some areas unsuitable for certain species and more suitable for others. For example, shifts in NARW distribution patterns are likely in response to changes in prey densities, driven in part by climate change (Reygondeau and Beaugrand 2011; Meyer-Gutbrod et al. 2015, 2021; O'Brien et al. 2022). These long-term, high-consequence impacts could include increased energetic costs associated with altered migration routes; reduction of suitable breeding habitat, foraging habitat, or both; and reduced individual fitness.

Available data also suggest changing ocean temperatures and sea level rise may lead to changes in the sex ratio of sea turtle populations (e.g., green sea turtle [*Chelonia mydas*] population feminization predicted under Intergovernmental Panel on Climate Change scenarios by 2120; Booth et al. 2020), loss of nesting area, and a decline in population growth due to incubation temperature reaching lethal levels (Patrício et al. 2019; Varela et al. 2019). In addition to affecting nesting activity, increased sea surface temperatures could have physiological effects on sea turtles during migration (Marn et al. 2017). Higher temperatures in migratory corridors would be especially risky for metabolic rates of female sea turtles post-nesting, as they do not generally forage during breeding periods, and their body condition would not be expected to be optimal to withstand unexpected changes in water temperature in their migratory habitat (Hays et al. 2014).

Finfish and invertebrate migration patterns can be influenced by warmer waters, as can the frequency and magnitude of disease (Hare et al. 2016). Regional water temperatures that increasingly exceed the thermal stress threshold may affect recovery of the American lobster fishery off the U.S. East Coast (Rheuban et al. 2017). Ocean acidification driven by climate change is contributing to reduced growth, and, in some cases, decline of invertebrate species with calcareous shells. Increased freshwater input into nearshore estuarine habitats can result in water quality changes and subsequent effects on invertebrate species (Hare et al. 2016). Based on a recent study, marine, estuarine, and riverine habitat types were found to be moderately to highly vulnerable to stressors resulting from climate change (Farr et al. 2021). In general, rocky and mud bottom, intertidal, kelp, coral, and sponge habitats and special areas of conservation were considered the most vulnerable habitats to climate change in marine ecosystems (Farr et al. 2021). Similarly, estuarine habitats considered most vulnerable to climate change include intertidal mud and rocky bottom, shellfish, kelp, submerged aquatic vegetation, and native wetland habitats (Farr et al. 2021). Riverine habitats found to be most vulnerable to climate change include native wetland, sandy bottom, water column, and submerged aquatic vegetation habitats (Farr et al. 2021). As invertebrate habitat, finfish habitat, and Essential Fish Habitat (EFH) may overlap with these habitat types, marine life and habitats could experience dramatic changes and decline over time as impacts from climate change continue (Farr et al. 2021).

The Gulf of Maine Research Institute (GMRI) reported an average sea surface temperature of 53.66°F (12°C) in the Gulf of Maine in 2022, which was the second hottest year on record and an increase of over 3.72°F (2.07°C) above the long-term average from 1982 through 2011 (GMRI 2023). The hottest year on record was 54.14°F (12.3°C) in 2021, which was more than 4°F (1.5°C) above normal (GMRI 2023). Long-term data show that the water temperatures in the Gulf of Maine have been increasing over the last decade at a rate faster than 97% of the world's oceans (Pershing et al. 2015; Pershing et al. 2021; Balch et al. 2022; Seidov and Parsons 2021; GMRI 2023). The temperature changes have a cascading effect on all trophic levels. Further, changes in these trophic systems will likely have long term consequences on marine species that may not be recoverable (Pershing et al. 2015; Pershing et al. 2021). The extent of these effects is unknown; however, ESA-listed populations already stressed by other factors likely will be the most affected by the repercussions of climate change, particularly in the Gulf of Maine. The current effects from climate change could result in population-level effects that compromise the viability of some species.

3.3 Avoidance, Minimization, Monitoring, and Reporting Measures

This section outlines the proposed mitigation, monitoring, and reporting conditions intended to minimize or avoid potential effects on ESA-listed species from all activities included under the Proposed Action. The measures considered part of the Proposed Action are those measures proposed by BOEM which will be followed by the State of Maine, PTOW, and any contractors performing the survey activities described in Section 3.1. These measures, to the extent they are known, are described below.

BOEM will propose implementing the following conditions related to protected species and habitat. These conditions have been considered as part of the Proposed Action and apply to site assessment activities and site characterization activities. Additionally, the Lessee must also follow any applicable mitigation requirements included with their MMPA take authorization, if such authorization is pursued or deemed necessary.

As used herein, the term “protected species” means species of fish, wildlife, or plant that have been determined to be endangered or threatened under Section 4 of the ESA. ESA-listed species are provided in 50 C.F.R. 17.11-12. The term also includes marine mammals protected under the MMPA. Marine debris is defined as any object or fragment of wood, metal, glass, rubber, plastic, cloth, paper, or any other man-made item or material that is lost or discarded in the marine environment.

3.3.1 Marine Debris Awareness and Elimination

The Lessee must ensure that vessel operators, employees, and contractors engaged in offshore activities as part of all survey activities under the Proposed Action complete marine trash and debris awareness training annually. The training consists of two parts: (1) viewing a marine trash and debris training video or slide show (described below); and (2) receiving an explanation from management personnel that emphasizes their commitment to the requirements. The marine trash and debris training videos, training slide packs, and other marine debris related educational material may be obtained at https://www.bsee.gov/debris or by contacting BSEE at marinedebris@bsee.gov. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities must continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are trained. The training process must include the following elements:

- Viewing of either a video or slide show by the personnel specified above;
- An explanation from management personnel that emphasizes their commitment to the requirements;
- Attendance measures (initial and annual); and
- Recordkeeping and the availability of records for inspection by the Department of the Interior (DOI).

By January 31 of each year, the Lessee must submit to DOI an annual report signed by the Lessee that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. The Lessee must send the reports via email to email to renewable_reporting@boem.gov and BSEE (via Technical Information Management System (TIMS) Web Portal and protectedspecies@bsee.gov).

Materials, equipment, tools, containers, and other items used in OCS activities, which are of such shape or configuration that make them likely to snag or damage fishing devices or be lost or discarded overboard, must be clearly marked with the vessel or facility identification number, and properly secured to prevent loss overboard. All markings must clearly identify the owner and must be durable enough to resist the effects of the environmental conditions to which they may be exposed.

The Lessee must recover marine trash and debris that is lost or discarded in the marine environment while performing OCS activities when such incident is likely to (1) cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components, with particular attention to marine trash or debris that could entangle or be ingested by marine protected species; or (2) significantly interfere with OCS uses (e.g., the marine trash or debris that is likely to snag or damage fishing equipment, or present a hazard to navigation). The Lessee must notify DOI within 48 hours of the incident (using the email address listed on DOI's most recent incident reporting guidance) if recovery activities are (a) not possible because conditions are unsafe; or (b) not practicable and warranted because the marine trash and debris released is not likely to result in any of the conditions listed in (1) or (2) above. Notwithstanding this notification, DOI may still order the Lessee to recover the lost or discarded marine trash and debris if DOI finds the reasons provided by the Lessee in the notification unpersuasive. If the marine trash and debris is located within the boundaries of a potential archaeological resource/avoidance area, or a sensitive ecological/benthic resource area, the Lessee must contact DOI for concurrence before conducting any recovery efforts.

Recovery of the marine trash and debris should be completed as soon as practicable, but no later than 30 calendar days from the date on which the incident occurred. If the Lessee is not able to recover the marine trash or debris within 48 hours of the incident, the Lessee must submit a plan to DOI explaining the activities planned to recover the marine trash or debris (Recovery Plan). The Lessee must submit the Recovery Plan no later than 10 calendar days from the date on which the incident occurred. Unless DOI objects within 48 hours of the filing of the Recovery Plan, the Lessee can proceed with the activities described in the Recovery Plan. The Lessee must request and obtain a time extension if recovery activities cannot be completed within 30 calendar days from the date on which the incident occurred. The Lessee must enact steps to prevent similar incidents and must submit a description of these actions to BOEM and BSEE within 30 calendar days from the date on which the incident occurred.

The Lessee must report to DOI (OSWIncidentReporting@bsee.gov) all lost or discarded marine trash and debris. This report must be made monthly and submitted no later than the fifth day of the following month. The Lessee is not required to submit a report for those months in which no marine trash and debris was lost or discarded. The report must include the following:

- Project identification and contact information for the Lessee and for any operators or contractors involved.
- The date and time of the incident.
- The lease number, OCS area and block, and coordinates of the object's location (latitude and longitude in decimal degrees).
- A detailed description of the dropped object, including dimensions (approximate length, width, height, and weight) and composition (e.g., plastic, aluminum, steel, wood, paper, hazardous substances, or defined pollutants).
- Pictures, data imagery, data streams, and/or a schematic/illustration of the object, if available.
- An indication of whether the lost or discarded item could be detected as a magnetic anomaly of greater than 50 nT, a seafloor target of greater than 1.6 ft (0.5 m), or a sub-bottom anomaly of greater than 1.6 ft (0.5 m) when operating a magnetometer or gradiometer, side scan sonar, or sub-bottom profiler in accordance with DOI's most recent, applicable guidance.
- An explanation of how the object was lost.
- A description of immediate recovery efforts and results, including photos.

In addition to the foregoing, the Lessee must submit a report within 48 hours of the incident (48-hour Report) if the marine trash or debris could (1) cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components, with particular attention to marine trash or debris that could entangle or be ingested by marine protected species; or (2) significantly interfere with OCS uses (e.g., the marine trash or debris is likely to snag or damage fishing equipment or presents a hazard to navigation). The information in the 48-hour Report must be the same as that listed for the monthly report, but only for the incident that triggered the 48-hour Report. The Lessee must report to DOI (using the email address listed on DOI's most recent incident reporting guidance) if the object is recovered and, as applicable, describe any substantial variance from the activities described in the Recovery Plan that were required during the recovery efforts. The Lessee must include and address information on unrecovered marine trash and debris in the description of the site clearance activities provided in the decommissioning application required under 30 C.F.R. § 585.906.

3.3.2 Minimize Vessel Interactions with Listed Species

The Lessee must ensure all vessels associated with any project activities (transiting or actively surveying, originating from any of the ports described in **Section 3.1.1.2** and **3.1.2.15**) comply with the vessel strike avoidance measures specified below. The only exception is when the safety of the vessel or crew necessitates deviation from these requirements. If any such incidents occur, they must be reported as outlined in **Section 3.3.6**.

3.3.2.1 Vessel Crew and Trained Lookout Training

The Lessee must provide Project-specific training to all vessel crew members and trained lookouts on the detection of sea turtles and marine mammals, vessel strike avoidance, reporting protocols, and the associated regulations for avoiding vessel collisions with protected species. Trained lookouts are used when professional, third-party PSOs are not required. Third-party PSO requirements are outlined in **Section 3.3.5**. Trained lookouts must receive additional training in protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. Reference materials for identifying sea turtles and marine mammals must be available aboard all Project vessels. The expectation and process for reporting of protected species sighted during surveys must be clearly communicated and posted in highly visible locations aboard all project vessels, so that there is an expectation for reporting to the designated vessel contact (such as the lookout or the vessel captain), as well as a communication channel and process for crew members to do so.

Confirmation of the training and understanding of the requirements must be documented on a training course log sheet, and the Lessee must provide the log sheets to DOI upon request. The Lessee must communicate to all crew members its expectation for them to report sightings of sea turtles and marine mammals to the designated vessel contacts. The Lessee must communicate the process for reporting sea turtles and marine mammals (including live, entangled, and dead individuals) to the designated vessel contact and all crew members. The Lessee must post the reporting instructions, including communication channels, in highly visible locations aboard all Project vessels.

3.3.2.2 Vessel Observation Requirements

1. Vessel captain and crew must maintain a vigilant watch for all protected species and reduce speed, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any listed species. The presence of a single individual at the surface may indicate the presence of submerged animals in the vicinity; therefore, precautionary measures should always be exercised. If pinnipeds or small delphinids of the following genera: *Delphinus*, *Lagenorhynchus*, *Stenella*, and *Tursiops* are visually detected approaching the vessel (i.e., to bow ride) or towed equipment, vessel speed reduction, course alteration, and shutdown are not required.

2. Anytime a survey vessel is underway (transiting or surveying), a PSO must monitor for protected species, and the vessel must maintain a minimum separation distance of 1,640 ft (500 m) or greater from any sighted ESA-listed species, or other unidentified large marine mammal visible at the surface, to ensure detection of that animal in time to take necessary measures to avoid striking the animal. If a survey vessel does not require a PSO for the type of survey equipment used, crew may be used as a Trained Lookout to meet this requirement. For monitoring around autonomous surface vehicles (ASVs) controlled from a manned vessel, regardless of the equipment it may be operating, a dual thermal/HD camera must be installed on the mother vessel facing forward and angled in a direction so as to provide a field of view ahead of the vessel and around the ASV. A dedicated operator must be able to monitor the real-time output of the camera on hand-held computer tablets. Images from the cameras must be able to be captured and reviewed to assist in verifying species identification. A monitor must also be installed in the bridge displaying the real-time images from the thermal/HD camera installed on the front of the ASV itself, providing an additional forward view of the craft.
    a. Survey plans (see Section 3.3.6.1 for further details) must include identification of the Project vessel strike avoidance measures, including procedures for equipment shut down and retrieval, communication between PSOs/Trained Lookouts, equipment operators, and the captain, and other measures necessary to avoid vessel strikes while maintaining vessel and crew safety. If any circumstances are anticipated that may preclude the implementation of this measure, they must be clearly identified in the survey plan and alternative procedures outlined in the plan to ensure minimum distances are maintained and vessel strikes can be avoided.
    b. All vessel crew members must be briefed in the identification of protected species that may occur in the survey area and in regulations and best practices for avoiding vessel collisions. Reference materials must be available aboard all project vessels for identification of listed species. The expectation and process for reporting of protected species sighted during surveys must be clearly communicated and posted in highly visible locations aboard all project vessels, so that there is an expectation for reporting to the designated vessel contact (such as the lookout or the vessel captain), as well as a communication channel and process for crew members to do so. Vessel crew members must be provided with an Atlantic reference guide to help identify marine mammals and sea turtles that may be encountered. Vessel personnel must also be provided material regarding NARW SMAs, DMAs, Slow Zones, sightings information, and reporting.

A minimum separation distance of 1,640 ft (500 m) from all ESA-listed whales (including unidentified large whales) must be maintained around all surface vessels at all times.

    a. If a large whale is identified within 1,640 ft (500 m) of the forward path of any vessel, the vessel operator must steer a course away from the whale at 10 knots or less until the 1,640 ft (500 m) minimum separation distance has been established. Vessels may also shift to idle if feasible.

If a large whale is sighted within 656 ft (200 m) of the forward path of a vessel, the vessel operator must reduce speed and shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 1,640 ft (500 m). If stationary, the vessel must not engage engines until the large whale has moved beyond 1,640 ft (500 m).

If a sea turtle or manta ray is sighted at any distance within the operating vessel's forward path, the vessel operator must slow down to 4 knots and steer away (unless unsafe to do so). The vessel may resume normal vessel operations once the vessel has passed the individual.

    a. Vessels must avoid transiting through areas of visible jellyfish aggregations or floating vegetation (e.g., sargassum lines or mats) that are easily sighted and exceed 164 ft (50 m) in length or width. In the event that operational safety prevents avoidance of such areas, vessels must slow to 4 knots while transiting through such areas.

Vessels operating in water depths with less than four feet of clearance between the vessel and the bottom should maintain speeds no greater than 4 knots to minimize risk of vessel strikes on sturgeon and salmon.

a. Vessels underway must not divert their course to approach any protected species.

Any observations of a marine mammal or ESA-listed species by crew members aboard any vessel associated with the survey must be relayed to the PSO on duty and/or captain of the vessel.

To monitor the minimum separation distance, one PSO (or Trained Lookout if PSOs are not required) must be posted during all times a vessel is underway (transiting or surveying) to monitor for listed species within a 180-degree direction of the forward path of the vessel (90 degrees port to 90 degrees starboard).

Visual observers monitoring the minimum separation distance can be either PSOs or Trained Lookouts (if PSOs are not required). If the Trained Lookout is a vessel crew member, this must be their designated role and primary responsibility on shift. Any crew designated as Trained Lookouts must receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. All observations must be recorded per reporting requirements.

Regardless of monitoring duties, all crew members responsible for navigation duties must receive site-specific training on ESA-listed species sighting/reporting and vessel strike avoidance measures.

Vessels underway must not divert their course to approach any ESA-listed species and marine mammals.

Regardless of vessel size, vessel operators must reduce vessel speed to 10 knots or less while operating in any Seasonal Management Area (SMA) and Dynamic Management Area (DMA) or Slow Zone triggered by visual and/or acoustic detections of NARWs. An exception to this requirement is for vessels operating in areas within a portion of a DMA or Slow Zone where it is not reasonable to expect the presence of NARWs (e.g., shallow harbors), unless a detection of a NARW in that area triggered the DMA or Slow Zone.

BOEM encourages increased vigilance through the required mitigation and monitoring measures to minimize vessel interactions with protected species, by reducing speeds to 10 knots or less when operating within a DMA or Slow Zone, and when feasible, avoid operating in or transiting through DMAs and Slow Zones all together.

All vessel operators must conduct daily checks for information regarding mandatory or voluntary ship strike avoidance (SMAs, DMAs, Slow Zones) and daily information regarding NARW sighting locations. These media may include, but are not limited to: NOAA weather radio, U.S. Coast Guard NAVTEX and channel 16 broadcasts, Notices to Mariners, the Whale Alert app, or WhaleMap website.

a. NARW Sighting Advisory System info can be accessed at: https://apps-nefsc.fisheries.noaa.gov/psb/surveys/MapperiframeWithText.html.
b. Information about active SMAs, DMAs, and Slow Zones can be accessed at: https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-vessel-strikes-north-atlantic-right-whales.

All vessels carrying out the survey activities included under the Proposed Action (Section 3.1) must have a trained lookout for NARWs on duty at all times, during which the trained lookout must monitor a vessel strike avoidance zone around the vessel. The trained lookout must maintain a vigilant watch at all times a vessel is underway and, when technically feasible, monitor the 1,640-ft (500-m) Vessel Strike Avoidance Zone for ESA-listed species to maintain minimum separation distances.

Alternative monitoring technology (e.g., night vision, thermal cameras) must be available on all survey vessels to maintain a vigilant watch at night and in any other low-visibility conditions such that observers can still effectively detect marine mammals and sea turtles and monitor the vessel strike avoidance zone. All observations must be recorded per reporting requirements. Outside of active watch duty, members of the monitoring team must check NMFS' NARW sightings (https://www.fisheries.noaa.gov/resource/map/north-atlantic-right-whale-sightings) for the presence of NARWs in the Action Area. The trained lookout must check the Sea Turtle Sighting Hotline (https://seaturtlesightings.org/) before each trip and report any detections of sea turtles in the vicinity of the planned transit to all vessel operators or captains and lookouts on duty that day.

For all vessels operating north of the Virginia/North Carolina border, the Lessee must have a trained lookout posted between June 1 and November 30 on all vessel transits during all phases of the Project to observe for sea turtles. If a vessel is carrying a trained lookout for the purposes of maintaining watch for NARWs, an additional trained lookout for sea turtles is not required, provided that the trained lookout maintains watch for marine mammals and sea turtles. If the trained lookout is a vessel crew member, the lookout obligations as noted above must be that person's designated role and primary responsibility while the vessel is transiting.

3.3.2.3 Vessel Speed Requirements

Vessels of all sizes must operate at 10 knots or less between October 1 and May 30 and while operating port to port and operating in the lease area, or in the transit area to and from ports in Maine and Massachusetts. Regardless of vessel size, vessel operators must reduce vessel speed to 11.5 mph (18.5 kph or 10 kn) or less while operating in any SMA, DMA or Slow Zones. An exception to this requirement is for vessels operating in areas within a portion of a designated DMA or Slow Zone where it is not reasonable to expect the presence of NARWs (e.g., shallow harbors), unless a sighting of a NARW in that area triggered the DMA or Slow Zone. This requirement also does not apply when necessary for the safety of the vessel or crew. Any such events must be reported.

The Lessee may only request a waiver from any Slow Zone or DMA vessel speed reduction requirements during FLiDAR buoy operations and maintenance by submitting a vessel strike risk reduction plan that details revised measures and an analysis demonstrating that the measure(s) will provide a level of risk reduction at least equivalent to the vessel speed reduction measure(s) proposed for replacement. The plan included with the request must be provided to NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division and BOEM at least 90 days prior to the date scheduled for the activities for which the waiver is requested. The plan must not be implemented unless NMFS and BOEM reach consensus on the appropriateness of the plan.

3.3.3 Minimize Interactions with Listed Species during Geophysical Survey Operations

To avoid injury of and minimize any potential disturbance to protected species, implement the following measures for all vessels using boomer, sparker, bubble gun, and chirp sub-bottom profiler categories of equipment. Shutdown, pre-start clearance, and ramp-up procedures are not required during HRG survey operations using only other sources (e.g., ultra-short baselines, fathometers, parametric shallow penetration sub-bottom profilers, hull-mounted non-parametric SBP, side-scan sonars, pingers, acoustic releases, echosounders, and instruments attached to submersible vehicles (HOV/AUV/ROVs).

1. For situational awareness of marine mammals and ESA-listed species that may be in the survey area, during times third-party protected species observers (PSOs) are on duty, they must monitor to the farthest extent practicable, at least 1,640 ft (500 m) around geophysical survey vessels (i.e., the Clearance Zone). At all times PSOs are on duty, any observed species must be recorded (see reporting requirements below).
2. Any observations of a marine mammal or ESA-listed species by crew members aboard any vessel associated with the survey must be relayed to the PSO on duty.
3. For autonomous surface vessels (ASV) that require remote PSO monitoring from the mother vessel[2], a dual thermal/HD camera must be installed on the mother vessel facing forward and angled in a direction to provide a field of view ahead of the vessel and around the ASV. PSOs must be able to monitor the real-time output of the camera on hand-held computer tablets. Images from the cameras must be able to be captured and reviewed to assist in verifying species identification. A monitor must also be installed in the bridge displaying the real-time images from the thermal/HD camera installed on the front of the ASV itself, providing a further forward view of the craft. In addition, night-vision goggles with thermal clip-ons and a handheld spotlight must be provided and used such that PSOs can focus observations in any direction around the mother vessel and/or the ASV.
4. To minimize exposure of ESA-listed species of marine mammal to noise that could be disturbing, a 1,640 ft (500 m) Shutdown Zone for NARW and unidentified whales, and a 328 ft (100 m) Shutdown Zone for all other ESA-listed whales visible at the surface must be established around the sound source operating at frequencies <180 kHz (e.g., boomer, sparker, bubble gun equipment). If the Shutdown Zone(s) cannot be adequately monitored for ESA-listed species presence (i.e., PSO discretion determines conditions, including night or other low visibility conditions, are such that listed species cannot be reliably sighted within the Shutdown Zone(s) with the available monitoring equipment, no equipment that requires PSO monitoring can be deployed until such time that the Shutdown Zone(s) can be effectively monitored.
5. The Shutdown Zone(s) must be monitored by third-party PSOs at all times when boomer, sparker, bubble gun, or Chirp sub-bottom profiler categories of equipment are being operated and all observed ESA-listed species must be recorded (see reporting requirements below).
6. A PSO must notify the survey crew that a shutdown of all active boomer, sparker, and bubble gun acoustic sources is immediately required. The vessel operator and crew must comply immediately with any call for a shutdown by the PSO. Any disagreement or discussion must occur only after shutdown.
7. Clearance Zones of at least 1,640 ft (500 m) for all ESA-listed species of marine mammal must be clear of all animals for 30 minutes before ramp-up or any deployed survey equipment is activated.
8. If any protected species is observed within the respective Clearance Zone during the 30-minute pre-clearance period, the relevant acoustic sources must not be initiated until the ESA listed whale (or unidentified whale) is confirmed by visual observation to have exited the relevant zone, or, until 30 minutes have elapsed with no further sighting of the animal.
9. A “ramp up” of the boomer, sparker, or bubble gun survey equipment must occur at the start or re-start of geophysical survey activities when technically feasible. A ramp up must begin with the power of the smallest acoustic equipment for the geophysical survey at its lowest power output. When technically feasible the power will then be gradually turned up and other acoustic sources added in a way such that the source level would increase gradually.

---

[2] Lessees must discuss ASV deployment with BOEM prior to contracting to understand what measures may be necessary for the ASV system under consideration.

10. Following a shutdown for any reason, ramp up of the equipment may begin immediately only if: (a) the shutdown is less than 30 minutes, (b) visual monitoring of the Shutdown Zone(s) continued throughout the shutdown, (c) the animal(s) causing the shutdown was visually followed and confirmed by PSOs to be outside of the Shutdown Zone(s) and heading away from the vessel, and (d) the Shutdown Zone(s) remains clear of all ESA-listed species. If all the conditions above are not met, a 1,640 ft (500 m) distance must be monitored for all ESA-listed species for 30 minutes of pre-clearance observation before noise-producing equipment can be turned back on.
11. No geophysical surveys may be conducted at night or during low-visibility conditions unless PSOs are able to effectively monitor the full extent of the Clearance and Shutdown Zone(s).
12. An Alternative Monitoring Plan (AMP) must be submitted to BOEM (or the federal agency authorizing, funding, or permitting the survey) detailing the monitoring methodology that will be used during nighttime and low-visibility conditions. The AMP must include technologies that have the technical feasibility to detect all ESA-listed species in the Clearance and Shutdown Zone(s). Low-light equipment (i.e., night-vision goggles and/or infrared technology) must be available for use during low visibility (e.g., inclement weather, nighttime) monitoring.
13. PSOs must be trained and experienced with any AMP technology used. The AMP must describe how calibration will be performed, for example, by including observations of known objects at set distances and under various lighting conditions. This calibration should be performed during mobilization and periodically throughout the survey operation.
14. PSOs shall make nighttime observations from a platform with no visual barriers, due to the potential for the reflectivity from bridge windows or other structures to interfere with the use of the night vision optics. Alternative monitoring technology (e.g., night vision, infrared/thermal cameras, etc.) must be available on all survey vessels for monitoring at night and in any other low visibility conditions.
15. To minimize risk to North Atlantic right whales, no surveys may occur in Cape Cod Bay from January 1–May 15 of any year (in an area beginning at 42°04′56.5″ N-070°12′00.0″ W; thence north to 42°12′00.0″ N-070°12′00.0″ W; thence due west to charted mean high-water line; thence along charted mean high water within Cape Cod Bay back to beginning point).
16. During good conditions (e.g., daylight hours; Beaufort scale 3 or less) when survey equipment is not operating, to the maximum extent practicable (accounting for recommended shift schedules and vessel activities), PSOs should conduct observations for listed species for comparison of sighting rates and behavior with and without use of active geophysical survey equipment. Any observed listed species must be recorded regardless of any mitigation actions required.
17. At times when multiple survey vessels using boomer, sparker, or bubble gun categories of equipment are operating within the Research Lease Area, adjacent areas, or exploratory cable routes, a minimum separation distance much be maintained between survey vessels to ensure sound sources do not overlap.

3.3.4 Minimize Vessel Interactions with Listed Species during use of a Moon Pool

While the final vessel contractors have not yet been selected for the survey activities included under the Proposed Action, the State of Maine and PTOW may contract vessels equipped with a moon pool for the proposed survey activities. During times of year when sea turtles are known to occur in the survey area and if there is an intention to utilize a moon pool for the required activities, the following BMPs must be followed:

1. General requirements:

   a. Where the moon pools have hull doors, the operator(s) should keep the doors closed as much as reasonably practicable when no activity is occurring within the moon pool, unless the safety of crew or vessel require otherwise. This will prevent protected species from entering the confined area during periods of non-activity.
   b. Use of a moon pool requires regular monitoring while open to the water column and if a vessel is not underway. Regular monitoring means 24-hour video monitoring with hourly recurring checks for at least five minutes of the video feed, or hourly recurring visual checks of the moon pool for at least five minutes by a dedicated crew observer with no other tasks during that short visual check.
   c. If water conditions are such that observers are unable to see within a meter of the surface, operations requiring the lowering or retrieval of equipment through the moon pool must be conducted at a rate that will minimize potential harm to protected species.
2. Movement of the vessel and equipment deployment and/or retrieval (no hull door):
   a. Before movement of the vessel and/or the deployment and/or retrieval of equipment, the moon pool must be monitored continuously for a minimum of 30 minutes, by a dedicated crew observer with no other tasks, to ensure no individual protected species is present in the moon pool area.
   b. If a protected species is observed in the moon pool before movement of the vessel, the vessel must not be moved and equipment must not be deployed or retrieved, except for human safety considerations. If the observed animal leaves the moon pool, the operator may commence activities. If the observed animal remains in the moon pool, contact BSEE before planned movement of the vessel according to reporting requirements (see *Reporting of Observations of Protected Species within an Enclosed Moon Pool* below).
   c. Should a protected species be observed in a moon pool before activity commences (including lowering or retrieval of equipment), recovery of the animal or other actions specific to the scenario may be required to prevent interaction with the animal. If protected species are observed during activity, only reporting is required (see *Reporting of Observations of Protected Species within an Enclosed Moon Pool* below). Operators must not take such action except at the direction of, and after contact with, NMFS.
3. Closure of the Hull Door:
   a. Should the moon pool have a hull door that can be closed, then prior to and following closure, the moon pool must be monitored continuously by a dedicated crew observer with no other tasks to ensure that no individual protected species is present in the moon pool area. If visibility is not clear to the hull door from above (e.g., turbidity or low light), 30 minutes of monitoring is required prior to hull door closure.
   b. If a protected species is observed in the moon pool prior to closure of the hull door, the hull door must not be closed, to the extent practicable. If the observed animal leaves the moon pool, the operator may commence closure. If the observed animal remains in the moon pool, contact BSEE prior to closure of the hull doors according to reporting requirements (see *Reporting of Observations of Protected Species within an Enclosed Moon Pool* below).
4. Reporting of Observations of Protected Species within an Enclosed Moon Pool:
   a. If a protected species is observed within an enclosed moon pool and does not demonstrate any signs of distress or injury or an inability to leave the moon pool of its own volition, measures described in this section must be followed (only in cases where they do not jeopardize human safety). Although this particular situation may not require immediate assistance and reporting, a protected species could potentially become disoriented with their surroundings and may not be

able to leave the enclosed moon pool of their own volition. In order for operations requiring use of a moon pool to continue, the following reporting measures must be followed:

b. Within 24 hours of any observation, and daily after that for as long as an individual protected species remains within a moon pool (i.e., in cases where an ESA listed species has entered a moon pool but entrapment or injury has not been observed), The following information must be reported to BSEE (protectedspecies@bsee.gov):

  - For an initial report, all information described above should be included.
  - For subsequent daily reports:
    - Describe the animal's status to include external body condition (e.g., note any injuries or noticeable features), behaviors (e.g., floating at surface, chasing fish, diving, lethargic, etc.), and movement (e.g., has the animal left the moon pool and returned on multiple occasions?);
    - Description of current moon pool activities, if the animal is in the moon pool (e.g., drilling, preparation for demobilization, etc.);
    - Description of planned activities in the immediate future related to vessel movement or deployment of equipment;
    - Any additional photographs or video footage of the animal, if possible;
    - Guidance received and followed from NMFS liaison or stranding hotline that was contacted for assistance;
    - Whether activities in the moon pool were halted or changed upon observation of the animal; and
    - Whether the animal remains in the pool at the time of the report, or if not, the time/date the animal was last observed.

BOEM does not advocate the lowering of crew members into the moon pool to free protected species and NMFS should be contacted if protected species are encountered in the moon pool.

3.3.5 Third-Party PSO Requirements

When surveys or vessels require the use of third-party PSOs (as opposed to Trained Lookouts), such as for HRG surveys for which MMPA take authorization is being requested (**Section 3.1.2.2**), the Lessee must use qualified PSOs provided by a third party to observe Clearance and Shutdown Zones, and implement mitigation measures as outlined in the conditions in the previous and following subsections. Additionally:

1. All PSOs must have completed a training program with BOEM-approved PSO training materials. PSOs must also have received NMFS approval to act as a PSO for geophysical surveys. The Lessee must provide to BOEM upon request, documentation of NMFS approval as PSOs for geophysical activities in the Atlantic and copies of the most recent training certificates of individual PSOs' successful completion of a commercial PSO training course with an overall examination score of 80% or greater. Instructions and application requirements to become a NMFS- approved PSO can be found at: https://www.fisheries.noaa.gov/national/endangered-species-conservation/protected-species-observers.
2. For situations where Trained Lookouts are used when PSOs are not required, training must include protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements.

3. PSOs deployed for mitigation, monitoring, and reporting of geophysical survey activities must be employed by a third-party observer provider. While the vessel is underway, they must have no other tasks other than to conduct observational effort, record data, communicate with and instruct relevant vessel crew to the presence of listed species and implement required mitigation and monitoring measures. PSOs on duty must be clearly listed on daily data logs for each shift.
    a. Non-third-party observers may be approved by NMFS on a case-by-case basis for limited, specific duties in support of approved, third-party PSOs.
4. A minimum of two PSO must be on duty for observing listed species on each vessel at all times, including times with low visibility (e.g., nighttime, fog) that noise-producing equipment is operating, or the survey vessel is actively transiting.
    a. The Lessee must include a PSO schedule showing that the number of PSOs used is sufficient to effectively monitor the affected area for the project (e.g., surveys) and record the required data. PSOs must not be on watch for more than 4 consecutive hours, with at least a 2-hour break after a 4-hour watch. PSOs must not work for more than 12 hours in any 24-hour period.
5. Visual monitoring must occur from the most appropriate vantage point on the associated operational platform that allows for maximum possible 360-degree field of view around the sound source and vessel. If 360-degree field of view is not possible from a single vantage point, multiple PSOs must be on watch to ensure such coverage to ensure both geophysical survey and vessel strike avoidance requirements for ESA-listed species can be implemented.
6. The Lessee must ensure that suitable equipment is available to each PSO to adequately observe the full extent of the Clearance and Shutdown Zones prior to and during all geophysical survey activity respectively and meet all reporting requirements. The following equipment must be available.
    a. Visual observations must be conducted using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.
    b. Rangefinders (at least one per PSO, plus backups) or reticle binoculars (e.g., 7 x 50) of appropriate quality (at least one per PSO, plus backups) to estimate distances to listed species located in proximity to the Clearance and Shutdown Zone(s).
    c. Digital cameras with a telephoto lens that is at least 300 mm or equivalent on a full-frame single lens reflex (SLR). The camera or lens should also have an image stabilization system. Used to record sightings and verify species identification when possible.
    d. A laptop or tablet to collect and record data electronically.
    e. Global Positioning Units (GPS) if data collection/reporting software does not have built-in positioning functionality.
    f. PSO data must be collected in accordance with standard data reporting, software tools, and electronic data submission standards approved by BOEM and NMFS for the particular activity.
    g. Any other tools deemed necessary to adequately perform PSO tasks.

PSOs must have no Project-related tasks other than to observe, collect and report data, and communicate with and instruct relevant vessel crew regarding the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards). PSOs must have completed a commercial PSO training program for the Atlantic with an overall examination score of 80% or greater. The Lessee must provide training certificates for individual PSOs to BOEM upon request. PSOs and PAM operators must be approved by NMFS before the start of a survey.

PSOs must be approved by NMFS prior to the start of a survey, and the Lessee must submit documentation of NMFS' approval upon request to BOEM (at renewable_reporting@boem.gov) and BSEE (via TIMS Web Portal and protectedspecies@bsee.gov). Application requirements to become a NMFS-approved PSO for geological and geophysical surveys can be obtained by sending an inquiry to nmfs.psoreview@noaa.gov.

Lead PSOs must have prior approval from NMFS as an unconditionally approved PSO.

a. At least one lead PSO must be present on each HRG survey vessel.
b. PSOs on transit vessels must be approved by NMFS but need not be authorized as a lead PSO.
c. All PSOs on duty must be clearly listed and the lead PSO identified on daily data logs for each shift.
d. A sufficient number of PSOs must be deployed to record data in real time and effectively monitor the required clearance, shutdown, or monitoring zone for the Project.
e. Where applicable, the number of PSOs deployed must meet the NARW enhanced seasonal monitoring requirements.
f. A PSO must not be on watch for more than 4 consecutive hours and must be granted a break of no fewer than 2 hours after a 4-hour watch.
g. A PSO must not work for more than 12 hours in any 24-hour period unless an alternative schedule is authorized in writing by BOEM.
h. The Lessee must ensure that suitable equipment is available to PSOs (including binoculars, range-finding equipment, a digital camera, and electronic data recording devices [e.g., a tablet]) to adequately monitor the extent of the clearance and shutdown zones, determine the distance to protected species during surveys, record sightings and verify species identification, and record data. PSO observations must be conducted while free from distractions and in a consistent, systematic, and diligent manner.

3.3.6 Reporting Requirements

To ensure compliance and evaluate effectiveness of mitigation measures, regular reporting of survey activities and information on listed species will be required as follows. Only vessel surveys which require third-party PSOs will be required to meet reporting requirements under Sections **3.3.6.1** through **3.3.6.4.** Reporting requirements listed under **Sections 3.3.6.5** and **3.3.6.6** must be completed if applicable regardless of survey type or type of observer.

3.3.6.1 Survey Reporting

Prior to conducting each physical, biological, or cultural resources survey in support of the submission of a plan, the Lessee must submit to the Lessor a survey plan. Each distinct survey effort (e.g., mobilization) must be addressed by a survey plan, although a single survey plan may cover more than one survey effort and may cover multiple types of activities (e.g., geotechnical and geophysical surveys on lease and along cable routes).

Each survey plan must include details of activities to be conducted and timelines of each survey effort necessary to support the submission of a plan (i.e., necessary to satisfy the information requirements in the applicable regulations, including but not limited to 30 CFR 585.606, 610,611,621,626,627, et al.). The Lessor will not accept survey plans that do not provide sufficient detail for review, including but not limited to specific description and illustration of the geographic areas to be surveyed, specific discussion of the survey methods and equipment to be employed, and a schedule of survey activities.

The Lessee must demonstrate compliance include any waiver requests in its initial survey plan and the Lessee's intentions to coordinate with the U.S. Coast Guard (USCG) to prepare a Notice to Mariners for the specific survey activities described in the survey plan.

The Lessee must submit a survey plan to the Lessor at least 90 calendar days prior to commencement of any survey activities described in the survey plan. Within 30 calendar days from receipt, the Lessor may request the Lessee modify the survey plan to address any comments the Lessor submits to the Lessee on the contents of the survey plan. Comments must be addressed by the Lessee in a manner deemed satisfactory by the Lessor prior to commencement of the survey activities. If the Lessor does not respond with comments or objections within 30 calendar days of receipt of the survey plan, the Lessee may proceed with the survey activities per the proposed schedule. The lack of Lessor comment or objection to the survey plan does not ensure acceptance of the survey results with the SAP and/or RAP. If the Lessee is proposing a fisheries survey that could result in the take of species listed under the Endangered Species Act, additional time should be allowed for consultation and/or permits authorizing the activity.

3.3.6.2 Monthly Survey Reports

Monthly reporting of raw PSO data collected during geophysical survey activities must be submitted to BOEM (renewable_reporting@boem.gov) and BSEE (via TIMS Web Portal and protectedspecies@bsee.gov) by the PSO provider on the 15th of each month for each vessel conducting survey work. Any editing, review, and quality assurance checks must be completed only by the PSO provider prior to submission to BOEM and ensure use of standard field codes and formats (**Appendix A**). Monthly data reporting from all PSO observations must be recorded based on standard PSO collection and reporting requirements. PSOs must use standardized electronic data forms to record data. The PSOs may record data electronically in data collection software, but the data fields listed below must be recorded and exported to an Excel file for submittal. Alternatively, BOEM has developed an Excel spreadsheet with all the necessary data fields that is available upon request.

3.3.6.3 Final Survey Reports

Final survey reports must be submitted to BOEM in coordination with PSOs within 90 calendar days following completion of a survey. Final reports must contain all survey activity included under each submitted survey plan, but include individual vessel departure and return ports, PSO names and training certifications, the PSO provider contact information, dates of the survey, a vessel track, a summary of all PSO documented sightings of protected species, survey equipment shutdowns that occurred, any vessel strike-avoidance measures taken, takes of protected species that occurred, and any observed injured or dead protected species. The DOI will work with the Lessee to ensure that DOI does not release confidential business information found in the monitoring reports.

3.3.6.4 Instructions for Geophysical Survey Reports

The following data fields for PSO reports of geological and geophysical surveys must be reported in Excel format (.xls file) along with metadata defining all data fields.

Survey Information:

- Project name
- Lease number
- State coastal zones
- Survey contractor
- Survey type

- Reporting start and end dates
- Visual monitoring equipment used (e.g., bionics, magnification, IR cameras);
- Distance finding method used
- PSO names (last, first), training certification, and affiliation
- PSO location and observation height above sea surface

Operations Information:

- Vessel name(s)
- Sound sources including equipment type, power levels, and frequencies used
- Greatest RMS source level
- Dates of departures and returns to port with port name

Monitoring Effort Information:

- Date (YYYY-MM-DD)
- Source status at time of observation (on/off)
- Number of PSOs on duty
- Start time of observations for each shift in UTC (YY-MM-DDT HH:MM)
- End time of observations for each shift in UTC (YY-MM-DDT HH:MM)
- Duration of visual observations of protected species
- Weather
- Wind speed (knots), direction (cardinal direction)
- Beaufort sea state
- Water depth (meters)
- Visibility (km)
- Glare severity related to monitoring area (none, slight, moderate, extreme)
- Time pre-clearance visual monitoring began in UTC (YY-MM-DDT HH:MM)
- Time pre-clearance monitoring ended in UTC (YY-MM-DDT HH:MM)
- Duration of pre-clearance visual monitoring
- Time of day of pre-clearance began (day/night)
- Time power-up/ramp-up began
- Time equipment full power was reached
- Duration of power-up/ramp-up (if conducted)
- Time survey activity began (equipment on) in UTC
- Time survey activity ended (equipment off) in UTC
- Survey duration

- Did a shutdown/power-down occur?
  - Time shutdown was called for (UTC)
  - Time equipment was shut down (UTC)
- Vessel location (latitude/longitude, decimal degrees) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts; recorded at 30 second intervals if obtainable from data collection software
- Habitat or prey observations (narrative)
- Marine debris sightings (narrative)

<u>Detection Information (in addition to the Survey, Operation, and Monitoring fields)</u>

- Date (YYYY-MM-DD)
- Sighting ID (multiple sightings of the same animal or group should use the same ID)
- Time at first detection in UTC (YY-MMDDT HH:MM)
- Time at last detection in UTC (YY-MM-DDT HH:MM)
- PSO name(s) (last, first) on duty
- Observer location
- Number of observers on duty
- Watch status (on effort PSO, off effort PSO, opportunistic, crew, alternate vessel/platform)
- Effort (ON=device on; OFF=device off)
- Start time of observations
- End time of observations
- Location of vessel when detection occurs: Latitude and Longitude (decimal degrees)
- Compass heading of vessel (degrees)
- Beaufort sea state
- Wind speed (knots/direction)
- Swell height (meters)
- Weather/precipitation
- Visibility (kilometers)
- Cloud coverage (%)
- Glare severity related to monitoring area (none, slight, moderate, extreme)
- Species (Species Code)
- Certainty of identification
- Number of adults (high, low, best)
- Number of juveniles (high, low, best)
- Total number of animals or estimated group size

- Sighting cue (Blow, Breach, White water, Flukes, Body)
- Bearing to animal(s) when first detected (ship heading in degrees + clock face direction to animal)
- Distance determination method (use code)
- Distance from vessel at first detection (e.g., reticle distance in meters)
- Description of unidentified animals (include features such as overall size; shape of head; color and pattern; size, shape, and position of dorsal fin; height, direction, and shape of blow, etc.)
- Detection narrative (note behavior, especially changes in relation to survey activity and distance from source vessel)
- Direction of travel/first approach (relative to vessel)
- Behaviors observed: indicate behaviors and behavioral changes observed in sequential order (use behavioral codes)
- If any bow-riding behavior observed, record total duration during detection (YY-MM-DDT HH:MM)
- Initial heading of animal(s) (ship heading in degrees + clock face direction to animal)
- Final heading of animal(s) (ship heading in degrees + clock face direction to animal)
- Shutdown zone size during detection (meters)
- Was the animal inside the shutdown zone? (Y/N)
- Closest distance to vessel (reticle distance in meters)
- Time at closest approach (UTC YY-MM-DDT HH:MM)
- Time animal entered shutdown zone (UTC YY-MM-DDT HH:MM)
- Time animal left shutdown zone (UTC YY-MM-DDT HH:MM)
- If observed/detected during ramp-up/power-up: first distance (reticle distance in meters), closest distance (reticle distance in meters), last distance (reticle distance in meters), behavior at final detection
- Did a shutdown/power-down occur? (Y/N)
- Time shutdown was called for (UTC)
- Time equipment was shut down (UTC)

3.3.6.5 Protected Species Incident Reporting

Regardless of survey type or the need to provide a dedicated trained watch stander or PSO, any potential take, strikes, or dead/injured protected species caused by Project activities must be reported to the NMFS GARFO Protected Resources Division (nmfs.gar.incidental-take@noaa.gov), NOAA Fisheries 24-hour Stranding Hotline – for marine mammals from Maine-Virginia, report to (866) 755-6622, and from North Carolina-Florida to (877) 942-5343 and for sea turtles from Maine-Virginia, report to (866) 755-6622, and from North Carolina-Florida to (844)732-8785.BOEM (renewable_reporting@boem.gov) and BSEE (via TIMS and protectedspecies@bsee.gov) as soon as practicable, but no later than 24 hours from the time the incident took place (Protected Species Incident Report). The Protected Species Incident Report must include the following information:

- Contact info for the person providing the report;
- Time, date, and location (latitude/longitude) of the incident;
- Species identification (if known) or description of the animal(s) involved;
- Condition of the animal(s) (e.g., live, injured, dead);
- Observed behaviors of the animal(s), if alive;
- If available, photographs or video footage of the animal(s); and
- General circumstances (e.g., vessel speed/direction of travel, sound sources in use) under which the animal was impacted.

3.3.6.6 Dead or Injured Protected Species Reporting

All dead or injured protected species must be reported to NMFS, BOEM, and BSEE regardless of whether they were observed during operations or directly due to Lessee activities. In the event that an injured or dead marine mammal or sea turtle is sighted, regardless of the cause, the Lessee must report the incident to the NMFS Protected Resources Division (nmfs.gar.incidental-take@noaa.gov), NMFS 24-hour Stranding Hotline number (866-755-6622), BOEM (renewable_reporting@boem.gov), and BSEE (protectedspecies@bsee.gov) as soon as practicable (taking into account crew and vessel safety), but no later than 24 hours from the sighting (Dead or Injured Protected Species Report). Staff responding to the hotline call will provide any instructions for the handling or disposing of any injured or dead protected species by individuals authorized to collect, possess, and transport sea turtles. The Protected Species Incident Report must include the following information:

- Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);
- Species identification (if known) or description of the animal(s) involved;
- Condition of the animal(s) (including carcass condition if the animal is dead);
- Observed behaviors of the animal(s), if alive;
- If available, photographs or video footage of the animal(s); and
- General circumstances under which the animal was discovered.

3.3.6.7 Reporting of All NARW Sightings

The Lessee must immediately report all NARWs observed to BOEM and BSEE; the NOAA Fisheries 24-hour Stranding Hotline number (866-755-6622); the Coast Guard (via telephone at (617) 223-5757 or via Channel 16); and WhaleAlert. The report must include the time, location, and number of animals sighted.

3.3.7 Entanglement Avoidance

Ensure any mooring systems used during data collection activities under the Proposed Action are designed to prevent potential entanglement or entrainment of listed species, and in the unlikely event that entanglement does occur, ensure proper reporting of entanglement events according to the measures specified below:

1. Ensure that any buoys attached to the seafloor use the best available mooring systems. Buoys, lines (chains, cables, or coated rope systems), swivels, shackles, and anchor designs must prevent any potential entanglement of listed species while ensuring the safety and integrity of the structure or device. All mooring lines and ancillary attachment lines must use one or more of the following measures to reduce entanglement risk: shortest practicable line length, rubber sleeves, weak-links, chains, cables, or similar equipment types that prevent lines from looping, wrapping, or entrapping protected species.
2. Any survey gear or equipment included under the Proposed Action (described in **Section 3.1**) must be attached by a line within a rubber sleeve for rigidity. The length of the line must be as short as necessary to meet its intended purpose.
3. When practicable, all survey gear, including buoys, included under the Proposed Action should be lowered and raised slowly to minimize risk to listed species and benthic habitat. No survey gear, including buoys, should be deployed or retrieved if large whales or sea turtles are sighted within 1,640 ft (500 m) of the survey gear/buoy being deployed/retrieved.
4. If a live or dead marine protected species becomes entangled, operators must immediately contact the applicable stranding network coordinator using the reporting contact details (see Reporting Requirements section) and provide any on-water assistance requested.
5. All buoys must be properly labeled with owner and contact information.

3.3.8 Benthic Habitat and Ecosystem Monitoring Conditions

All vessel anchoring and any seafloor-sampling activities are restricted from seafloor areas with deep/cold-water coral reefs and shallow/mesophotic reefs. All vessel anchoring and seafloor sampling must also occur at least 492 ft (150 m) from any known locations of threatened or endangered coral species. All sensitive live bottom habitats (eelgrass, cold-water corals, etc.) should be avoided as practicable. All vessels in coastal waters will operate in a manner to minimize propeller wash and seafloor disturbance and transiting vessels should follow deep-water routes (e.g., marked channels), as practicable, to reduce disturbance to sturgeon habitat. Additionally, no geotechnical or bottom disturbing activities will take place during the spawning/rearing season within freshwater reaches of rivers where Atlantic or shortnose sturgeon spawning occurs. Any survey plan that includes geotechnical or other benthic sampling activities in freshwater reaches (salinity 0 to 0.5 ppt) of such rivers will identify a time of year restriction that will avoid such activities during the time of year when Atlantic sturgeon spawning and rearing of early life stages occurs in that river. Time of year restrictions applicable to Atlantic sturgeon spawning and rearing of early life stages only occur in the Hudson and Delaware Rivers, both of which are outside the Action Area (**Figure 3-1**) and therefore not applicable for the Proposed Action.

3.3.8.1 Benthic Survey Plan

The Lessee must provide a Benthic Survey Plan prior to completion of the RAP to NMFS-GARFO, BOEM, and BSEE. The Lessee must review all NOAA and DOI comments on the Plans. The Lessee must provide to DOI the revised Fisheries Research Monitoring Plan and Benthic Survey Plan and written responses for all NOAA comments not addressed in the Benthic Survey Plan. DOI will review the revised Benthic Survey Plan and written responses from the Lessee for all NOAA comments not addressed in the Benthic Survey Plan, and provide comments, if any, to the Lessee within 45 days of their submittal to DOI. The Lessee must resolve all comments on revisions to the Benthic Survey Plan to DOI's satisfaction prior to implementation of the revised Benthic Survey Plan.

3.3.9 Fishery Monitoring Conditions for Endangered and Threatened Species

The Lessee must ensure that the fisheries monitoring survey plan design follows the Fisheries Survey Guidelines (Fisheries Guidelines, updated 27 March 2023; BOEM 2023b). The Fisheries Guidelines provides guidance for standardizing survey plan design and aims to reduce the risk of interactions between protected species and sampling gear by minimizing the amount of gear fished (i.e., set or towed), the gear soak or tow duration, and the spatial and temporal overlap with protected species. Additionally, the Lessee must ensure compliance with gear restrictions and requirements as detailed in the Atlantic Large Whale Take Reduction Plan (ALWTRP) Risk Reduction Rule (50 CFR Part 229 Subpart C) in order to minimize potential entanglement risk.

3.3.9.1 Best practices for trap/pot gear

The Lessee must ensure that all trap/pot gear follow required best practices, including:

- Reduce the number of vertical lines: Minimizing the number of vertical lines can be accomplished by reducing the number of vertical lines used by reducing the number of traps set, trawling up; or use of ropeless gear.
- No wet storage: All sampling gear will be hauled at least once every 30 days, and all gear will be removed from the water and stored on land between sampling season.
- No surface floating buoy lines will be used.
- All groundlines will be composed of sinking line.
- Buoy lines will use weak links (less than 1,700-pound [771-kilogram] breaking strength). The number and placement of weak inserts should be consistent with the specifications provided by the ALWTRP.
- Knot-free buoy lines will be used to the extent practicable.

Additional mitigation requirements include:

- No trawl surveys may be carried out in water depths shallower than 197 feet (60 meters) to minimize the potential for interaction with Atlantic sturgeon.
- No gear may be set in the Lobster Management Area 1 restricted area between October 1 and January 31 (NMFS 2023a).

3.3.9.2 Gear Marking

The Lessee must ensure that all trap/pot gear used in fishery surveys is uniquely marked to distinguish it from other commercial or recreational gear. All gear should have a 3-foot-long yellow/black mark using paint in the top two fathoms of the vertical line and three additional 1-foot yellow/black marks in the top, middle, and bottom of each vertical line using paint or woven tracer. This gear marking scheme is distinct from gear markings used in other fisheries. Any changes in marking must not be made without notification and concurrence from BOEM. BOEM will consult with the NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division concerning any requested changes as may be necessary.

3.3.9.3 Lost gear

The Lessee must ensure that any survey gear lost is reported and recovered according to the Marine Debris Elimination and Reporting conditions. All lost gear must also be reported to NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division (at nmfs.gar.incidental-take@noaa.gov) within 24 hours of the documented time when gear is discovered to be missing or lost. This report must include information on any markings on the gear and any efforts undertaken or planned to recover the gear.

3.3.9.4 Observer Training

The Lessee must ensure all fisheries survey vessels have at least one survey team member onboard the trawl surveys and ventless trap surveys who has completed Northeast Fisheries Observer Program observer training (or another training in protected species identification and safe handling, inclusive of taking genetic samples from Atlantic sturgeon) or similar training program (program must be reviewed and deemed acceptable by NMFS GARFO and DOI) within the last 5 years. Reference materials for identification, disentanglement, safe handling, and genetic sampling procedures must be available on board each survey vessel. This requirement is in place for any trips where gear is set or hauled. Documentation of training must be provided to BOEM and BSEE within 48 hours upon request.

3.3.9.5 Disentanglement Protocols

The Lessee must ensure all vessels deploying fixed gear (e.g., pots/traps) must have adequate disentanglement equipment (i.e., knife and boathook) onboard. Any disentanglement must occur consistent with the Northeast Atlantic Coast Sea Turtle Disentanglement Network Guidelines and the procedures described in “Careful Release Protocols for Sea Turtle Release with Minimal Injury.”

3.3.9.5.1 Sea turtle and sturgeon protocols

The Lessee must ensure any sea turtles or Atlantic sturgeon caught and/or retrieved in any fisheries survey gear are identified to species or species group and reported to DOI via email to BOEM (renewable_reporting@boem.gov), BSEE (via TIMS), and NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division (nmfs.gar.incidental-take@noaa.gov). Each ESA-listed species caught and/or retrieved must then be properly documented using appropriate equipment and the NMFS data collection form. Biological data, samples, and tagging must occur as outlined below:

The Lessee must follow the Sturgeon and Sea Turtle Take Standard Operating Procedures (NMFS 2021b).

1. The Lessee must equip survey vessels with a passive integrated transponder (PIT) tag reader onboard capable of reading 134.2 kHz and 125 kHz encrypted tags (e.g., Biomark GPR Plus Handheld PIT Tag Reader), and this reader must be used to scan any captured sea turtles and sturgeon for tags. Any recorded tags must be recorded on the take reporting form 10 and reported to DOI via email to BOEM (via TIMS), BSEE, (OSWSubmittals@bsee.gov), and NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division (nmfs.gar.incidental-take@noaa.gov).
    a. The Lessee must take genetic samples from all captured Atlantic sturgeon (alive or dead) to allow for identification of the distinct population segment (DPS) of origin of captured individuals and the tracking of the amount of incidental take. This sample collection must be done in accordance with the Procedures for Obtaining Sturgeon Fin Clips.
    b. Fin clips must be sent to a BOEM approved laboratory capable of performing genetic analysis and assignment to DPS of origin. Results of genetic analysis, including assigned DPS of origin, must be submitted to DOI via email to BOEM (renewable_reporting@boem.gov), BSEE (via TIMS) and NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division (nmfs.gar.incidental-take@noaa.gov) within 6 months of the sample collection.
    c. Subsamples of all fin clips and accompanying metadata form must be held and submitted to the Atlantic Coast Sturgeon Tissue Research Repository on a quarterly basis utilizing the Sturgeon Genetic Sample Submission Form.

2. The Lessee must ensure all captured sea turtles and Atlantic sturgeon are documented with required measurements, photographs, body condition, and descriptions of any marks or injuries. This information must be entered as part of the record for each capture. An NMFS Take Report Form must be filled out for each individual sturgeon and sea turtle and submitted to DOI via email to BOEM (renewable_reporting@boem.gov), BSEE (via TIMS), and NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division (nmfs.gar.incidental-take@noaa.gov).
3. The Lessee must ensure any live, uninjured animals are returned to the water as quickly as possible after completing the required handling and documentation. Live and responsive sea turtles or Atlantic sturgeon caught and retrieved in gear used in any fisheries survey should be released according to established protocols and whenever at-sea conditions are safe for those releasing the animal(s). Any unresponsive sea turtles or Atlantic sturgeon caught and retrieved in gear used in fisheries surveys must be handled and resuscitated whenever at-sea conditions are safe for those handling and resuscitating the animal(s). Specifically:
4. To the extent allowed by sea conditions, the Lessee must give priority to the handling and resuscitation of any sea turtles or sturgeon that are captured in the gear being used. Handling times for these species should be minimized (i.e., kept to 15 minutes or less) to limit the amount of stress placed on the animals.
5. All survey vessels must have copies of the sea turtle handling and resuscitation requirements found at 50 CFR 223.206(d)(1) prior to the commencement of any on-water activity. These handling and resuscitation procedures must be executed any time a sea turtle is incidentally captured and brought onboard a survey vessel.
    a. For sea turtles that appear injured, sick, distressed, or dead (including stranded or entangled individuals), survey staff must immediately contact the Greater Atlantic Region Marine Animal Hotline at 866-755-6622 for further instructions and guidance on handling, retention, and/or disposal of the animal. If unable to contact the hotline (e.g., due to distance from shore or lack of ability to communicate via phone), the Coast Guard should be contacted via VHF marine radio on Channel 16. If required, hard-shelled sea turtles (i.e., non-leatherbacks) may be held on board for up to 24 hours, provided that conditions during holding are authorized by the NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division and safe handling practices are followed. If the hotline or an available veterinarian cannot be contacted and the injured animal cannot be taken to a rehabilitation center, activities that could further stress the animal must be stopped. When sea-to-shore contact with the hotline or an available veterinarian is not possible, the animal must be allowed to recover and be responsive before safely releasing it to the sea.
    b. Attempts must be made to resuscitate any Atlantic sturgeon that are unresponsive or comatose by providing a running source of water over the gills as described in the Sturgeon Resuscitation Guidelines.
    c. NMFS may authorize that dead sea turtles or Atlantic sturgeon be retained on board the survey vessel, provided that appropriate cold storage facilities are available on the survey vessel. Sea turtle and sturgeon carcasses should be held in cold storage (frozen is preferred, although refrigerated is permitted if a freezer is not available) until retention or disposal procedures are authorized by the NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division for transfer to an appropriately permitted partner or facility on shore.

6. The Lessee must notify DOI via email to BOEM (renewable_reporting@boem.gov), BSEE (via TIMS), and NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division (nmfs.gar.incidental-take@noaa.gov) within 24 hours of any interaction with a sea turtle or sturgeon and include the NMFS take reporting form (https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics-greater-atlantic#biological-opinion---take-reporting). The report must include at a minimum, the following: (1) survey name and applicable information (e.g., vessel name, station number); (2) Global Positioning System (GPS) coordinates describing the location of the interaction (in decimal degrees); (3) gear type involved (e.g., bottom trawl, longline); (4) soak time, gear configuration and any other pertinent gear information; (5) time and date of the interaction; (6) identification of the animal to the species level (if possible), and (7) a photograph or video of the animal (multiple photographs are suggested, including at least one photograph of the head scutes). If reporting within 24 hours is not possible (e.g., due to distance from shore or lack of ability to communicate via phone, fax, or email), reports must be submitted as soon as possible; late reports must be submitted with an explanation for the delay.

3.3.9.6 Fisheries Survey Reporting

The Lessee must submit an annual report within 90 days of the completion of each survey season to BOEM (renewable_reporting@boem.gov) and NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division (nmfs.gar.incidental-take@noaa.gov). The report must include all information on any observations of and interactions with ESA-listed species and contain information on all survey activities that took place during the season, including location of gear set, duration of soak/trawl, and total effort. The report on survey activities must be comprehensive of all activities, regardless of whether ESA-listed species were observed.

4 ESA-listed Species and Critical Habitat in the Action Area

4.1 ESA-listed Species in the Action Area

Table 4-1 presents all ESA-listed species and associated designated critical habitat that occur within the Action Area.

Table 4-1. ESA-listed species and designated critical habitat that may be affected by the Proposed Action

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Blue whale (*Balaenoptera musculus*)	E–35 *FR* 18319	-- --	FR Not Available 07/1998 11/2020
Fin whale (*Balaenoptera physalus*)	E–35 *FR* 18319	-- --	75 *FR* 47538 07/2010
North Atlantic right whale (*Eubalaena glacialis*)	E–73 *FR* 12024	81 *FR* 4837	70 *FR* 32293 08/2004
Sei whale (*Balaenoptera borealis*)	E–35 *FR* 18319	-- --	FR Not Available 12/2011
Sperm whale (*Physeter macrocephalus*)	E–35 *FR* 18319	-- --	75 *FR* 81584 12/2010
Sea Turtles			
Green turtle (*Chelonia mydas*) – North Atlantic DPS	T–81 *FR* 20057	-- --[1]	FR Not Available 10/1991–U.S. Atlantic
Kemp's Ridley turtle (*Lepidochelys kempii*)	E–35 *FR* 18319	-- --	FR Not Available 09/1991–U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011
Leatherback turtle (*Dermochelys coriacea*)	E–35 *FR* 8491	-- --[2]	FR Not Available 10/1991–U.S. Caribbean, Atlantic, and Gulf of Mexico
Loggerhead turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T–76 *FR* 58868	-- --[3]	74 *FR* 2995 10/1991–U.S. Caribbean, Atlantic, and Gulf of Mexico 01/2009–Northwest Atlantic
Fishes			
Atlantic salmon (*Salmo salar*) – Gulf of Maine DPS	E–74 *FR* 29344 and 65 *FR* 69459	74 *FR* 39903	70 *FR* 75473 11/2005 FR Not Available 02/2019
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Gulf of Maine DPSs	E–77 *FR* 5913	82 *FR* 39160	03/2018[4]
Giant manta ray (*Mobula birostris*)	T–83 *FR* 2916	-- --	12/2019[4]

Species	ESA Status	Critical Habitat	Recovery Plan
Oceanic whitetip shark (*Carcharhinus longimanus*)	T–83 *FR* 4153	-- --	09/2018[4]
Shortnose sturgeon (*Acipenser brevirostrum*)	E–32 *FR* 4001	-- --	63 *FR* 69613 12/1998

-- -- = not applicable; DPS = distinct population segment; E = endangered; *FR* = *Federal Register*; T = Threatened

[1] Green sea turtle critical habitat (63 *FR* 46693) is established outside of the Action Area.

[2] Leatherback sea turtle critical habitat (44 *FR* 17710 in the Atlantic and 77 *FR* 4169 in the Pacific) is established outside of the Action Area.

[3] Loggerhead sea turtle critical habitat (79 *FR* 39856) is established outside of the Action Area.

[4] No Recovery Plan is available for this species. However, NMFS has developed a Recovery Outline to serve as interim guidance for this species until a full Recovery Plan is developed.

4.2 ESA-listed Species and Critical Habitat Considered but Excluded from Further Analysis

Two ESA-listed species have broad geographic ranges that include portions of the northwest Atlantic but are not expected to occur within the Gulf of Maine with any reasonable certainty. Based on sighting histories and habitat preferences, these species, namely the giant manta ray (*Mobula birostris*) and oceanic whitetip shark (*Carcharhinus longimanus*), are unlikely to be present in the Action Area. Given this, **no effec**t is expected for these species as they would not encounter any project vessels or equipment included under the Proposed Action (Section 3.1). Explanations for excluding these species from further analysis are provided in the following subsections.

Critical habitat for Atlantic sturgeon – Gulf of Maine DPS exist in rivers in the vicinity of the Action Area. However, there is no marine habitat identified as critical habitat and no Proposed activities will overlap with any Atlantic sturgeon critical habitat units. Therefore, the effects of the Proposed Action considered for this BA would have **no effect** on the critical habitat of Atlantic sturgeon. Critical habitat for Atlantic sturgeon is excluded from further analyses. Information is provided in the subsections below for excluding this critical habitat from further analysis.

4.2.1 Giant Manta Ray (Threatened)

The giant manta ray is the world's largest ray and can be found worldwide in tropical, subtropical, and temperate waters between 35°N and 35°S latitudes. They primarily feed on planktonic organisms, including euphausiids and copepods (NMFS 2022a). The giant manta ray was listed as threatened throughout its range under the ESA in 2018 (83 *FR* 2916). Commercial fishing is the primary threat to the giant manta ray as it is targeted and caught as bycatch in several global fisheries throughout its range (NMFS 2022a). No areas within U.S. jurisdiction meet the definition of critical habitat for the giant manta ray (84 *FR* 66652) and, therefore, no critical habitat is designated for the species.

Giant manta rays travel long distances during seasonal migrations and may be found in upwelling waters at the shelf break. The species may also follow warm Gulf Stream water intrusions into areas north of 35°N, typically in late summer and early fall when sea surface temperatures are the highest (Farmer et al. 2022). Sighting records of giant manta rays in the Mid-Atlantic and New England are rare, but individuals have been observed as far north as New Jersey (Miller and Klimovich 2017) and Block Island (Gudger 1922; Farmer et al. 2022). Based on the best available information, BOEM has determined that the giant manta ray is not likely to be present in the Action Area and therefore, they are not expected to encounter any project vessels or equipment included under the Proposed Action. Therefore, **no effect** is expected for the giant manta ray resulting from the Proposed Action.

4.2.2 Oceanic Whitetip Shark (Threatened)

The oceanic whitetip shark, listed as threatened in 2018 (83 *FR* 4153), can be found globally in tropical and warm-temperate waters. The species is typically found in water temperatures between 59°F and 82°F (15°C and 28°C), though is most common in waters warmer than 68°F (20°C) (Bonfil et al. 2008; Carlson and Gulakt 2012; Tolotti et al. 2015; NMFS 2023b). It is a pelagic species with a preference for open ocean waters but can also be found on the OCS or around oceanic islands in waters deeper than 604 ft (184 m) (NMFS 2023b).

Oceanic whitetip sharks typically occur between 10° N and 10° S, but can be found in decreasing numbers out to latitudes of 30° N and 30° S, with abundance decreasing with greater proximity to continental shelves (Young et al. 2017). In the Northwest Atlantic Ocean, they are most commonly observed south of Virginia, though records of occurrence include the Mid-Atlantic and northeast U.S. (Kohler et al. 1998; Young and Carlson 2020; Vaudo et al. 2022). The overall range of the species in the North Atlantic Ocean expands northward during the summer and fall in response to seasonally warmer temperatures and increased prey availability (Vaudo et al. 2022). Oceanic whitetip sharks are not expected to occur in the Action Area given their geographic range and preference for warm pelagic waters away from the continental shelf. As a result, they are not expected to encounter project vessels or equipment included under the Proposed Action. Therefore, **no effect** is expected for oceanic whitetip sharks resulting from the Proposed Action.

4.2.3 Atlantic Sturgeon Critical Habitat – Gulf of Maine DPS

The Gulf of Maine DPS of Atlantic sturgeon was listed as threatened under the ESA in 2012 (77 *FR* 5880; 77 *FR* 5914). The final rule for Atlantic sturgeon critical habitat (all listed DPS) was issued in 2017 (82 *FR* 39160). Included in this rule are 31 units, all rivers, occurring from Maine to Florida (**Figure 4-1**). No marine habitats were identified as critical habitat because the physical and biological features in these habitats essential for the conservation of Atlantic sturgeon could not be identified.

The critical habitat designation (82 *FR* 39160) for all DPSs is for habitats that support successful Atlantic sturgeon reproduction and recruitment. The physical features essential for Atlantic sturgeon reproduction and recruitment and therefore to the conservation of the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (NMFS 2017) include: (1) hard-bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0 to 0.5 ppt range) for settlement of fertilized eggs, refuge, growth, and development of early life stages; (2) aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development; (3) water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support unimpeded movements of adults to and from spawning sites, seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary, and staging, resting, or holding of subadults or spawning condition adults; and (4) water quality conditions between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support spawning, annual and interannual adult, subadult, larval, and juvenile survival, and larval, juvenile, and subadult growth, development, and recruitment (e.g., 13° C to 26° C for spawning habitat and no more than 30° C for juvenile rearing habitat, and 6 mg/L or greater dissolved oxygen for juvenile rearing habitat).

Critical habitat designations for the Atlantic sturgeon Gulf of Maine DPS encompasses five rivers in Maine, New Hampshire, and Massachusetts (Units 1 through 5). However, the Action Area does not overlap with any portion of Atlantic sturgeon critical habitat. Therefore, no Proposed Activities will be conducted in Atlantic sturgeon critical habitat and **no effect** from the Proposed Action will occur.

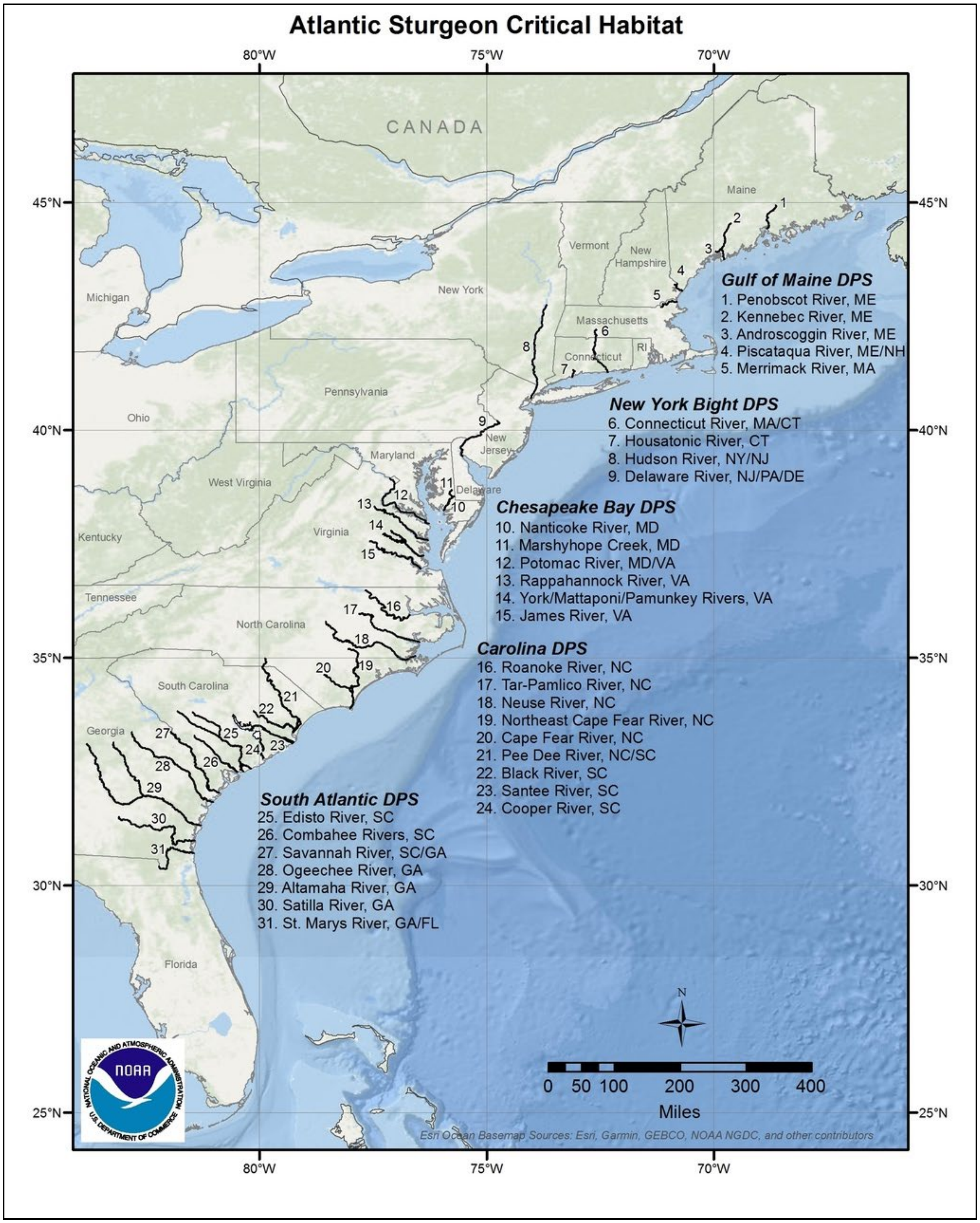


Figure 4-1. Map identifying designated critical habitat for the Atlantic sturgeon

5 Description of Species and Critical Habitat Considered for Further Analysis

5.1 ESA-listed Species Considered for Further Analysis

BOEM has determined that the following ESA-listed species are likely to be present in the Action Area and thus require further analysis: fin whale–Western North Atlantic stock (*Balaenoptera physalus*); North Atlantic right whale–Western North Atlantic stock; sei whale–Nova Scotia stock (*Balaenoptera borealis*); sperm whale–North Atlantic stock (*Physeter macrocephalus*); blue whale – North Atlantic stock (*Balaenoptera musculus*); green sea turtle–North Atlantic DPS; Kemp's ridley sea turtle (*Lepidochelys kempii*); leatherback sea turtle (*Dermochelys coriacea*); loggerhead sea turtle–Northwest Atlantic Ocean DPS (*Caretta caretta*); Atlantic Salmon–Gulf of Maine DPS (*Salmo salar*); Atlantic sturgeon–All DPSs (*Acipenser oxyrinchus oxyrinchus*); and shortnose sturgeon (*Acipenser brevirostrum*). The following subsections discuss the habitat, foraging preferences, acoustic behavior, status, and occurrence of each ESA-listed species considered for further analysis.

5.1.1 Marine Mammals

Five species of ESA-listed marine mammals are carried forward in this assessment. Habitat-based marine mammal density data (Roberts et al. 2023) was analyzed for each species; mean densities for all marine mammal species (in number of animals per square kilometer) within the Action Area (**Figure 3-3**) are presented in **Table 5-1**. These data (visualized through the heatmap applied to the table) are used to assess seasonal and relative distribution patterns for NARW, fin, sei, sperm, and blue whales within the Action Area, in addition to data from other surveys and published reports.

Table 5-1. Monthly marine mammal mean densities (individuals per square kilometer) within the Action Area

	January	February	March	April	May	June	July	August	September	October	November	December	Yearly Average
NARW	0.00129	0.00082	0.00080	0.00131	0.00058	0.00017	0.00021	0.00003	0.00001	0.00053	0.00131	0.00051	0.00063
Fin	0.00250	0.00162	0.00138	0.00173	0.00394	0.00541	0.00575	0.00637	0.00458	0.00384	0.00263	0.00297	0.00356
Sei	0.00010	0.00008	0.00018	0.00113	0.00282	0.00145	0.00047	0.00033	0.00057	0.00155	0.00133	0.00032	0.00086
Sperm	0.00006	0.00005	0.00004	0.00002	0.00003	0.00008	0.00012	0.00014	0.00021	0.00008	0.00004	0.00005	0.00008
Blue	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001

Data source: Roberts et al. 2023
Note: Table cell colors correspond to relative geographic and temporal densities assessed for from January through December for each species, individually. Warm colors (i.e., red) indicate months of highest relative density whereas cool colors (i.e., green) indicate months of lowest relative density for that species. Only annual density data is available for the blue whale (Roberts et al. 2023); therefore, all months indicate the same average annual density for blue whales.

5.1.1.1 Fin Whale –Western North Atlantic Stock (Endangered)

Fin whales are a globally distributed baleen whale species found in temperate to polar regions in all ocean basins (Edwards et al. 2015). The western North Atlantic stock is concentrated in the U.S. and Canadian Atlantic Exclusive Economic Zones from Cape Hatteras to Nova Scotia (NMFS 2024a) and is therefore the most likely source of individuals occurring in the Action Area. Fin whales are the most commonly sighted large whale species in this region, accounting for 46 percent of all sightings in aerial surveys conducted from 1978 to 1982 (CETAP 1982; NMFS 2024a) and constitute the majority of large whale sightings in recent aerial and shipboard surveys (NEFSC and SEFSC 2018; Kraus et al. 2016a). They have been observed in every season throughout most of their range, though densities do vary seasonally (Edwards et al. 2015). While they prefer the deeper waters of the continental shelf (300 to 600 ft [91 to 183 m]), they are regularly observed anywhere from coastal to abyssal areas (NMFS 2024a).

Fin whales are the second largest cetacean, with adults in the North Atlantic reaching lengths up to 78.7 ft (24 m). Fin whales are fast swimmers typically found in social groups of two to seven, often congregating with other whales in large feeding groups (Hayes et al. 2017). The species returns annually to established feeding areas and fasts during migration between feeding and calving grounds. Fin whales in the North Atlantic feed on krill (*Meganyctiphanes norvegica* and *Thysanoessa inermis*) and schooling fish such as capelin (*Mallotus villosus*), herring (*Clupea harengus*), and sand lance (*Ammodytes* spp.), captured by skimming or lunge feeding (Borobia et al. 1995). The Gulf of Maine represents one of the main feeding grounds for fin whales, where they preferentially forage on small schooling fish such as herring, sand lance, young mackerel, and krill (DMR 2022d) Several studies suggest that distribution and movements of fin whales along the east coast of the U.S. are influenced by the availability of sand lance (Kenney and Winn 1986; Payne et al. 1990). Some level of site fidelity among females at their feeding grounds likely exist (Clapham and Seipt 1991; Agler et al. 1993; Schleimer et al. 2019). While fin whales likely migrate into Canadian waters, deep offshore areas, or tropical latitudes, distinct, population-wide large-scale annual migrations are unlikely (NMFS 2024a). Data suggests that calving may take place from October through January in the Mid-Atlantic region (Hain et al. 1992), though calving, mating, and wintering patterns for the majority of the population remain unknown. The fin whale's ecological role and influence on ecosystem processes surpasses that of all other cetacean species in the Western North Atlantic due to their large stock size and prey requirements (Hain et al. 1992; Kenney et al. 1997). Within the Action Area, biologically important areas (BIA) for feeding are delineated for the Southern Gulf of Maine year-round and the Northern Gulf of Maine from June to October (LaBrecque et al. 2015).

Fin whales and other baleen whales belong to the low-frequency cetacean (LFC) marine mammal hearing group, which has a generalized hearing range of 7 hertz (Hz) to 35 kHz (NMFS 2018). The predicted best hearing sensitivity of fin whales is believed to range from 20 HZ to 20 kHz (Erbe 2002; Southall et al. 2019).

5.1.1.1.1 Current Status

Fin whales have been listed as endangered under the ESA since the act's passage in 1973 (35 *FR* 8491), and critical habitat has not been designated. The best available abundance estimate for the western North Atlantic stock[3] is 6,802 individuals, with a minimum population estimate of 5,573 based on shipboard and aerial surveys conducted in 2016 and the 2016 Northeast Fisheries Science Center and DFO surveys (NMFS 2024a). The extents of these two surveys do not overlap; therefore, the survey estimates were added together. NMFS has not conducted a population trend analysis for the full stock due to insufficient data and irregular survey design (NMFS 2024a). The best available information indicates

---

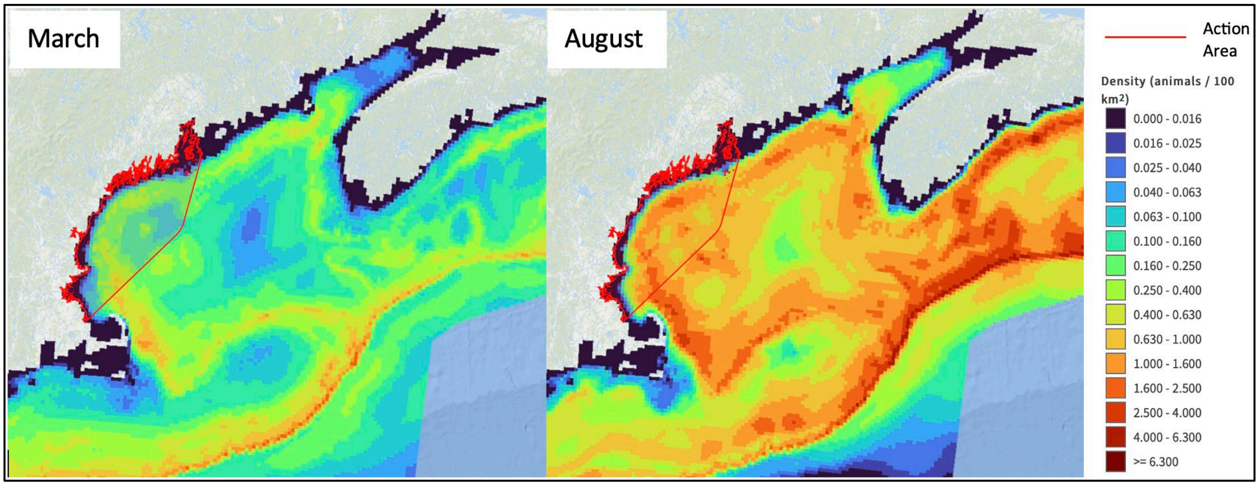
[3] "Stock" is defined by the MMPA as a group of individuals "of the same species or smaller taxa in a common spatial arrangement that interbreed when mature" (16 USC § 1362.11).

that the gross annual reproduction rate is 8 percent, with a mean calving interval of 2.7 years (NMFS 2024a). For 2017 through 2021, the minimum annual rate of human-caused (i.e., vessel strike and entanglement in fishery gear) mortality and serious injury was 2.05 per year (NMFS 2024a). No critical habitat has been designated for fin whales in the Action Area.

5.1.1.1.2 Potential Occurrence Within the Action Area

Fin whales are one of the most commonly sighted large whales in OCS waters from the Mid-Atlantic U.S. coast to Nova Scotia, Canada, principally from Cape Hatteras, North Carolina and northward (Sergeant 1977; Sutcliffe and Brodie 1977; CETAP 1982, Hain et al. 1992; NMFS 2019). The Gulf of Maine, including the Action Area, represents an important foraging area for fin whales; two BIAs for fin whale feeding overlap with the Action Area (LaBrecque et al. 2015). There is also evidence for maternally-directed site fidelity over multiple years in the Gulf of Maine (Clapham and Seipt 1991). All life stages of fin whales could be encountered in the Action Area.

Habitat-based marine mammal density data indicate the highest densities throughout the Action Area would most likely occur in August and the lowest in March (**Figure 5-1**; Roberts et al. 2023). The temporal and geographic distribution of fin whale densities within the Action Area is presented in **Table 5-1**; the data indicate that, while fin whales are widespread throughout the Gulf of Maine throughout the year, they are likely to occur in highest densities during the summer.



Source: Roberts et al. 2023

Figure 5-1. Fin whale minimum (March) and maximum (August) mean densities within the Action Area and surrounding region

5.1.1.2 North Atlantic Right Whale – Western North Atlantic Stock (Endangered)

The NARW is a large baleen whale, ranging from 45 to 55 ft (13.7 to 16.8 m) in length and weighing up to 70 tons at maturity, with females being larger than males. The primary habitat for this species is coastal or OCS waters ranging from calving grounds off the Southeastern U.S. to feeding grounds off the Northeastern U.S. (NMFS 2024a). Important feeding habitats include coastal waters off southern New England, Gulf of Maine, Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence.

There are two critical habitat areas for NARWs in Canadian waters (Brown et al. 2009) and two in U.S. waters: all U.S. waters within the Gulf of Maine are designated as a Foraging Area Critical Habitat while waters off the Southeastern U.S. are designated as a Calving Area Critical Habitat (81 *FR* 4837;

NMFS 2024a). The Mid-Atlantic OCS between the two U.S. critical habitat areas has been identified as a principal migratory corridor and thus an important habitat for NARWs as they travel between breeding and feeding grounds (CETAP 1982; NMFS 2024a). This migratory pathway is considered a BIA for the species (LaBrecque et al. 2015). While some individuals undergo yearly migrations between spending summer months at their northern feeding grounds and winter months at their southern breeding grounds, the location of most individuals throughout much of the year is not known. Year-round presence in all habitat areas has been recorded (Bailey et al. 2018; Davis et al. 2017). In addition, long-range movements are also apparent, with some individuals being identified in the eastern North Atlantic and others covering long distances over short time periods (NMFS 2024a).

Foraging habits of NARWs show a clear preference for the late juvenile developmental stage of the zooplanktonic copepod, *Calanus finmarchicus* (Mayo et al. 2001). This species occurs in dense patches and demonstrates both diel and seasonal vertical migration patterns (Baumgartner et al. 2011). The NARW distribution and movement patterns within their foraging grounds is highly correlated with concentrations and distributions of their prey, which exhibit high variability within and between years (Pendleton et al. 2012). Due to the heightened energetic requirements of pregnant and nursing females, yearly reproductive success of the population is directly related to foraging success and the abundance of *C. finmarchicus* (Meyer-Gutbrod et al. 2015), which in turn is correlated with decadal-scale variability in climate and ocean patterns (Greene and Pershing 2000).

Skim feeding is an important activity identified in effects assessments because it demonstrates a critical behavior (feeding) that could be disrupted by external stressors. Baumgartner et al. (2017) investigated NARW foraging ecology in the Gulf of Maine and southwestern Scotian Shelf using archival tags; diving behavior was variable but followed distinct patterns correlated with the vertical distribution of forage species in the water column. Importantly, Baumgartner et al. (2017) found that NARWs spent 72 percent of their time within 33 ft (10 m) of the surface. Although NARWs are always at risk of ship strike when breathing, the tendency to forage near but below the surface for extended periods substantially increases this risk (Baumgartner et al. 2017). NARW feeding behavior varies by region in response to different seasonal and prey availability conditions. For example, NARWs may rely more frequently on skim-feeding when in transit between core habitats or when dense concentrations of prey are less available (Whitt et al. 2013). Similarly, right whales spend extended periods of time at the water's surface actively socializing in what are known as surface active groups (SAGs); SAGs have been documented in all habitat regions, during all seasons, involve all age classes, and include mating behaviors, play, and the maintenance of social bonds (Parks et al. 2007). The extensive and biologically critical surface behaviors of NARWs, such as surface skim feeding and SAGs, represent a vulnerable time for right whales as they are exposed to an increased risk for ship strike when active at or near the surface.

The diversity of zooplankton across the Northeast U.S. Continental Shelf is relatively high (greater than 100 species), although seasonal and interannual trends in abundance differ among species (NEFSC n.d.; Johnson et al. 2017; DFO 2017). Seasonal trends in overall zooplankton abundance have been detected over the shelf waters of southern New England, ranging from relatively low densities (0.73 to 1.4 cubic inches per 2.4 cubic mile) in January through February to relatively high densities (greater than 3.36 cubic inches per 2.4 cubic mile) during May through August (NEFSC n.d.). These trends are also present for *C. finmarchicus*, which is also an important food source for many fish species, including NARWs. On average, *C. finmarchicus* has been the most abundant during the spring and summer (March through August), with a peak density in May through June along the Northeast U.S. Shelf (NEFSC n.d.). Overall, average zooplankton densities have been remarkably consistent over the past 20 years, though interannual variability is present. Mean total density for *C. finmarchicus* along the Northeast U.S. Shelf varied greatly from year to year, commonly halving or doubling from one year to the next (NEFSC n.d.). Results from Runge et al. (2015) and Ji et al. (2017) specify that predicting fluctuations in abundance or circumstances for disappearance of *C. finmarchicus* in the northwest Atlantic would require models that address the roles of local production and advection.

NARW distribution and pattern of habitat use has shifted both spatially and temporally beginning in 2010 (Davis et al. 2017). Meyer-Gutbrod and Greene (2018) recorded NARW sightings in several traditional feeding habitats beginning to decline in 2012, causing speculation that a shift in NARW habitat usage was occurring (Pettis and Hamilton 2024). An increased presence of NARWs in the Gulf of St. Lawrence beginning in 2015 further supports a shift in habitat use, potentially in response to shifting prey resources as a result of climate change (Crowe et al. 2021; Meyer-Gutbrod et al. 2015, 2021). Additionally, a recent increase in habitat use and year-round presence in the southern New England region, including Nantucket Shoals, indicates that the area is an increasingly important NARW habitat (O'Brien et al. 2022). These data and literature therefore collectively suggest that NARW habitat use, including changes in their distribution patterns linked to prey resources, is dynamic and likely related to climate change processes.

NARW and other baleen whales belong to the LFC marine mammal hearing group, which has a generalized hearing range of 7 Hz to 35 kHz (NMFS 2018). Right whale vocalizations most frequently observed during PAM studies include upsweeps rising from 30 to 450 Hz, often referred to as "upcalls," and broadband (30 to 8,400 Hz) pulses, or "gunshots," with SLs between 172 and 187 dB re 1 µPa m (Erbe et al. 2017). However, recent studies have shown that mother-calf pairs reduce the amplitude of their calls in the calving grounds, possibly to avoid detection by predators (Parks et al. 2019). Modeling conducted using right whale ear morphology suggest that the best hearing sensitivity for this species is between 16 Hz and 25 kHz (Southall et al. 2019).

5.1.1.2.1 Current Status

NARWs in U.S. waters belong to the Western Atlantic stock. The NARW is listed as endangered under the ESA and critically endangered by the International Union for Conservation of Nature (IUCN) Red List (Cooke 2020; NMFS 2024a). Right whales are considered to be one of the most critically endangered large whale species in the world (NMFS 2024a). The Western North Atlantic population size was estimated to be 340 individuals in the most recent draft 2023 stock assessment report (SAR), which used a hierarchical, state-space Bayesian open population model of sighting histories from the photo-identification recapture database through August 2022 (NMFS 2024a). Between 2011 and 2021, overall population abundance declined 29.3 percent, further evidenced by the decreased abundance estimate from 451 individuals in 2018 to the current 2023 estimate of 340 individuals (NMFS 2024a). This decline in abundance follows a previously positive population trend from 1990 to 2011 of a 2.8 percent increase per year from an initial abundance estimate of 270 individuals in 1998 (NMFS 2024a). Over time, there have been periodic swings of per capita birth rates (NMFS 2024a), although current birth rates continue to remain below expectations (Pettis and Hamilton 2024), with an approximately 40 percent decline in reproductive output for the species since 2010 (Kraus et al. 2016b). Twelve new calves were born during the 2023 calving season, down from 15 in 2022 and 20 in 2021; so far, 17 calves have been identified during the 2024 calving season (NMFS 2024b). Although an increasing birth rate is a good sign, it is still significantly below what is expected, and the rate of mortality is still higher than what is sustainable (Pettis and Hamilton 2024; NMFS 2024a). A reduction in adult female survival rates relative to male survival rates has caused a divergence between male and female abundance. In 1990, there were an estimated 1.15 males per female, and by 2015, estimates indicated 1.46 males per female (Pace et al. 2017).

Net productivity rates do not exist for the Western North Atlantic stock (NMFS 2024a). The average annual human-related mortality/injury rate exceeds that of the calculated PBR of 0.7, and due to its listing as endangered under the ESA, this population is classified as strategic and depleted under the MMPA (NMFS 2024a). Observed human-caused mortality and serious injury between 2017 and 2021 was 7.1 whales per year, of which 4.6 whales per year are attributed to fisheries interactions and the remainder

2.5 whales per year caused by vessel strike (NMFS 2024a). However, it is likely that not all mortalities are observed and it is estimated that only one-third of mortalities are actually recorded (NMFS 2024a). As such, modeling suggests the mortality rate could be as high as 27.2 animals per year (NMFS 2024a) based on NARW population data from 2016 to 2020 and accounting for undetected mortality and serious injury. Most recent data continue to indicate substantial population decline, up to 29.3 percent between 2011 and 2021 (NMFS 2024a). There have been elevated numbers of mortalities reported since 2017, which prompted NMFS to designate an Unusual Mortality Event (UME) for NARWs (NMFS 2024c). These elevated mortalities have continued into 2024, totaling 40 mortalities, 34 serious injuries, and 51 sublethal injuries or illness as of 10 April 2024 (NMFS 2024c). Based on the mortalities for which the carcasses could be examined, preliminary analyses indicate that all mortalities are likely to be human-caused, predominantly from entanglement in fishing gear or vessel collisions (NMFS 2024c). Of the 40 mortalities, 15 have been identified as resulting from vessel strikes and 9 from entanglements, and 1 is still pending results of a necropsy (NMFS 2024c). Although many of the mortalities have occurred in Canadian waters, the U.S. population is not separated from those in Canada; therefore, the effects of mortality affect the population considered in the assessment process. While vessel strikes and entanglements in fishing gear represent the most significant threat to NARWs, other risks to the population include acoustic disturbance and masking, climate change, and climate-driven shifts in prey species (NMFS 2024a).

To mitigate the potential for vessel strikes, NMFS designated certain nearshore waters along the U.S. East Coast as Seasonal Management Areas (SMAs) (73 *FR* 60173). These management areas are in effect seasonally and established such that all vessels greater than 65 ft (19.8m) in overall length must operate at speeds of 10 knots or less within these areas. Portions of existing NARW SMAs overlap with the southern portion of the Action Area:

- Cape Cod Bay SMA – January 1 to May 15
- Off Race Point SMA – March 1 to April 30

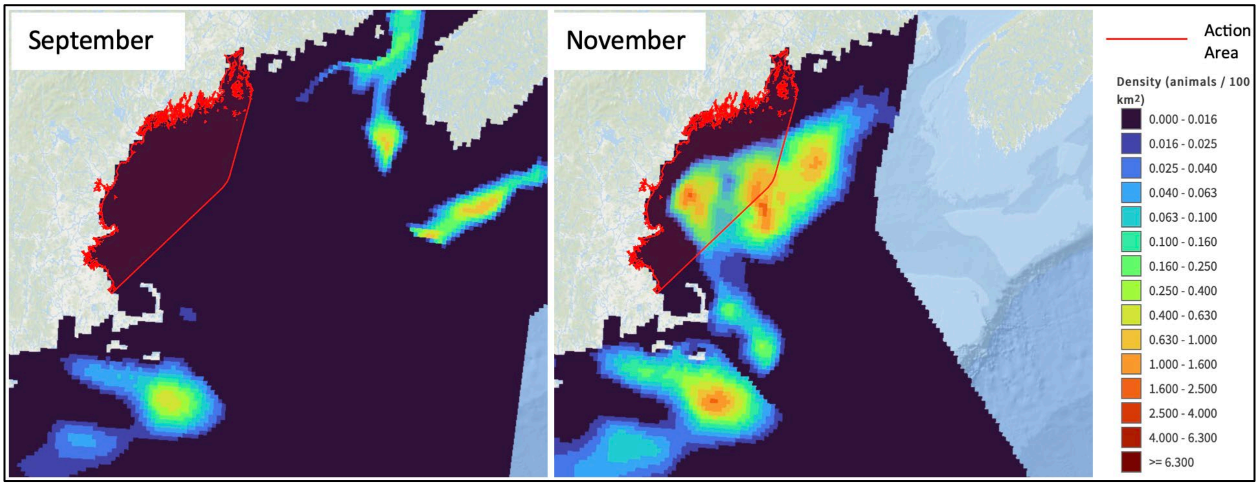
Amendments to the NARW speed rule (Proposed Rule, 87 FR 46921) would decrease the size of vessels required to comply with the 10-knot speed restriction to 35 ft (10.7m) and expand the geographic areas to regional sections rather than immediately surrounding ports and transit corridors. While the southern portion of the Action Area would overlap with the Atlantic zone, the Research Lease Area would fall just outside of these zones.

Critical habitat for the NARW within the Action Area comprises the Northeastern U.S. Foraging Area (Unit 1) in the Gulf of Maine, including Cape Cod Bay, Stellwagen Bank, and the Great South Channel (81 *Federal Register* 4837). Additional NARW critical habitat is designated in the species' nearshore calving grounds that stretch from Cape Canaveral, Florida to Cape Fear, North Carolina (Southeastern U.S. Calving Area [Unit 2]); this portion of NARW critical habitat does not overlap with the Action Area. See **Section 5.2.1** for a complete discussion of NARW critical habitat.

5.1.1.2.2 Potential Occurrence Within the Action Area

NARWs are common in the Gulf of Maine; visual and acoustic surveys indicate that NARWs may be present year-round in the Gulf of Maine, though the highest abundances occur from mid-fall through early summer (NMFS 2024a; MGEL 2022; Davis et al. 2017). The species is less commonly observed in the Action Area during July, August, and September when they are more likely to be in the Bay of Fundy (outside of the Action Area) or in more northern feeding grounds such as the Gulf of St. Lawrence, Canada (Pendleton et al. 2012; Kraus et al. 2016a; Leiter et al. 2017; Crowe et al. 2021). The Gulf of Maine represents an important foraging habitat for the NARW; the unique bathymetric features of the Gulf of Maine support dense aggregations of their preferred prey. NARWs typically arrive to the Gulf of Maine in the early spring and enter Cape Cod Bay, where large, dispersed groups, including mothers with their offspring, are commonly sighted. From mid-spring through early summer, individuals move out of Cape Cod Bay to utilize other areas of the Gulf of Maine, Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence. While these movement patterns are generalized, satellite telemetry data indicate that individuals are highly mobile and can exhibit sporadic large scale movement patterns between sighting events (Mate et al. 1992). Therefore, individuals may occur within the Action Area throughout the year, even when predicted densities are expected to be low.

Habitat-based marine mammal density data indicate the highest densities throughout the Action Area would most likely occur in November and the lowest in September (**Figure 5-2**; Roberts et al. 2023). The temporal and geographic distribution of NARW densities within the Action Area is presented in **Table 5-1**; the data indicate that, while NARW may occur year-round in the Gulf of Maine, they are likely to occur in highest densities during the winter and spring.



Source: Roberts et al. 2023

Figure 5-2. NARW minimum (September) and maximum (November) mean densities within the Action Area and surrounding region

There continue to be shifts in NARW abundances and feeding activity; and more uncertainty in foraging patterns should be expected throughout the entirety of the Proposed Action (Hudak et al. 2023; Ross et al. 2023). There are several planned and ongoing acoustic studies for NARWs in the Gulf of Maine to better understand shifts in abundances (https://www.fisheries.noaa.gov/new-england-mid-atlantic/endangered-species-conservation/passive-acoustic-research-atlantic-ocean).

5.1.1.3 Sei Whale – Nova Scotia Stock (Endangered)

The sei whale is a large baleen whale species found in subtropical, temperate, and subpolar waters around the globe, most commonly observed in temperate waters at mid-latitudes. Sei whales are often associated with deeper waters and areas along the continental shelf edge (Hain et al. 1985); however, this general offshore pattern of sei whale distribution is disrupted during occasional incursions into more shallow and inshore waters (NMFS 2024a). Sightings in U.S. Atlantic waters are typically centered on mid-shelf and the shelf edge and slope (Olsen et al. 2009). The species is notable for its unpredictable distribution, concentrating in specific areas in large numbers for a period and then abandoning those habitats for years or even decades. The breeding and calving areas used by this species are unknown (NMFS 2024a).

This species is highly mobile, and there is no indication that any population remains in a particular area year-round (NMFS 2011). Sei whale occurrence in any particular feeding ground is considered unpredictable or irregular (Schilling et al. 1992) but may be correlated to incursions of relatively warm waters related to broadscale oceanographic circulation patterns (NMFS 2024a). Olsen et al. (2009) also indicated that sei whales' movements appear to be associated with oceanic fronts, thermal boundaries, and specific bathymetric features. NMFS (2011) indicated that climate change may affect sei whale habitat availability and food availability, as migration, feeding, and breeding locations may be affected by ocean currents and water temperature.

Sei whales usually travel alone or in small groups of two to five animals, occasionally in groups as large as 10 (NMFS 2024a). Potential species occurrence in the Action Area is likely to be closely tied to feeding behavior and seasonal availability of preferred prey resources. Sei whales in the North Atlantic preferentially prey on calanoid copepods, particularly *C. finmarchicus*, over all other zooplankton species (Christensen et al. 1992; NMFS 2011; Prieto et al. 2014). Data indicate that sei whales have a clear preference for copepods between June and October, with euphausiids constituting a larger part of the diet in May and November (NMFS 2011; Prieto et al. 2014). They also feed on small schooling fish and cephalopods, including squid. Sei whales prefer to feed at dawn and may exhibit unpredictable behavior while foraging and feeding on prey (NMFS 2023c). Their feeding behaviors include gulping, skimming, and lunging at the surface.

Sei whales are occasionally killed in collisions with vessels. Of three sei whales that stranded along the U.S. Atlantic coast between 1975 and 1996, two showed evidence of collisions with ships (Laist et al. 2001). Between 1999 and 2005, there were three reports of sei whales being struck by vessels along the Atlantic coast of the U.S. and the maritime provinces of Canada (Cole et al. 2005; Nelson et al. 2007). Two of these vessel strikes were reported as having resulted in the death of the sei whale.

Sei whales and other baleen whales belong to the LFC hearing group of marine mammals, which has a generalized hearing range of 7 Hz to 35 kHz (NMFS 2018). Peak hearing sensitivity of sei whales is believed to range from 1.5 to 3.5 kHz based on recorded vocalization patterns (Erbe 2002).

5.1.1.3.1 Current Status

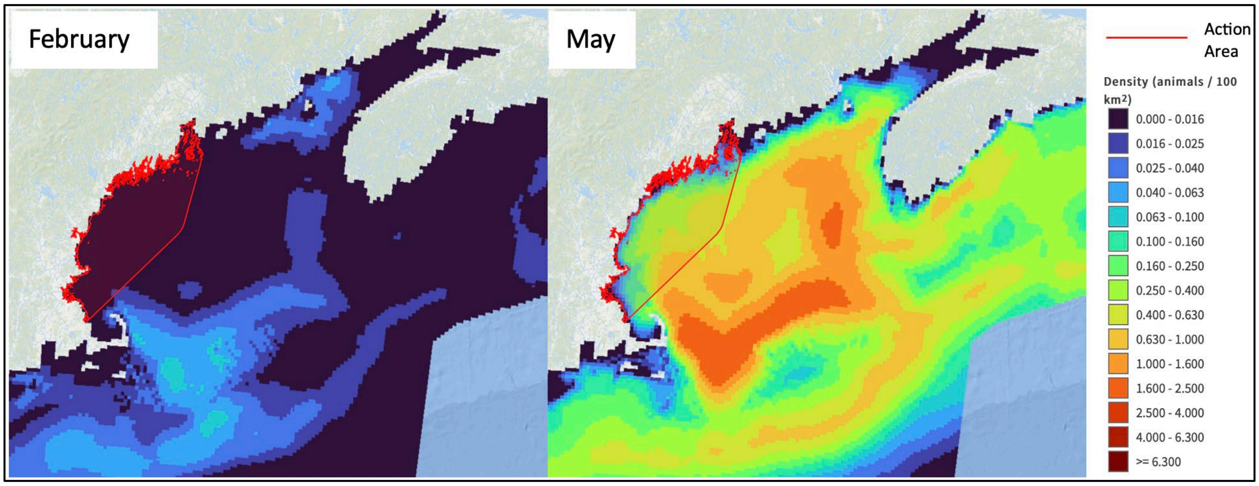
Sei whales have been ESA-listed as endangered since the passage of the act in 1973 (35 *FR* 8491). Sei whales occurring in the U.S. Atlantic EEZ belong to the Nova Scotia stock, which range from the northeast U.S. coast northward to south of Newfoundland throughout continental shelf waters (NMFS 2024a). The current best abundance estimate for this stock is 6,292 individuals (NMFS 2024a). A population trend is not available for the Nova Scotia sei whale stock because of insufficient data (NMFS 2024a). This stock is listed as strategic and depleted under the MMPA due to its endangered status (NMFS 2024a). The PBR for this stock is 6.2, and annual human-caused mortality and serious injury from 2017 to 2021 was estimated to be 0.6 per year (NMFS 2024a). Threats to sei whales include vessel strike and entanglement in fisheries gear. No critical habitat has been designated for sei whales in the Action Area.

5.1.1.3.2 Potential Occurrence Within the Action Area

Sei whales are typically distributed in deep waters in association with the shelf edge throughout their range, though incursions into shallower OCS waters occurs, generally in response to oceanographic patterns and prey availability (Hain et al. 1985; NMFS 2024a). Sei whales are present in the Action Area primarily during spring and summer, though they have been observed year-round near the shelf break (Palka et al. 2021). Available data suggest sei whales primarily occur in deeper shelf waters in the southern and eastern portions of the Action Area near the shelf break, only occasionally traveling closer to shore to feed (Palka et al. 2021; NMFS 2024a; Roberts et al. 2023). The Gulf of Maine is primarily used for foraging; however the sei whale preference for cooler waters (less than 10°C) indicate that preferential feeding grounds may be in decline and populations would be in flux (NMFS 2024a). Passive acoustic analyses support this with records showing that sei whales had a higher acoustic occurrence after 2010 in the Mid-Atlantic (Davis et al. 2020).

Low numbers of sei whales are expected to be encountered within the Action Area, with highest likelihood in offshore waters beyond the 100-m isobath; however, variable patterns in distribution could result in very high or very low encounter rates for any given year (NMFS 2024a).

Habitat-based marine mammal density data indicate the highest densities throughout the Action Area would most likely occur in May and the lowest in February (**Figure 5-3**; Roberts et al. 2023). The temporal and geographic distribution of sei whale densities within the Action Area is presented in **Table 5-1**; the data indicate that, while sei whales may occur year-round in the Gulf of Maine, they are likely to occur in highest densities during the spring and again during the fall.



Source: Roberts et al. 2023

Figure 5-3. Sei whale minimum (February) and maximum (May) mean densities within the Action Area and surrounding region

5.1.1.4 Sperm Whale – North Atlantic Stock (Endangered)

The sperm whale is the largest member of the order Odontocetes, or toothed whales, with adults ranging from 39 to 59 ft (12 to 18 m) in length. Sperm whales occur throughout the world's oceans. They can be found near the edge of the ice pack in both hemispheres and are also common along the equator. The North Atlantic stock is distributed mainly along the OCS-edge, over the continental slope, and mid-ocean regions, where they prefer water depths of 1,969 ft (600 m) or more and are less common in waters less than 984 ft (300 m) deep (Perry et al. 1999; NMFS 2024a). The stock exhibits a distinct seasonal cycle in U.S. Atlantic EEZ waters (Perry et al. 1999; Stanistreet et al. 2018). During the winter, sperm whales are observed east and northeast of Cape Hatteras, predominantly past the OCS edge (NMFS 2024a). In the spring, sperm whale distribution shifts north and they are more widely distributed throughout the Mid-Atlantic Bight and southern portions of George's Bank (NMFS 2024a). Their summer distribution is similar to the spring, but with heightened occurrence inshore of the 328-foot (100-meter) isobath south of New England and in the Mid-Atlantic (NMFS 2024a). Sperm whale occurrence on the OCS in areas south of New England is at its highest in the fall, while occurrence in the Mid-Atlantic Bight is along the shelf edge (NMFS 2024a). The observed seasonality is likely driven by the distributions of their preferred prey (cephalopods), which may aggregate along distinct oceanographic features such Gulf Stream eddies and temperature fronts in association with bathymetric features of the shelf edge (Waring et al. 1993; Jaquet and Whitehead 1996; Griffin 1999).

While deep water is their typical habitat, sperm whales have been observed near Long Island, New York, in water between 135 and 180 ft (41 and 55 m; Scott and Sadove 1997); and in the Gulf of Maine in 525 ft (160 m) water depths (Tran et al. 2014). When they are found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956).

Geographic distribution of sperm whales appears to be linked to social structure. Females and juveniles tend to congregate in matrilineal social groups in subtropical waters, whereas males range widely from the tropics to high latitudes and breed across social groups (NMFS 2024a). Sperm whales in the North Atlantic display sufficient genetic isolation from other Atlantic groupings to justify their identification as a breeding stock, but insufficient data are available to determine a definitive population structure (Waring et al. 2015).

Sperm whales are predatory specialists known for hunting prey in deep water. The species is among the deepest diving of all marine mammals. Males have been known to dive 3,936 ft (1,200 m), whereas females dive to at least 3,280 ft (1,000 m); both can continuously dive for more than 1 hour. Sperm whales are also relatively fast swimmers, capable of swimming at speeds of up to 20 miles per hour (9 m per second [m/s]) (Aoki et al. 2007). The species preferentially targets squid, which make up at least 70 percent of the whale’s typical diet (Kawakami 1980; Pauly et al. 1998). Sperm whale may also prey on bottom-oriented organisms such as octopus, fish, shrimp, crab, and sharks (Leatherwood et al. 1982; Pauly et al. 1998).

Sperm whales belong to the mid-frequency cetacean (MFC) marine mammal hearing group, which has a generalized hearing range of 150 Hz to 160 kHz (NMFS 2018). Peak hearing sensitivity of sperm whales ranges from 5 to 20 kHz based on auditory brainstem response to recorded stimuli completed on a stranded neonate (Ridgway and Carder 2001). Sperm whales communicate and search for prey using broadband transient signals between 500 and 24 kHz, with most sound energy focused in the 2- and 9-kHz range (Lohrasbipeydeh et al. 2013).

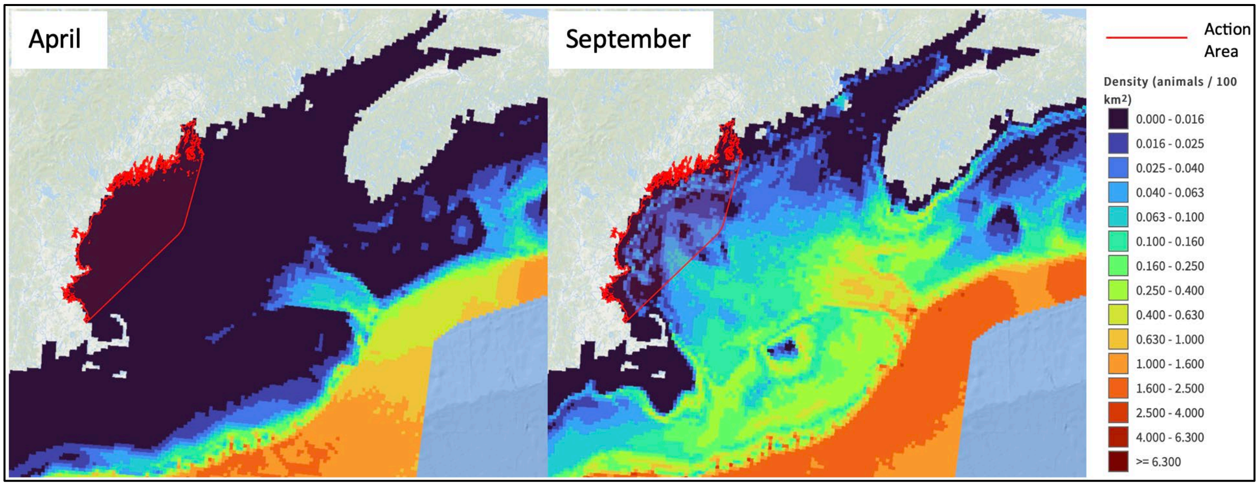
5.1.1.4.1 Current Status

Sperm whales have been listed as endangered under the ESA since the initial passage of the act (35 *FR* 18319). The stock structure of the Atlantic population of sperm whales is poorly understood. It is not clear whether the western North Atlantic population is discrete from the eastern North Atlantic population (NMFS 2024a). However, the portion of the population found within the U.S. EEZ likely belongs to a larger stock in the western North Atlantic. The species was subjected to intense commercial whaling pressure in the 18th, 19th, and early 20th centuries, resulting in a prolonged and severe decline in abundance. Sperm whale populations are rebuilding after the cessation of commercial whaling on the species; the primary threats today are ship collisions and fishing gear entanglement (NMFS 2024a). The most recent abundance estimate for the North Atlantic stock is 5,895 (NMFS 2024a). However, this group is likely part of a larger western North Atlantic population, and that population may or may not be distinct from the eastern North Atlantic population (NMFS 2024a). There were no reports of fishery-related mortality or serious injury between 2017 and 2021, and while there were 10 strandings documented during this period, two of which showed indications of human interaction, specifically plastic ingestion (NMFS 2024a). No critical habitat has been designated for sperm whales in the Action Area.

5.1.1.4.2 Potential Occurrence Within the Action Area

Sperm whales are not common in the Action Area, but are common at the shelf break in water depths of 656 to 3,280 ft (200 to 1,000 m), particularly in the area of the Northeast Channel with a year-round occurrence. The Gulf of Maine had the lowest abundance estimates for sperm whales during AMAPPS surveys compared to the shelf and offshore habitats along the US east coast (Palka et al. 2021). There were no sperm whale sightings along tracklines encompassing the Action Area during AMAPPS surveys conducted in 2016; and all acoustic detections displayed in the NMFS Passive Acoustic Cetacean Map are outside the Action area along the shelf. Habitat density models show year-round low densities in the Gulf of Maine with some increase into the Action Area during July to October (Roberts et al. 2023). Given their habitat preferences, the sperm whale is considered relatively uncommon in shelf waters in the vicinity of the Action Area.

Habitat-based marine mammal density data indicate the highest densities throughout the Action Area would most likely occur in September and the lowest in April (**Figure 5-4**; Roberts et al. 2023). The temporal and geographic distribution of sperm whale densities within the Action Area is presented in **Table 5-1**; the data indicate that, while sperm whales may occur year-round in the Gulf of Maine, they are likely to occur in highest densities from summer to fall.



Source: Roberts et al. 2023

Figure 5-4. Sperm whale minimum (April) and maximum (September) mean densities within the Action Area and surrounding region

5.1.1.5 Blue Whale–North Atlantic Stock (Endangered)

The documented range of blue whales in the North Atlantic extends from the subtropics to the Greenland Sea. As described in the most recent SA, blue whales have been detected and tracked acoustically in much of the North Atlantic Ocean, with most acoustic detections around the Grand Banks area of Newfoundland and west of the British Isles (Hayes et al. 2020). Photo-identification in eastern Canadian waters indicates blue whales from the St. Lawrence River, Newfoundland, Nova Scotia, Northeast U.S., and Greenland all belong to the same stock, whereas blue whales photographed off Iceland and the Azores appear to be part of a separate population (Cetacean and Turtle Assessment Program [CETAP] 1982; Wenzel et al. 1988; Sears and Calambokidis 2002; Sears and Larsen 2002). The largest concentrations of blue whales are found in the lower St. Lawrence Estuary (Lesage et al. 2007; Comtois et al. 2010), which is outside of the Action Area. Blue whales do not regularly utilize habitat within the

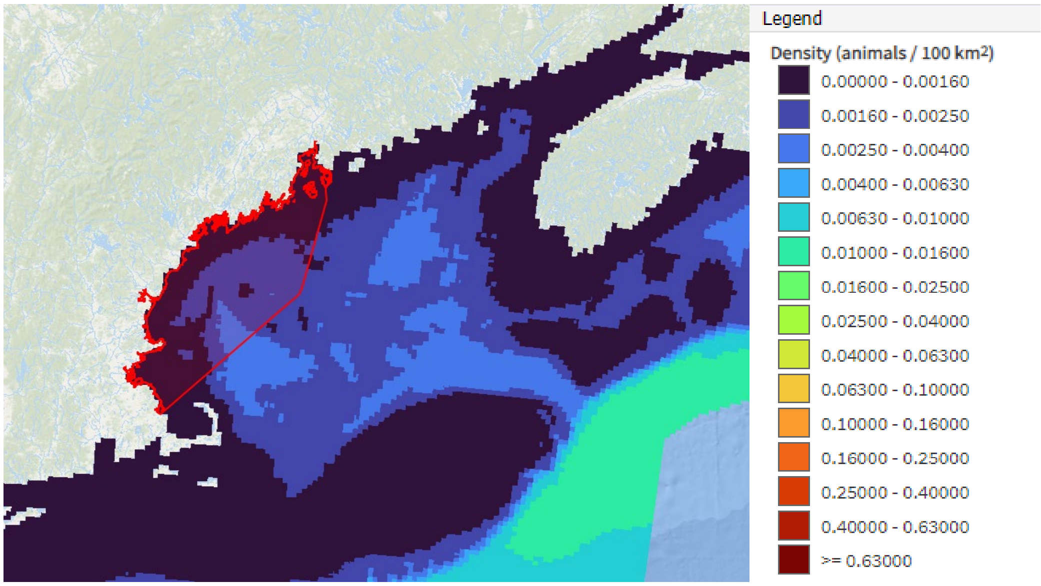
U.S. Exclusive Economic Zone (EEZ), typically occurring farther offshore in depths of 328 ft (100 m) or more (Waring et al. 2012). Sightings and strandings data indicate blue whales occur along the U.S. East Coast only rarely because their primary northwest Atlantic habitat is offshore eastern Canada (Reeves et al. 1998; Kraus et al. 2016a; Hayes et al. 2020). Blue whales primarily feed on krill, but fish and copepods may also be part of their diet (NMFS 2023d).

5.1.1.5.1 Current Status

Blue whales have been listed as endangered under the ESA Endangered Species Conservation Act of 1969, with a recovery plan published under 63 *FR* 56911. Blue whales are separated into two major populations (North Pacific and North Atlantic) and further subdivided into stocks. The North Atlantic Stock includes mid-latitude (North Carolina coastal and open ocean) to Arctic waters (Newfoundland and Labrador). The population size of blue whales off the U.S. East Coast is not known; however, a catalogue count of 402 individuals from the Gulf of St. Lawrence establishes the minimum population estimate (Hayes et al. 2020). There are no recent confirmed records of anthropogenic mortality or serious injury to blue whales in the U.S. Atlantic EEZ or in Atlantic Canadian waters (Henry et al. 2020). As a result, the total level of anthropogenic mortality and serious injury is unknown, but it is believed to be insignificant and approaching zero (Hayes et al. 2020). No critical habitat has been designated for the blue whale.

5.1.1.5.2 Potential Occurrence within the Action Area

Historical observations indicate the blue whale has a wide distribution throughout the North Atlantic Ocean, from warm temperate latitudes in the winter months to northern regions in the summer months. Based on limited sighting and standing data, blue whales are only occasional visitors to U.S. Atlantic EEZ waters, exhibiting a more pelagic distribution (Kraus et al. 2016a; Lesage et al. 2017). Blue whales in the North Atlantic appear to target high-latitude feeding areas and may use deep-ocean features such as sea mounts outside the feeding season (Pike et al. 2009; Lesage et al. 2017, 2018). Given their reported occurrence and habitat preferences, their presence in the Action Area is expected to be rare (Hayes et al. 2020). Blue whales have been reported in the Gulf of Maine and a known individual was resighted between the Gulf of Maine, Scotian Shelf, and Gulf of St. Lawrence (Hayes et al. 2020).



Source: Roberts et al. 2023

Figure 5-5. Blue whale mean annual densities within the Action Area and surrounding region

5.1.2 Sea Turtles

5.1.2.1 Green Sea Turtle – North Atlantic Distinct Population Segment (Threatened)

Green sea turtles have a worldwide distribution and can be found in both tropical and subtropical waters (NMFS and USFWS 1991; NatureServe 2023). They are the largest of the hard-shelled sea turtles, growing to a maximum length of approximately 4 ft (1.2 m) and weighing up to 440 pounds (200 kilograms [kg]) (NMFS and USFWS 1991). In the Western North Atlantic Ocean, the species can be found from Massachusetts to Texas as well as in waters off Puerto Rico and the U.S. Virgin Islands (NMFS and USFWS 1991). Depending on the life stage, green sea turtles inhabit high-energy oceanic beaches, convergence zones in pelagic habitats, and benthic feeding grounds in shallow protected waters (NMFS and USFWS 1991). They are most commonly observed feeding in shallow waters of reefs, bays, inlets, lagoons, and shoals that are abundant in algae or marine grass, such as eelgrass (NMFS and USFWS 2007a). Green sea turtles are known to make long-distance migrations between their nesting and feeding grounds. Individuals display fidelity for specific nesting habitats, which are concentrated in lower latitudes well south of the Action Area. The primary breeding areas in the U.S. are located in southeast Florida (NMFS and USFWS 1991). Nesting also occurs annually in Georgia, South Carolina, North Carolina, and Texas (NMFS 2023e). Hatchlings occupy pelagic habitats and are omnivorous. Juvenile foraging habitats include coral reefs, emergent rocky bottoms, *Sargassum* spp. mats, lagoons, and bays (USFWS 2023a). Once mature, green sea turtles leave pelagic habitats and enter benthic foraging grounds, primarily feeding on seagrasses and algae (Bjorndal 1997), although they will occasionally feed on sponges and invertebrates (NMFS 2023e).

Green sea turtles spend most of their lives in coastal foraging grounds, including open coastline waters (NMFS and USFWS 2007a). They often return to the same foraging grounds following periodic nesting migrations (Godley et al. 2002). However, some remain in the open ocean habitat for extended periods and possibly never recruit to coastal foraging sites (Pelletier et al. 2003). Once thought to be strictly herbivorous, more recent research indicates that this species also forages on invertebrates, including jellyfish, sponges, sea pens, and pelagic prey while offshore, and sometimes in coastal habitats (Heithaus et al. 2002).

Hatchling green sea turtles occupy pelagic habitats. Juveniles, upon reaching a carapace length of 20 to 25 cm, move to foraging habitats such as coral reefs, emergent rocky bottoms, *Sargassum* spp. mats, lagoons, and bays (Waring et al. 2012; USFWS 2023a). Once adults, green turtles will leave pelagic habitats and enter benthic foraging grounds (Bjorndal 1997). Available tagging and sighting data suggest green turtles generally prefer shallower waters (Palka et al. 2021). Juveniles are found more frequently than adults in the northeast Atlantic, migrating northward and residing in the New England area from May through November (NMFS 2023e).

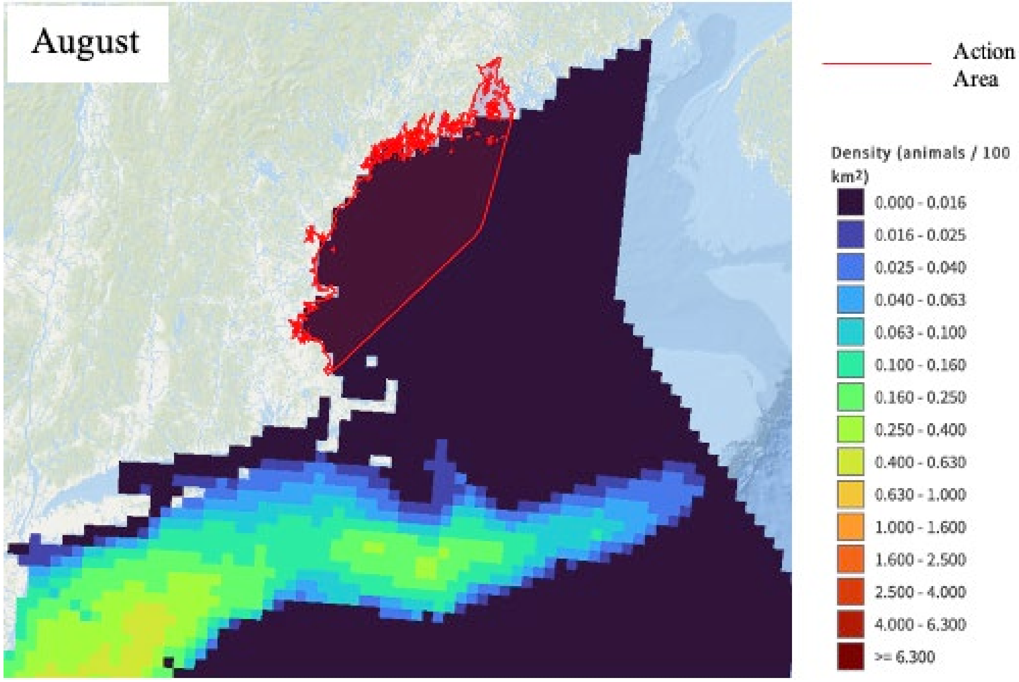
Bartol and Ketten (2006) measured the auditory evoked potentials of two Atlantic green sea turtles and six sub adult Pacific green sea turtles. Sub-adults were found to respond to stimuli between 100 and 500 Hz, with a maximum sensitivity of 200 and 400 Hz. Juveniles responded to stimuli between 100 and 800 Hz, with a maximum sensitivity between 600 and 700 Hz. Piniak et al. (2016) found that the auditory evoked potentials of juvenile green sea turtles were between 50 and 1,600 Hz in water and 50 and 800 Hz in air, with ranges of maximum sensitivity between 50 and 400 Hz in water and 300 and 400 Hz in air.

5.1.2.1.1 Current Status

The green sea turtle was originally listed under the ESA in 1978 as threatened across its range. The listing was subsequently updated in 2016 (81 *FR* 20057), confirming threatened status across the range, with specific breeding populations in Florida and the Pacific Coast of Mexico listed as endangered (Seminoff et al. 2015). Individuals occurring within the Action Area belong to the North Atlantic DPS and is listed as threatened (81 *FR* 20057). The primary nesting beaches for the North Atlantic DPS of green sea turtles are Costa Rica, Mexico, U.S. (Florida), and Cuba. According to Seminoff et al. (2015), nesting trends are generally increasing for this DPS. The most recent status review for the North Atlantic DPS estimates the number of female nesting sea turtles to be approximately 167,424 individuals (NMFS and USFWS 2015a). Critical habitat has not been designated. The species was listed on the basis of significant population declines resulting from egg harvesting, incidental mortality in commercial fisheries, and nesting habitat loss.

5.1.2.1.2 Potential Occurrence Within the Action Area

Green sea turtles may be found as far north as Nova Scotia, and due to the warming of the Gulf of Maine may become more common in the Action Area compared to the last decade (Griffin et al. 2019; NMFS and USFWS 1991). During the summer, the distribution of foraging subadults and adults can expand to include subtropical waters at higher latitudes. Juveniles and subadults are occasionally observed in Atlantic coastal waters as far north as Massachusetts (NMFS and USFWS 1991), including Cape Cod Bay (CETAP 1982), and therefore may occur in the Action Area during the summer months. Data from NOAA Fisheries Sea Turtle Stranding and Salvage Network (STSSN) show two green sea turtle strandings within the Action Area between January 1, 2013 and September 5, 2023 (NMFS 2023g). Nesting has not been reported within the Action Area. Density surface models indicate highest regional green sea turtle occurrences during August, though incursion into the Gulf of Maine is considered rare (**Figure 5-6**; DiMatteo et al. 2023a, 2023b; NMFS 2023f). Therefore, green sea turtle occurrence within the Action Area is also considered rare.



Source: DiMatteo et al. 2023a, 2023b

Figure 5-6. Green sea turtle maximum mean density during August within the Action Area and surrounding region

5.1.2.2 Kemp's Ridley Sea Turtle (Endangered)

The Kemp's ridley sea turtle is the smallest of sea turtle species. Adults can weigh between 70.5 and 108 pounds (32 and 49 kg) and reach up to 24 to 28 in (60 to 70 cm) in length (NMFS and USFWS 2007b). This species primarily inhabits the Gulf of Mexico, although large juveniles and adults travel along the U.S. Atlantic coast. Kemp's ridley inhabit coastal waters around Cape Canaveral, Florida up to Cape Hatteras, North Carolina during the winter (Waring et al. 2012).

In late fall, Atlantic juveniles/sub adults travel northward to forage in the coastal waters off Georgia through New England, then return southward for the winter (Stacy et al. 2013; NMFS 2022b). Nesting typically occurs from April to July and, unlike most other sea turtles, the species nests during the daytime. Most nesting areas are in the western Gulf of Mexico, primarily Tamaulipas and Veracruz, Mexico. Some nesting occurs periodically in Texas and few other U.S. states, occasionally extending up the Atlantic coast to North Carolina. Kemp's ridley sea turtles return to beaches, often in groups, to nest every 1 to 3 years and lay an average of two to three clutches per season (NMFS 2022b).

Juvenile and subadult Kemp's ridley sea turtles are known to travel as far north as Cape Cod Bay during summer foraging (NMFS 2011). The species is primarily associated with habitats on the OCS, with preferred habitats consisting of sheltered areas along the coastline, including estuaries, lagoons, and bays (Burke et al. 1994; NMFS 2022b) and nearshore waters less than 120 ft deep (Shaver et al. 2005; Shaver and Rubio 2008), although it can also be found in deeper offshore waters. The species is coastally oriented, rarely venturing into waters deeper than 160 ft (50 m). It is primarily associated with mud sand-bottomed habitats, where primary prey species are found (NMFS and USFWS 2007b).

Kemp's ridley sea turtles are generalist feeders that prey on a variety of species, including crustaceans, mollusks, fish, jellyfish, and tunicates, and forage on aquatic vegetation (Byles 1988; Carr and Caldwell 1956; Schmid 1998). However, the preferred diet of the Kemp's ridley sea turtle is crabs (NMFS and USFWS 2007b). The species is also known to ingest natural and anthropogenic debris (Burke et al. 1993, 1994; Witzell and Schmid 2005).

Dow Piniak et al. (2012) concluded that sea turtle hearing is generally confined to lower frequency ranges below 1.6 kHz, with the greatest hearing sensitivity between 100 and 700 Hz, varying by species. Bartol and Ketten (2006) determined that Kemp's ridley hearing is more limited, ranging from 100 to 500 Hz, with greatest sensitivity between 100 and 200 Hz.

5.1.2.2.1 Current Status

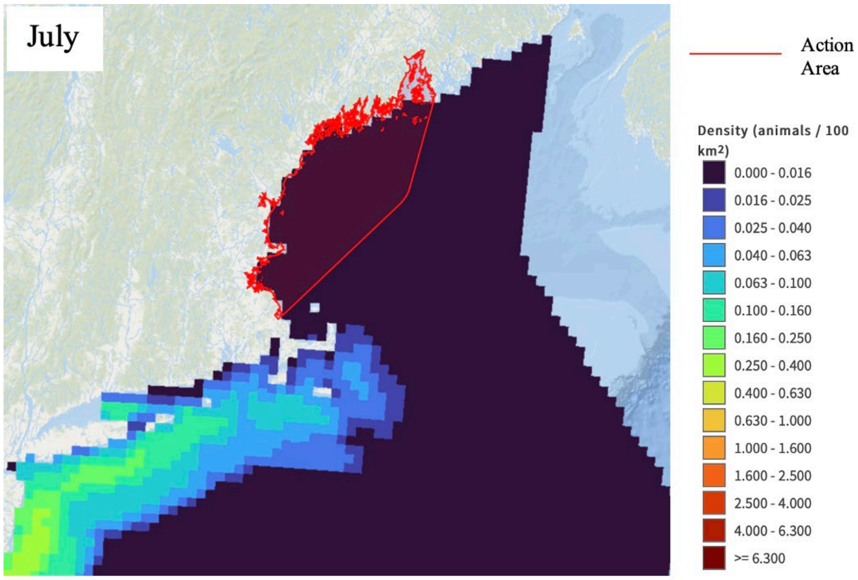
The Kemp's ridley sea turtle was listed as endangered at the species level with the passage of the ESA in 1973 (35 *FR* 18319). All Kemp's ridley sea turtles belong to a single population. The species has experienced large population declines due to egg harvesting, loss of nesting habitat to coastal development and related human activity, bycatch in commercial fisheries, vessel strikes, and other anthropogenic and natural threats. The species began to recover in abundance and nesting productivity since conservation measures were initiated following listing. However, since 2009, the number of successful nests has declined markedly (NMFS and USFWS 2015b). Potential explanations for this trend, including the *Deepwater Horizon* oil spill in 2010, have proven inconclusive, suggesting that the decline in nesting may be due to a combination of natural and anthropogenic stressors (Caillouet et al. 2018). Current threats include incidental fisheries mortality, ingestion, and entanglement in marine debris, and vessel strikes (NMFS and USFWS 2015b).

The population was severely reduced by 1985 due to intensive egg collection and fishery bycatch, with a low of 702 nests counted from an estimated 250 nesting females on three primary nesting beaches in Mexico (Bevan et al. 2016; NMFS and USFWS 2015b). Recent estimates of the total population of age 2 years and older is 248,307; however, recent models indicate a persistent reduction in survival or recruitment, or both, in the nesting population, suggesting that the population is not recovering to historical levels (NMFS and USFWS 2015b). A record high number of Kemp's sea turtle nests were recorded in 2017 (24,586 in Mexico and 353 in Texas). In 2019 there were 11,090 nests, a 37.61 percent decrease from 2018, and a 54.89 percent decrease from 2017. This decline is typical due to the reproduction biology of the species, as females nest approximately every 1 to 3 years (National Park Service 2023). Using the standard IUCN protocol for sea turtle assessments, the number of mature individuals was recently estimated at 22,341; the assessment concluded the current population trend is unknown (Wibbels and Bevan 2019). There is no designated critical habitat for Kemp's ridley sea turtles.

5.1.2.2.2 Potential Occurrence Within the Action Area

Kemp's ridley sea turtles may be found as far north as New England and due to the warming of the Gulf of Maine are increasingly likely to be found there, as they prefer warmer, nearshore coastal waters (Griffin et al. 2019; NMFS 2022b). Adult Kemp's ridley undergo a seasonal migration each year in the Atlantic, starting their journey to northern foraging grounds in spring, reaching New England by June, and traveling back to southern habitat in the fall, reaching the Mid-Atlantic by early November (Waring et al. 2012). Sea surface temperatures in the Gulf of Maine have warmed 97% faster (as of 2022) than the global ocean over the last decade, and as such, Kemp's ridley turtles are likely to occur more frequently as evidenced by higher numbers of cold stunned strandings reported from North Atlantic waters during late summer to late fall (Griffin et al. 2019).

STSSN data show 19 Kemp's ridley sea turtle strandings within the Action Area between January 1, 2013 and September 5, 2023 (NMFS 2023g). All of these strandings have occurred within Massachusetts. Nesting has not been reported within the Action Area. The species may be encountered near the Action Area from June through November, but are more likely from July through September (DiMatteo et al., 2023a and 2023b). Density surface models indicate highest regional Kemp's ridley sea turtle occurrences during July (**Figure 5-7;** DiMatteo et al. 2023a and 2023b). Based on these data and stranding reports, occurrence within the Gulf of Maine is considered rare and likely limited to Cape Cod and Cape Cod Bay.



Source: MGEL, 2023

Figure 5-7. Kemp's ridley sea turtle maximum mean density during July within the Action Area and surrounding region

5.1.2.3 Leatherback Sea Turtle (Endangered)

The leatherback sea turtle is primarily a pelagic species and is distributed in temperate and tropical waters worldwide, and are a species that regularly occur in colder waters where they can take advantage of high productivity regions with good foraging opportunities (Okuyama et al., 2021). The leatherback is the largest, deepest diving, most migratory, widest ranging, and most pelagic of the sea turtles (NMFS 2023g). Adults can reach up to 2,000 pounds (900 kg) and can be more than 6 ft (2 m) long (NMFS and USFWS 2013; NMFS 2023g). Adult leatherback sea turtles forage in temperate and subpolar regions in all oceans. Satellite tagged adults reveal migratory patterns in the North Atlantic that can include a circumnavigation of the North Atlantic Ocean basin, following ocean currents that make up the North Atlantic gyre, and preferentially targeting warm-water mesoscale ocean features such as eddies and rings as favored foraging habitats (Hays et al. 2006).

Leatherback sea turtles are dietary specialists, feeding almost exclusively on jellyfish, siphonophores, and salps, and the species' migratory behavior is closely tied to the availability of pelagic prey resources (Eckert et al. 2012; NMFS and USFWS 2020a). Unlike other predatory sea turtles with crushing jaws, the leatherback has evolved a sharp-edged jaw for consuming soft-bodied oceanic prey (NMFS 2023g) They are also known to feed on sea urchins, squid, crustaceans, tunicates, fish, blue-green algae, and floating seaweed (NMFS 2023g; USFWS 2023b).

James et al. (2006) studied leatherbacks' migratory behavior using satellite tags and observed that the timing of southerly migration ranges widely, extending from mid-August to mid-December, but with a distinct peak in October. The continental slope to the east and south of Cape Cod and the OCS south of Nantucket appear to be hotspots, where several tagged leatherback sea turtles congregated to feed for extended periods. These findings are consistent with Kraus et al. (2016a), who recorded most of their leatherback sightings in the same area. The migratory corridors between breeding and northerly feeding areas appear to vary widely, with some individuals traveling through the OCS and others using the open ocean far from shore (James et al. 2006).

In a study tracking 135 leatherbacks fitted with satellite tracking tags, the species was identified to inhabit waters with sea surface temperatures ranging from 52°F to 89°F (11°C to 32°C) (Bailey et al. 2012). The leatherback sea turtle dives the deepest of all sea turtles to forage and is thought to be more tolerant of cooler oceanic temperatures than other sea turtles. The study also found that oceanographic features such as mesoscale eddies, convergence zones, and areas of upwelling attracted foraging leatherbacks because these features are often associated with aggregations of jellyfish.

Nesting beaches in the U.S. are concentrated in southeastern Florida from Brevard County south to Broward County (NMFS and USFWS 2013, 2020a; USFWS 2023b). Leatherbacks are a pelagically oriented species, but they are often observed in coastal waters along the U.S. continental shelf (NMFS and USFWS 2020a). Leatherbacks have been sighted along the entire coast of the eastern U.S. from the Gulf of Maine in the north and south to Puerto Rico, the Gulf of Mexico, and the U.S. Virgin Islands (NMFS and USFWS 2020a).

Dow Piniak et al. (2012) determined that the hearing range of leatherback sea turtles extends from approximately 50 to 1,200 Hz in water and 50 and 1,600 Hz in air, which is comparable to the general hearing range of turtles across species groups. Leatherbacks' greatest hearing sensitivity is between 100 and 400 Hz in water and 50 and 400 Hz in air.

5.1.2.3.1 Current Status

Leatherback sea turtles in the Action Area belong to the Northwest Atlantic population, which is one of seven leatherback populations globally. The species was listed as endangered under the ESA in 1970

(35 *FR* 8491), inclusive of all populations[4]. The breeding population (total number of adults) estimated in the North Atlantic is 34,000 to 94,000 (NMFS and USFWS 2013; TEWG 2007). NMFS and USFWS (2020a) concluded that the Northwest Atlantic population has a total index of nesting female abundance of 20,659 females with a decreasing nest trend at nesting beaches with the greatest known nesting female abundance.

Critical habitat for the Northwest Atlantic population is designated in the U.S. Virgin Islands and does not occur in the Action Area (NMFS and USFWS 2020a). Primary threats to the species include illegal harvesting of eggs, nesting habitat loss, and shoreline development. In-water threats include incidental catch and mortality from commercial fisheries, vessel strikes, anthropogenic noise, marine debris, oil pollution, and predation by native and exotic species (NMFS and USFWS 2020a).

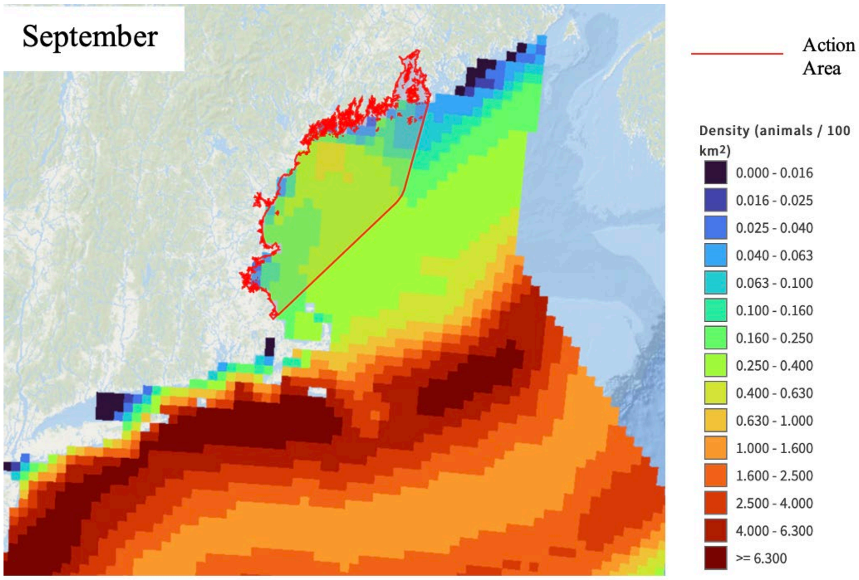
5.1.2.3.2 Potential Occurrence Within the Action Area

In the Northwest Atlantic, leatherback sea turtles are widely dispersed. They are generally a highly mobile species, inhabiting open ocean environments as hatchlings and adults, although pelagic distribution of hatchling or juvenile leatherback sea turtles is largely unknown (NMFS and USFWS 1992). Adult leatherbacks are highly migratory and are believed to be the most pelagic of all sea turtles (NMFS and USFWS 1992) and would be expected to remain further offshore relative to other sea turtle species, including waters beyond the shelf break. Tagged turtles have been documented migrating over large distances, greater than 7,000 km to foraging grounds located around the Atlantic (Palka et al. 2017, 2021). Leatherbacks have been spotted off Massachusetts in August, historically with no sightings from October through June (Musick and Limpus 1996). As with other species of sea turtles, with the temperatures of the Gulf of Maine increasing 97% faster compared to the rest of the ocean, they may be found more frequently in the area (Griffin et al. 2019).

STSSN data show 35 leatherback strandings within the Action Area between January 1, 2013 and September 5, 2023 (NMFS 2023g). Nesting has not been reported within the Action Area. Density surface models indicate highest regional leatherback sea turtle occurrences during September (**Figure 5-8**; DiMatteo et al. 2023a, 2023b). The species may be encountered within the Action Area year-round, but are more likely to occur from June through November (DiMatteo et al. 2023a, 2023b). While occurrence within the Gulf of Maine is generally widespread, densities within the Action Area are much lower than in waters in the vicinity of Georges Bank and coastal shelf waters further south. Although leatherbacks are the most abundant sea turtle species in the Action Area, their occurrence is still only in low numbers and seasonal within the Gulf of Maine.

---

[4] NMFS and USFWS have not designated DPSs for leatherback sea turtles because the species is listed as endangered throughout its global range (85 *FR* 48332); however, after reviewing the best available information, USFWS and NMFS (2020) identified seven leatherback populations that meet the discreteness and significance criteria of the DPS Policy, including the Northwest Atlantic population.



Source: DiMatteo et al. 2023a, 2023b

Figure 5-8. Leatherback sea turtle maximum mean density during September within the Action Area and surrounding region

5.1.2.4 Loggerhead Sea Turtle – Northwest Atlantic Ocean Distinct Population Segment (Threatened)

The loggerhead sea turtle is a globally distributed species found in temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (NMFS and USFWS 2008). Loggerheads are the most common sea turtle species observed in offshore and nearshore waters along the U.S. East Coast, and virtually all of these individuals belong to the Northwest Atlantic Ocean DPS. Most of the loggerhead sea turtles nesting in the eastern U.S. occur from North Carolina through southwest Florida. Some nesting also occurs in southern Virginia and along the Gulf of Mexico coast westward into Texas (NMFS and USFWS 2008). Foraging loggerhead sea turtles range widely; they have been observed along the entire Atlantic coast of the U.S. as far north as the Gulf of Maine (Shoop and Kenney 1992) and northward into Canadian waters.

Female loggerhead sea turtles in the western north Atlantic nest from late April through early September. Individual females might nest several times within one season and usually nest at intervals of every 2 to 3 years. For their first 7 to 12 years of life, loggerhead sea turtles inhabit pelagic waters near the North Atlantic Gyre and are called pelagic immatures. When loggerhead sea turtles reach 40 to 60 cm straight-line carapace length, they begin recruiting to coastal inshore and nearshore waters of the OCS through the U.S. Atlantic and Gulf of Mexico and are referred to as benthic immatures. Benthic immature loggerheads have been found in waters from Cape Cod, Massachusetts, to southern Texas. Most recent estimates indicate that the benthic immature stage ranges from ages 14 to 32 years; they reach sexual maturity at approximately 20 to 38 years of age. Loggerhead sea turtles are largely present year-round in waters south of North Carolina, but will forage during summer and fall as far north as the Northeastern U.S. and Canada and migrate south as water temperatures drop. Prey species for omnivorous juveniles include crab, mollusks, jellyfish, and vegetation at or near the surface. Coastal subadults and adults feed on benthic invertebrates, including mollusks and decapod crustaceans (TEWG 2009).

The loggerhead sea turtle has a powerful beak and crushing jaws specially adapted to feed on hard-bodied benthic invertebrates, including crustaceans and mollusks. Mollusks and crabs are primary food items for juvenile loggerheads (Burke et al. 1993). Although loggerheads are dietary specialists, the species demonstrates the ability to adjust its diet in response to changes in prey availability in different geographies (Plotkin et al. 1993; Ruckdeschel and Shoop 1988). Loggerheads in Chesapeake Bay, Virginia, primarily targeted horseshoe crabs (*Limulus polyphemus*) in the early to mid-1980s but subsequently shifted their diet to blue crabs in the late 1980s, and then to finfish from discarded fishery bycatch in the mid-1990s (Seney and Musick 2007).

Martin et al. (2012) and Lavender et al. (2014) used behavioral and auditory brainstem response methods to identify the hearing range of loggerhead sea turtles. Both teams identified a generalized hearing range from 100 Hz to 1.1 kHz, with greatest hearing sensitivity between 200 and 400 Hz.

5.1.2.4.1 Current Status

The Northwest Atlantic Ocean DPS of loggerhead sea turtle was listed as federally threatened under the ESA in 2011 (76 *FR* 58868). The regional abundance estimate in the Northwest Atlantic OCS in 2010 was approximately 588,000 adults and juveniles of sufficient size to be identified during aerial surveys (interquartile range of 382,000 to 817,000 [NEFSC and SEFSC 2011]). The three largest nesting subpopulations responsible for most of the production in the western North Atlantic (peninsular Florida, northern U.S., and Quintana Roo, Mexico) have all been declining since at least the late 1990s, thereby indicating a downward trend for this population (TEWG 2009). While some progress has been made since publication of the 2008 Loggerhead Sea Turtle Recovery Plan, the recovery units have not met most of the critical benchmark recovery criteria (NMFS and USFWS 2023).

Critical habitat for Northwest Atlantic Ocean DPS of loggerhead sea turtles was designated in 2014 (79 *FR* 39755; 79 *FR* 51264). The four designated critical habitat units are nesting beaches in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. No designated critical habitat occurs within the Action Area. Factors affecting the conservation and recovery of this species include beach development, related human activities that damage nesting habitat, and light pollution (NMFS and USFWS 2008, 2023). In-water threats include bycatch in commercial fisheries, vessel strikes, anthropogenic noise, marine debris, legal and illegal harvest, oil pollution, and predation by native and exotic species (NMFS and USFWS 2008, 2023).

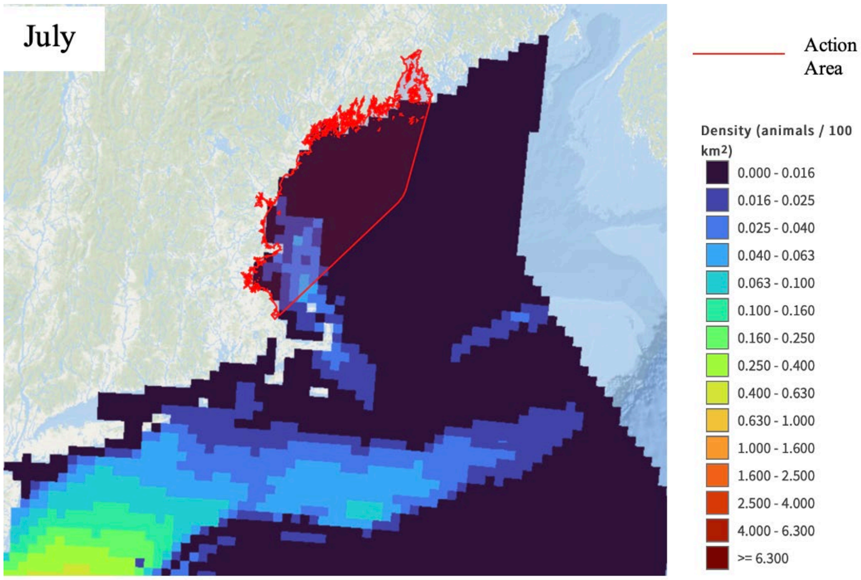
5.1.2.4.2 Potential Occurrence Within the Action Area

Loggerhead sea turtles inhabit nearshore and offshore habitats, ranging, in the Northwest Atlantic, as far north as Newfoundland (NMFS 2022c). Post-hatchling loggerhead sea turtles have been found to inhabit areas that are characterized by linear accumulations of *Sargassum* spp. near nearshore, localized downwellings (NMFS and USFWS 2008). Winton et al. (2018) reported that loggerheads tagged within the Northwest Atlantic primarily restrict their summertime distribution to OCS waters and occasionally make excursions inshore to bays and estuaries. Core habitat includes sea surface temperatures from 59.0°F to 82.4°F and at depths between 8 and 92 m, and the highest probability of occurrence occurs in regions with sea surface temperatures from 63.9°F to 77.5°F and at depths between 26 and 74 m (Patel et al. 2021).

AMAPPS data from tagged loggerhead sea turtles and visual surveys indicate this species is observed throughout the U.S. Atlantic OCS in summer and fall, with a shift towards the southeastern U.S. in the winter and spring (Palka et al. 2021). Loggerheads are not frequently encountered in the Gulf of Maine, with one study of 70,000 otter trawl hauls over 15 years only finding one loggerhead (Warden 2011).

STSSN data show 7 loggerhead sea turtle strandings within the Action Area between January 1, 2013 and September 5, 2023 (NMFS 2023g). Nesting has not been reported within the Action Area. The species may be encountered within the Action Area year-round, but are more likely to occur from June through

October (DiMatteo et al. 2023a, 2023b). Density surface models indicate highest regional loggerhead sea turtle occurrences during July (**Figure 5-9**; DiMatteo et al. 2023a, 2023b). Based on these data, occurrence within the Gulf of Maine is considered rare and likely limited to the southwestern portion of the Action Area.



Source: DiMatteo et al. 2023a, 2023b

Figure 5-9. Loggerhead sea turtle maximum mean density during July within the Action Area and surrounding region

5.1.3 Marine Fish

5.1.3.1 Atlantic Sturgeon – All Distinct Population Segments (Endangered; Threatened)

The Atlantic sturgeon is a large, long-lived, benthic fish found from Canada to Florida in river, estuarine, marine coastal, and OCS habitats. Individuals may be up to 13 ft (4 m) long, can reach up to 600 pounds, and live up to 60 years. Atlantic sturgeon are anadromous, meaning they are born in freshwater, migrate to sea, and then back to freshwater to spawn. Historically, Atlantic sturgeon were present in approximately 38 rivers in the U.S. from St. Croix, ME to the Saint Johns River, FL, of which 35 rivers have been confirmed to have had a historical spawning population (ASSRT 2007). There are 22 rivers along the U.S. East Coast that currently host spawning Atlantic Sturgeon (NMFS 2023h). Spawning in rivers from Delaware to Canada occurs from spring to early summer; some rivers may support a second fall spawning population, though supporting data is limited (NMFS 2023h). Spawning occurs in the late summer and fall in rivers from Georgia to Chesapeake Bay (NMFS 2023h). Females throughout the Atlantic tend to spawn every 2 to 5 years, with egg production between 400,000 to 2 million depending on maturity (NMFS 2023i). In non-spawning years, adults remain in marine waters year-round (Smith and Clugston 1997). Larvae develop into juveniles as they migrate downstream. Juveniles typically remain in their natal river for two to three years before migrating into coastal and ocean waters (NMFS 2023h). Subadults move out to estuarine and coastal waters in the fall; adults inhabit fully marine environments and migrate through deep water when not spawning (ASSRT 2007). They typically occur within the 50-meter depth contour when in the marine environment (NMFS 2023i). While most individuals are most common near their natal river, extensive migrations within the marine environment have been documented for both adults and subadults, with some individuals traveling thousands of kilometers from their natal rivers (Kazyak et al. 2021). Their distribution and abundance vary by season as they are found in shallow coastal waters during the summer months and move to deeper waters in winter and early spring (Dunton et al. 2010). In the pelagic marine environment, Atlantic sturgeon range as far north as eastern Canada and occupy shelf waters up to a depth of 75 m (246 ft).

Adult and subadult Atlantic sturgeon range widely across the Atlantic OCS, feeding primarily on benthic invertebrates and small fish on or near the seafloor. They appear to congregate in areas providing favorable foraging conditions (Stein et al. 2004a, b), exhibit dietary flexibility, and can adapt to changing prey availability (Guilbard et al. 2007; Johnson et al. 1997). During migrations along the eastern seaboard, Atlantic sturgeon are thought to travel north in the spring and south in the fall (Erickson et al. 2011). In a modeled study, Breece et al. (2018) discovered that spring migration takes place in shallower nearshore waters and, conversely, in deeper offshore waters for fall migration. Five genetically distinct DPSs make up the U.S. East Coast population; the Action Area falls within the Gulf of Maine DPS. However, given the species' proclivity to migrate, with extensive movements up and down the U.S. East Coast and into Canadian waters, Atlantic sturgeon encountered within the Action Area more broadly may originate from any of the five DPSs (Kazyak et al. 2021).

Male Atlantic sturgeon generally do not reach maturity until at least 12 years and females as late as 19 years (Dovel and Berggren 1983). Their interannual spawning period can range from 3 to 5 years, and adults inhabit marine waters either all year during non-spawning years or seasonally during spawning years (Bain 1997). Tagging data show that while at sea, adults intermix with populations from other rivers (ASSRT 2007). Despite their ability to range widely along the Atlantic coast, tagging and genetic studies indicate high site fidelity in natal rivers and very low gene flow among populations (Dovel and Berggren 1983; Grunwald et al. 2008; Savoy and Pacileo 2003).

Atlantic sturgeon are opportunistic predators that feed primarily on benthic invertebrates but will adjust their diet to exploit other types of prey resources when available. For example, Johnson et al. (1997) found that polychaetes composed approximately 86 percent of the diet of adult Atlantic sturgeon captured in the NY Bight. Isopods, amphipods, clams, and fish larvae composed the remainder of the diet, with the latter accounting for up to 3.6 percent of diet in some years. In contrast, Guilbard et al. (2007) observed that small fish accounted for up to 38 percent of subadult Atlantic sturgeon diet in the St. Lawrence River estuarine transition zone during summer, but less than 1 percent in fall. The remainder of the species' diet consisted primarily of amphipods, oligochaetes, chironomids, and nematodes, with the relative importance of each varying by season.

There is no available information on the hearing capabilities of Atlantic sturgeon specifically, although the hearing of other species of sturgeon have been studied. Meyer et al. (2010) and Lovell et al. (2005a) studied the auditory system morphology and hearing ability of lake sturgeon (*Acipenser fulvescens*), a closely related species. The *Acipenseridae* (sturgeon family) have a well-developed inner ear that is independent of the swim bladder. The results of these studies indicate a generalized hearing range from 50 to approximately 700 Hz, with greatest sensitivity between 100 and 300 Hz. Popper (2005) summarized studies measuring the physiological responses of the ear of European sturgeon (*Acipenser sturio*). The results of these studies suggest sturgeon are likely capable of detecting sounds from below 100 Hz to about 1 kHz. While sturgeon do have a swim bladder, it is not involved in hearing (Popper et al. 2014).

5.1.3.1.1 Current Status

All five DPSs of the Atlantic sturgeon are listed under the ESA; the Gulf of Maine DPS is listed as threatened whereas all others (i.e., New York Bight, Chesapeake Bay, Carolinas, and South Atlantic DPSs) are endangered (77 *FR* 5880, 77 *FR* 5914). The 2017 Atlantic sturgeon stock assessment reported that all DPSs remain depleted relative to historic distributions (ASMFC 2017). Though these DPSs represent distinct geographic populations along the U.S. Atlantic Coast, individuals from all DPSs migrate along the coast and are not easily distinguished visually from one another. Therefore, any Atlantic sturgeon encountered in the Action Area is considered endangered for the purpose of this analysis. In 2017, critical habitat was designated for all five DPSs of Atlantic sturgeon (82 *FR* 39160); these critical habitat designations are riverine. Atlantic sturgeon critical habitat is discussed in **Section 4.2.3**.

The species has suffered significant population declines across its range as a result of historical overfishing and degradation of freshwater and estuarine habitats by human development (ASSRT 2007). Bycatch mortality, water quality degradation, and dredging activities remain persistent threats. Some populations are impacted by unique stressors, such as habitat impediments and apparent ship strikes (ASSRT 2007). Historically, the Delaware River is thought to have supported the largest population of Atlantic sturgeon; recent studies estimate the current breeding population size is likely less than 250 adults, representing a greater than 99 percent decline since the late 1800s (USGS 2022). Indices from the New York Bight and Carolina DPSs indicated a greater than 50 percent chance of population increase since 1998, although the index from the Chesapeake Bay DPS only had a 36 percent chance of population increase across the same timeframe (ASMFC 2017). There are no abundance estimates available for the Gulf Maine DPS. Similarly, there are no abundance trends available due to limited available data. Data indicate that there is a 51 percent likelihood that the Gulf of Maine DPS population has increased since 1998, although there is a 74 percent probability that mortality of individuals exceed the mortality threshold (ASMFC 2017).

5.1.3.1.2 Potential Occurrence Within the Action Area

Atlantic sturgeon could be present throughout the Action Area depending on the various life history developmental stages. Similar to the shortnose sturgeon, the Gulf of Maine DPS of Atlantic sturgeon frequent coastal rivers including the Penobscot, Kennebec, Saco, and Merrimack Rivers near the Action Area (Wippelhauser et al. 2017; Fernandes et al. 2010). The Kennebec River system is the only known spawning population within the DPS and sturgeon typically enter the area for spawning in April and May when temperature is on average less than 16.0 degrees C, departing after July, though with some males remaining until October (Wippelhauser et al. 2017). Atlantic sturgeon have similarly been found in the Penobscot River from late May through the end of October, spending the fall and winter in the marine environment or in deeper more saline parts of rivers (Fernandes et al. 2010; Collins and Smith 1997).

Their occurrence within the Action Area is most likely as transients occurring in marine waters in the fall and winter (Fernandes et al. 2010; Collins and Smith 1997). Based on existing information presented previously in this section, Atlantic sturgeon would be more likely to occur near the coast (within the 50-meter depth contour) from fall to early spring rather than farther offshore in the Research Lease Area.

5.1.3.2 Atlantic Salmon – Gulf of Maine DPS (Endangered)

The geographic range of the Gulf of Maine DPS includes the Dennys River watershed to the Androscoggin River (74 *FR* 29343). Freshwater habitats in the Gulf of Maine provide spawning habitat and thermal refuge for adults; overwintering and rearing areas for eggs, fry, and parr; and migration corridors for smolts and adults (Bardonnet and Bagliniere 2000). Spawning tends to happen from late October through November, with a preference to lay eggs in gravel areas with sufficient circulation (Fay et al. 2006). Eggs hatch in March or April, and the sac fry emerge from the gravel in mid-May, spending two to three years in the river before migrating to offshore areas (Fay et al. 2006). This migration is strongly affected by oceanic features such as gyres, currents, and water temperature (Meister 1984; Lacroix and Knox 2005; Lacroix et al. 2012). Although individuals utilize the entire water column during their offshore migrations, post-smolts are most commonly detected in the upper 5 m; those that swim in the upper water column have higher survival rates than those that swim deeper (Renkawitz et al. 2012).

Atlantic salmon in the Gulf of Maine are known to migrate long distances in the open ocean to feeding areas in the Davis Strait between Labrador and Greenland, approximately 2,485 mi (4,000 km) from their natal rivers (Danie et al. 1984; Meister 1984). To make these long migrations, salmon smolts require a steady food source, as they are initially energy deficient (Lacroix and Knox 2005; Jonsson and Jonsson 2003). Atlantic salmon consume a variety of food sources, with juveniles eating a variety of invertebrates and plankton, and adults preferring capelin fish when in the open ocean, though they are also opportunistic predators (NMFS 2023i; Dixon et al. 2017). In recent years, notably from estimates from 1968-2008, capelin size has decreased by 33.7%, which has likely impacted foraging of the salmon (Renkawitz et al. 2015). Lacroix and Knox (2005) found that post-smolts, the life stage when salmon adapt from fresh to saltwater but are not yet full grown, consumed crustaceans including the amphipod hyperiidae, krill, and larval fish such as sand lances. These prey options extend across the open ocean, with the Gulf of Maine providing more krill than larval fish in their diet (Lacroix and Knox 2005). Approximately 90 percent of Atlantic salmon from the Gulf of Maine return after spending two winters at sea; usually less than 10 percent return after spending one winter at sea and approximately 1 percent of returning salmon are repeat spawners or have spent three winters at sea (Baum 1997).

Atlantic salmon appear not to have sensitive hearing, likely because their swim bladder is not connected to their hearing (Harding et al. 2016; Hawkins and Johnstone 1978). Atlantic salmon may hear at higher frequencies of 400 to 800 Hz, though they may be sensitive to frequencies greater than 100 (Hawkins and Johnstone 1978) or 200 Hz (Harding et al. 2016)

5.1.3.2.1 Current Status

The Gulf of Maine DPS of Atlantic salmon is the only DPS listed under the ESA that may occur within the Action Area. They were originally listed as endangered in December 2000 (65 *FR* 69459), and the listing was updated in June 2009 to expand the range of the Gulf of Maine DPS listed under the ESA (74 *FR* 29343). Though water quality improvements led to an increase in the total population to approximately 5,000 individuals in 1985, due to the continued existence of dams and low survival at sea, the average number of adults that return to Gulf of Maine rivers is currently 1,200 (NMFS 2023i; NMFS and USFWS 2019).

Threats to Atlantic salmon are primarily a result of dams and their effects on migration paths; additional threats include a lack of habitat complexity in certain freshwater areas, poor or insufficient water quantity, disease, and predation (NOAA and USFWS 2019; Fay et al. 2006). The Gulf of Maine DPS is also vulnerable to changing conditions resulting from climate change, particularly at the post-smolt stage. Changes in spring winds have left post-smolts more susceptible to predation in their migration corridors, pushing them closer to inshore waters where they encounter new predators and for a longer amount of time (Friedland et al. 2012).

Critical habitat is designated in the State of Maine for a total of 19,571 km of river, stream, and estuary habitat, as well as 799 sq. km of lake (74 *FR* 29299) (**Section 5.2.2**).

5.1.3.2.2 Potential Occurrence Within the Action Area

Atlantic salmon utilize the Gulf of Maine as juveniles to transit hundreds of kilometers to their offshore foraging areas near Greenland before crossing the Gulf of Maine again after two years to return to their natal river for spawning (Danie et al. 1984; Meister 1984; Lacroix et al. 2012). The adults have historically entered rivers from May to Mid-July for spawning, and afterwards return to sea and may return to the river in future years to lay more eggs (Baum 1997; NMFS 2023i).

After the eggs hatch, the juveniles, referred to as parr, spend two to three years in freshwater (NMFS 2023i), and then emerge from the rivers, utilizing specific migration corridors when transiting to the open sea, with studies showing that they prefer areas with high tidal forces (Kocik et al. 2009). They spend about 3 to10 days traveling down a given river, within a 25-day period for juveniles from all rivers, moving from natal rivers to the Gulf of Maine, although a high mortality rate of 53-64% is experienced when entering nearshore waters, potentially due to the transition to saltwater (Kocik et al. 2009). This transition to the marine environment by post-smolts occurs mainly from May through June, though it may extend into July. Individuals then travel eastward across the Gulf of Maine and then northeast along the coast of Nova Scotia, Canada (Meister 1984; Lacroix et al. 2012). Based on this generalized migration pattern, Atlantic salmon are most likely to occur in the marine environment in the Action Area during the summer.

5.1.3.3 Shortnose Sturgeon (Endangered)

The shortnose sturgeon (*Acipenser brevirostrum*) is an anadromous species, spawning and growing in fresh water and foraging in both the estuary of its natal river and shallow marine habitats close to the estuary (Bain 1997; Fernandes et al. 2010). Shortnose sturgeon occur in the Northwest Atlantic Ocean but are typically found in freshwater or estuarine environments. Historically, the species was found in coastal rivers along the entire east coast of North America. Shortnose sturgeon are found in large rivers and estuaries along the North American eastern seaboard from the Indian River in Florida to the Saint John River in New Brunswick, Canada. Generally, spawning occurs far upstream in their natal rivers, with individuals moving downriver to the estuaries to feed, rest, and spend most of their time. They are a primarily benthic species and are rarely known to leave their natal freshwater rivers (Kieffer and Kynard 1993); therefore, their presence in the coastal marine environment is uncommon (Baker and Howsen 2021). Movement of shortnose sturgeon between rivers is rare, though there have been some reported migrations (Shortnose Sturgeon Status Review Team 2010).

5.1.3.3.1 Current Status

Because of threats such as habitat degradation, water pollution, dredging, water withdrawals, fishery bycatch, and habitat impediments (e.g., dams), shortnose sturgeon were listed as endangered in 1967 (32 *FR* 4001) throughout the entire population range. There are 19 documented populations of shortnose sturgeon ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Currently, there are significantly more shortnose sturgeon in the northern portion of their overall range.

Developments in genetic research as well as differences in life history support the grouping of shortnose sturgeon into five genetically distinct groups, all of which have unique geographic adaptations (see Grunwald et al. 2008; Grunwald et al. 2002; King et al. 2001; Waldman et al. 2002; Walsh et al. 2001; Wirgin et al. 2005). These groups are: 1) Gulf of Maine; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River and Chesapeake Bay; and 5) Southeast. The Gulf of Maine, Delaware/Chesapeake Bay and Southeast groups function as metapopulations. The other two groups (Connecticut/Housatonic and the Hudson River) function as independent populations. The Gulf of Maine metapopulation is the only group of shortnose sturgeon expected to occur within the Action Area.

While there is migration within each metapopulation (i.e., between rivers in the Gulf of Maine and between rivers in the Southeast) and occasional migration between populations (e.g., Connecticut and Hudson), interbreeding between river populations is limited to very few individuals per generation; this results in morphological and genetic variation between most river populations (Walsh et al. 2001; Grunwald et al. 2002; Waldman et al. 2002; Wirgin et al. 2005). Indirect gene flow estimates from mitochondrial DNA indicate an effective migration rate of less than two individuals per generation. This means that while individual shortnose sturgeon may move between rivers, very few sturgeon are spawning outside their natal river; it is important to remember that the result of physical movement of individuals is rarely genetic exchange.

5.1.3.3.2 Potential Occurrence within the Action Area

Available data indicate that shortnose sturgeon within the Gulf of Maine metapopulation are present in the Penobscot, Kennebec, Androscoggin, Sheepscot, Saco, St. George, Medomak, Damariscotta, Presumpscot, and Piscataqua Rivers (Zydlewski et al. 2011; Altenritter et al. 2018; GARFO 2023b). Individuals have also been documented in smaller coastal rivers; however, the duration of presence has been limited to hours or days and the smaller coastal rivers are thought to be only used occasionally (Zydlewski et al. 2011; Altenritter et al. 2018; GARFO 2023b).

Since the removal of the Veazie and Great Works Dams (2013 and 2012, respectively), in the Penobscot River, shortnose sturgeon range from Penobscot Bay to the Milford Dam. Shortnose sturgeon now are presumed to have access to their full historical range. Adult and large juvenile sturgeon have been documented using the river. While potential spawning sites have been identified in the Penobscot River, no spawning has been documented; overwintering and potentially foraging are known to occur in the Penobscot River (Fernandes et al. 2010).

It is common for sturgeon to migrate from the Penobscot to the Kennebec, though not vice versa; as reproduction has thus far only been observed in the Kennebec River, it has been hypothesized that most sturgeon from these two rivers originate from the Kennebec River (Altenritter et al. 2018; Dionne et al. 2013). Wippelhauser et al. (2015) found that most sturgeon tagged in other rivers and estuaries in Maine migrated to reach the spawning habitat in the Kennebec System, and it was suggested that this system is targeted for spawning and wintering habitat by many shortnose sturgeon in the Gulf of Maine. Sturgeon that migrate were found to grow larger and faster than those solely in the Penobscot River, indicating the productive benefits of migration between the rivers (Altenritter et al. 2018). Migrations have been observed in coastal waters throughout the year, with an average trip of 12 days in the spring, 13.2 days in the fall, and 36.7 days in the summer, with likely movements through the coastal Maine river and bay system (Altenritter et al. 2018; Dionne et al. 2013; Wippelhauser et al. 2015). These patterns indicate that time spent in the marine environment and within the Action Area remains very low. Shortnose sturgeon have also been found entering coastal rivers between the Penobscot and Kennebec, though few east of the Penobscot River (Dionne et al. 2013).

5.2 Critical Habitat Considered for Further Analysis

5.2.1 North Atlantic Right Whale Critical Habitat

In 1994, NMFS designated critical habitat for the Northern right whale population in the North Atlantic Ocean (59 *FR* 28805). This critical habitat designation included portions of Cape Cod Bay, Stellwagen Bank, the Great South Channel, and waters adjacent to the coasts of South Carolina, Georgia, and the east coast of Florida. These areas were determined to provide critical feeding, nursery, and calving habitat for the North Atlantic population of northern right whales.

In 2016, NMFS revised designated critical habitat for the North Atlantic right whale with two new expanded areas. The areas designated as critical habitat contains approximately 29,763 nmi^2 (102,084.2 km^2) of marine habitat in the Gulf of Maine and Georges Bank region (Unit 1) (**Figure 5-10**) and off the Southeast U.S. coast (Unit 2) (**Figure 5-11**). Unit 1 is the only critical habitat that overlaps with the Action Area. The physical and biological features (PBFs) essential to the conservation of the North Atlantic right whale, which provide foraging area functions in Unit 1 are a combination of: (1) the physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that combine to distribute and aggregate *C. finmarchicus* for North Atlantic right whale foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes; (2) low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins; (3) late stage *C. finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region; and (4) Diapausing *C. finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region.

The PBFs essential to the conservation of North Atlantic right whale calving habitat that are essential to the conservation of the North Atlantic right whale, which provide calving area functions in Unit 2 are: (1) calm sea surface conditions of Force 4 or less on the Beaufort Wind Scale; (2) sea surface temperatures from a minimum of seven degrees Celsius, and never more than 17 degrees Celsius; and (3) water depths of 6 to 28 m (19.7 to 91.9 ft) where these features simultaneously co-occur over contiguous areas of at least 231 nmi^2 (792.3 km^2) of ocean waters during the months of November through April. When these features are available, they are selected by North Atlantic right whale cows and calves in dynamic combinations that are suitable for calving nursing, and rearing, and which vary, within the ranges specified, depending on factors such as weather and age of the calves (81 *FR* 4838).

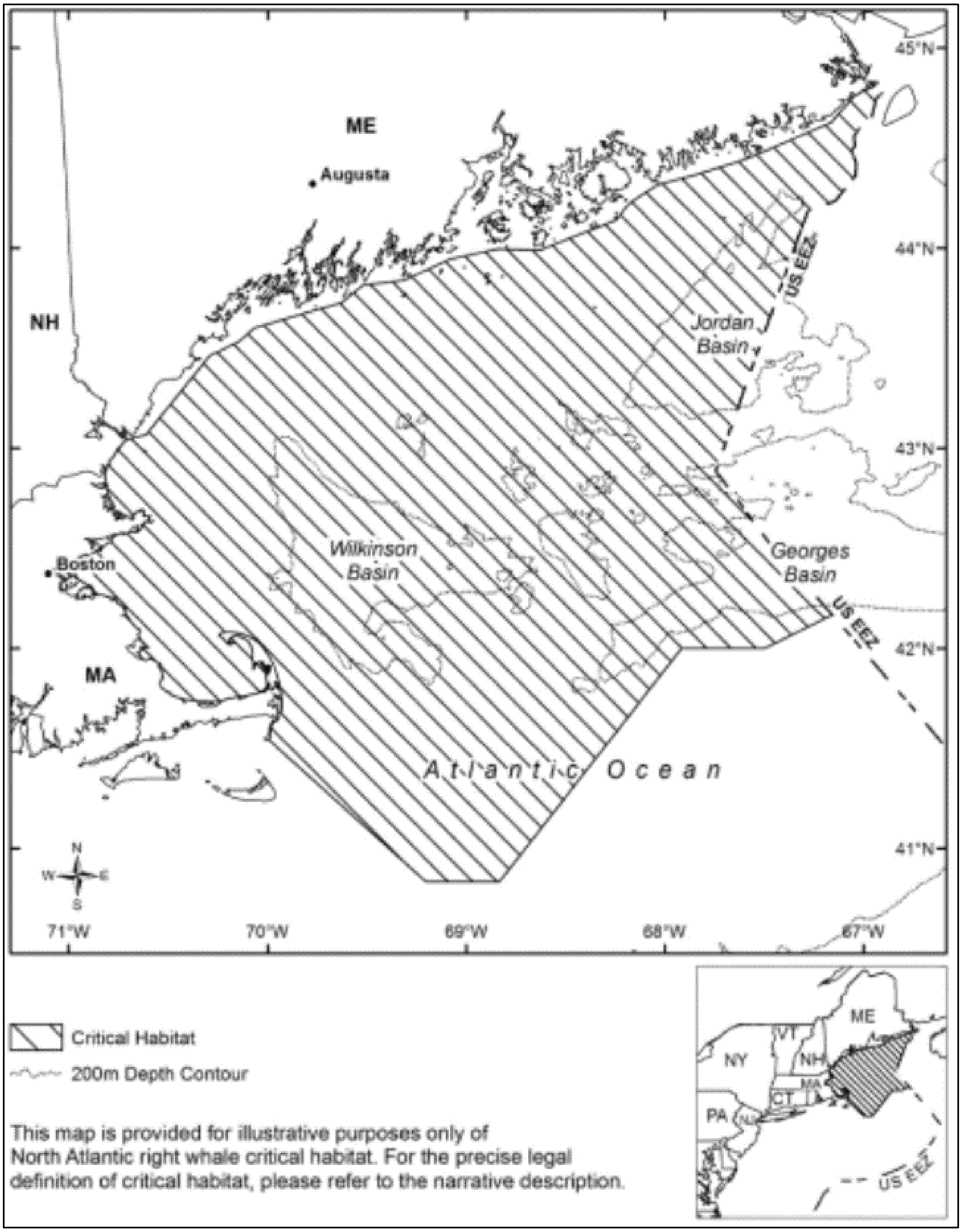


Figure 5-10. Map identifying designated critical habitat in the northeastern foraging area Unit 1 for the North Atlantic right whale

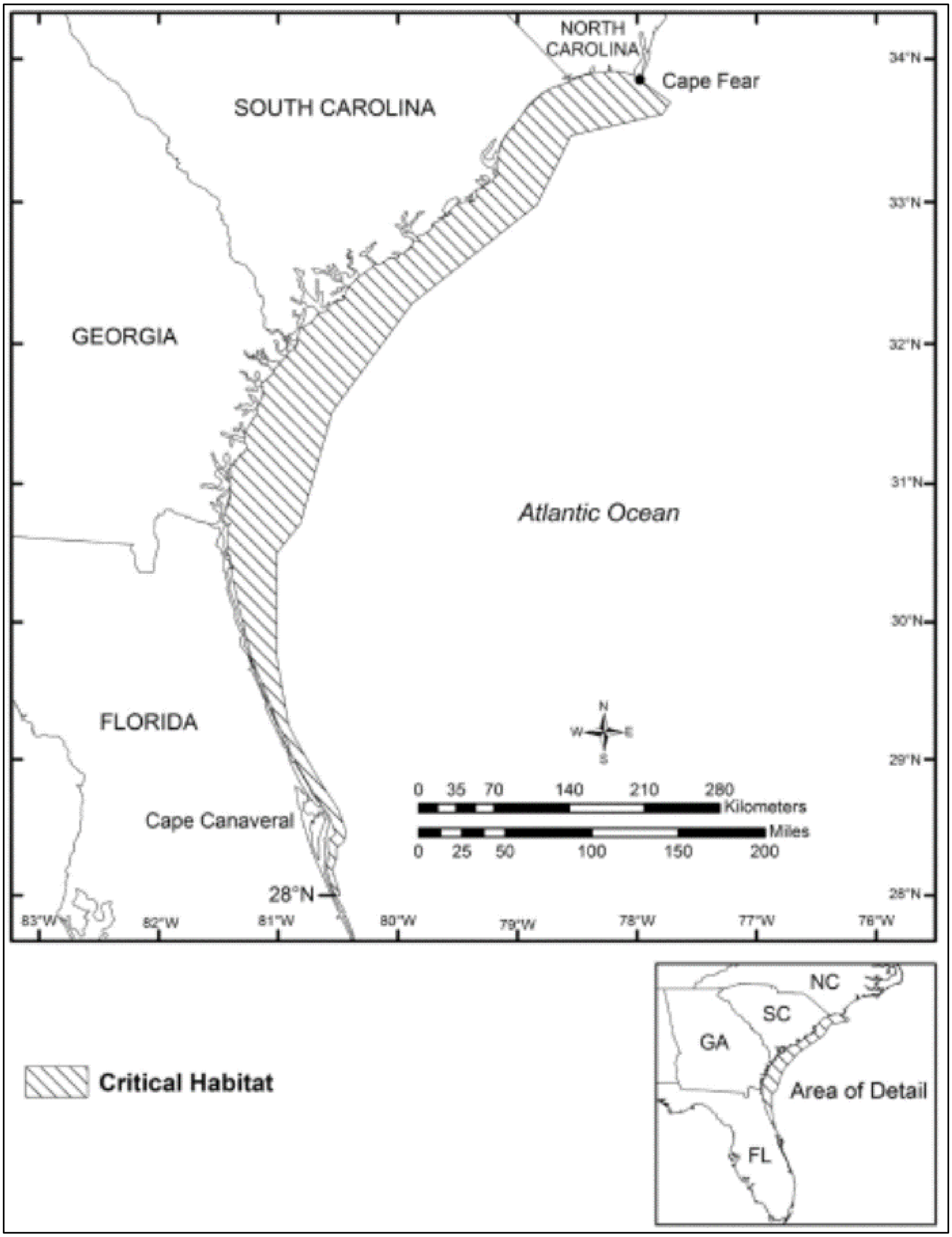


Figure 5-11. Map identifying designated critical habitat in the southeastern calving area Unit 2 for the North Atlantic right whale

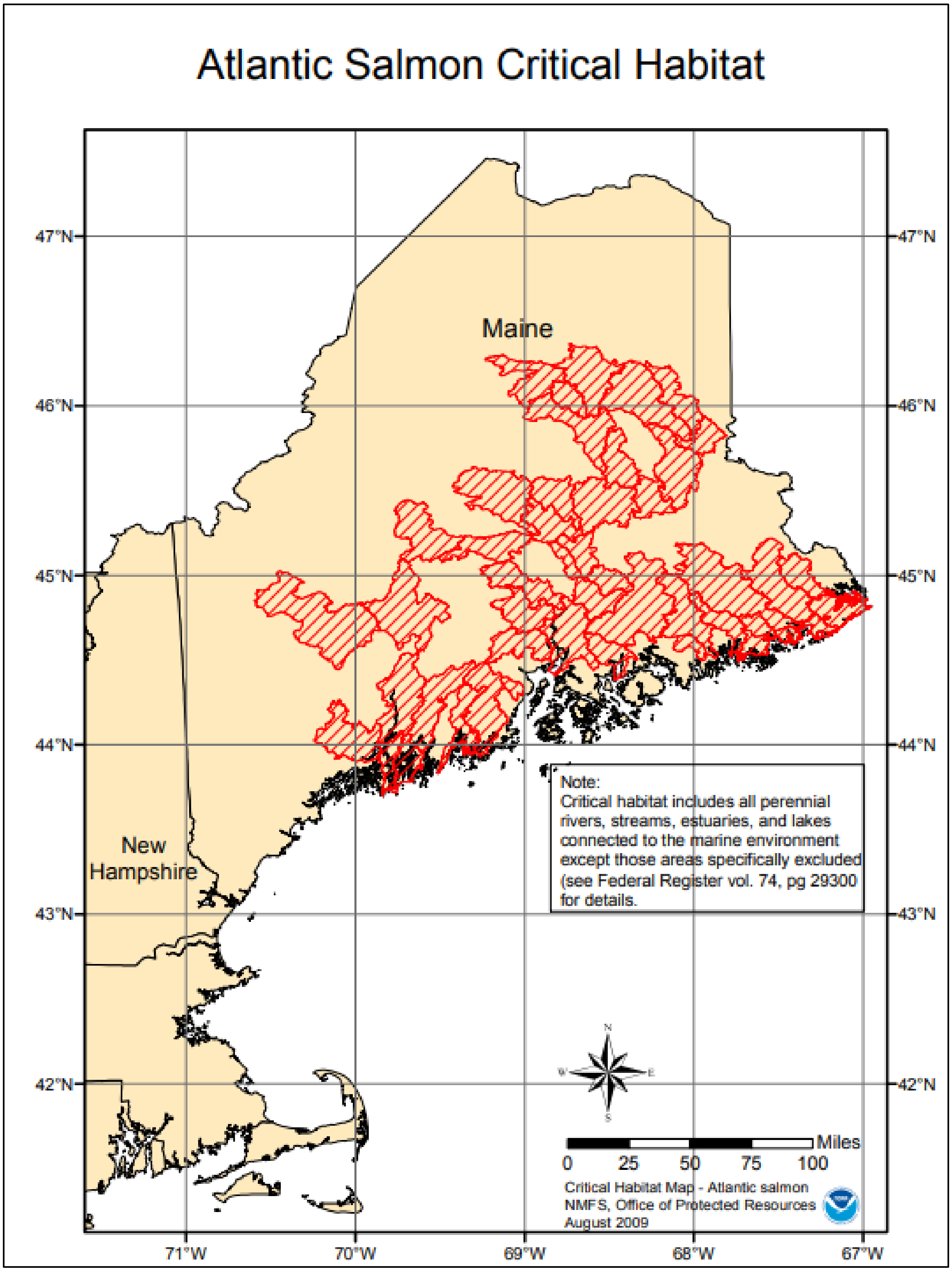
Unit 2 is outside of the Action Area whereas Unit 1 encompasses the entirety of the Action Area, so only Unit 1 is carried forward in the effects analysis in Section 7.

5.2.2 Atlantic Salmon Critical Habitat – Gulf of Maine DPS

Critical habitat for the Atlantic Salmon Gulf of Maine DPS was designated in June 2009 (74 *FR* 29300), with corrections published in August 2009 (74 *FR* 39903). This area is made up of perennial river, stream, estuary, and lake habitats that serve as critical areas for spawning, nursery and feeding grounds, and migration corridors to and from offshore marine waters. The FR determined that the successful return of adult salmon to spawning habitat, spawning, egg incubation and hatching, juvenile survival during the rearing time in freshwater, and smolt migration out of the rivers to the ocean are all essential to the conservation of Atlantic salmon. No marine habitats were identified as critical habitat because marine migration and feeding in these habitats essential for the conservation of Atlantic salmon could not be identified.

This habitat constitutes 12,273 mi (19,751 km) of river, stream, and estuary habitat, as well as 308.5 mi^2 (799 km^2) of lake which lies adjacent to the Action Area (**Figure 5-12**). The physical and biological features identified for spawning and rearing include (1) deep, oxygenated pools and cover (e.g., boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during the summer while they await spawning in the fall; (2) freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development; (3) freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development, and feeding activities of Atlantic salmon fry; freshwater rearing sites (4) with space to accommodate growth and survival of Atlantic salmon parr; (5) with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production; (6) with cool, oxygenated water to support growth and survival of Atlantic salmon parr; and (7) with diverse food resources to support growth and survival of Atlantic salmon parr.

The physical and biological features necessary for migration of Atlantic salmon include freshwater and estuary migratory sites (1) free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations; (2) with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon; (3) with abundant, diverse native fish communities to serve as a protective buffer against predation; (4) free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment; (5) with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration; and (6) with water chemistry needed to support sea water adaptation of smolts.



Note:
Critical habitat includes all perennial rivers, streams, estuaries, and lakes connected to the marine environment except those areas specifically excluded (see Federal Register vol. 74, pg 29300 for details.

Source: https://www.fisheries.noaa.gov/resource/map/atlantic-salmon-gulf-maine-dps-critical-habitat-map-and-gis-data

Figure 5-12. Map identifying designated critical habitat for the Atlantic Salmon DPS

6 Effects of the Action on ESA-listed Species

This BA analyzes the potential effects that may result from site assessment and site characterization activities considered part of the Proposed Action described in **Section 3**. Stressors that may affect listed species and critical habitat are listed in **Table 6-1.** The results of this assessment determined the following stressors **may affect but are not likely to adversely affect** any of the ESA-listed species considered in this BA. An overview of these stressors is provided in **Table 6-2** followed by a detailed analysis of each stressor provided in **Sections 6.3** through **6.10.**

"Effects of the action are all consequences to listed species or critical habitat that are caused by the Proposed Action, including the consequences of other activities that are caused by the Proposed Action. A consequence is caused by the Proposed Action if the effect would not occur but for the Proposed Action and the effect is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action" (50 CFR 402.02).

In this section of the BA, we assess the effects of the action on listed species expected to occur in the Action Area. The quantitative and qualitative analyses in this section are based upon the best available commercial and scientific data on species biology and the effects of the action. Data are limited, so we are often forced to make assumptions to overcome the limits in our knowledge. Sometimes, the best available information may include a range of values for a particular aspect under consideration, or different analytical approaches may be applied to the same data set. In those cases, the uncertainty is resolved in favor of the species. This approach provides the "benefit of the doubt" to threatened and endangered species.

Effects of the Proposed Action are first evaluated for the potential to affect a listed species. If a Project-related activity may affect a listed species, the exposure level and duration of effects are evaluated further for the potential for those effects to result in adverse effects to any individuals. No pproject-related activities assessed in this BA were determined to result in adverse effects to ESA-listed species.

The following sections present the potential project-related effects on listed species of marine mammals, sea turtles, and fish from site assessment and site characterization activities described in **Section 3.1** with the application monitoring and mitigation measures as described in **Section 3.3**. This effects discussion is organized by stressor responsible for impacts to each ESA-animal group (e.g., marine mammals, sea turtles, and marine fish). Effects to critical habitat are discussed in **Section 7**.

6.1 Description of Stressors

Stressors that may affect ESA-listed species and critical habitat analyzed in this assessment that were not already discounted in **Sections 4.2** and **4.3** are presented in **Table 6-1**.

Table 6-1. Stressors that could affect listed species and critical habitat

Stressor[a]	Description	Sources and/or Activities	Listed Species and Critical Habitat Exposed to the Stressor
Underwater Noise	Refers to noise from various sources and commonly associated with geophysical and geotechnical surveys, and vessel traffic.	• Vessels • Geophysical and geotechnical surveys	Fin whale (*Balaenoptera physalus*) NARW (*Eubalaena glacialis*) Sei whale (*Balaenoptera borealis*) Sperm whale (*Physeter macrocephalus*) Green sea turtle (*Chelonia mydas*) Kemp's ridley sea turtle (*Lepidochelys kempii*) Leatherback sea turtle (*Dermochelys coriacea*) Loggerhead sea turtle (*Caretta caretta*) Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) Atlantic salmon (*Salmo salar*) NARW critical habitat
Vessel Strike Risk	Refers to marine vessel traffic, including vessel strikes of marine mammals, sea turtles, and marine fish.	• Vessels	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon

Stressor[a]	Description	Sources and/or Activities	Listed Species and Critical Habitat Exposed to the Stressor
Habitat Disturbance	Refers to effects from turbidity resulting from benthic disturbances; temporary seafloor disturbances; and the presence of structures.	• Placement and removal of the FLiDAR buoy • Geotechnical surveys, • Benthic surveys • Vessel anchoring.	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon Atlantic salmon NARW critical habitat Atlantic salmon critical habitat
Entanglement and capture	Survey activities under the Proposed Action that pose an entanglement and capture risk to ESA-listed species due to the use of in-water fisheries sampling gear. This includes bottom trawl surveys for marine fish and invertebrates, plankton and larval lobster surveys, and lobster trap surveys.	• FLiDAR buoy and PAM mooring • Fisheries surveys	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Atlantic salmon NARW critical habitat
Air emissions	Refers to the release of gaseous or particulate pollutants into the atmospheres. Can occur on- and offshore.	• Internal combustion engines within mobile sources such as vessels, vehicles, or aircraft	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle
Lighting	Refers to the presence of light above the water onshore and offshore as well as underwater	• Vessels or FLiDAR Buoy	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle

Stressor[a]	**Description**	**Sources and/or Activities**	**Listed Species and Critical Habitat Exposed to the Stressor**
Non-Routine Events	Effects associated with non-routine events, such as storms, allisions and collisions, accidental spills, and recovery of lost equipment.	• Vessels • Fisheries Surveys • Benthic surveys	Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon Atlantic salmon NARW critical habitat Atlantic salmon critical habitat

BA = Biological Assessment; ESA = Endangered Species Act; HRG = high-resolution geophysical; NARW = North Atlantic right whale; USCG = U.S. Coast Guard; USEPA = U.S. Environmental Protection Agency

[a] The following stressors have been discounted from the assessment in the BA for the ESA-listed resources analyzed because they are not expected to have any discernable effects on these species: land disturbance, in-air noise.

6.2 Determination of Effects

The term “consequences,” was introduced to the ESA to replace “direct” and “indirect” effects in 2019. Consequences are a result or effect of an action on ESA species. NMFS uses two criteria to identify the ESA-listed species and designated critical habitat that are **not likely to be adversely affected** by the Proposed Action.

The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If NMFS concludes that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, they must also conclude that the species or designated critical habitat is **not likely to be adversely affected** by those activities.

The second criterion is the probability of a response given exposure. An ESA-listed species or designated critical habitat that co-occurs with a stressor of the action but is not likely to respond to the stressor is also **not likely to be adversely affected** by the Proposed Action.

Section 7(a)(2) of the ESA requires federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

“Jeopardize the continued existence of” means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR §402.02).

“Destruction or adverse modification” means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of an ESA-listed species as a whole (50 CFR §402.02).

Based on an analysis of potential consequences, we provide a determination for each species and designated critical habitat. One of the following three determinations, as defined by the ESA, has been applied for listed species and critical habitat that have potential to be affected by the project: No effect; may affect, not likely to adversely affect; may affect, likely to adversely affect.

The probability of an effect on a species or designated critical habitat is a function of exposure intensity and susceptibility of a species to a stressor’s effects (i.e., probability of response).

No effect – This determination indicates that the Project would have no impacts, positive or negative, on species or designated critical habitat. Generally, this means that the species or critical habitat would not be exposed to the Project and its environmental consequences.

A **may affect, not likely to adversely affect** determination would be given if the project’s effects are wholly beneficial, insignificant, or discountable.

Beneficial effects have an immediate positive effect without any adverse effects to the species or habitat.

Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. *Insignificant* is the appropriate effect conclusion when plausible effects are going to happen but will not rise to the level of constituting an adverse effect.

Discountable[5] effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is extremely unlikely to occur (USFWS and NMFS 1998).

This BA analyzes the potential effects that may result from site assessment and site characterization activities considered part of the Proposed Action described in **Section 3**. The results of this assessment determined the following stressors **may affect but are not likely to adversely affect** any of the ESA-listed species considered in this BA. An overview of these stressors is provided in **Table 6-2** followed by a detailed analysis of each stressor provided in **Sections 6.3** through **6.10**.

---

[5] When the terms "discountable" or "discountable effects" appear in this document, they refer to potential effects that are found to support a "not likely to adversely affect" conclusion because they are extremely unlikely to occur. The use of these terms should not be interpreted as having any meaning inconsistent with the ESA regulatory definition of "effects of the action."

Table 6-2. Stressors that are not likely to adversely affect ESA-listed species

Stressor		Marine Mammals					Sea Turtles				Marine Fish		
		Fin Whale	**North Atlantic Right Whale**	**Sei Whale**	**Sperm Whale**	**Blue Whale**	**Green Sea Turtle (North Atlantic DPS)**	**Leatherback Sea Turtle**	**Loggerhead Sea Turtle (Northwest Atlantic DPS)**	**Kemp's Ridley Sea Turtle**	**Atlantic Sturgeon**	**Atlantic Salmon**	**Shortnose Sturgeon**
Underwater Noise	Geophysical Reconnaissance Survey Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	NE	NE	NE	NE
	Active Acoustic Survey Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	NE	NE	NE	NE
	Seafloor Habitat Characterization Survey Equipment Noise	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Vessel Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Geotechnical Sampling Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	HRG Survey Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Vessel Strike		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
Habitat Disturbance	Temporary Seafloor Disturbances	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Turbidity	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Behavioral Changes due to the Presence of Structures	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Entanglement and Capture		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE
Air Emissions		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE
Lighting		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Non-Routine Events	Storms	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Allisions and Collisions	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Spills	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Recovery of Lost Survey Equipment	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Overall Effects Determination		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA

DPS = distinct population segment; HRG = high-resolution geophysical; NARW = North Atlantic right whale; NE = no effect; NLAA = not likely to adversely affect

6.3 Underwater Noise

BOEM recognizes that ESA-listed species can be exposed to underwater noise resulting from activities under the Proposed Action including vessel noise, HRG surveys, and geotechnical surveys. While the geophysical reconnaissance surveys will also use geophysical survey equipment, the proposed equipment all have operating frequencies (greater than 180 kHz) above relevant marine mammal, sea turtle, and ESA-listed fish primary hearing sensitivities or produce very narrow beam widths; thus they are unlikely to be detectable beyond a few meters from the sources for most species so no notable effects are expected. The extent and severity of auditory and non-auditory effects from the Proposed Action generated underwater noise is dependent on the timing of activities relative to species occurrence, the type of noise impact, and species-specific sensitivity.

Underwater sounds in the marine environment originate from a variety of sources including non-biological sources such as wind and waves, and the movements or vocalizations of marine life (Hildebrand 2009). Human activities can also introduce sound into the marine environment through activities like oil and gas exploration, construction, military sonars, and vessel traffic (Hildebrand 2009). The soundscape, or acoustic habitat, of a given ecosystem comprises all such sounds—biological, non-biological, and anthropogenic (Pijanowski et al. 2011). Soundscapes are highly variable across space, time, and water depth, among other factors, due to the properties of sound transmission and the types of sound sources present in each area. A soundscape is sometimes called the “acoustic habitat,” as it is a vital attribute of a given area where an animal may live (i.e., habitat) (Hatch et al. 2016).

Sounds are created by the vibration of an object within its medium, in this case water. When the object’s vibration is coupled to the medium, that vibration travels as a propagating wave away from the sound source. As this wave moves through the water, the particles undergo tiny back-and-forth movements (i.e., particle motion), when the motion results in more particles in one location, that location has relatively higher pressure. Particles are then accelerated out of the higher pressure region causing particle motion. The particles themselves do not travel with the wave, instead they oscillate in roughly the same location, transferring their energy to surrounding particles. Acoustic pressure is a non-directional (scalar) quantity, whereas particle motion is an inherently directional quantity (a vector). The total energy of the sound wave includes the potential energy associated with the sound pressure as well as the kinetic energy from particle motion.

Propagation of underwater sound can be described through a source-path-receiver model. An underwater acoustic source emits sound energy that radiates outward and travels through the water and the seafloor as mechanical waves. The sound level decreases with increasing distance from the acoustic source as the sound pressure waves spread out under the influence of the surrounding receiving environment. The amount by which the sound levels decrease between a source and a receiver is called transmission loss. The amount of transmission loss that occurs depends on the source-receiver separation, the frequency of the sound, the properties of the water column, and the properties of the seafloor. Underwater sound levels are expressed in decibels (dB), which is a logarithmic ratio relative to a fixed reference pressure of 1 micropascal (μPa) (equal to 10^{-6} pascals [Pa] or 10^{-11} bar).

The efficiency of underwater sound propagation allows marine animals to use underwater sound as a method of communication, navigation, prey detection, and predator avoidance (Richardson et al. 1995; Southall et al. 2007; Dow Piniak et al. 2012; Popper and Hawkins 2018, 2019). Anthropogenic (i.e., human-introduced) noise has gained recognition as a potential stressor for marine life because of their reliance on underwater hearing for maintenance of these critical biological functions (Richardson et al. 1995; Ketten 1998; Dow Piniak et al. 2012; Popper and Hawkins 2018, 2019). Underwater noise generated by human activities can often be detected by marine animals many kilometers from the source.

With increasing distance from a noise source, potential acoustic impacts can range from physiological injury to permanent or temporary hearing loss, behavioral changes, and acoustic masking (i.e., communication interference). All the above impacts could induce stress on marine animals in their receiving environment (OSPAR Commission 2009; Erbe 2013).

Anthropogenic noise sources are classified as either impulsive or non-impulsive and continuous or intermittent based on their acoustic characteristics (NMFS 2018, 2023j). Specifically, when it comes to potential damage to marine animal hearing, sounds are classified as either impulsive or non-impulsive, and when considering the potential to affect behavior or acoustic masking, sounds are classified as either continuous or intermittent.

Impulsive noises are characterized as having (Finneran 2016):

- broadband frequency content;
- fast rise-times and rapid decay times;
- short durations (i.e., less than 1 s); and
- high peak sound pressures.

Whereas the characteristics of non-impulsive sound sources are less clear but may be:

- variable in spectral composition, i.e., broadband, narrowband, or tonal;
- longer rise-time/decay times, and total durations compared to an impulsive sound; and
- continuous (e.g., vessel engine radiated noise), or intermittent (e.g., echosounder pulses).

Impulsive sounds are more likely to induce auditory function effects, including temporary threshold shift (TTS) and permanent threshold shift (PTS), than non-impulsive sounds with the same energy. This binary, at-the-source classification of sound types, therefore, provides a conservative framework upon which to predict potential adverse hearing impacts to marine life.

For behavioral effects of anthropogenic sound on marine mammals, NMFS classifies sound sources as either intermittent or continuous (NMFS 2023j). Continuous sounds, such as vessel noise continuously produce noise above ambient sound levels, for a given period of time, during which exposures to the noise may induce a behavioral reaction. An intermittent sound typically consists of pulses of sound on a regular on-off pattern, also called the duty-cycle. Examples of intermittent sounds are those from scientific echosounders, sub-bottom profilers, and geotechnical coring. It is important to recognize that these delineations are not always practical in application, as a continuous yet moving sound source (such as a vessel passing over a fixed receiver) could be considered intermittent from the perspective of the receiver.

Sensitivity to PTS, TTS, and behavioral disturbance will depend upon the frequency of the source and the hearing sensitivity of the receiver to those frequencies. For auditory effects (i.e., PTS, TTS), underwater noise is less likely to affect an animal's hearing if the received noise occurs at frequencies outside an animal's primary hearing sensitivity. The importance of underwater noise for a given animal can be scaled by frequency weighting relative to an animal's sensitivity to those frequencies (Nedwell et al. 2007). Acoustic thresholds used for the purpose of predicting the extent of potential noise impacts on marine mammal, sea turtle, and fish hearing and subsequent management of these impacts account for the duration of exposure, incorporation of more recent hearing and TTS data, and the differences in hearing acuity in various marine species or life stages (Finneran 2016; NMFS 2023j).

Auditory thresholds from underwater noise are expressed using three common metrics: root-mean-square sound pressure level (SPL) and peak sound pressure level (L_{pk}), both measured in dB re 1 μPa, and sound exposure level (SEL), a measure of energy in dB re 1 μPa^2 s. L_{pk} is an instantaneous value, whereas SEL is the total noise energy over a given time period or event. As such, the SEL accumulated over 24 hours, (SEL_{24h}) is appropriate when assessing effects to marine mammals from cumulative exposure to multiple pulses or durations of exposure. SPL is a root mean square average over a period of time and is equal to the SEL divided (linearly) by the time period of exposure. Therefore, if the time period is 1 second, the SEL and the SPL are equal.

The auditory and non-auditory thresholds used in this BA are given below for each species group. The extent and severity of auditory and non-auditory effects from project generated underwater noise is dependent on the timing of activities relative to species occurrence, the type of noise impact, and species-specific sensitivity.

6.3.1 Overview of Underwater Noise and ESA-listed Species

6.3.1.1 Underwater Noise and Marine Mammals

Marine mammals rely heavily on acoustic cues for extracting information from their environment. Sound travels faster and farther in water (~1500 m/s) than it does in air (~350 m/s), making this a reliable mode of information transfer across large distances and in environments where visual cues are limited. Acoustic communication is used in a variety of contexts, such as attracting mates, communicating to young, or conveying other relevant information (Bradbury and Vehrencamp 1998). Marine mammals can also glean information about their environment by listening to acoustic cues, like ambient sounds from a reef, the sound of an approaching storm, or the call from a nearby predator. Finally, toothed whales produce and listen to echolocation clicks to locate food and to navigate (Madsen and Surlykke 2013).

Like terrestrial mammals, the auditory anatomy of marine mammals generally includes the inner, middle, and outer ear (Ketten 1994). Not all marine mammals have an outer ear, but if it is present, it funnels sound into the auditory pathway, capturing the sound. The middle ear acts as a transformer, filtering and amplifying the sound. The inner ear is where auditory reception takes place. The key structure in the inner ear responsible for auditory perception is the cochlea, a spiral-shaped structure containing the basilar membrane, which is lined with auditory hair cells. Specific areas of the basilar membrane vibrate in response to the frequency content of the acoustic stimulus, causing hair cells mapped to specific frequencies to be differentially stimulated and send signals to the brain (Ketten 1994). While the cochlea and basiliar membrane are well conserved structures across all mammalian taxa, there are some key differences in the auditory anatomy of terrestrial versus marine mammals that require explanation. Marine mammals have the unique need to hear in aqueous environments. Amphibious marine mammals (including seals, sea otters, and sea lions) have evolved to hear in both air and under water, and all except phocid pinnipeds have external ear appendages. Cetaceans do not have external ears, do not have air-filled external canals, and the bony portions of the ear are much denser than those of terrestrial mammals (Ketten 1994).

All marine mammals have binaural hearing and can extract directional information from sound. But the pathway that sound takes into the inner ear is not well understood for all cetaceans and may not be the same for all species. For example, in baleen whales (i.e., mysticetes), bone conduction through the lower jaw may play a role in hearing (Cranford and Krysl 2015), while odontocetes have a fat-filled portion of the lower jaw which is thought to funnel sound towards the ear (Mooney et al. 2012). Hearing tests have been conducted on several species of odontocetes, but there has yet to be a hearing test on a baleen whale, so most of our understanding comes from examining the ears from deceased whales (Erbe et al. 2016; Houser et al. 2017).

Many marine mammal species produce sounds through vibrations in their larynx (Frankel 2009). In baleen whales, for example, air in the lungs and laryngeal sac expands and contracts, producing vibrations and sounds within the larynx (Frankel 2009). Baleen whales produce low frequency sounds that can be used to communicate with other animals over great distances (Clark and Gagnon 2002). Differences in sound production among marine mammal species vary, in part, with their use of the marine acoustic environment. Toothed whales hunt for their prey using high-frequency echolocation signals. To produce these signals they have a specialized structure called the "melon" in the top of their head that is used for sound production. When air passes through the phonic lips, a vibration is produced, and the melon helps transmit the vibration from the phonic lips to the environment as a directed beam of sound (Frankel 2009). It is generally believed that if an animal produces and uses a sound at a certain frequency, its hearing sensitivity will at least overlap those particular frequencies. An animal's hearing range is likely much broader than this, as they rely heavily on acoustic information, beyond the signals they produce themselves, to understand their environment.

The sections below provide an overview of the available information on marine mammal hearing, the thresholds applied, information available in the literature regarding source levels for sound sources assessed in this BA, and the impact consequences for each potential underwater noise generating activity for the Proposed Action.

For sound sources or for species where no Project specific modeling was completed, information available in the literature regarding source levels was used to develop the effects analysis.

6.3.1.1.1 Auditory Criteria for Injury and Behavioral Disturbance to Marine Mammals

Assessment of the potential effects of underwater noise on marine mammals requires acoustic thresholds against which received sound levels can be compared. For marine mammals, established acoustic criteria for hearing injury and behavioral disturbance recognized by NMFS have recently been updated in terms of auditory injury thresholds (NMFS 2023j). The revised auditory injury thresholds apply dual criteria based on Lpk and SEL_{24hr} and are based on updated frequency weighting functions for five marine mammal hearing groups described by NMFS (2023j), Southall et al. (2007) and Finneran and Jenkins (2012). However, the species considered in the analysis in this BA only belong to two hearing groups, as summarized in **Table 6-3.**

Table 6-3. Marine mammal hearing groups for Endangered Species Act (ESA)-listed marine mammal species

Hearing Groups	Taxonomic Group	Generalized Hearing Range[1]
Low-frequency cetaceans (LFC)	Baleen whales (e.g., NARW, fin whale)	7 Hz to 35 kHz
Mid-frequency cetaceans (MFC)	Sperm whale	150 Hz to 160 kHz

Source: Southall et al. (2007) Finneran and Jenkins (2012), and NMFS (2023j)
Hz = hertz; kHz = kilohertz; NARW = North Atlantic right whale
[1] The generalized hearing range is for all species within a group. Individual hearing may vary. Generalized hearing range based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LFC (Southall et al. 2007).

Behavioral disturbance thresholds for marine mammals are based on SPL of 160 dB re 1 μPa for impulsive or non-impulsive, intermittent sounds and 120 dB re 1 μPa for non-impulsive, continuous sounds for all marine mammal species (NMFS 2023j). Although these behavioral disturbance thresholds remain current (in the sense that they have not been formally superseded by newer directives), they are not frequency weighted to account for different hearing abilities by the five marine mammal hearing groups.

The potential for underwater noise exposures to result in adverse impacts on a marine mammal depends on the received sound level, the frequency content of the sound relative to the hearing ability of the animal, the duration, and the level of natural background noise. Potential effects range from subtle changes in behavior at low received levels to strong disturbance effects or potential injury at high received levels.

Sound reaching the receiver at sufficient loudness and for an ample duration can result in a loss of hearing sensitivity in marine animals termed a noise-induced threshold shift. This may consist of TTS or PTS. TTS is a relatively short-term, reversible loss of hearing following exposure (Southall et al. 2007, 2019), often resulting from cellular fatigue and metabolic changes (Saunders et al. 1985; Yost 2000). While experiencing TTS, the hearing threshold rises, and subsequent sounds must be louder to be detected. Data indicate that TTS onset in marine mammals is more closely correlated with the received SEL_{24h} than with the Lpk and that received sound energy over time, not just the single strongest pulse, should be considered a primary measure of potential impact (Southall et al. 2007; Finnern et al. 2017; NMFS 2018). PTS is an irreversible loss of hearing (permanent damage; not fully recoverable) following exposure that commonly results from inner ear hair cell loss or structural damage to auditory tissues (Saunders et al. 1985; Henderson et al. 2008). PTS has been demonstrated in harbor seals (Reichmuth et al. 2019; Kastak et al. 2008). TTS has been demonstrated in some odontocete and pinniped species in response to exposure to impulsive and non-impulsive noise sources in a laboratory setting (a full review is provided in Southall et al. 2007; Finneran et al. 2017). Prolonged or repeated exposures to sound levels sufficient to induce TTS without recovery time can lead to PTS (Southall et al. 2007).

Table 6-4 outlines the acoustic thresholds for onset of acoustic impacts (PTS and behavioral disturbances) for marine mammals for both impulsive and non-impulsive noise sources. Impulsive noise sources for the Project include some HRG equipment. Non-impulsive noise sources associated with the Project include some HRG equipment, vessel activities, and geotechnical surveys.

Table 6-4. Acoustic marine mammal thresholds (temporary threshold shift [TTS] and permanent threshold shift [PTS]) based on National Marine Fisheries Service (NMFS) (2023j for Endangered Species Act (ESA)-listed cetaceans

Marine Mammal Hearing Group	Effect	Impulsive Source		Non-Impulsive Source
		Unweighted Lpk (dB re 1 µPa)	Weighted SEL24h (dB re 1 µPa² s)	Weighted SEL24h (dB re 1 µPa² s)
LFC	PTS	219	183	199
	TTS	213	168	179
MFC	PTS	230	185	198
	TTS	224	170	178

Source: NMFS 2023j
dB re 1 µPa = decibels relative to 1 micropascal; dB re 1 µPa^{2}s = decibels relative to 1 micropascal squared second; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; PTS = permanent threshold shift; TTS = temporary threshold shift

Marine mammals show varying levels of behavioral disturbance in response to underwater noise sources. Observed behavioral responses include displacement and avoidance, decreases in vocal activity, and habituation. Behavioral responses can consist of disruption in foraging patterns, increases in physiological stress, and reduced breeding opportunities, among other responses. To better understand and categorize the potential effects of behavioral responses, Southall et al. (2007) developed a behavioral response severity scale of low, moderate, or high (Southall et al. 2007; Finneran et al. 2017). This scale was recently updated in Southall et al. (2021). The revised report updated the single severity response criteria defined in Southall et al. (2007) into three parallel severity tracks that score behavioral responses from 0 to 9. The three severity tracks are (1) survival, (2) reproduction, and (3) foraging. This approach is acknowledged as being relevant to vital rates, defining behaviors that may affect individual fitness, which may ultimately affect population parameters.

It was noted that not all the responses within a given category need to be observed but that a score is assigned for a severity category if any of the responses in that category are displayed (Southall et al. 2021). To be conservative, the highest (or most severe) score is to be assigned for instances when several responses are observed from different categories. In addition, the Southall et al. (2021) acknowledge it is no longer appropriate to relate “simple all-or-nothing thresholds” to specific received sound levels and behavioral responses across broad taxonomic groupings and sound types due to the high degree of variability within and between species and noise types. The new scale also moves away from distinguishing noise impacts from impulsive versus non-impulsive sound types into considering the specific sources of noise.

Auditory masking occurs when sound signals used by marine mammal overlap in time, space, and frequency with another sound source (Richardson et al. 1995). Masking can reduce communication space, limit the detection of relevant biological cues, and reduce communication or echolocation effectiveness. A growing body of literature is focused on improving the framework for assessing the potential for masking of animal communication by anthropogenic noise and understanding the resulting effects. More research is needed to understand the process of masking, the risk of masking by anthropogenic activities such as sonar emissions, the ecological significance of masking, and what anti-masking strategies are used by marine animals and their degree of effectiveness before masking can be incorporated into regulation strategies or mitigation approaches (Erbe et al. 2016). For the current assessment, masking was considered possible if the frequency of the sound source overlaps with the hearing range of the marine mammal (**Table 6-3**).

6.3.1.2 Underwater Noise and Sea Turtles

Potential adverse auditory effects to sea turtles from Project generated underwater noise includes PTS, TTS, and behavioral disruption. The section below provides an overview of the available information on sea turtle hearing, the thresholds applied, and the impact consequences for each potential activity.

6.3.1.2.1 Auditory Criteria for Injury and Disturbance to Sea Turtles

The outermost part of the sea turtle ear, or tympanum, is covered by a thick layer of skin covering a fatty layer that conducts sound in water to the middle and inner ear. This is a distinguishing feature from terrestrial and semi-aquatic turtles. This thick outer layer makes it difficult for turtles to hear well in air, but it facilitates the transfer of sound from the aqueous environment into the ear (Ketten et al. 1999). The middle ear has two components that are encased by bone, the columella and extracolumella, which provides the pathway for sound from the tympanum on the surface of the turtle head to the inner ear. The middle ear is also connected to the throat by the Eustachian tube. The inner ear consists of the cochlea and basilar membrane. Because there is air in the middle ear, it is generally believed that sea turtles detect sound pressure rather than particle motion. Sea turtle ears are described as being similar to a reptilian ear, but due to the historically limited data in sea turtles and reptiles, fish hearing has often been used as an analog when considering potential impacts of underwater sound.

Hearing in sea turtles has been measured through electrophysiological and/or behavioral studies both in air and in water on a limited number of life stages for each of the five species. In general, sea turtles hear best in water between 200 to 750 Hz and do not hear well above 1 kHz. It is worth noting that there are species-specific and life-stage specific differences in sea turtle hearing (**Table 6-5**). Sea turtles are also generally less sensitive to sound than marine mammals, with the most sensitive hearing thresholds underwater measured at or above 75 dB re 1 µPa (Papale et al. 2020; Reese et al. 2023). Loggerhead sea turtles have been studied most thoroughly with respect to other species, including post-hatchlings (Lavender et al. 2012, 2014), juveniles (Bartol et al. 1999; Lavender et al. 2012, 2014), and adults (Martin et al. 2012).

Table 6-5. Hearing capabilities of sea turtles

Species	Life stages tested	Hearing Frequency Range (Hz)	Max sensitivity (Hz)	References
Loggerhead (*Caretta caretta*)	Post-hatchling, juvenile	100–900 (in air)	500–700	Ketten & Bartol 2005
	Post-hatchling, juvenile, adult	50–1,100 (underwater)	100–400	Bartol & Bartol 2011, Lavender et al. 2014, Martin et al. 2012, Lenhardt 2002, Bartol et al. 1999
Green (*Chelonia mydas*)	Juvenile, sub-adult	50–2,000 (in air)	200–700	Ridgway et al. 1969; Ketten & Bartol 2005; Piniak et al. 2016
	Juvenile	50–1,600 (underwater)	200–400	Piniak et al. 2016
Leatherback (*Dermochelys coriacea*)	Hatchling	50–1.600 (in air)	300	Piniak 2012, Dow Piniak et al. 2012
	Hatchling	50–1,200 (underwater)	300	Piniak 2012, Dow Piniak et al. 2012
Kemps ridley (*Lepidochelys kempii*)	Juvenile	100–500 (in air)	100–200	Ketten & Bartol 2005

As with marine mammals, the potential for underwater noise to result in adverse impacts on a sea turtle depends on the received sound level, the frequency content of the sound relative to the hearing ability of the animal. Potential effects range from subtle changes in behavior at low received levels to strong disturbance effects or potential injury and/or mortality at high received levels.

Also known as auditory fatigue, TTS is the milder form of hearing impairment that is non-permanent and reversible, and results from exposure to high intensity sounds for short durations or lower intensity sounds for longer durations. In most cases, it is assumed that TTS would occur before PTS; and ranges to TTS thresholds are expected to be greater than PTS threshold ranges. Both PTS and TTS are species-specific, and lead to an elevation in the hearing threshold, meaning it is more difficult for an animal to hear sounds. TTS can last for minutes, hours, or days; the magnitude of the TTS depends on the level (frequency and intensity), energy distribution, and duration of the noise exposure among other considerations. While there is no direct evidence of PTS occurring in sea turtles, TTS has been demonstrated in other marine species in response to exposure to impulsive and non-impulsive noise sources in laboratory studies (a full review is provided in Southall et al. [2007]). Prolonged or repeated exposure to sound levels sufficient to induce TTS without recovery time can lead to PTS (Southall et al. 2007). TTS is typically applied when assessing regulatory impacts of specific activities (e.g., military operations, explosions). Preliminary analyses from a Woods Hole Oceanographic Institution (WHOI) (2022) freshwater turtle study showed TTS onset occurring lower than the 200 dB re 1 µPa^2 s criteria currently used to predict TTS in sea turtles, which could be a function of species and other conditions. The WHOI (2022) study indicated that TTS up to 40 dB re 1 µPa may be experienced in freshwater turtles; however, hearing returned to initial sensitivities following a recovery period of 20 minutes to several days (WHOI 2022). It is reasonable to assume that the thresholds for TTS onset are lower than those for PTS onset, but higher than behavioral disturbance onset. Until more studies improve the understanding of TTS in sea turtles, ranges to TTS thresholds and TTS exposures should be considered qualitative; and mitigation measures designed to reduce PTS and behavioral exposures should also contribute to reducing the risk of the TTS exposures.

Tables 6-6 and **6-7** outline the acoustic thresholds used in the assessment for the onset of PTS, TTS, and behavioral disruptions for sea turtles. Behavioral criteria for both impulsive and non-impulsive sources were developed by the U.S. Navy in consultation with NMFS and was based on exposure to air guns noise presented in McCauley et al. (2000b; Finneran et al. 2017). Vessel noise produces non-impulsive, continuous sounds, HRG survey equipment includes both impulsive and non-impulsive, intermittent sources, and geotechnical surveys produce non-impulsive, intermittent sources. In addition, the working group that prepared the ANSI Sound Exposure Guidelines (Popper et al. 2014) provide parametric descriptors of sea turtle behavioral responses to impulsive noise (**Table 6-8**); however, these guidelines were based on pile driving which may not be fully comparable to sources in the proposed activities.

The received sound level at which sea turtles are expected to actively avoid impulsive sounds, an SPL of 175 dB re 1 µPa, is also expected to be the received sound level at which sea turtles would actively avoid exposure to both impulsive and non-impulsive sound sources (Finneran et al. 2017). For sea turtles, no distinction is made in the behavioral threshold between impulsive and non-impulsive sources.

Table 6-6. Acoustic impact thresholds[1] for sea turtles – impulsive sources

PTS		TTS		Behavioral[2]
L_{pk} Unweighted	SEL_{24h} Weighted	L_{pk} Unweighted	SEL_{24h} Weighted	SPL Unweighted
232	204	226	189	175

Sources: Finneran et al. (2017)

[1] Dual metric thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds are recommended for consideration

[2] The behavioral disturbance threshold is for all sources – currently, there are not enough data to derive separate thresholds for different source types

L_{pk} = peak sound pressure levels in units of decibels referenced to 1 micropascal; SEL_{24h} = sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; PTS permanent threshold shift; TTS = temporary threshold shift

Table 6-7. Acoustic impact thresholds[1] for sea turtles – non-impulsive sources

PTS	TTS	Behavioral[2]
SEL_{24h} Weighted	SEL_{24h} Weighted	SPL Unweighted
220	200	175

Source: Finneran et al. (2017)

[1] Dual metric thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds are recommended for consideration

[2] Behavioral disturbance threshold applies to all sources – currently, there are not enough data to derive separate thresholds for different source types

SEL_{24h} = sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; PTS = permanent threshold shift; TTS = temporary threshold shift

Table 6-8. Qualitative acoustic impact guidelines for sea turtles

Recoverable Injury	Impairment TTS	Masking	Behavior
Impulsive Sources			
(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low
Continuous Sounds			
(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low

Source: Popper et al. (2014)
Notes: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N-tens of meters), intermediate (I - hundreds of meters), and far (F - thousands of meters). Guidelines are not provided for masking for explosive events since the animals are not exposed to more than a one or few explosive events, and masking would not last beyond the period of exposure. For continuous sounds, data is based on fish, knowing they will respond to sounds and their hearing sensitivity; however, there are no data on exposure or received levels that enable guideline numbers to be provided.
Recoverable injury refers to injuries, including hair cell damage, minor internal or external hematoma, etc. None of these injuries are likely to result in mortality.

6.3.1.3 Underwater Noise and Marine Fish

Many fishes produce sounds for basic biological functions like attracting a mate and defending territory. A recent study revealed that sound production in fishes has evolved at least 33 times throughout evolutionary time, and that most ray-finned fishes are likely capable of producing sounds (Rice et al. 2022). Fish may produce sounds through a variety of mechanisms, such as vibrating muscles near the swim bladder, rubbing parts of their skeleton together, or snapping their pectoral fin tendons (Ladich and Bass 2011; Rice et al. 2022).

There are some species that do not appear produce sounds, but still have acute hearing (e.g., goldfish), which has led scientists to surmise that animals glean a great deal of information about their environment through acoustic cues, a process called “auditory scene analysis” (Fay 2009). All the sounds in a given environment, both natural and human-made, compose the “soundscape,” or acoustic habitat for that species (Pijanowski et al. 2011). Acoustic habitats naturally vary over space and time, and there is increasing evidence that some fish and invertebrate species can distinguish between soundscapes of different habitats (Kaplan et al. 2015; McWilliam and Hawkins 2013; Radford et al. 2008). In fact, some pelagic larvae may use soundscapes as a cue to orient towards suitable settlement habitat (Lillis et al. 2013, 2015; Montgomery 2006; Radford et al. 2007; Simpson et al. 2005; Vermeij et al. 2010) or to induce molting into their juvenile forms (Stanley et al. 2015).

All fishes are capable of sensing the particle motion component of underwater sound. The inner ear of fishes is similar to that of all vertebrates. Each ear has three otolithic end organs, which contain a sensory epithelium lined with hair cells, as well as a dense structure called an otolith (Popper et al. 2022). Particle motion is the displacement, or back and forth motion, of water molecules and as it moves the body of the fish (which has a density similar to seawater), the denser otoliths lag behind, creating a shearing force on the hair cells which sends a signal to the brain via the auditory nerve (Fay and Popper 2000). Available research shows that the primary hearing range of most particle-motion sensitive organisms is below 1 kHz (Popper et al. 2022).

In addition to particle motion detection shared across all fishes, some species are also capable of detecting the pressure component of underwater sound (Fay and Popper 2000). Special adaptations of the swim bladder in these species (e.g., anterior projections, additional gas bubbles, or bony parts) bring it in close proximity to the ear, and as the swim bladder expands and contracts, pressure signals are radiated within the body of the fish making their way to the ear in the form of particle motion (Popper et al. 2022). These species can typically detect a broader range of acoustic frequencies (up to 3-4 kHz; Wiernicki et al. 2020) and are therefore considered to be more sensitive to underwater sound than those that can only detect particle motion. Hearing sensitivity in fishes is generally considered to fall along a spectrum: the least-sensitive (sometimes called “hearing generalists”) are those that do not possess a swim bladder and only detect sound through particle motion, limiting their range to sounds below 1 kHz, while the most sensitive (“hearing specialists”) possess specialized structures enabling pressure detection which expands their detection frequency range (Popper et al. 2022). A few species in the herring family can detect ultrasonic (greater than 20 kHz) sounds (Mann et al. 2001), but this is considered very rare among the bony fishes. Another important distinction for species that do possess swim bladders is whether it is open or closed; species with open swim bladders can release pressure through a connection to the gut, while those with closed swim bladders can only release pressure very slowly, making them more prone to injury when experiencing rapid changes in pressure (Popper et al. 2019). It should also be noted that hearing sensitivity can change with age; in some species like black sea bass, the closer proximity between the ear and the swim bladder in smaller fish can mean that younger individuals are more sensitive to sound than older fish (Stanley et al. 2020). In other species, hearing sensitivity seems to improve with age (Kenyon 1996).

Compared to other fauna such as marine mammals, research has only scratched the surface in understanding the importance of sound to fish species, but there is sufficient data thus far to conclude that underwater sound is vitally important to their basic life functions, such as finding a mate, deterring a predator, or defending territory (Popper and Hawkins 2018; 2019). Therefore, these species must be able to detect components of marine soundscapes, and this detectability could be adversely affected by the addition of noise from anthropogenic activity.

As with marine mammals and sea turtles, fishes may experience a range of impacts from underwater sound depending on physical qualities of the sound source and the environment, as well as the physiological characteristics and the behavioral context of the species of interest. It is important to note that unlike marine mammals, whose hair cells do not regenerate, fishes are able to regrow hair cells that die or become damaged (Corwin 1981), making it extremely likely that they could experience PTS. However, fishes do experience TTS, and when very close to impulsive sound sources or explosions they could experience barotrauma, a term that refers to a class of injuries ranging from recoverable bruises to organ damage, which could ultimately lead to death (Popper et al. 2014; Stephenson et al. 2010). When the air-filled swim bladder inside the body of the fish quickly expands and contracts due to a rapid change in pressure, it can cause internal injuries to the nearby tissues (Halvorsen et al. 2011). The greater the difference between the static pressure at the site of the fish and the positive/negative pressures associated with the sound source, the greater the risk of barotrauma. As with marine mammals, continuous, lower-level sources (e.g., vessel noise) are unlikely to result in auditory injury but could induce changes in behavior or acoustic masking.

The three ESA-listed fish species considered in this BA include the Atlantic sturgeon, Atlantic salmon, and shortnose sturgeon, as described in **Section 5.1.3**. All three species have swim bladders so they are able to detect the sound pressure component of noise but it is not directly connected to their hearing like species of carp or herring and would therefore be less sensitive to underwater sound pressure (Popper et al. 2014).

6.3.1.3.1 Auditory Criteria for Injury and Disturbance to Marine Fish

The currently available underwater noise exposure thresholds for fish are based on the sound pressure component. However, as discussed previously, all fishes can detect water-borne particle motion. Anthropogenic sounds that interfere with the ability to detect both sound pressure and particle motion could interfere with an animal's ability to detect acoustic cues in its environment (Hawkins et al. 2021). While these potential effects are acknowledged, exposure thresholds for the particle motion component of sound have yet to be developed for fishes (Hawkins et al. 2021). As such, the potential effects on these species from the particle motion component of cannot be fully assessed at this time.

Acoustic criteria to assess the potential effects to fish were developed by the (FHWG 2008) and are presented in **Table 6-9**. These criteria include thresholds for impulsive sources (e.g., some HRG survey equipment) and non-impulsive sources (e.g., vessel noise, geotechnical sampling, some HRG survey equipment). Impulsive criteria include dual metrics which are used to assess the effects to fish exposed to high levels of accumulated energy (SEL_{24h}) for repeated impulsive sounds and a single strike at high L_{pk}. The criteria include a maximum accumulated SEL_{24h} for lower-level signals and a maximum L_{pk} for a single HRG equipment pulse (FHWG 2008). NMFS has not established a formal threshold for behavioral disturbance; however, the SPL threshold of 150 dB re 1 µPa threshold is typically used and was applied to all noise sources to assess the behavioral response of fish (Andersson et al. 2007; Wysocki et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011).

The FHWG was formed in 2004 and consists of biologists from NMFS, USFWS, the Federal Highway Administration (FHWA), USACE, and the California, Washington, and Oregon Departments of Transportation (DOTs), supported by national experts on underwater sound producing activities that affect fish and wildlife species of concern. In June 2008, the agencies signed a memorandum of agreement (MOA) documenting criterion for assessing physiological effects of impact pile driving on fish. The criteria were developed for the acoustic levels at which physiological effects to fish could be expected and is now applied to multiple source types, not just pile driving. The FHWG outlines thresholds for fish greater and less than 2 g in weight for the onset of physiological effects (Stadler and Woodbury 2009), and not necessarily levels at which fish are mortally damaged. These criteria, provided in **Table 6-9**, were developed to apply to all fish species.

Table 6-9. Thresholds for onset of physiological effects, mortality, and behavioral disturbance for fish from impulsive sources

Marine Fish Type	Physiological Effects[a]		Behavioral Disturbance[b]
	Lpk (dB re 1 µPa)	SEL24h (dB re 1 µPa2s)	SPL (dB re 1 µPa)
	Impulsive	Impulsive	Impulsive/Non-Impulsive
Fish (≥2 grams)	206	187	150
Fish (<2 grams)	206	183	150

[a] From the Fisheries Hydroacoustic Working Group (FHWG 2008).
[b] From Andersson et al. (2007); Mueller-Blenke et al. (2010); Purser and Radford (2011); and Wysocki et al. (2007).
> = greater than; < less than; dB re 1 µPa = decibels referenced to 1 micropascal; dB re 1 $\mu Pa^2 s$ = decibels referenced to 1 micropascal squared second

6.3.2 Effects from Exposure to Geophysical Reconnaissance Survey Noise

The only proposed equipment for this survey scope that operates under 180 kHz is the Innomar Medium USV parametric SBP (**Table 3-4**). This equipment has an operating frequency of 100 kHz, but it has a very narrow 2° beamwidth, which limits the area ensonified above acoustic thresholds. Vessel noise associated with geophysical reconnaissance surveys is considered in **Section 6.3.5** and not considered further in this section.

As discussed in Section 6.3.1, the operating frequency of 100 kHz expected for the Innomar Medium USV parametric SBP would only overlap with hearing of marine mammal species, specifically MFC (Table 6-3). However, this source has been considered *de minimis* and unlikely to result in adverse effects by Ruppel et al. (2022) and previous MMPA authorization analyses for marine mammals (85 Federal Register [FR] 33730, 87 FR 806, 88 FR 50117, 88 FR 41888, 88 FR 13783, 87 FR 61575). These assessments indicated PTS would not occur in marine mammals due to exposure to these sources, and though there is some potential for behavioral response, the only species considered in this BA that would be able to detect this noise source is sperm whales. Any behavioral responses that do occur for sperm whales would be limited to temporary changes that are not measurable, or so minor that they cannot be meaningfully evaluated and thus **insignificant**. Therefore, effects of exposure to noise during the proposed geophysical reconnaissance surveys **may affect, not likely to adversely affect** ESA-listed marine mammals.

Based on the available data, ESA-listed sea turtles and fish are not expected to be able to detect noise at frequencies >4 kHz (**Section 6.3.1**). Therefore, these species would not be able to detect the noise produced by this equipment and the proposed geophysical reconnaissance surveys would have **no effect** on ESA-listed sea turtles and fish.

6.3.3 Effects from Exposure to Active Acoustic Survey Noise

Under the Proposed Action, active acoustic surveys will be conducted along fixed transects in the Research Lease Area and vicinity to evaluate marine fish, particularly small pelagic species, and invertebrate species and taxon abundance and distribution in the water column and in proximity to the benthos. Surveys will utilize a Simrad EK60 echosounder system with three split-beam transducers (38, 120, and 200 kHz).

Based on the operational frequencies of this equipment, only MFC (i.e., sperm whales) would likely be able to detect noise produced during these surveys (**Section 6.3.1.1**). Though sperm whales may be able to detect some of the noise produced by this equipment, the assessment from Ruppel et al. (2022) classified these types of equipment as *de minimis* due to their operations and small bandwidth (approximately 7°). Manufacturer source levels are not available for the EK60. However, according to Ruppel et al. (2022), the EK60 radiated power is only 150 dB re 10^{-12} W, the second lowest power source of those considered by the authors, and is considered a *de minimus* source. Due to the frequency ranges, how this equipment operates, and the small bandwidth, the total area ensonified above marine mammal acoustic thresholds is expected to be extremely small, reducing the risk of exposure (Ruppel et al. 2022). Based on the available information, PTS would not occur in marine mammals due to exposure to these sources, and though there is some potential for behavioral response, they would be limited to temporary changes that are not measurable, or so minor that they cannot be meaningfully evaluated and thus **insignificant**. Therefore, effects of exposure to noise during the proposed active acoustic surveys **may affect, not likely to adversely affect** ESA-listed marine mammals.

Based on the available data, ESA-listed sea turtles and fish are not expected to be able to detect noise at frequencies >4 kHz (Section 6.3.1). Therefore, these species would not be able to detect the noise produced by this equipment and the proposed active acoustic surveys would have **no effect** on ESA-listed sea turtles and fish.

6.3.4 Effects from Exposure to Seafloor Habitat Characterization Survey Noise

During the proposed seafloor habitat characterization surveys, noise will be produced by the survey vessels and the MBES proposed for these surveys. Vessel noise associated with seafloor habitat characterization surveys is considered in **Section 6.3.5** and not considered further in this section.

The specifics of the proposed MBES equipment are summarized by years in **Table 3-5**. All MBES equipment proposed for these surveys operate >180 kHz. This frequency is above the hearing range for all ESA-listed species considered in this BA (**Section 6.3.1**) so these species would not be able to detect the noise produced by this equipment and the proposed MBES equipment operations would have **no effect** on ESA-listed marine mammals, sea turtles, and fish.

6.3.5 Effects from Exposure to Vessel Noise

Vessel sound is characterized as low-frequency, typically below 1,000 Hz with peak frequencies between 10 and 50 Hz, non-impulsive, continuous sound, meaning there are no substantial pauses in the sounds that vessels produce. The acoustic signature produced by a vessel varies based on the type of vessel (e.g., tanker, bulk carrier, tug, container ship) and vessel characteristics (e.g., engine specifications, propeller dimensions and number, length, draft, hull shape, gross tonnage, speed). Larger barges and commissioning vessels would produce lower frequency noise with a primary energy near 40 Hz and underwater source levels that can range from 177 to 200 dB re 1 μPa m (McKenna et al. 2012; Erbe et al. 2019). Smaller crew transfer vessels would typically produce higher-frequency noise (1,000 to 5,000 Hz) at source levels between 150 and 180 dB re 1 μPa m (Kipple and Gabriele 2003, 2004). Vessels using DP thrusters for station-keeping are known to generate substantial underwater noise with source levels ranging from 150 to 180 dB re 1 μPa m depending on operations and thruster use (BOEM 2013; McPherson et al. 2016). However, regardless of the propulsion system or type of thruster used, the risk of effects on ESA-listed species would not differ significantly, and the determinations in the following subsections are based on the loudest potential noise levels based on the most common types of vessels expected under the Proposed Action.

Parsons et al. (2021) reviewed literature for the source levels and spectral content of vessels less than 82 ft (25 m) in length, a category often not addressed in vessel noise assessment measurements. Parsons et al. (2021) found reported source levels in these smaller vessels to be highly variable (up to 20 dB difference); however, an increase in speed was consistently shown to increase source levels while vessels at slower speeds were shown to emit low-frequency acoustic energy (less than 100 Hz) that is often not characterized in broadband analyses of small vessel sources. The vessels and estimated number of transits that would be used and occur under the Proposed Action are presented in **Sections 3.1.1.2** and **3.1.2.15** of this BA.

6.3.5.1 Marine Mammals

Due to the non-impulsive nature of the sources and relatively low source levels produced (BOEM 2013; McPherson et al. 2016), PTS is unlikely to occur for any ESA-listed marine mammals as a result of vessel noise and the risk of this effect on marine mammals is **discountable**. The most likely effects marine mammals may experience due to Project-related vessel noise are behavioral disturbances.

A comprehensive review of the literature (Richardson et al. 1995; Erbe et al. 2019) revealed that most of the reported adverse effects of vessel noise and presence are changes in behavior, though the specific behavioral changes vary widely across species. Physical behavioral responses include changes to dive patterns (e.g., longer dives in beluga whales [Finley et al. 1990]), disruption to resting behavior (harbor seals [Mikkelsen et al. 2019]), increases in swim velocities (belugas [Finley et al. 1990]; humpback whales [Sprogis et al. 2020]; narwhals [*Monodon monoceros*; Williams et al. 2022]), and changes in respiration patterns (longer inter-breath intervals in bottlenose dolphins [Nowacek et al. 2006]; increased breathing synchrony in bottlenose dolphin pods [Hastie et al 2003]; increased respiration rates in humpback whales [Sprogis et al. 2020]). A playback study of humpback whale mother-calf pairs exposed to varying levels of vessel noise revealed that the mother's respiration rates doubled and swim speeds increased by 37 percent in the high noise conditions (low-frequency weighted received SPL at 100 m was 133 dB re 1 μPa) compared to control and low-noise conditions (SPL of 104 dB re 1 μPa and 112 dB re 1μPa respectively [Sprogis et al. 2020]). Changes to foraging behavior, which can have a direct effect on an animal's fitness, have been observed in porpoises (Wisniewska et al. 2018) and killer whales (Holt et al. 2021) in response to vessel noise. Thus far, one study has demonstrated a potential correlation between low-frequency anthropogenic noise and physiological stress in baleen whales. Rolland et al. (2012) showed that fecal cortisol levels in NARWs decreased following the 9/11 terrorist attacks, when vessel activity was significantly reduced. Interestingly, NARWs do not seem to avoid vessel noise nor vessel presence (Nowacek et al. 2004), yet they may incur physiological effects as demonstrated by Rolland et al. (2012). This lack of observable response, despite a physiological response, makes it challenging to assess the biological consequences of exposure. In addition, there is evidence that individuals of the same species may have differing responses if the animal has been previously exposed to the sound versus if it is completely novel interaction (Finley et al. 1990). Reactions may also be correlated with other contextual features, such as the number of vessels present, their proximity, speed, direction or pattern of transit, or vessel type. For a more detailed and comprehensive review of the effects of vessel noise on specific marine mammal groups the reader is referred to Erbe et al. (2019).

Some marine mammals may change their acoustic behaviors in response to vessel noise, either due to a sense of alarm or in an attempt to avoid masking. For example, fin whales (Castellote et al. 2012) and belugas (Lesage et al. 1999) have altered frequency characteristics of their calls in the presence of vessel noise. When vessels are present, bottlenose dolphins have increased the number of whistles (Buckstaff 2006; Guerra et al. 2014), while sperm whales decrease the number of clicks (Azzara et al. 2013), and humpbacks and belugas have been seen to completely stop vocal activity (Tsujii et al. 2018; Finley et al. 1990). Some species may change the duration of vocalizations (fin whales shortened their calls [Castellote et al. 2012]) or increase call amplitude (killer whales [Holt et al. 2009]) to avoid acoustic masking from vessel noise.

Understanding the scope of acoustic masking is difficult to observe directly, but several studies have modeled the potential decrease in "communication space" when vessels are present (Clark et al. 2009, Erbe et al. 2016; Putland et al. 2017). For example, Putland et al. (2017) showed that during the closest point of approach (less than 10 km) of a large commercial vessel, the potential communication space of Bryde's whale (*Balaenoptera edeni*) was reduced by 99 percent compared to ambient conditions.

Although there have been many documented behavioral changes in response to vessel noise (Erbe et al. 2019), it is necessary to consider what the biological consequences of those changes may be. One of the first attempts to understand the energetic cost of a change in vocal behavior found that metabolic rates in bottlenose dolphins increased by 20 to 50 percent in comparison to resting metabolic rates (Holt et al. 2015). Although this study was not tied directly to exposure to vessel noise, it provides insight about the potential energetic cost of this type of behavioral change documented in other works (i.e., increases in vocal effort such as louder, longer, or increased number of calls). In another study, the energetic cost of high-speed escape responses in dolphins was modeled, and the researchers found that the cost per swimming stroke was doubled during such a flight response (Williams et al. 2017). When this sort of behavioral response was also coupled with reduced glide time for beaked whales, the researchers estimated that metabolic rates would increase by 30.5 percent (Williams et al. 2017). Differences in response have been reported both within and among species groups (Finley et al. 1990; Tsujii et al. 2018). Despite demonstrable examples of biological consequences to individuals, there is still a lack of understanding about the strength of the relationship between many of these acute responses and the potential for long-term or population-level effects.

Overall, ESA-listed marine mammals may be exposed to noise above the behavioral thresholds and may experience masking effects depending on the type and speed of the vessel. However, the likelihood of prolonged exposures that would affect biologically important behaviors such as foraging or reproduction is low with the proposed mitigation and monitoring measures (**Section 3.3**) and the limited number of vessels and transits expected (**Table 3-3** and **Table 3-6**). The contribution of noise from project vessels under the Proposed Action would increase ambient noise conditions, but that increase would be temporary given the limited number of vessel transits anticipated. The Proposed Action includes mitigation for vessel strike avoidance (**Section 3.3**) such as minimum separation distances, which would reduce the risk of an animal being close enough to receive sound energy above the behavioral threshold, and vessel speed restrictions. This, in turn would help reduce the level of noise exposure from Project vessels because vessels would remain farther from ESA-listed marine mammals and would slow (thus reducing noise output) in the presence of ESA-listed marine mammals (ZoBell et al. 2021). With mitigation measures, behavioral disturbance would be so small that they could not be measured, detected, or evaluated and is therefore, **insignificant**; and vessel noise as a result of the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals.

6.3.5.2 Sea Turtles

Sea turtles are less sensitive to sound compared to faunal groups like marine mammals and no PTS from vessel noise is anticipated under the Proposed Action. It is unlikely that received levels of underwater noise from vessel activities would exceed PTS thresholds for sea turtles, as the PTS threshold for non-impulsive sources is an SEL_{24h} of 200 dB re 1 μPa^2 s (NMFS 2023j) which comparable to the maximum source level reported for large shipping vessels described previously in this section. This means beyond 1 m, the sound level produced by the loudest Project vessel would likely be below the sea turtle PTS threshold and the potential for ESA-listed sea turtles to be exposed to Project vessel noise above PTS thresholds is considered extremely unlikely to occur and is **discountable**. The most likely effects of vessel noise on sea turtles would include behavioral disturbances.

There is very little information regarding the behavioral responses of sea turtles to underwater noise. A recent study suggests that sea turtles may exhibit TTS effects even before they show any behavioral response (WHOI 2022). Hazel et al. (2007) demonstrated that sea turtles appear to respond behaviorally to vessels at approximately 33 ft (10 m) or closer. Based on the source levels outlined previously, the behavioral threshold for sea turtles is likely to be exceeded by Project vessels. Behavioral disturbance for sea turtles is likely to be highly contextual and site specific; therefore, generalized effects categories may be more applicable for this group. Popper et al. (2014) suggests that in response to continuous shipping sounds, sea turtles have a high risk for behavioral disturbance in the closer to the source (e.g., tens of meters), moderate risk at hundreds of meters from the source, and low risk at thousands of meters from the source.

Behavioral effects are considered possible but unlikely and any effects would be temporary with effects dissipating once the vessel or individual has left the area. The Proposed Action includes the implementation of minimum vessel separation distance of 164 ft (50 m) for sea turtles which, though geared towards vessel strike avoidance, would help to reduce the level of noise a turtle is exposed to and reducing the likelihood of sea turtles receiving sound energy above the behavioral threshold. The additional BOEM proposed measures to reduce vessel strikes on sea turtles which includes slowing to 4 kn when sea turtle sighted within 328 ft (100 m) of the forward path of the vessel and avoiding transiting through areas of visible jellyfish aggregations or floating sargassum will also reduce the potential for behavioral disturbance effects by reducing the sound level received by sea turtles in the Action Area during vessel activities. Though these mitigation measures will not eliminate the potential for sea turtles to be exposed to above-threshold noise, the potential effects if exposure were to occur would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects on this brief exposure would be so small that they could not be measured, detected, or evaluated and are, therefore, **insignificant**. Therefore, the effects of noise exposures above behavioral disturbance thresholds during Project vessel operations **may affect, not likely to adversely affect** ESA-listed sea turtles.

6.3.5.3 Marine Fish

Research indicates that the effects of vessel noise, including DP vessel noise, will not cause mortality or injuries in adult fish (Hawkins et al. 2014) given the low source levels and non-impulsive nature of this source. The potential for exposures above physiological injury thresholds to occur is extremely unlikely and are **discountable**. The most likely effects marine fish may experience due to Project-related vessel noise are behavioral disturbances.

Several studies have shown an increase in cortisol, a stress hormone, after playbacks of vessel noise (Wysocki et al. 2006; Nichols et al. 2015; Celi et al. 2016), but other work has shown that the stress of being handled during the experiment itself may induce a greater stress response than an acoustic stimulus (Harding et al. 2020; Staaterman et al. 2020). The overlap in the frequency of vessel noise and fish auditory capabilities could lead to masking of important auditory cues, including conspecific communication (Haver et al. 2021; Parsons et al. 2021). Stanley et al. (2017) demonstrated that the communication range of both haddock and cod (species with swim bladders not involved in hearing) would be significantly reduced in the presence of vessel noise, which is frequent in their habitat in Cape Cod Bay. Generally speaking, species that are sensitive to acoustic pressure would experience masking at greater distances than those that are only sensitive to particle motion (See Affected Environment section for an explanation of fish hearing). Rogers et al. (2021) and Stanley et al. (2017) theorize that fish may be able to use the directional nature of particle motion to extract meaning from short range cues (e.g., other fish vocalizations) even in the presence of distant noise from vessels.

Avoidance of vessels and vessel noise has been observed in several pelagic, schooling fishes, including Atlantic herring (Vabø et al. 2002), Atlantic cod (Handegard et al. 2003) and others (reviewed in De Robertis and Handegard [2013]). Fish may dive toward the seafloor, move horizontally out of the vessel's path, or disperse from their school (De Robertis and Handegard 2013). These types of changes in schooling behavior could render individual fish more vulnerable to predation but these behavioral responses are unlikely to have population-level effects. A more recent body of work has documented other, more subtle behaviors in response to vessel noise, but has focused solely on tropical reef-dwelling fish which are not likely to occur in the Action Area. For example, damselfish antipredator responses (Simpson et al. 2016; Ferrari et al. 2018) and boldness (Holmes et al. 2017) seem to decrease in the presence of vessel noise, while nest-guarding behaviors seem to increase (Nedelec et al. 2017). There is some evidence of habituation, though: Nedelec et al. (2016) found that domino damselfish increased hiding and ventilation rates (i.e., rate of oxygen absorption) after two days of vessel sound playbacks, but responses diminished after one to two weeks, indicating habituation over longer durations.

The planktonic larvae of fishes and invertebrates may experience acoustic masking from continuous sound sources like vessels. Several studies have shown that larvae are sensitive to acoustic cues, and may use sound signals to navigate towards suitable settlement habitat (Simpson et al. 2005; Montgomery 2006), metamorphosize into their juvenile forms (Stanley et al. 2012), or maintain group cohesion during their pelagic journey (Staaterman et al. 2014). However, given the short range of such biologically-relevant signals for particle motion-sensitive animals (Kaplan and Mooney 2016), the spatial scale at which these cues are relevant is rather small. If vessel transit areas overlap with settlement habitat, it is possible that vessel noise could mask some biologically relevant sounds (Holles et al. 2013), but these effects are expected to be short term and would occur over a limited area around the operating vessel.

Overall, evidence suggests fish will return to normal baseline behavior faster following exposure to continuous sources such as vessel noise versus intermittent noise (Neo et al. 2014). Therefore, while vessel noise would be present within the Action Area throughout the life of the Proposed Action, behavioral disturbances would only be expected within and few meters of the vessel and would dissipate once the vessel has moved away. In addition, Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon have swim bladders, which are not involved in hearing (Popper et al. 2014); these species are thought to be more sensitive to particle motion that sound pressure (Popper and Hawkins 2018; Mickle and Higgs 2022). Given the nature of non-impulsive sources such as vessels noise, particle motion levels sufficient to result in behavioral disturbances would not occur more than a few meters from the source, and any effects to this brief exposure would be so small that they could not be measured, detected, or meaningfully evaluated and are, therefore, **insignificant**. Therefore, the effects from exposure to noise levels above behavioral thresholds resulting from vessel operations **may affect, not likely to adversely affect** ESA-listed fish.

6.3.6 Effects from Exposure to Geotechnical Survey Noise

Geotechnical surveys that employ coring equipment may produce non-impulsive, intermittent, low frequency noise (less than 3 kHz) with a back-calculated source level, expressed as SPL, estimated to be 187 dB re 1 µPa m (Chorney et al. 2011). Geotechnical survey activities would occur over approximately 420 days between March and October 2024. Vessel noise associated with geotechnical surveys is considered in **Section 6.3.5** and not considered further in this section.

6.3.6.1 Marine Mammals

PTS is unlikely to occur for any ESA-listed marine mammals as a result of geotechnical survey noise due to the non-impulsive nature of the sources and relatively low source levels produced (BOEM 2013; McPherson et al. 2016) and is **discountable**.

Noise produced during the proposed geotechnical surveys would be within the hearing range of ESA-listed marine mammals Though the estimated source levels do exceed the behavioral disturbance threshold of 160 dB re 1 µPa, they would only be exceeded within approximately 65 ft (20 m) of the source using spherical spreading loss equations. Therefore, while geotechnical survey noise may be detectable it is unlikely to result in measurable behavioral effects for any marine mammals species and potential impacts are therefore **discountable**. Therefore, the effects of noise exposure above the behavioral disturbance threshold during the proposed geotechnical surveys **may affect, not likely to adversely affect** ESA-listed marine mammals.

6.3.6.2 Sea Turtles

Sea turtles are less sensitive to sound compared to faunal groups like marine mammals and no PTS from geotechnical survey noise is anticipated under the Proposed Action. It is unlikely that received levels of underwater noise from geotechnical survey activities would exceed PTS thresholds for sea turtles, as the PTS threshold for non-impulsive sources is an SEL_{24h} of 200 dB re 1 μPa^2 s (NMFS 2023j) which comparable to the maximum source level estimated for geotechnical coring equipment described previously in this section. This means beyond 3 ft (1 m), the sound level produced by geotechnical survey activities would likely be below the sea turtle PTS threshold and the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely to occur and is **discountable**.

Geotechnical surveys using coring equipment would also be detectable by sea turtles, but based on the back-calculated source level, expressed as SPL, of 187 dB re 1 µPa m (Chorney et al. 2011), the behavioral disturbance threshold for sea turtles would only be exceeded within approximately 16 ft (5 m) of the source using spherical spreading loss equations. Therefore, while geotechnical survey noise may be detectable it is unlikely to result in measurable behavioral effects for any sea turtle species and potential impacts are therefore **discountable.** Therefore, the effects of noise exposure above the behavioral disturbance threshold during the proposed geotechnical survey activities **may affect, not likely to adversely affect** ESA-listed sea turtles.

6.3.6.3 Marine Fish

Research indicates that the effects of non-impulsive sound sources, like geotechnical surveys, will not cause mortality or injuries in adult fish (Hawkins et al. 2014) given the low source levels and non-impulsive nature of this source. The potential for exposures above physiological injury thresholds to occur is extremely unlikely and are **discountable**.

The estimated source level of geotechnical survey equipment is above the behavioral disturbance threshold of 150 dB re 1 µPa for fish recommended by the Fisheries Hydroacoustic Working Group (2008) and NMFS (2023l), so it could lead to behavioral changes, increased stress, or masking. However, geotechnical surveys would only occur between March and October 2024 and the relatively short duration of these surveys would lower the risk of effects on behaviors relevant for foraging or spawning. Overall, due to the transient and localized nature of this source, the likelihood of geotechnical survey noise on ESA-listed is expected to be **discountable**. Therefore, the effects of exposure to noise above physiological injury thresholds as a result of geotechnical survey activity **may affect, not likely to adversely affect** ESA-listed fish species.

6.3.7 Effects from Exposure to HRG Survey Noise

HRG surveys using some types of impulsive and/or non-impulsive, intermittent SBPs (e.g., parametric SBP, sparker systems) may produce noise levels within hearing frequencies and above regulatory hearing thresholds for some marine mammals, sea turtles, and fish. A summary of the equipment proposed for the HRG surveys is provided in Table 3-4. Vessel noise associated with HRG surveys is considered in **Section 6.3.5** and not considered further in this section.

In the 2021 Biological Assessment for Data Collection and Site Survey Activities for Renewable Energy on the Atlantic OCS published by BOEM (Baker and Howsen 2021), estimated distances to auditory injury thresholds were less than 15 m for all equipment and species assessed, and the distance to the behavioral thresholds were a maximum of 500 m for marine mammals during use of sparker systems operating at their maximum power settings for all species. Recently, BOEM and USGS characterized underwater sounds produced by HRG sources and their potential to affect marine mammals (Ruppel et al. 2022). Some geophysical sources can be detected by marine mammals, and subsequently by sea turtles and fish; however, Ruppel et al (2022) also found that only a small number of HRG source categories have the potential to produce sound fields that meet or exceed acoustic thresholds.

6.3.7.1 Marine Mammals

No PTS is expected to occur for any marine mammal species given the small distances to the PTS thresholds, the sound source characteristics of the proposed equipment, the implementation of mitigation measures (**Section 3.3**), and that no Level A (i.e., PTS) takes have been requested by PTOW in their IHA application (Stantec Consulting Services, Inc. 2023). Both the clearance and shutdown ranges would extend out to 500 m for NARW and 100 m for all other ESA-listed marine mammals, which would fully cover the area over which PTS thresholds may be exceeded (**Section 3.3.8**). Therefore, the potential for PTS exposures during HRG surveys is **discountable**.

HRG surveys would occur for less than a 1-year period between March and October 2024, with sources operational for up to 125 days (Stantec Consulting Services, Inc. 2023). The IHA application estimated that up to 18 fin whales, 1 NARW, 3 sei whales, and 0 sperm whales may be exposed to noise above the behavioral disturbance threshold during the proposed HRG surveys (Stantec Consulting Services, Inc. 2023). Although some geophysical sources, including the proposed sparker source (**Table 3-4**), can be detected by marine mammals, given several key physical characteristics of the sound sources, including source level, frequency range, duty cycle, and beamwidth, most HRG sources are unlikely to result in behavioral disturbance of marine mammals, even without mitigation (Ruppel et al. 2022). This finding is supported empirically: Kates Varghese et al. (2020) found no change in three of four beaked whale foraging behavior metrics (i.e., number of foraging clicks, foraging event duration, click rate) during two deep-water mapping surveys using a 12 kHz multibeam echosounder. There was an increase in the number of foraging events during one of the mapping surveys, but this trend continued after the survey ended, suggesting that the change was more likely in response to another factor, such as the prey field of the beaked whales, than to the mapping survey. During both multibeam mapping surveys, foraging continued in the survey area and the animals did not leave the area (Kates Varghese et al. 2020, 2021). Vires (2011) found no change in Blainville's beaked whale click durations before, during, and after a scientific survey with a 38 kilohertz EK-60 echosounder, while Cholewiak et al. (2017) found a decrease in beaked whale echolocation click detections during use of an EK-60 echosounder and Quick et al. (2017) found that short-finned pilot whales did not change foraging behavior but did increase their heading variance during use of an EK-60 echosounder.

The areas where HRG surveys will occur overlap with Unit 1 of the designated critical habitat for foraging NARWs (**Section 5.2.1**) and would only comprise a small area of the entire designated habitat. There is no designated critical habitat for fin whales, and neither the Southern nor Northern Gulf of Maine biologically important foraging area (NOAA 2023) would overlap with the area in which HRG surveys are likely to occur; although HRG surveys could overlap with foraging fin whales (**Section 5.1.1.1.2**), this would only occur in a small portion of available habitat and no long-term disruptions to foraging are expected. Similarly, sei whales may be present in the area year-round (**Section 5.1.1.3.2**) and HRG surveys could overlap with foraging animals; however, the HRG source area comprises only a small portion of available habitat so no long-term disruptions to foraging are expected. The area over which HRG surveys would occur would not extend to the outer shelf break where sperm whales are more commonly observed, as evidenced by the low abundance estimates discussed in **Section 5.1.1.4**.

Only a small proportion of HRG sources (e.g., sparkers) have the potential to produce sound levels that exceed behavioral thresholds beyond a few meters from the source (Ruppel et al. 2022). For these sources ESA-listed marine mammals have the potential to be exposed to sound levels that meet or exceed behavioral disturbance thresholds. For the proposed HRG surveys, a 656-foot (200-meter) clearance and shutdown zone for NARW and a 328-foot (100-meter) shutdown zone for all other marine mammals is included under the Proposed Action (**Section 3.3.**) which would limit the potential for behavioral effects. Given the small distance to the thresholds (Ruppel et al. 2022) and the mitigation measures included in the Proposed Action, above-threshold noise would not be expected impede the use of critical habitat by NARWs or access to foraging habitat for other ESA-listed marine mammals. There may be some masking effects from the HRG sources; however, most masking would be the result of vessel operations and not HRG equipment.

Given the small distances to the behavioral disturbance thresholds, the limited duration of these surveys, and the mitigation included in the Proposed action, exposures, if they were to occur, would be **insignificant**. Behavioral changes, if they were to occur, would be temporary and not measurable.

Therefore, effects of exposures above behavioral thresholds from Project HRG surveys **may affect, not likely to adversely affect** ESA-listed marine mammals.

6.3.7.2 Sea Turtles

No PTS is expected to occur for any sea turtle species given the small distances to the PTS thresholds and the sound source characteristics of these equipment (Ruppel et al. 2022). Therefore, the potential for PTS exposures during HRG surveys is **discountable**.

The behavioral disturbance threshold for sea turtles is higher than that for marine mammals since the threshold is higher, meaning the range to the behavioral threshold is smaller. Only a small proportion of HRG sources (e.g., sparkers) have the potential to produce sound levels that exceed behavioral thresholds beyond a few meters from the source (Ruppel et al. 2022). For these sources ESA-listed sea turtles have the potential to be exposed to sound levels that meet or exceed behavioral disturbance thresholds; however, any effects of exposure to noise above thresholds are transient and would dissipate as the vessel moves away from the turtle. Given the low abundance of sea turtles expected in the Gulf of Maine (**Section 5.1.2**), the limited duration of these surveys (approximately 125 days of source operations), and the temporary, transient nature of the HRG surveys (**Section 3.1.2.2**), the potential for behavioral disturbance to ESA-listed turtles is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposures above behavioral thresholds during HRG surveys **may affect, not likely to adversely affect** ESA-listed sea turtles.

6.3.7.3 Marine Fish

Of the sources that may be used during HRG surveys under the Proposed Action, only sparkers emit sounds at frequencies that are within the hearing range of most fish (Crocker and Fratantonio 2016; Ruppel et al. 2022). For the HRG sources that are audible for fishes, it is important to consider other factors such as source level, beamwidth, and duty cycle when assessing the potential risk of adverse effects (Ruppel et al. 2022). Additionally, Atlantic sturgeon, Atlantic salmon, and shortnose sturgeon are not expected to be in the Action Area in large numbers, and HRG surveys would not overlap with any spawning habitat. Given the small ranges to thresholds, low abundance, and transient nature of the survey, the potential for physiological injury in ESA-listed fish resulting from HRG surveys are **discountable**.

Behavioral impacts could occur over slightly larger spatial scales given the SPL threshold of 150 dB re 1 μPa recommended for behavioral disturbance in marine fish (FHWG 2008). However, this threshold does not account for the duration of the exposure, and it is worth noting that these numbers are reported in terms of acoustic pressure because there are currently no behavioral disturbance thresholds for particle motion. Additionally, given the limited duration of these surveys (approximately 125 days of source operations) and because HRG equipment are considered intermittent sources, where they are typically “on” for short periods with silence in between, the amount of noise emitted from a moving vessel towing an active acoustic source that would reach fish or invertebrates below is limited, behavioral effects would be intermittent and temporary. Should an exposure occur, the potential effects would be brief, and no long-term avoidance of the Action Area or effects on reproduction are expected. Effects of this brief exposure could result temporary disruptions to foraging behavior; however, any impacts associated with this avoidance would be so small that they could not be measured, detected, or evaluated and are, therefore, **insignificant**. Therefore, the effects exposure to noise above behavioral thresholds during HRG surveys **may affect, not likely to adversely affect** ESA-listed fish.

6.3.8 Effects to Prey from Underwater Noise

Prey species important to ESA-listed marine mammals, sea turtles, and fish include plankton, squid, small schooling fish, bottom-dwelling fish such as sand lance, crustaceans, and sea grasses. Further details of the primary prey for each species considered in this BA is provided in **Section 5.1**.

Reduction of prey availability could affect marine animals if rising sound levels alter prey abundance, behavior, distribution, or both (McCauley et al. 2000a, 2000b; Popper and Hastings 2009; Slabbekoorn et al. 2010). Prey species may show responses to noise; however, there are limited data on hearing mechanisms and potential effects of noise on common prey species (i.e., crustaceans, cephalopods, fish) that would result loss of availability to marine mammals. These species have been increasingly researched as concern has grown related to noise effects on the food web. Invertebrates appear to be able to detect sounds and particle motion (André et al. 2016; Budelmann 1992; Solé et al. 2016, 2017) and are most sensitive to low-frequency sounds (Packard et al. 1990; Budelmann and Williamson 1994; Lovell et al. 2005a, 2005b; Mooney et al. 2010).

Squid and other cephalopods are an extremely important food chain component for many higher order marine predators, including fin and sperm whales. Cephalopods (i.e., octopus, squid) and decapods (i.e., lobsters, shrimps, crabs) are capable of sensing low-frequency sound. Packard et al. (1990) showed that three species of cephalopod were sensitive to particle motion, not sound pressure, with the lowest particle acceleration thresholds reported as 0.002 to 0.003 m/s^2 at 1 to 2 Hz. Solé et al. (2017) showed that SPL ranging from 139 to 142 dB re 1 µPa at one-third octave bands centered at 315 Hz and 400 Hz may be suitable threshold values for trauma onset in cephalopods. Cephalopods have exhibited behavioral responses to low frequency sounds under 1,000 Hz, including inking, locomotor responses, body pattern changes, and changes in respiratory rates (Kaifu et al. 2008; Hu et al. 2009). In squid, Mooney et al. (2010) measured acceleration thresholds of -26 dB re 1 m/s^2 between 100 and 300 Hz and an SPL threshold of 110 dB re 1 µPa at 200 Hz. Lovell et al. (2005a) found a similar sensitivity for common prawn (*Palaemon serratus*), SPL of 106 dB re 1 µPa at 100 Hz, noting that this was the lowest frequency at which they tested and that the prawns might be more sensitive at frequencies below this. Hearing thresholds at higher frequencies have been reported, such as 134 and 139 dB re 1 µPa at 1,000 Hz for the oval squid (*Sepioteuthis lessoniana*) and the common octopus (*Octopus vulgaris*), respectively (Hu et al. 2009). McCauley et al. (2000a) reported that of caged squid exposed to seismic airguns showed behavioral responses such as inking. Wilson et al. (2007) exposed two groups of longfin inshore squid (*Loligo pealeii*) in a tank to killer whale echolocation clicks at SPL from 199 to 226 dB re 1 µPa, which resulted in no apparent behavioral effects or any auditory debilitation. However, both the McCauley et al. (2000a) and Wilson et al. (2007) experiments used caged squid, so it is unclear how unconfined animals would react. André et al. (2011) exposed four cephalopod species (European squid [*Loligo vulgaris*], cuttlefish [*Sepia officinalis*], octopus, and southern shortfin squid [*Ilex coindetii*]) to 2 hours of continuous noise from 50 to 400 Hz at received SPL of 157 dB re 1 µPa ± 5 dB, and reported lesions occurring on the statocyst's sensory hair cells of the exposed animals that increased in severity with time, suggesting that cephalopods are particularly sensitive to low-frequency sound. Similar to André et al. (2011), Solé et al. (2013) conducted a low-frequency (50 to 400 Hz) controlled exposure experiment on two deep-diving squid species (southern shortfin squid and European squid), which resulted in lesions on the statocyst epithelia. Sóle et al. (2013) described their findings as "morphological and ultrastructural evidence of a massive acoustic trauma induced by low-frequency sound exposure." In experiments conducted by Samson et al. (2014), cuttlefish exhibited escape responses (i.e., inking, jetting) when exposed to sound frequencies between 80 and 300 Hz with SPL above 140 dB re 1 µPa and particle acceleration of 0.01 m/s^2; the cuttlefish habituated to repeated 200 Hz sounds. The intensity of the cuttlefish response with the amplitude and frequency of the sound stimulus suggest that cuttlefish possess loudness perception with a maximum sensitivity of approximately 150 Hz (Samson et al. 2014).

Several species of aquatic decapod crustaceans are also known to produce sounds. Popper et al. (2001) concluded that many are able to detect substratum vibrations at sensitivities sufficient to tell the proximity of mates, competitors, or predators. Popper et al. (2001) reviewed behavioral, physiological, anatomical, and ecological aspects of sound and vibration detection by decapod crustaceans and noted that many decapods also have an array of hair-like receptors within and upon the body surface that potentially respond to water- or substrate-borne displacements, as well as proprioceptive organs that could serve secondarily to perceive vibrations. However, the acoustic sensory system of decapod crustaceans remains poorly studied (Popper et al. 2001). Lovell et al. (2005a, 2005b, 2006) reported potential auditory-evoked responses from prawns showing auditory sensitivity of sounds from 100 to 3,000 Hz, and Filiciotto et al. (2016) reported behavioral responses to vessel noise within this frequency range.

Solé et al. (2021) showed that seagrasses may be sensitive to anthropogenic noise. In their study, they exposed Neptune grass (*Posidoniaceae oceanica)* to noise sweeping through 50 to 400 Hz frequencies at received SPL of 157 dB re 1 µPa within a few meters (16 ft [less than 5 m]) from the source to the grasses. Neptune grass is a slow-growing seagrass, endemic to the Mediterranean Sea; though is not the same species as the common eelgrass (*Zostera marina*) which is typically found in the Northeastern U.S. Atlantic, they both come from same order (Alismatales) and have similar physiological traits (Biodiversity of the Central Coast 2022). Results show deformed structure of starch grains in the plants studies after 48 hours of noise exposure, and damage to starch grains present after 96 to 120 hours of exposures (Solé et al. 2021). Damage to the starch grains in seagrasses could affect successful growth, and though the sound source used in the study is not the same as many of the noise-producing activities included under the Proposed Action, this shows seagrasses may be affected by low-frequency noise.

Fish are typically sensitive to the 100 to 500 Hz range, which is below most HRG survey sources, but does overlap with many of the Project activities described previously. Several studies have demonstrated that seismic airguns and impulsive sources might affect the behavior of at least some species of fish. For example, field studies by Engås et al. (1996) and Løkkeborg et al. (2012) showed that the catch rate of haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*) significantly declined over the 5 days immediately following seismic surveys, after which the catch rate returned to normal. Other studies found only minor responses by fish to noise created during or following seismic surveys, such as a small decline in lesser sand eel (*Ammodytes marinus*) abundance that quickly returned to pre-seismic levels (Hassel et al. 2004) or no permanent changes in the behavior of marine reef fishes (Wardle et al. 2001). However, both Hassel et al. (2004) and Wardle et al. (2001) noted that when fish sensed the airgun firing, they performed a startle response and sometimes fled. Squid (*Sepioteuthis australis*) are an extremely important food chain component for many higher order marine predators, including fin and sperm whales. McCauley et al. (2000a) recorded caged squid responding to airgun signals. Given the generally low sound levels produced by HRG sources in comparison to airgun sources, no short-term effects on potential prey items (fishes, cephalopods, crustaceans) are expected from the proposed survey activities.

Minimal data are available for zooplankton (the primary prey for NARW) responses to anthropogenic sound. A 2022 study (Guihen et al. 2022) found a noted avoidance of Antarctic krill species to the presence of an autonomous glider carrying a single beam echosounder. However, these disturbances had small ranges (approximately 131 ft [40 m]) and did not show a large-scale movement in krill. It is expected that although reactionary behavior to acoustic disturbance by zooplankton is likely, the localized and temporary nature of the movement would not cause significant loss in the availability of the species to marine mammals.

6.4 Vessel Strike Risk

Vessel strikes are a known source of injury and mortality for marine mammals, sea turtles, and sturgeon. Increased vessel activity in the Action Area associated with the survey activities of the Proposed Action would pose a theoretical risk of increased collision-related injury and mortality for ESA-listed species. In general, large vessels traveling at high speeds pose the greatest risk of mortality to ESA-listed marine mammals, whereas sea turtles and sturgeon are vulnerable to a range of vessel types and speeds depending on the environment.

Vessel strike is relatively common with cetaceans (Kraus et al. 2005) and one of the primary causes of anthropogenic mortality in large whale species (NMFS 2024a; Hayes et al. 2020; Hill et al. 2017). NARWs are particularly vulnerable to vessel strikes based on the distribution of preferred coastal region habitats and their feeding, diving, and socializing behaviors (Baumgartner et al. 2017). Risk of collision injury is commensurate with vessel speed; the probability of a vessel strike increases significantly as speeds increase above 10 kn (Conn and Silber 2013; Kite-Powell et al. 2007; Laist et al. 2001; Vanderlaan and Taggart 2007). Vessels operating at speeds exceeding 10 kn under poor visibility conditions have been associated with the highest risk for vessel strikes of NARWs (Vanderlaan and Taggart 2007), though collisions at lower speeds are still capable of causing serious injury, even when smaller vessels (less than 20 m length) are involved (Kelley et al. 2020).

Vessel strikes are also implicated in sea turtle mortality, with collision risk similarly commensurate with vessel speed although at much lower speeds (Hazel et al. 2007; Shimada et al. 2017). Hazel et al. (2007) found that green sea turtles were unlikely to actively avoid vessels traveling faster than 2.1 kn (4 km/hour), indicating that 10-knot speed restrictions may not be protective for this and potentially other sea turtle species.

Atlantic and shortnose sturgeon are vulnerable to vessel collisions within restricted riverine habitats resulting in potential mortality (Balazik et al. 2012); risk in open ocean environments is unknown but speculative at best. Vessel strike is not a documented risk for Atlantic salmon (NMFS 2023i); therefore, vessel strike risk under the Proposed Action is expected to have **no effect** on Atlantic salmon.

6.4.1 Project Survey Traffic

BOEM estimates that the total number of vessel trips from routine activities under the Proposed Action would be approximately 980 round trips over a 6-year period, which equates to approximately 163 vessel roundtrips per year. While the vessel traffic anticipated as a result of Proposed Action would add to the existing vessel traffic in the region, the estimated number of round trips over the 6-year span is considered a relatively small amount of activity over baseline traffic in the region (**Section 3.2.1.7**). Proposed Action vessels would range in size from approximately 37 ft (11 m) to 262 ft (80 m) and include 12- and 24-hour survey vessels, research vessels, commercial fishing vessels, and crew boats. The vessels that would be used under the Proposed Action are presented in **Sections 3.1.1.2** and **3.1.2.1.15** of this BA. Some survey vessels would remain at the Research Lease Area or potential cable route region for days or weeks at a time, potentially making infrequent trips to port for crew changes, bunkering, and provisioning as needed. Other vessels would conduct daily transits, departing and returning to port each day. All vessels are expected to travel at speeds slow speeds (i.e., 4 to 7 knots) during surveys, though transits may exceed 10 knots. The majority of vessel transits would originate from either Portland, Maine or Boothbay Harbor, Maine. However, for the purposes of this BA and given that not all ports are yet known, ports located from Plymouth, Massachusetts to Stonington, Maine are considered in this assessment.

The approximate average of 163 vessel round trips per year resulting from the Proposed Action represent 0.83 percent of the average annual vessel tracks counted in the Gulf of Maine from 2019 to 2021 (**Table 3-8**) and 151 percent of the average vessels tracks counted in the State of Maine’s requested lease area during the same time period (**Table 3-9**). However, as discussed in **Section 3.2.1.7**, AIS and VMS data does not capture all vessel activity in a region and is likely to underestimate actual vessel transits, particularly for recreational vessels and smaller commercial fishing vessels.

6.4.1.1 Marine Mammals

Project vessels working under the Proposed Action pose a potential collision risk to marine mammals. Vessel strikes are a well-documented threat to large whales worldwide and are a measurable source of mortality and injury for many marine mammal species (Laist et al. 2001; Vanderlaan and Taggart 2007; Martin et al. 2016; Hayes et al. 2022); they are a known or suspected contributor to three active unusual mortality events in the Atlantic Ocean for cetaceans (humpback whale, minke whale, and NARW) (NMFS 2024d). Vessel strikes are of particular concern for mysticetes due to their size, relatively slow maneuverability, proportion of time spent at the surface between dives, lack of clear and consistent avoidance behavior, and their relatively low detectability by vessels without focused observation efforts and (Garrison et al. 2022; Gende et al. 2011; Rockwood et al 2017; Martin et al 2016).

If a vessel strike does occur, the impact on marine mammals would range from minor injury to mortality of an individual, depending on the species and severity of the strike. Injuries are typically the result of one of two mechanisms: either blunt force trauma from impact with the vessel or lacerations from contact with the propellers (Wiley et al. 2016). Depending on the severity of the strike and the injuries inflicted, the animal may or may not recover (Wiley et al. 2016). The size of the vessel and animal, speed of the vessel, and the orientation of the marine mammal with respect to vessel trajectory all affect the severity of the injury (Vanderlaan and Taggart 2007; Martin et al. 2016).

The ability for vessel operators to detect a marine mammal within the path of the moving vessel can reduce vessel strike risk and is dependent on a variety of factors, including atmospheric/visibility conditions, observer training and experience, and vessel size and speed. Vessel speed is inversely correlated with detection rates, such that slower transit speeds, especially those below 9.7 kn (5.0 m/s), generally lead to a higher in-time detection rates for most vessel sizes provided adequate (3,281 ft [greater than 1,000 m]) reliable detection ranges (Baille and Zitterbart 2022).

Almost all sizes and classes of vessels have been involved in collisions with marine mammals around the world, including large container ships, ferries, cruise ships, military vessels, recreational vessels, commercial fishing boats, whale-watch vessels, research vessels and even jet skis (Dolman et al. 2006; Winkler et al. 2020).

Primary factors that affect the probability of a marine mammal-vessel strike include:

- Density, distribution, species, age, size, speed, health, and behavior of animal(s) (Vanderlaan and Taggart 2007; Martin et al. 2016);
- Number, speed, and size of vessel(s) (Vanderlaan and Taggart 2007; Martin et al. 2016);
- Vessel path (Vanderlaan and Taggart 2007; Martin et al. 2016);
- Operator's ability to detect and avoid collisions (Martin et al. 2016; Williams et al. 2016); and
- Animal's ability to detect an approaching vessel and propensity to avoid collisions (Gende et al. 2019; McKenna et al. 2015; Nowacek et al. 2004).

An individual's ability to detect and actively avoid a vessel collision is poorly understood. Aversion to an approaching vessel is likely dependent on the age and behavioral state of the animal and will differ among species (Gende et al. 2019; McKenna et al. 2015; Nowacek et al. 2004). Auditory recognition of a vessel by a marine mammal such that timely avoidance is triggered is likely highly variable and highly contextual. The following factors can impair the ability of a marine mammal to detect and locate the sound of an approaching vessel:

- Attenuation of low frequency vessel sound near the surface (i.e., Lloyd mirror effect);
- Decreased propeller sound at the bow as a vessel's length increases (i.e., spreading loss);
- Impedance of forward-projecting propeller sound due to hull shape and relative placement of keel (above-keel propeller location resulting in acoustic shadowing); and
- Ambient (background) sound interfering with the sound of an approaching vessel (i.e., acoustic masking).

Vessel speed and size are two of the most important factors for determining the probability and severity of vessel strikes. The size and bulk of large vessels inhibits the ability for crew to detect and react to marine mammals along the vessel's transit route. In 93 percent of marine mammal collisions with large vessels reported in Laist et al. (2001), whales were either not seen beforehand, or were seen too late to be avoided. Laist et al. (2001) reported that the most lethal or severe injuries are caused by ships 262 ft (80 m) or longer traveling at speeds greater than 13 kn (6.7 m/s). An analysis conducted by Conn and Silber (2013) built upon collision data collected by Vanderlaan and Taggart (2007) and Pace and Silber (2005) and included new observations of serious injury to marine mammals as a result of vessel strikes at lower speeds (e.g., 2 and 5.5 kn [1.0 and 2.8 m/s]). The relationship between lethality and strike speed was still evident; the probability of a vessel strike increases significantly as speeds increase above 10 kn (Conn and Silber 2013; Kite-Powell et al. 2007; Laist et al. 2001; Vanderlaan and Taggart 2007). Smaller vessels have also been involved in marine mammal collisions. Minke, humpback, and fin whales have been killed or fatally wounded by whale-watching vessels around the world (Jensen and Silber 2004). Strikes have occurred when whale watching boats were actively watching whales as well as when they were transiting through an area, with the majority of reported incidences occurring during active whale watching activities (Laist et al. 2001; Jensen and Silber 2004).

In general, ESA-listed marine mammal densities within the Action Area range from relatively low to seasonally high (**Section 5.1.1**). Fin whale densities are the greatest whereas NARW and sei whale densities are comparatively lower; sperm whale densities are the lowest. Fin whales are common and widespread throughout the Gulf of Maine, with highest abundances during summer and fall (MGEL 2022). NARWs are also common in the Gulf of Maine; visual and acoustic surveys area indicate that NARWs may be present year-round in the Gulf of Maine, though the highest abundances occur from mid-fall through early summer (Hayes et al. 2023; MGEL 2022; Davis et al. 2017). Sei whales typically express irregular movement patterns that appear to be associated with oceanic fronts, sea surface temperatures, and specific bathymetric features (Olsen et al., 2009; Hayes et al., 2022); the species is considered regular in the Gulf of Maine, with higher, though variable, densities from spring through fall (MGEL, 2022). Sperm whales are primarily found in deeper offshore waters near the continental shelf edge beyond Georges Bank and in proximity to the prominent bathymetric features such as the Northeast Channel (Hayes et al. 2020); the species is considered uncommon within the Gulf of Maine, with seasonal occurrences during the summer to early fall months (MGEL 2022).

A range of mitigation and monitoring measures to minimize the potential for vessel collisions and impacts to marine mammals are included under the Proposed Action (**Section 3.3**). Specific to mitigating for vessel strike, **Section 3.3.4** describes all conditions under the Proposed Action for protected species detection and vessel strike avoidance conditions. Specifically, the following measures serve to reduce the likelihood of a vessel strike occurring when effectively implemented:

- Project-specific training to all vessel crew members, Visual Observers, and Trained Lookouts on the identification of sea turtles and marine mammals, vessel strike avoidance and reporting protocols, and the associated regulations for avoiding vessel collisions with protected species.

- Alternative monitoring technology (e.g., night vision, thermal cameras, etc.) must be available on all survey vessels to maintain a vigilant watch at night and in any other low visibility conditions.
- Vessels of all sizes must operate at 10 knots or less between October 1 and May 30 and while operating port to port and operating in the lease area, or in the transit area to and from ports in Maine and Massachusetts.
- Regardless of vessel size, vessel operators must reduce vessel speed to 10 knots (11.5 mph) or less while operating in any SMA or DMA or Slow Zones. Additionally, any proposed revisions to the NARW speed rule will be followed upon Rule adoption.
- Regardless of vessel size, the vessel captain and crew must maintain a vigilant watch for all protected species and slow down, stop their vessel, or alter course, as appropriate, to avoid striking any listed species.
- Minimum separation distances and strike avoidance protocols are established in **Section 3.3.4**, and includes a 1,640 ft (500 m) separation from all ESA-listed whales or large unidentified whales.

While the baseline encounter rate for vessels and animals to be within a strike risk with one another is already low, several additional factors are expected to further reduce the probability of a Proposed Action-related vessel strike. The communication and reporting procedures outlined in **Section 3.3.6** are designed to increase awareness to the presence of marine mammals, and NARWs in particular. All Project-related vessels operating in the Action Area are required to post trained and dedicated lookouts onboard that will utilize the best available tools and/or technology to continuously monitor the vessel strike zone anytime a vessel is underway. All protected species sightings will be shared among all Project vessels to increase situational awareness to the presence of marine mammals. Although the Proposed Action will result in a temporary increase in the number of vessels operating in the Action Area, data sharing amongst all vessels will be beneficial to each trained lookout. When combined with the effective implementation of vessel strike avoidance mitigation measures, encounters that have a high risk of resulting in collision or injury would be minimized by reducing both the encounter potential (e.g., separation distances, seasonal restrictions, avoidance of aggregations) and severity potential (e.g., speed reduction, vessel positioning parallel to animals). Slower operational speeds of less than or equal to 10 kn would allow whales to avoid vessels, vessels to avoid whales, or both to take evasive actions. Additionally, slower vessel speeds are generally correlated with a reduction in injury extent and reduced instances of mortality when compared to faster vessel speeds (Vanderlaan and Taggart 2007). All vessels, including those traveling faster than 10 kn when permitted to do so, are required to maintain minimum separation distances of 1,640 ft (500 m) from all observed ESA-listed whales. While this measure cannot entirely eliminate an undetected marine mammal from entering this zone, a reduction in strike/injury risk ultimately relies on the ability for a responsive action to be taken if there is an encounter with a marine mammal. The deployment of trained lookouts on all vessels along with operable and effective monitoring equipment, including equipment specialized for low-light conditions (i.e., thermal imaging, night vision devices) in order to effectively monitor at night, will serve to minimize the collision and injury risk of any encounters that may occur.

Seasonally high densities of ESA-listed whales, specifically fin whales and NARWs, are possible within the Action Area. However, the contribution of the number of vessel trips under the Project compared to current baseline levels in the Action Area is considered very low for both site assessment and site characterization activities combined. In addition, the mitigation measures outlined above and in **Section 3.3.4** are expected to minimize potential interactions with ESA-listed species during vessel movements when properly and fully implemented. As a result, there is a low risk of interaction between marine mammals and Project vessel traffic during site assessment and site characterization activities based on the estimated vessel activity over the total activity period and the effective implementation of mitigation measures.

The risk of vessel strike cannot be fully eliminated due to the unpredictable nature of animal-vessel interactions, even with dedicated observers. However, vessel strike risk, and importantly, injury resulting from vessel strikes, can be significantly reduced to a negligible level by strict adherence to the guidelines and proposed mitigation measures outlined in the vessel strike avoidance measures in **Section 3.3.4**. Therefore, vessel strike risk is low, but not eliminated, when monitoring and mitigation activities are effectively implemented, as outlined; and trained, dedicated lookouts are used on all vessels. With full implementation of mitigation measures, the potential for injury-causing vessel strikes to ESA-listed marine mammals is considered **insignificant**. Therefore, the effects of Project-related vessel traffic **may affect, not likely to adversely affect** ESA-listed marine mammals.

6.4.1.2 Sea Turtles

Vessels working under the Proposed Action pose a potential collision risk to sea turtles. Vessel-animal collisions are a measurable and increasing source of mortality and injury for sea turtles; the percentage of stranded loggerhead sea turtles with injuries that were apparently caused by vessel strikes increased from approximately 10 percent in the 1980s to over 20 percent in 2004, although some stranded turtles may have been struck post-mortem (NMFS and USFWS 2008). Sea turtles are expected to be most vulnerable to vessel strikes in coastal foraging areas and may not be able to avoid collisions when vessel speeds exceed 2 kn (1 m/s) (Hazel et al. 2007). The recovery plan for loggerhead sea turtles (NMFS and USFWS 2008) notes that, from 1997 to 2005, 14.9 percent of all stranded loggerheads in the U.S. Atlantic and Gulf of Mexico were documented as having some type of propeller or collision injuries, although it is not known what proportion of these injuries occurred before or after the turtle died. Regardless, increased vessel traffic associated with the Proposed Action may increase the potential for impacts from vessel strikes.

Vessels traveling at higher speeds pose a higher risk to sea turtles. Relative to marine mammals, as discussed in **Section 6.4.1.1**, sea turtles require more stringent speed reductions before lethal injury probabilities are reduced. To reduce the risk of lethal injury to loggerhead sea turtles from vessel strikes by 50 percent, Sapp (2010) found that small vessels (10 to 30 ft [3 to 6 m] in length) had to slow down to 7.5 kn (3.9 m/s); the probability of lethal injury decreased by 60 percent for vessels idling at 4 kn (2.1 m/s). Foley et al. (2008) further indicated that vessel speed greater than 4 kn (2.1 m/s) may cause serious injury or mortality to sea turtles. The most informative study of the relationship between ship speed and collision risk was conducted on green sea turtles (Hazel et al. 2007). Green sea turtles often failed to flee approaching vessels. Hazel et al. (2007) concluded that green sea turtles rarely fled when encountering fast vessels (greater than 10 kn [5 m/s]), infrequently fled when encountering vessels at moderate speeds of around 6 kn (3.1 m/s), and frequently fled when encountering vessels at slow speeds of approximately 2 kn (1 m/s). Based on the observed responses of green sea turtles to approaching boats, Hazel et al. (2007) further concluded that sea turtles rely primarily on vision rather than hearing to avoid vessels; although both may play a role in eliciting responses, sea turtles may habituate to vessel sound and be more likely to respond to the sight of a vessel rather than the sound of a vessel. The potential for collisions between vessels and sea turtles, thus, increases at night and during inclement weather. Based on these findings, vessel speed restrictions may be inconsequential to reducing strike risk at anything but the slowest speeds (less than 2 kn [1 m/s]) due to the relatively low rate of flee responses of sea turtles.

The contribution of the number of vessel trips under the Proposed Action compared to current baseline levels in the Action Area is considered very low for both site assessment and site characterization activities combined. Additionally, sea turtle densities within the Gulf of Maine are very low and seasonal, with occurrence rates for all ESA-listed sea turtle species limited to summer and fall months (**Section 5.1.2**). As a result, there is a low risk of interaction between ESA-listed sea turtles and project vessel traffic during Project activities based on the relative occurrence of sea turtles in the Action Area and the estimated vessel activity during site assessment and site characterization activities.

There are limited measures that have been proven to be effective at reducing collisions between sea turtles and vessels (Schoeman et al. 2020). The relatively small size of turtles and the significant time spent below the surface makes their observation by vessel operators extremely difficult, therefore reducing the effectiveness of trained observers to mitigate vessel strike risk on sea turtles. Nevertheless, the use of trained lookouts would serve to reduce potential collisions. In addition to the observer requirements discussed in **Section 6.4.1.1** for marine mammals, strike avoidance measures that are specifically geared towards sea turtles (**Section 3.3.4**) include:

- Vessels must slow down to 4 knots if a sea turtle is sighted within 328 ft (100 m) of the operating vessel's forward path.
- Between June 1 and November 30, all vessels must avoid transiting through areas of visible jellyfish aggregations or floating vegetation (e.g., sargassum lines or mats). In the event that operational safety prevents avoidance of such areas, vessels must slow to 4 knots while transiting through such areas.
- All vessel crew members must be briefed on the identification of sea turtles and on regulations and best practices for avoiding vessel collisions. Reference materials must be available aboard all Project vessels for identification of sea turtles.

Although vessel strike risk to sea turtles is expected to be reduced with the application of monitoring and mitigation measures, some unavoidable effects on sea turtles may occur, primarily due to the difficulty in detecting sea turtles. Though vessel speed restrictions are designed primarily to reduce impact to marine mammals, they would also reduce potential impacts to sea turtles. However, sea turtle collisions may still occur at slow speeds, and individuals would still be vulnerable when vessels travel over 2 kn (1 m/s). Additionally, effective detection of sea turtles in low visibility conditions (nighttime, fog, inclement weather) is likely low, even with the application of alternative monitoring technologies, thereby increasing the vulnerability of sea turtles to vessel strike risk during these periods, even with all other mitigative measures implemented.

The increase in vessel traffic associated with the Proposed Action is likely to increase the relative risk of vessel strike for sea turtles, particularly during nighttime and periods of reduced visibility. However, given the relatively low levels of vessel traffic expected under the Proposed Action (described in Section 6.4.1) and the low sea turtle densities in the Action Area, strike risk, though not fully eliminated, is not expected to exceed negligible levels. The seasonal patterns of sea turtles in the region will result in a reduction in risk during periods of time when individuals are less likely to be present, such as during winter months. Mitigation measures (e.g., minimum vessel separation distances, vessel speed restrictions) would reduce the overall encounter potential. The deployment of trained observers on all vessels along with operable and effective monitoring equipment, including the alternative monitoring gear such as night vision, thermal cameras, etc., would additionally contribute to minimizing the collision risk with sea turtles. As a result, the probability of a vessel strike between Project vessels and sea turtles under the Proposed Action would be **insignificant**. Therefore, the effects of Project-related vessel traffic **may affect, not likely to adversely affect** ESA-listed sea turtles.

6.4.1.3 Marine Fish

Propeller-driven vessels and barges can pose a risk to fishes that swim near the water surface and are a potential source of mortality for Atlantic and shortnose sturgeon due to direct collisions with the vessel's hull or propeller (Brown and Murphy 2010). The majority of vessel-related sturgeon mortality is likely caused by large transoceanic vessels in river channels (Brown and Murphy 2010; Balazik et al. 2012). Large vessels have been implicated because of their deep draft (up to 40 to 45 ft) relative to smaller vessels (15 ft), which increases the probability of vessel collision with demersal fishes like sturgeon, even in deep water (Brown and Murphy 2010). Although smaller vessels and those with relatively shallow drafts provide more clearance with the river bottom, they can operate at a higher speed, which is expected to limit a sturgeons' ability to avoid being struck. However, as discussed previously in Sections 4.2.2.2, 4.3.1, and 4.3.2, no Project vessels will transit upriver, so Project vessel traffic will be limited to coastal waters and deeper waters offshore near the Research Lease Area. The representative ports and vessels under consideration for the Project are described in **Sections 3.1.1.2** and **3.1.2.15**.

There are limited measures that would be effective at reducing collisions between ESA-listed fish and vessels; while the use of trained lookouts and other monitoring and mitigation measures such as vessel speed restrictions would reduce potential collisions to some extent, these measures ultimately provide little effectiveness at reducing vessel strike risk to ESA-listed fish.

Atlantic and shortnose sturgeon strikes are most likely to occur in areas where sturgeon populations overlap with abundant boat traffic such as large ports or areas with relatively narrow waterways (ASSRT 2007). A recent study indicated that the loss of only a few adult female Atlantic sturgeon from the Delaware River riverine population because of vessel strikes would hinder recovery of that riverine population (Brown and Murphy 2010). Additionally, date from the most recent 5-Year review of Atlantic sturgeon indicate that most fatalities of Atlantic sturgeon carcasses examined where the result of being struck by large vessels (NMFS 2022d). Atlantic sturgeon spend most of their time below the water's surface, making their observation by vessel operators extremely difficult and therefore reducing the effectiveness of trained observers to mitigate vessel strike risk. The potential occurrence of the Atlantic sturgeon near the Project ports described in **Sections 3.1.1.2** and **3.1.2.15** and shallow navigation channels are expected to be the areas of highest risk for vessel interaction with this benthic-dwelling species. However, their limited presence at the water's surface and the dispersed nature of vessel traffic and individual sturgeon reduces the potential for co-occurrence of individual sturgeon with Project-related vessels. Additionally, vessel transits within riverine habitat are not considered under the Proposed Action, further reducing the co-occurrence of Project vessels with Atlantic sturgeon. Based on the best available information on vessel strike risk, BOEM finds that vessel strikes as a result of the Proposed Action with Atlantic sturgeon are extremely unlikely to occur.

Reports are limited for evidence of shortnose sturgeon vessel strikes in the Gulf of Maine. Only one carcass has been reported from the lower Kennebec River in 2008 with evidence of lacerations to the head presumed to be the result of a propeller strike (Shortnose Sturgeon Status Review Team 2010). Project vessels in the Action Area are expected to use ports in Portland, Bristol, and Boothbay, Maine which could occur offshore or within the bays at the mouth of the Sheepscot River, Medomak River, Damariscotta River, Androscoggin River, and Presumpscot River, and within Penobscot Bay which are adjacent to the critical habitat rivers. However, none of the proposed survey vessel traffic will transit upriver where shortnose sturgeon are most likely to occur, and vessel traffic associated with surveys of the wet storage area in Penobscot Bay would be expected to remain in the Bay and would not travel up the Penobscot River. Shortnose sturgeon would therefore only encounter Project vessel traffic during their migrations in coastal marine waters, which are not documented to be a common occurrence, during the fall, spring, and summer (Altenritter et al. 2018; Dionne et al. 2013; Wippelhauser et al. 2015). Few mitigation measures would be effective at reducing collisions between shortnose sturgeon and vessels; the time spent below the surface makes their observation extremely difficult, therefore reducing the effectiveness of trained observers (e.g., PSOs) to mitigate vessel strike risk. Nevertheless, mitigation measures such as vessel speed restrictions could reduce the risk of potential collisions.

The increase in vessel traffic associated with site assessment and site characterization activities under the Proposed Action is likely to increase the relative risk of vessel strike for Atlantic sturgeon and shortnose sturgeon. However, given their limited presence at the water's surface and the dispersed occurrence throughout the Action Area, the rate of co-occurrence with Project-related vessel traffic is expected to be very low for Atlantic sturgeon and shortnose sturgeon. As such, the likelihood of vessel strikes occurring is assumed to be extremely low and would be **discountable**. Therefore, the effects of Project-related vessel traffic **may affect, not likely to adversely affect** Atlantic sturgeon and shortnose sturgeon.

As indicated previously, vessel strike is not a documented risk for Atlantic salmon (NMFS 2023i); therefore, vessel strike risk under the Proposed Action is expected to have **no effect** on Atlantic salmon.

6.5 Habitat Disturbance

6.5.1 Temporary Seafloor Disturbances

Temporary disturbances of the seafloor during the proposed site assessment and site characterization activities would result from the placement and removal of the FLiDAR buoy, geotechnical surveys, benthic surveys, and vessel anchoring. The total estimated area of temporary seafloor disturbance resulting from the Proposed Action during these survey activities is provided in **Table 6-10**.

Table 6-10. Estimated temporary seafloor disturbance resulting from the site assessment and site characterization activities for the Proposed Action

Activity	Disturbance Area
FLiDAR Buoy	32 ft^2 (3 m^2)
Geotechnical Surveys	Up to hundreds of ft^2 (several m^2) per sample
Benthic Surveys	Up to hundreds of ft^2 (several m^2) per grab
Vessel anchoring	Up to hundreds of ft^2 (several m^2) per anchor

Source: Draft EA Section 2.2, BOEM 2023a

Restoration of marine soft-sediment habitats occurs through a range of physical (e.g., currents, wave action) and biological (e.g., bioturbation, tube building) processes (Dernie et al. 2003). In areas of seafloor disturbance, benthic habitat recovery and mobile and sessile benthic infaunal and epifaunal species abundances may take 1 to 3 years to recover to preimpact levels, based on the results of a number of studies on benthic recovery (e.g., AKRF et al. 2012; Carey et al. 2020; Germano et al. 1994; Guarinello and Carey 2022; Hirsch et al. 1978; Kenny and Rees 1994; Department for Business, Enterprise and Regulatory Reform 2008; Collie et al. 2000; Gerdes et al. 2008). Based on a review of impacts of sand mining in the U.S. Atlantic and Gulf of Mexico, softbottom communities within the cable corridors would recover within 3 months to 2.5 years (Brooks et al. 2006; Kraus and Carter 2018; Normandeau Associates 2014). However, it is important to note that the actual mechanisms of recovery are highly complex and site-specific; recovery to baseline conditions may take much longer in some areas and for some benthic species. Generally, soft-bottom habitats are more rapidly restored following a disturbance compared to complex or hard-bottom habitats (Collie et al. 2000).

Benthic habitat recolonization rates depend on the benthic communities in the area surrounding the affected region. The Action Area comprises both rocky sediment with sand and gravel deposits with muddy sediment deposits over large areas (**Section 3.2.1.2**). Previous surveys have found silt and sand was the most common sediment type found in the Research Lease Area and sand concentrations are also common in nearshore areas less than 164 ft (50 m) depth (**Section 3.2.1.2**). Areas of coarser sediment are often more dynamic in nature and therefore quicker to recover following a disturbance than more stable environments such as those with fine-grained sediment or rocky reefs (Dernie et al. 2003). Species inhabiting these dynamic habitats are adapted to deal with physical disturbances, for example, frequent sedimentation associated with strong bottom currents and ground swell. As such, these communities are expected to recolonize more quickly after a disturbance than communities not well-adapted to frequent disturbance (e.g., cobble and boulder habitats). Mobile species may be indirectly affected by the temporary reduction of benthic forage species; however, given the prevalence of similar habitat in the area, this is likely to have a nominal effect.

6.5.1.1 Marine Mammals

Given the range of benthic habitat present in the Action Area (**Section 3.2.1.2**), some displacement of benthic prey resources for marine mammals may occur, but this is expected to be temporary. Seafloor disturbances for the Proposed Action could be on the order of tens of thousands of square feet (thousands of square meters) assuming several hundred geotechnical samples and benthic grabs are required and each result in a disturbance of hundreds of square feet (several square meters) (**Table 6-10**).

The only forage fish species for marine mammals that is expected to be impacted by the physical disturbance of sediment would be benthic fish species like the sand lance. The only marine mammal species that is expected to feed on benthic prey species are fin whales, which may feed on sand lance in the Action Area (**Section 5.1.1.1**). There are two biologically important foraging areas identified for fin whales within the Gulf of Maine: the Southern Gulf of Maine BIA, which only overlaps with potential vessel transits where fin whales forage year round; and the Northern Gulf of Maine BIA, which partially overlaps with the proposed benthic surveys where fin whales forage between June and October (LaBrecque et al. 2015). However, only a small portion of the Northern Gulf of Maine BIA overlaps with the area in which benthic surveys may occur in the Penobscot Bay area; only a minimal amount of seafloor disturbances within this area are expected. Additionally, there is no evidence to suggest that fin whales occurring within this region feed exclusively on sand lance; the species is expected to utilize other pelagic prey resources within the Action Area, which would therefore minimize potential impact as a result of potential seafloor disturbances.

Given the limited overlap with important benthic feeding habitats for ESA-listed marine mammals, and the temporary, localized nature of the disturbance, effects from seafloor disturbance would be so small that they could not be meaningfully measured, detected, or evaluated and are **insignificant**. Therefore, effects of seafloor disturbance from the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals.

6.5.1.2 Sea Turtles

The site assessment and characterization surveys of the Proposed Action would result in temporary disturbances of the seafloor within the Action Area as provided in **Table 6-10**. After the survey activities are completed, the areas of temporary disturbance should return to the baseline state. Seafloor disturbances could directly impact benthic species such as mollusks and crabs, which are prey for some sea turtle species (**Section 5.1.2**). Leatherback sea turtles (**Section 5.1.2.3**) are dietary specialists, feeding almost exclusively on pelagic jellyfish, salps, and siphonophores, rather than prey species affected by benthic habitat alteration.

Green, Kemp's ridley, and loggerhead sea turtles all may feed on benthic organisms, though some degree of behavioral plasticity is evident for all species. Once mature, green sea turtles leave pelagic habitats and enter benthic foraging grounds, primarily feeding on seagrasses and algae (Bjorndal 1997), although they will occasionally feed on sponges and invertebrates (NMFS 2023e). Kemp's ridley sea turtles are generalist feeders that prey on a variety of species, including crustaceans, mollusks, fish, jellyfish, and tunicates, and forage on aquatic vegetation (Byles 1988; Carr and Caldwell 1956; Schmid 1998). Although loggerheads are dietary specialists, the species demonstrates the ability to adjust its diet in response to changes in prey availability in different geographies (Plotkin et al. 1993; Ruckdeschel and Shoop 1988); juvenile loggerhead sea turtles are likely better adept at responding to changing environmental conditions than adults (Cardona et al. 2017).

Benthic habitat disturbances are anticipated to be temporary and localized (**Table 6-10**) and unlikely to affect the availability of prey resources for these species. Although the Proposed Action would temporarily impact benthic prey resources, those effects would be temporary and limited to a very small percentage of the Action Area. Given that the Action Area is naturally dynamic and exposed to anthropogenic disturbance (**Section 3.2.1**), the individuals that do occur in this region are expected to be able to adjust their foraging behavior based on prey availability. Green and Kemp's ridley sea turtles are omnivorous species with flexible diets, and loggerhead sea turtles readily target new prey species to adapt to changing conditions. Additionally, as discussed in **Section 5.1.2**, green, Kemp's ridley, and loggerhead sea turtle occurrence within the Gulf of Maine is quite low, indicating the region is not current a critical foraging habitat for large numbers of individuals.

Given the limited amount of foraging habitat exposed to seafloor disturbances, the temporary and localized nature of these effects, and the ability of these species to adjust their diet in response to resource availability, the resulting effects of temporary seafloor disturbance on these species would be **insignificant** and **may affect, not likely to adversely affect** ESA-listed sea turtles.

6.5.1.3 Marine Fish

The site assessment and site characterization activities of the Proposed action would result in temporary disturbances of the seafloor within the Action Area as provided in **Table 6-10**. After the survey activities are completed, the areas of temporary disturbance should return to the baseline state. Although the Proposed Action would kill or displace preferential prey organisms (invertebrates, such as crustaceans, worms, and mollusks, and bottom-dwelling fish, such as sand lance) within the survey footprint, these effects would be temporary in duration and limited to a very small area of available foraging habitat in the Action Area.

Sturgeon are known to eat a variety of benthic organisms and are believed to be opportunistic feeders with stomach contents ranging from mollusks, worms, amphipods, isopods, shrimp, and small benthic fish (e.g., sand lance; Smith 1985; Johnson et al. 1997; Dadswell 2006; Novak et al. 2017). Generally, the disturbance of benthic habitat would be short term and localized (**Table 6-10**), with an abundance of similar foraging habitat and prey available in adjacent areas for Atlantic sturgeon. As discussed in **Section 5.1.3.1.2**, Atlantic sturgeon in the Gulf of Maine would primarily inhabit coastal waters and spawning rivers, so there would be minimal overlap with foraging sturgeon and the proposed benthic and geotechnical surveys. Given their generalist feeding behaviors and the limited total area of potential habitat disturbance, Atlantic sturgeon are unlikely to be affected by the effects of short-term, localized, seabed disturbance. As discussed in **Section 5.1.3.3**, shortnose sturgeon are a primarily benthic species, but they most commonly occur in their natal freshwater rivers and would only be present in nearshore marine waters during their migrations between rivers in the fall, spring and summer (Altenritter et al. 2018; Dionne et al. 2013; Wippelhauser et al. 2015), limiting their expected overlap with the benthic and geotechnical sampling areas. Atlantic salmon prey vary based on their age; adults prefer capelin, which is a pelagic species, while juveniles forage on insects, invertebrates, and plankton (NMFS 2023i). As discussed in **Section 5.1.3.2.2**, juveniles spend two or three years in freshwater before migrating across the Gulf of Maine to their offshore foraging areas near Greenland. Therefore, Atlantic salmon occurring in the benthic and geotechnical sampling areas would be minimal and a low number of them would likely be foraging on benthic prey species.

Given the limited extent of effects and the likelihood of rapid recovery to baseline benthic community conditions, the effects of seafloor disturbance from the Proposed Action are likely to be **insignificant** and **may affect, not likely to adversely affect** ESA-listed fish.

6.5.2 Turbidity

The site assessment and site characterization surveys of the Proposed Action are likely to result in elevated levels of turbidity in the immediate proximity of seafloor-disturbing activities like placement and removal of the FLiDAR buoy, geotechnical surveys, benthic surveys, and vessel anchoring. There would be temporary increases in sediment suspension and deposition during activities that entail the disturbance of the seafloor. The Proposed Action could be on the order of tens of thousands of square feet (thousands of square meters) assuming several hundred geotechnical samples and benthic grabs are required and each results in a disturbances are of hundreds of square feet (several square meters) (**Table 6-10**). However, only a few benthic grabs and geotechnical coring samples would be expected per day during sampling surveys and only one FLiDAR buoy would be placed and removed between June 2023 and June 2025. Vessel anchoring is likely to be minimal per day throughout the duration of the Proposed Action. Given the nature of these activities, the increases in turbidity are not likely to persist beyond a few hours, so cumulative increases in turbidity from day to day would not occur, and the increased total suspended solids (TSS) for each day of sampling would likely be experienced by marine life as discrete and temporary events.

6.5.2.1 Marine Mammals

The NMFS Atlantic Region has developed a policy statement on turbidity and TSS effects on ESA-listed species for the purpose of Section 7 consultation (Johnson 2018). The agency concluded that elevated TSS could result in effects on listed whale species under specific circumstances (e.g., high TSS levels over long periods during dredging operations), but insufficient information is available to make ESA effect determinations. In general, marine mammals are not subject to effects mechanisms that injure fish (e.g., gill clogging, smothering of eggs and larvae), so injury-level effects are unlikely. Behavioral effects, including avoidance or changes in behavior, increased stress, and temporary loss of foraging opportunity, could occur but only at excessive TSS levels (Johnson 2018). Todd et al. (2015) postulated that dredging and related turbidity effects could affect the prey base for marine mammals, but the significance of those effects would be highly dependent on site-specific factors. Small-scale changes from one-time, localized activities are not likely to have significant effects.

Data are not available regarding whales' avoidance of localized turbidity plumes; however, Todd et al. (2015) suggest that since marine mammals often live in turbid waters, significant effects from turbidity are not likely. If elevated turbidity caused any behavioral responses such as avoiding the turbidity zone or changes in foraging behavior, such behaviors would be temporary, and any negative effects would likewise be short term and temporary. Cronin et al. (2017) suggest that NARWs may use vision to find copepod aggregations, particularly if they locate prey concentrations by looking upwards. However, Fasick et al. (2017) indicate that NARWs must rely on other sensory systems (e.g., vibrissae on the snout) to detect dense patches of prey in very dim light (at depths greater than 525 ft [160 m] or at night). These studies indicate that whales, including NARWs, are likely able to forage in low-visibility conditions and, thus, could continue to feed in the elevated turbidity. If turbidity from the proposed activities caused foraging whales to leave the area, there would be an energetic cost of swimming out of the turbid area. However, increases in turbidity from the Proposed Action would be temporary, localized events, and whales could resume foraging behavior once they were outside of the turbidity zone or once the suspended sediment settled out of the water column.

Elevated TSS concentrations are expected to be limited in magnitude, short term in duration, and likely within the range of natural variability. This limited temporal effect over a relatively small area are not expected to interfere with ESA-listed species foraging success. Therefore, effects from increased turbidity are expected to be localized, temporary, non-measurable and **insignificant**. Increased turbidity associated with the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals.

6.5.2.2 Sea Turtles

NMFS has concluded that although scientific studies and literature are lacking, the effects of elevated TSS on ESA-listed sea turtles are likely to be similar to the expected effects on marine mammals (Johnson 2018). Physical or lethal effects in increased turbidity during the proposed surveys are unlikely because sea turtles are air-breathing and, therefore, do not share the physiological sensitivities of susceptible organisms like fish and invertebrates. Additionally, only short-term, localized increases in turbidity around the survey activities would be expected to settle quickly due to the nature of these activities.

Elevated TSS may cause individuals to alter normal movements and behaviors (e.g., moving away from an affected area). They may also experience behavioral stressors, like reduced ability to forage and avoid predators; however, turtles are migratory species that forage over wide areas and would likely be able to avoid short-term TSS impacts that are limited in severity and extent without consequence. As a result, these behavioral changes are expected to be limited in extent, short term in duration, and likely too small to be detected (NOAA 2021). Moreover, many sea turtle species routinely forage in nearshore and estuarine environments with periodically high natural turbidity levels. Therefore, short term exposure to elevated suspended sediment levels is unlikely to measurably inhibit foraging (Michel et al. 2013). However, elevated levels of turbidity may negatively affect sea turtle prey items, including benthic mollusks, crustaceans, sponges, and sea pens by clogging respiratory apparatuses. The more mobile prey items like crabs may also be negatively affected by turbidity by clogging their gills but likely to a lesser extent due to their ability to leave the turbid area (BOEM 2021a). Only short term, limited impacts to fish and invertebrates are expected from suspended sediments; therefore, secondary effects on sea turtle prey availability are not expected. Any effects from increased turbidity levels from the proposed survey activities on turtles, their habitat, or their prey would be isolated and temporary and are so small that they could not be measured and are, therefore, **insignificant**. Increased turbidity associated with the Proposed Action **may affect, not likely to adversely affect** ESA-listed sea turtles.

6.5.2.3 Marine Fish

Studies of the effects of turbid water on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute reaction is expected (Wilber and Clarke 2001). Johnson (2018) recommends that sturgeon should not be exposed to TSS levels of 1,000 milligrams per liter above ambient levels for longer than 14 days at a time to avoid behavioral and physiological effects. Tolerance of juvenile Atlantic sturgeon to suspended sediments has been evaluated in a laboratory setting and exposed individuals to TSS concentrations of 100, 250, and 500 milligrams per liter for a 3-day period (Wilkens et al. 2015). Of the fish exposed, 96 percent survived the test, and the authors suggested that the absence of any significant effects on survival or swimming performance indicates that the impacts of sediment plumes in natural settings are minimal where fish can move or escape. Directed studies of sturgeon TSS tolerance are currently lacking, but sturgeons, as a whole, are adapted to living in naturally turbid environments like large rivers and estuaries (Johnson 2018). Given this, adult and subadult sturgeon expected to occur in the Action Area are likely tolerant of elevated suspended sediment levels.

Increases in TSS can influence the behavior of Atlantic salmon. Robertson et al. (2007) observed avoidance responses in all individuals studied in response to an increase in suspended sediment concentration from 20 to 180 mg/L, and also observed increased foraging behaviors on the sediment floating in the water column as the sediment concentration increased. Studies have also noted that increased turbidity levels can also provide a level of protection from predation for migration salmon (Gregory and Levings 1998; Aldvén et al. 2015). However, the nominal increases in turbidity expected from the Proposed Action would provide minimal protection from predators, and would also result in minimal, if any, changes in behavior. While in the marine environment, the majority of individuals would occur and forage within the pelagic environment, with limited association with the seafloor. Therefore, there would be minimal overlap between the increases in turbidity from the Proposed Action and foraging Atlantic salmon.

Atlantic sturgeon are opportunistic benthivores that feed primarily on mollusks, polychaete worms, amphipods, isopods, shrimps and small bottom-dwelling fishes; therefore, suspended sediment and turbidity could result in some temporary avoidance of turbid areas or feeding challenges. Any effects from elevated level of turbidity from the Proposed Action on Atlantic sturgeon or their prey are considered so small that they could not be measured. Fish would likely depart or avoid unfavorable water quality conditions they may encounter.

As discussed in **Section 5.1.3.3**, shortnose sturgeon are a primarily benthic species, but they most commonly occur in their natal freshwater rivers and would only be present in nearshore marine waters during their migrations between rivers in the fall, spring and summer (Altenritter et al. 2018; Dionne et al. 2013; Wippelhauser et al. 2015), limiting their expected overlap with the areas where localized increases in turbidity from the Proposed Action would occur.

Suspended sediment and turbidity could result in some temporary avoidance of turbid areas, but the short-term increases in turbidity are expected to result in minor, non-measurable effects. In addition, suspended sediment concentrations during the proposed survey activities would likely be within the range of natural variability for this location. The effects of elevated turbidity on Atlantic sturgeon, Atlantic salmon, and shortnose sturgeon would be so small that they could not be measured and, therefore, **insignificant**. Increased turbidity associated with the Proposed Action **may affect, not likely to adversely affect** ESA-listed fish.

6.5.3 Presence of Structures

Under the Proposed Action, one FLiDAR buoy would be deployed in the Research Lease Area in a maximum of 620 ft (189 m) water depth between June 2023 and June 2025. The FLiDAR buoy will be moored with a single gravity-based anchor covering a total area of 32 ft^2 (3 m^2). The buoy will be connected to the anchor using chain or synthetic rope kept taut such that it would extend vertically up from the anchor and would not have any loops or slack.

6.5.3.1 Behavioral Changes due to the Presence of Structures

The FLiDAR buoy would present a vertical structure that constitutes an obstacle in the water column that could alter the normal behavior of marine species in the Action Area during the approximate 2-year deployment period.

A single FLiDAR buoy is unlikely to alter the foraging, migrating, or mating behavior of any ESA-listed marine mammal, sea turtle, or fish species given its minimal footprint within the Action Area. Therefore, the potential for effects is **discountable**. Behavioral changes due to the presence of structures under the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals, sea turtles, and fish.

6.6 Entanglement and Capture

All ESA-listed marine mammals, sea turtles, and fish are at risk from entanglement and/or capture. A number of mechanisms are in effect that may increase or alter exposure to entanglement and capture, potentially leading to injury or death. The mechanisms largely associated with entanglement risk include the presence of vertical lines, particularly those that extend through the whole water column; and slack lines with low tension between the anchor and the equipment/gear. Direct capture is possible via towed nets (i.e., trawls) and trap/pots. Survey activities that incorporate these mechanisms would pose an entanglement and capture risk to ESA-listed marine mammals, sea turtles, and fish. This risk can be minimized by reducing the amount of vertical line extending through the water column; increasing the tension of the lines between the anchor and equipment/gear; and implementing the mitigation measures described in **Section 3.3**.

6.6.1 Entanglement and Capture from Site Characterization Surveys

The mooring components associated with the FLiDAR buoy (**Section 3.1.1.1**) are expected to be under buoyant tension and are not expected to pose a direct entanglement risk to ESA-listed species. Additionally, PAM for marine mammals, ambient noise, and large pelagic and benthic fish monitoring (**Section 1.3.2.9**) will use units that are moored and floated approximately 50 ft (15 m) above the seafloor with no surface connection. Given the lack of vertical lines that reach the surface and the buoyant tension that the floated receivers will be under, no entanglement risk is associated with PAM surveys. All other site characterization activities pose no entanglement risk to ESA-listed species due to the survey and equipment types proposed (**Section 3.1.2.1** through **3.1.2.11**). These survey activities are therefore not considered further in this section.

Survey activities under the Proposed Action that pose an entanglement risk to ESA-listed species include bottom trawl surveys for marine fish and invertebrates (**Section 3.1.2.12**), plankton and larval lobster surveys (**Section 3.1.2.13**), and lobster trap surveys (**Section 3.1.2.14**). These survey activities will result in an increase in the amount of fishing or sampling gear in the water, which will therefore result in an increased entanglement risk for ESA-listed species. Proposed surveys will utilize both mobile (i.e., bottom trawl and vertical and neuston net tows) and stationary (i.e., vented and ventless lobster traps) gear types, which pose differential risk to the species considered in this BA. The Proposed Action-related surveys will be of limited frequency and duration, as summarized in **Table 6-11**.

Table 6-11. Estimated duration of site characterization survey activities that utilize in-water sampling gear

Activity	Gear Type	Number of Samples/Gear	Survey Period
Bottom trawl surveys for marine fish and invertebrates	Otter trawl with modified shrimp trawl net	Seasonal trawls totaling 30–38 tows per season (120–152 tows per year)	Quarter 4 2024 until approval of the RAP[1]
Plankton and larval lobster surveys	Vertical and Neuston net tows	Two tows per month; vertical tows conducted monthly year-round; Neuston net tows conducted monthly between April and November during survey period	Quarter 4 2023 until RAP is approved[1]
Lobster surveys	Vented and ventless lobster pots	Seasonal; deployments of 25 trawl strings equipped with 12 traps each (comprising a total of 300 traps) will be hauled three times per season	September 2023 through September 2025 (or until approval of the RAP)

Source: Draft EA Section 2.2, BOEM 2023a
RAP = Research Assessment Plan.
[1] This BA makes the conservative assumption that the RAP would be approved within 5 years of lease issuance, or approximately February 2029.

The implementation of monitoring and mitigation measures under the Proposed Action (**Section 3.3**) would help to reduce entanglement or capture risk for ESA-listed species in project-related site characterization surveys. All fisheries monitoring survey plan designs would be required to follow the Fisheries Survey Guidelines (Fisheries Guidelines, updated 27 March 2023; BOEM 2023b). The Fisheries Guidelines provides guidance for standardizing survey plan design and aims to reduce the risk of interactions between protected species and sampling gear by minimizing the amount of gear fished (i.e., set or towed), the gear soak or tow duration, and the spatial and temporal overlap with protected species. In accordance with BOEM's Fisheries Guidelines, best practices for trap/pot gear require that all gear is hauled at least once every 30 days and that all gear is removed and stored on land between sampling seasons; no surface floating buoy lines are used; all groundlines are composed of sinking line; buoy lines use weak links; and knot free buoy lines are used to the extent practicable. All survey vessels will also have at least one survey team member on board that has completed the Northeast Fisheries Observer Program observer training or similar, and all vessel using fixed gear will have adequate disentanglement equipment onboard. Application of these measures are considered in the assessment of impact for ESA-listed species in the following subsections. Additional measures that have been identified to contribute to specific impact reductions are discussed for each resource, where applicable.

6.6.1.1 Marine Mammals

Theoretically, any line in the water column, including line resting on or floating above the seafloor, set in areas where whales occur could entangle a marine mammal (Hamilton et al. 2019, Johnson et al. 2005). Entanglements may involve the head, flippers, or fluke; effects range from no apparent injury to death. Entanglement in fishing gear has been identified as one of the leading causes of mortality in NARW and may be a limiting factor in the species recovery (Hayes et al. 2023; Knowlton et al. 2012). Current estimates indicate that 83 percent of NARWs show evidence of at least one past entanglement and 60 percent with evidence of multiple fishing gear entanglements, with rates increasing over the past 30 years (King et al. 2021; Knowlton et al. 2012). Of documented NARW entanglements in which gear was recovered, 80 percent was attributed to non-mobile fishing gear (i.e., lobster and gillnet gear) (Knowlton et al. 2012). Additionally, recent literature indicates that the proportion of NARW mortality attributed to fishing gear entanglement is likely higher than previously estimated from recovered carcasses (Pace 2021). Entanglement may also be responsible for high mortality rates in other large whale species, including fin whales (Henry et al. 2020; Read et al. 2006).

As discussed above, large whales are most vulnerable to entanglement in stationary vertical and ground lines associated with trap/pot gear. The Final Environmental Impact Statement, Regulatory Impact Review, and Initial Regulatory Flexibility Analysis for Amending the ALWTRP: Risk Reduction Rule (NOAA 2021) provides an analysis of data that shows entanglement in commercial fisheries gear represents the highest proportion of all documented serious and non-serious incidents reported for humpback, North Atlantic right, fin, and minke whales. Entanglement was the leading cause of serious injury and mortality for North Atlantic right, humpback, fin, and minke whales from 2010 to 2018 for cases where the cause of death could be identified (NOAA 2021).

Under the Proposed Action, lobster trap surveys will utilize ropeless fishing gear, thereby eliminating the need for or use of any vertical buoy lines. Between each lobster pot will be a sinking groundline in accordance with NOAA (2021) recommendations. Sinking groundline minimizes the amount of line that is suspended in the water column, which reduces the potential for entanglement. All trap/pot gear will be in compliance with the ALWTRP Risk Reduction Rule. The application of these mitigative measures will serve to minimize and reduce entanglement risk to ESA-listed marine mammals.

NMFS' opinion on the Continued Prosecution of Fisheries and Ecosystem Research Conducted and Funded by the Northeast Fisheries Science Center and the Issuance of a Letter of Authorization under the Marine Mammal Protection Act for the Incidental Take of Marine Mammals pursuant to those Research Activities (dated June 23, 2016), concluded that impacts to NARW, humpback, fin, sei, and blue whales, if any, as a result of trawl gear use would be expected to be extremely unlikely to occur. Under the Proposed Action, the vessel operating the trawl (a commercial fishing vessel) would travel at slow speeds (i.e., ~3 knots) and, in accordance with BOEM's Fisheries Survey Guidelines (BOEM 2023b) conduct tows no longer than 20 minutes in duration. The slow speed of mobile trawl gear and the short tow times further reduce the potential for entanglements or other interactions. Observations during mobile gear use have shown that entanglement or capture of large whale species is extremely rare (NMFS 2016). Therefore, entanglement risk to ESA-listed marine mammals as a result of trawl surveys is considered extremely unlikely.

Neuston sampling is conducted with a plankton net towed at slow speeds (~4 knots) for short periods (~10 minutes) in the top 1.6 feet (0.5 meter) of the water column. The Neuston net frame is typically small (i.e., 2.4 meters by 0.6 meters [7.8 feet by 1.9 feet]) in size, and the net is made of a fine micrometer mesh. Given the size of the net relative to the body size of ESA-listed marine mammals, no marine mammal entanglement is expected to occur from Neuston net sampling. Vertical net tows are anticipated to use a frame and net similar to that described for the Neuston net, but are pulled vertically through the water column. The risk presented to ESA-listed marine mammals would be the same as that for Neuston net sampling. Therefore, no ESA-listed marine mammal entanglement is expected from plankton and larval lobster surveys net tows.

The contribution of sampling gear under the Proposed Action would represent a very small portion of the overall and ongoing fishing activity in the Gulf of Maine (**Section 3.2.1.8**). The potential for marine mammals to interact with the gear and to become entangled is therefore extremely unlikely given the low probability of a marine mammals encountering Proposed Action related fisheries gear within the Gulf of Maine. Additionally, given the expected limited frequency and duration of project-related sampling surveys (**Table 6-11**) and the application of mitigation measures (**Section 3.3**), including the use of ropeless technology for all lobster trap surveys, marine mammal entanglement is highly unlikely and the risk is considered **discountable**. Therefore, mobile and stationary gear utilization as part of the Proposed Action sampling surveys **may affect, not likely to adversely affect** ESA-listed marine mammals.

6.6.1.2 Sea Turtles

All sea turtle species are at risk of entanglement with fishing gear. A primary threat to sea turtles is their unintended capture in fishing gear, which can result in drowning or cause injuries that lead to mortality (e.g., swallowing hooks). For example, trawl fishing is among the greatest continuing primary threats to the loggerhead turtle (NMFS and USFWS 2008) and sea turtles are also caught as bycatch in other fishing gear including longlines, hook and line, pound nets, pot/traps, and dredge fisheries. A substantial impact of commercial fishing on sea turtles is the entrapment or entanglement that occurs with a variety of fishing gear, including both mobile (i.e., trawl) and stationary (i.e., traps/pots).

The capture and mortality of sea turtles in bottom trawl fisheries is well documented (Henwood and Stuntz 1987; NMFS and USFWS 1991, 1992, 2008; NRC 1990). NOAA has prioritized reduction of sea turtle interactions with fisheries where these species occur. Finkbeiner et al. (2011) compiled sea turtle bycatch in U.S. fisheries and found that in the Atlantic, a mean estimate of 137,700 interactions, of which 4,500 were lethal, occurred annually since the implementation of bycatch mitigation measures; however, a vast majority of the interactions (98 percent) and mortalities (80 percent) occurred in the Southeast/Gulf of Mexico shrimp trawl fishery, although sampling inconsistencies and limitations should be considered when interpreting this data (NMFS 2014). While sea turtles are capable of remaining submerged for long periods of time, they appear to rapidly consume oxygen stores when entangled and forcibly submerged in fishing gear (Lutcavage and Lutz 1997). Incidentally captured individuals would most likely suffer stress and potential injury. However, the preponderance of available research (Epperly et al. 2002; Sasso and Epperly 2006) and anecdotal information from past trawl surveys indicates that limiting tow times to less than 30 minutes would likely eliminate the risk of death for incidentally captured sea turtles. The proposed trawls would be limited to ≤20 minutes of tow time in accordance with BOEM's Fisheries Guidelines (BOEM 2023b). The relatively short tow duration is expected to minimize the potential for interactions with sea turtles and pose a negligible risk of mortality. The proposed mitigation measures outlined in **Sections 3.3.7** and **3.3.9** would be expected to minimize the risk of serious injury and mortality from forced submergence for sea turtles caught in the bottom otter trawl survey gear. Where possible, turtles are disentangled and, if injured, may be brought back to rehabilitation facilities for treatment and recovery. This helps to reduce the rate of death from entanglement. Safe release, disentanglement protocols, and rehabilitation would help to reduce the severity of impacts of these interactions.

Stationary gear poses a risk of entanglement for ESA-listed sea turtle species due to interaction with lines and ropes. Of all the ESA-listed sea turtles included in this assessment, the leatherback seems to be the most vulnerable to entanglement in trap/pot fishing gear, possibly due to its physical characteristics, diving and foraging behaviors; and distributional overlap with the gear (NMFS 2016). Individuals entangled in pot gear generally have a reduced ability to forage, dive, surface, breathe, or perform other behaviors essential for survival (Balazs 1985). In addition to mortality, gear entanglement can restrict blood flow to extremities and result in tissue necrosis and death from infection. Individuals that survive may lose limbs or limb function, decreasing their ability to avoid predators and vessel strikes (NMFS 2016). In the event of a sea turtle capture, survey vessels would be required to carry adequate disentanglement equipment and crew trained in proper handling and disentanglement procedures (**Section 3.3.9.5**). However, no vertical buoy lines will be utilized for lobster trap surveys under the Proposed Action and sinking groundline will be used in between individual pots; these measures will effectively reduce the risk of entanglement in stationary gear for sea turtles.

As discussed previously, neuston sampling is typically conducted with a plankton net towed at slow speeds for short periods in the top portion of the water column using a small frame and fine micrometer mesh net. Although capture is possible, given the relatively small size of the net, the use of trained observers onboard, and the limited tow length duration, no sea turtle entanglement or capture is expected to occur from Neuston net sampling. Vertical net tows are anticipated to use a frame and net similar to that described for the Neuston net, but are pulled vertically through the water column. The risk presented to sea turtles would be the same as that for Neuston net sampling. Therefore, entanglement and capture risk due to the methodology presented for plankton and larval lobster surveys net tows is extremely unlikely for sea turtles.

Proposed Action-related sampling surveys will be of limited frequency and duration (**Table 6-11**), and the contribution of fisheries sampling gear under the Proposed Action would represent a very small portion of the overall and ongoing fishing activity in the Gulf of Maine (**Section 3.2.1.8**). The potential for sea turtles to interact with Proposed Action related gear and to become entangled or captures is considered extremely unlikely given the low probability of a sea turtle encountering Proposed Action related gear within the Gulf of Maine. As described in **Section 5.1.2**, sea turtle occurrences within the Action Area are generally rare, and the likelihood of an individual encountering fishing gear is likewise considered rare. The implementation of mitigation measures (**Section 3.3**) will further reduce entanglement risk to sea turtles. Because of this, entanglement and capture in sampling gear is extremely unlikely to occur and are considered **discountable**. Therefore, mobile and stationary gear utilization as part of the Proposed Action sampling surveys **may affect, not likely to adversely affect** ESA-listed sea turtles.

6.6.1.3 Marine Fish

Marine fish are susceptible to entanglement and capture in fishing gear. Atlantic sturgeon are susceptible to capture in trawl nets, which may result in injury or death. Non-lethal effects could include reduced fecundity and delayed or aborted spawning migrations (Collins et al. 2000; Moser et al. 2000; Moser and Ross 1995). Mortality rates of Atlantic sturgeon caught in otter trawl gear is very low and approaches zero percent (ASSRT 2007). Negative impacts on sturgeon resulting from trawling capture are related to tow speed and duration (Moser et al. 2000). The risk to the species is greatest where high fishing efforts occur in regions with high Atlantic sturgeon abundances. However, the use of trawl gear has been employed as a safe and reliable method to capture sturgeon, provided that the tow time is limited (NMFS 2014). The relatively short tow duration (≤20 minutes, in accordance with BOEM's Fisheries Guidelines [BOEM 2023b]) is expected to minimize the potential for interactions with Atlantic sturgeon and pose a negligible risk of mortality. Furthermore, in the event of an Atlantic sturgeon capture, survey vessels would be required to carry adequate disentanglement equipment and crew trained in proper handling and disentanglement procedures to reduce potential mortality. Trawl surveys under the Proposed Action will not be carried out in water depths shallower than 197 feet (60 meters) (**Section 3.3.9**), which will further minimize the potential for interaction with Atlantic sturgeon. Accidental capture resulting in the death of an individual, if it were to occur, would be considered a take. However, based on the implementation of mitigation measures (**Section 3.3.9**) and the very low rate of incidental capture in bottom trawl fisheries in the Gulf of Maine in water depths exceeding 60 m (197 feet) (Dunton et al. 2010), interaction resulting in capture or mortality with Proposed Action related trawl gear is considered extremely unlikely.

Atlantic salmon predominantly face risk of incidental capture in recreational angling in freshwater habitats in the Gulf of Maine (which is not included under the Proposed Action) (NMFS and USFWS 2020b). Interaction with bottom trawl gear may be possible during their transits to or from their feeding grounds in the North Atlantic or while on their feeding grounds (NMFS and USFWS 2019). However, based on the very low rate of incidental capture in bottom trawl fisheries in the Gulf of Maine (USASAC 2021), interaction resulting in capture or mortality with Proposed Action related trawl gear is considered extremely unlikely. Similar to that for Atlantic sturgeon described above, the relatively short tow duration (≤20 minutes) is expected to further minimize the potential for interactions with Atlantic salmon.

Stationary pots that are baited and pose a potential risk to Atlantic sturgeon and Atlantic salmon. However, fish traps and pots were not recorded as potential sources for capture of Atlantic sturgeon in the Northeast Fisheries Observer Program data (Dunton et al. 2015) and it is unlikely that either species would become entangled in the lines or pots. An analysis of salmon bycatch data from Pacific groundfish fisheries indicate nearly all (>99%) bycatch results from trawl fisheries, suggesting very little, if any, bycatch is attributable to tap/pot type gear (Witherell et al. 2002). While this study analyzed data outside of the Action Area, the results are interpreted to indicate similar (i.e., low) entrapment risk for Atlantic salmon due to trap and pot gear types associated with the Proposed Action.

As discussed previously, neuston sampling is typically conducted with a plankton net towed at slow speeds for short periods in the top portion of the water column using a small frame and fine micrometer mesh net. Although capture is theoretically possible during Neuston net sampling, given the relatively small size of the net, the limited tow length duration, and the low rate of surface behaviors exhibited by Atlantic sturgeon or Atlantic salmon, no ESA-listed fish entanglement or capture is expected to occur. Vertical net tows are anticipated to use a frame and net similar to that described for the Neuston net, but are pulled vertically through the water column. The risk presented to ESA-listed fish would be the same as that for Neuston net sampling. Therefore, entanglement and capture risk due to the methodology presented for plankton and larval lobster surveys net tows is extremely unlikely for ESA-listed fish.

Similar to that described for sea turtles, a number of monitoring and mitigation measures are designed to standardize Atlantic sturgeon handling and reporting procedures in response to an entanglement (**Section 3.3.9.6**). These measures will reduce impact to Atlantic sturgeon by ensuring that the handling of any sturgeon caught in fisheries sampling gear will not cause or exacerbate any direct injury to the animal. Sufficient training and proper technique will also reduce impacts to captured sturgeon by minimizing the time of handling and, therefore, the individuals' stress (Beardsall et al. 2013; Bartholomew and Bohnsack, 2005).

As discussed above, entanglement or capture of Atlantic sturgeon and Atlantic salmon in Proposed Action survey gear is considered extremely unlikely given the limited extent and short duration of Project-related fisheries monitoring surveys (**Table 6-11**), the low likelihood of interactions expected, and the application of mitigation measures (**Section 3.3.9**). Impacts from mobile and stationary gear utilization as part of the Proposed Action sampling surveys are **discountable** and, therefore, **may affect, not likely to adversely affect** Atlantic sturgeon and Atlantic salmon.

All activities that pose an entanglement or capture risk to ESA-listed fish would occur within and up to 22 km surrounding the Research Lease Area (**Section 3.1**). Because the Research Lease Area is approximately 40 km from shore, the anticipated location of gear placement would be approximately 18 km from the nearest point to shore. Because shortnose sturgeon are only present in the marine environment during their coastal migrations between rivers (**Section 5.1.3.3.2**), they are not expected to occur in the Research Lease Area or surrounding areas where gear will be deployed. Therefore, mobile and stationary gear utilization as part of the Proposed Action sampling surveys would have **no effect** on shortnose sturgeon.

6.7 Air Emissions

It is expected that the vessels, aircrafts, and equipment used during the site assessment and site characterization surveys would generate emissions that could affect air quality within the marine component of the Action Area. Most emissions would likely result from the proposed vessel and aircraft activities in the Action Area.

At this time, there is no information on the effects of air quality on ESA-listed marine mammal and sea turtle species that may occur in the marine component of the Action Area. Marine mammal and sea turtle exposures to air pollutant emissions during the proposed surveys are anticipated to be temporary and short term in duration. Given the fact that vessel exhausts and aircrafts used during the digital aerial surveys are located high above the water surface, and most survey activity will occur in the open ocean where exhaust will be readily dispersed by winds, the likelihood of individual animals being repeatedly exposed to high concentrations of airborne pollutants from vessels is extremely low, and changes in concentration at the water surface level are expected to be so small that they cannot be meaningfully measured.

On this basis, it is reasonable to conclude that any effects to ESA-listed marine mammals and sea turtles from these emissions will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are **insignificant.** Air emissions resulting from the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals and sea turtles. Atlantic sturgeon, Atlantic salmon, and shortnose sturgeon would not be exposed to airborne emissions, therefore this stressor would have **no effect** on ESA-listed fish.

6.8 Lighting

The Proposed Action would introduce mobile and stationary artificial light sources to the Action Area that would persist from dusk to dawn. Vessels would have deck and safety lighting, producing artificial light throughout the duration of the Proposed Action. The FLiDAR buoy may also have lighting on the top-side structure, though this would likely only affect a limited area around the buoy.

Artificial light has been shown to alter the invertebrate epifauna and fish community composition and abundance in proximity to human-made structures (Davies et al. 2015; McConnell et al. 2010; Nightingale et al. 2006). Artificial lighting may disrupt the diel migration (vertical distribution) of some prey species, including zooplankton, which may secondarily influence marine mammal distribution patterns (Orr et al. 2013). Observations at offshore oil rigs showed dolphin species foraging near the surface and staying for longer periods of time around platforms that were lit (Cremer et al. 2009). Artificial light in coastal environments is an established stressor for juvenile sea turtles, which use light to aid in navigation and dispersal and can become disoriented when exposed to artificial lighting sources, but the significance of artificial light in offshore environments is less clear (Gless et al. 2008). Finfish impacts due to artificial light are highly species dependent and can either cause attraction or avoidance (Orr et al. 2013).

Collectively, these findings suggest the potential for effects on ESA-listed marine mammal, sea turtle, and fish species as a result of artificial lighting. Overall, these effects would be localized and limited to the area exposed to operational lights from the vessels and FLiDAR buoy. Orr et al. (2013) indicate that lights on offshore structures that flash intermittently for navigation or safety purposes and do not present a continuous light source. Limpus (2006) suggested that intermittent flashing lights with a very short “on” pulse and long “off” interval are non-disruptive to marine turtle behavior, irrespective of the color. Similarly, navigation and anchor lights on top of vessel masts are unlikely to adversely affect sea turtles (Limpus 2006). Atlantic sturgeon, Atlantic salmon, and shortnose sturgeon are demersal species and are unlikely to encounter the minimal lighting generated by the Proposed Action.

Orr et al. (2013) summarized available research on potential operational lighting effects from offshore structures and concluded that the operational lighting effects on marine mammal, marine turtle, and fish distribution, behavior, and habitat use were unknown but likely negligible when recommended design and operating practices are implemented. Specifically, using low-intensity shielded directional lighting on structures, activating work lights only when needed, and using red navigation lights with low strobe frequency would reduce the amount of detectable light reaching the water surface to negligible levels.

Based on the available information, effects of lighting of vessels and the FLiDAR buoy on ESA-listed marine mammals, sea turtles, and fish leading to changes in behavior and alterations in prey distribution would be too small to be meaningfully measured or detected and, therefore, **insignificant**. Given the small scale of effects, the effects of lighting associated with the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals, sea turtles, and fish.

6.9 Non-Routine Events

In this section, BOEM considers the “low probability events" that were identified by BOEM in Section 2.2.2 of the Draft EA. These events, while not part of the Proposed Action, include storms, allisions and collisions, spills, and recovery of lost survey equipment.

6.9.1 Storms

Severe weather events have the potential to cause structural damage and injury to personnel. Major storms, winter nor’easters, and hurricanes pass through the area regularly, resulting in elevated water levels (storm surge) and high waves and winds. Storm surge and wave heights from passing storms are worse in shallow water and along the coast but can pose hazards in offshore areas. The Atlantic Ocean hurricane season extends from June 1 to November 30, with a peak in September; hurricanes would be most likely to occur in the Action Area during this time. Storms could contribute to an increased likelihood of allisions and collisions that could result in a spill. However, the storm would cause the spill and its effects to dissipate faster, vessel traffic is likely to be significantly reduced in the event of an impending storm, and surveys related to the Proposed Action would be postponed until after the storm has passed. Although storms have the potential to affect the FLiDAR buoy, the structures are designed to withstand storm conditions. Though unlikely, structural failure of a FLiDAR buoy could result in a temporary hazard to navigation.

Storms in the Action Area resulting in potential structural failures of the FLiDAR buoy are not likely to effect ESA-listed marine mammals, sea turtles, or fish, and therefore **no effect** is expected for any species.

6.9.2 Allisions and Collisions

An allision occurs when a moving object (i.e., a vessel) strikes a stationary object (e.g., FLiDAR buoy); a collision occurs when two moving objects strike each other. The presence of the FLiDAR buoy in the Research Lease Area could pose a risk to vessel navigation. An allision between a vessel and the FLiDAR buoy could result in the damage or loss of the buoy and/or the vessel, as well as loss of life and spillage of petroleum product. Vessels conducting site assessment and site characterization activities could collide with other vessels, resulting in damages, petroleum product spills, or capsizing. Collisions between vessels and allisions between vessels and the FLiDAR buoy are considered unlikely because vessel traffic is subject to USCG Navigation Rules and Regulations and controlled by multiple routing measures, such as safety fairways, traffic separation schemes, and anchorages for vessels transiting into and out of the ports of Maine and the other New England states. Risk of allisions with FLiDAR buoys would be further reduced by USCG-required marking and lighting.

As explained in BOEM’s decision memorandum regarding the RFCI on August 17, 2022, in order to minimize the potential for conflicts identified by USCG in locating Maine’s proposed project in proximity to the existing traffic separation scheme (**Figure 6-1**), BOEM will consider issuance of no more than one lease within the Research Lease Area, and that lease will neither exceed 10,000 acres (40 km^2) nor support more than 12 floating wind turbine generators. BOEM also expanded the Research Lease Area beyond the preferred location (referred to as the Narrowed Area of Interest) identified in the State of Maine’s request for the research lease to provide more siting options should the preferred location be determined unsuitable. These measures are anticipated to minimize the potential for conflicts during all stages of the project, including site assessment and site characterization activities, which would result in only a temporary and negligible increase in vessel traffic in proximity to the traffic separation schemes.

BOEM anticipates that aerial surveys would not be conducted during periods of storm activity because the reduced visibility conditions would not meet visibility requirements for conducting the surveys; flying at low elevations would pose a safety risk during storms and times of low visibility.

Allisions and collisions of vessels and aircrafts under the Proposed Action with the FLiDAR buoy are not likely to affect ESA-listed marine mammals, sea turtles, or fish, and therefore **no effect** is expected for any species.

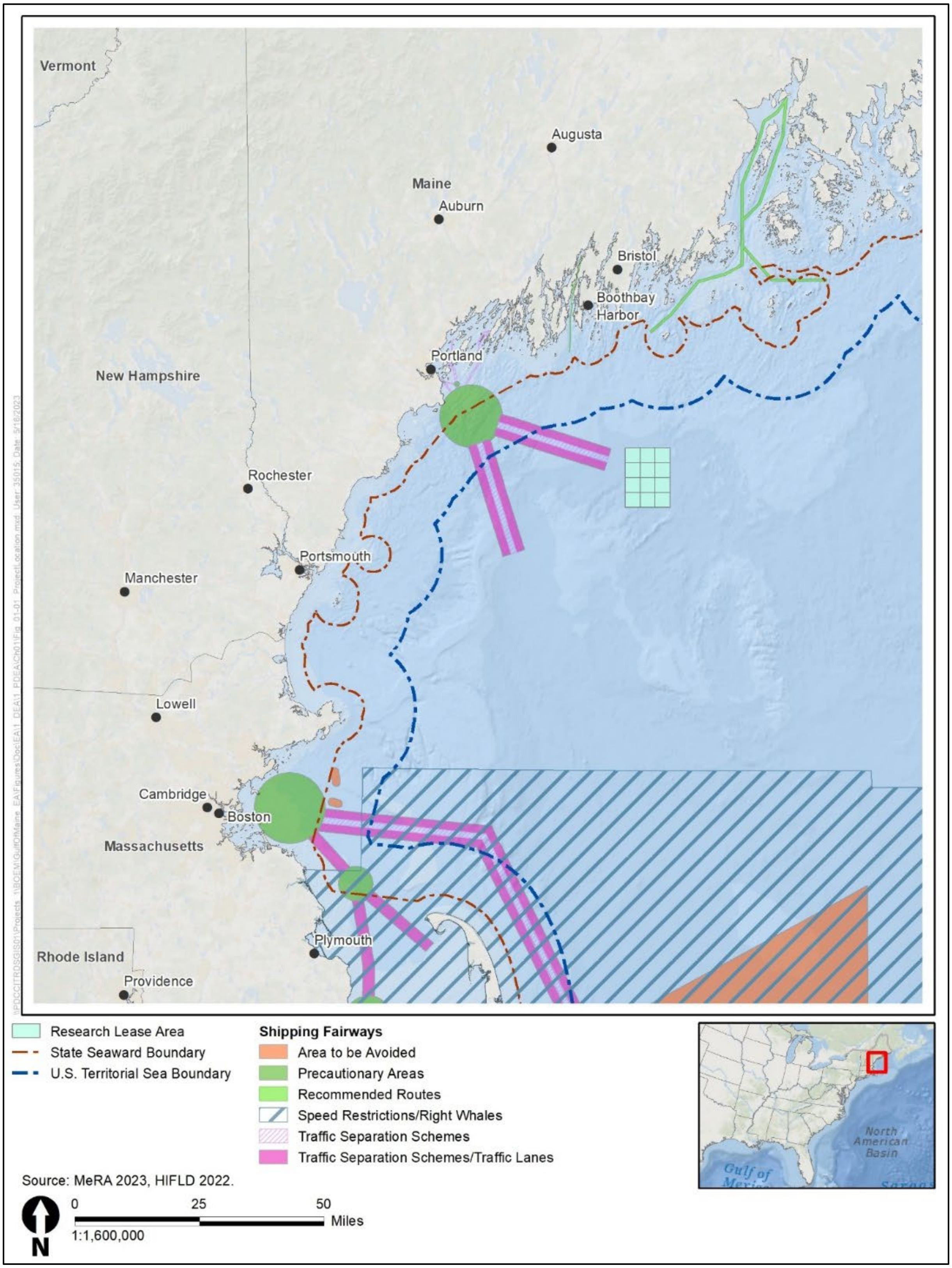


Figure 6-1. Location of the traffic separation schemes and traffic lanes in the Action Area

6.9.3 Spills

A spill of petroleum product could occur as a result of hull damage from allisions with a FLiDAR buoy, collisions between vessels, accidents during the maintenance or transfer of offshore equipment and/or crew, or natural events (i.e., strong waves or storms). From 2011 to 2021, the average spill size for vessels other than tank ships and tank barges was 95 gallons (360 liters) (USCG, 2022); should a spill from a vessel associated with the Proposed Action occur, BOEM anticipates that the volume would be similar.

Diesel fuel is lighter than water and may float on the water's surface or be dispersed into the water column by waves. Diesel would be expected to dissipate very rapidly, evaporate, and biodegrade within a few days (MMS, 2007). NOAA's Automated Data Inquiry for Oil Spills (an oil weathering model) was used to predict dissipation of a maximum spill of 2,500 barrels (105,000 gallons or 397,468 liters), a spill far greater than what is assumed as a non-routine event during the Proposed Action. Results of the modeling analysis showed that dissipation of spilled diesel fuel is rapid. The amount of time it took to reach diesel fuel concentrations of less than 0.05 percent varied between 0.5 and 2.5 days, depending on ambient wind (Tetra Tech Inc., 2015), suggesting that 95 gallons (360 liters) would reach similar concentrations much faster and limit the environmental impact of such a spill.

Vessels are expected to comply with USCG requirements relating to prevention and control of oil spills. Solar panels would be the primary source of power for equipment on the FLiDAR buoy, with backup energy supplied by methanol fuel cells in the hull, which would minimize the volume of oil and fuel that could be released in the event of a spill. BOEM expects that each of the vessels involved with site assessment and site characterization activities would minimize the potential for a release of oils and/or chemicals in accordance with 33 Code of Federal Regulations (CFR) Part 151, 33 CFR Part 154, and 33 CFR Part 155, which contain guidelines for implementation and enforcement of vessel response plans, facility response plans, and shipboard oil pollution emergency plans. Based on the size of the spill, it would be expected to dissipate very rapidly and would then evaporate and biodegrade within a day or two (at most), limiting the potential impacts to a localized area for a short duration.

Marine mammals are susceptible to the effects of contaminants from pollution and spills, which can lead to issues in reproduction and survivorship, and other health concerns (e.g., Pierce et al., 2008; Jepson et al., 2016; Hall et al., 2018; Murphy et al., 2018). All vessels would be expected to comply with USCG requirements relating to prevention and control of oil and fuel spills. Any spills associated with the Proposed Action would be an isolated event with rapid dissipation; impacts on marine mammals would be unlikely to occur and therefore **discountable**. Effects of spills under the Proposed Action therefore may affect, not likely to adversely affect ESA-listed marine mammals.

Similar to marine mammals, sea turtles are also susceptible to the effects of contaminants from pollution and spills, which can lead to issues in reproduction and survivorship, and other health concerns (e.g., Pierce et al., 2008; Jepson et al., 2016; Hall et al., 2018; Murphy et al., 2018). All vessels would be expected to comply with USCG requirements relating to prevention and control of oil and fuel spills. Any spills associated with the Proposed Action would be an isolated event with rapid dissipation; impacts on sea turtles would be unlikely to occur and therefore **discountable**. Effects of spills under the Proposed Action therefore may affect, not likely to adversely affect ESA-listed sea turtles.

Exposure to aquatic contaminants or inhalation of fumes from oil spills can result in mortality or sublethal effects on the affected ESA-listed fish, including adrenal effects, hematological effects, liver effects, lung disease, poor body condition, skin lesions, and several other health affects attributed to oil exposure (Mohr et al. 2008; Sullivan et al. 2019; Takeshita et al. 2017). All vessels would be expected to comply with USCG requirements relating to prevention and control of oil and fuel spills. Any spills associated with the Proposed Action would be an isolated event with rapid dissipation; impacts on Atlantic sturgeon, Atlantic salmon, or shortnose sturgeon would be unlikely to occur and therefore **discountable**. Effects of spills under the Proposed Action therefore may affect, not likely to adversely affect ESA-listed fish.

Water quality effects resulting from activities under the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals, sea turtles, fish.

6.9.4 Recovery of Lost Survey Equipment

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

Marine debris, such as lost survey equipment, that cannot be retrieved because it is either small or buoyant enough to be carried away by currents or is completely or partially embedded in the seafloor (for example, a broken vibracore rod) could create a potential hazard for bottom-tending fishing gear or cause additional bottom disturbance. A broken vibracore rod that cannot be retrieved may need to be cut and capped 1 to 2 m below the seafloor. For marine debris unable to be recovered within 48 hours, BOEM will work with the operator to develop a recovery plan as specified in **Section 3.3** developed through BOEM's programmatic ESA consultation with NMFS for data collection activities (BOEM 2021c). Selection of a mitigation strategy would depend on the nature of the lost equipment, and further consultation may be necessary.

Other impacts associated with recovery of marine debris such as lost survey equipment may include vessel traffic, noise and lighting, air emissions, and routine vessel discharges from a single vessel.

The recovery of lost equipment could affect marine mammals and sea turtles through additional vessel traffic and noise and the potential impact from entanglement stemming from the dragging of grapnel lines. Traffic and noise associated with non-routine activities likely would be from a single vessel and therefore **discountable**. The extent of impacts from the grapnel lines would be dependent upon the type of lost equipment, which would dictate the number of attempts made at recovery. Regardless, the potential for marine mammals or sea turtles to interact with the grapnel line and to become entangled is extremely unlikely given the low probability of a marine mammal or sea turtle encountering the line within the Action Area; therefore, impacts are expected to be **discountable**. Effects of recovery of lost survey equipment under the Proposed Action therefore **may affect, not likely to adversely affect** ESA-listed marine mammals and sea turtles.

The extent of impacts on ESA-listed fish would depend on the type of lost equipment and if it can be recovered. The larger the equipment lost, or the more costly it would be to replace, would dictate the number of attempts made at recovery, affecting the size of the resultant impact area and time spent searching. When equipment is not able to be retrieved, bottom disturbance may occur if the equipment interacts with the seafloor and is moved by bottom currents. However, the entanglement risk in grapnel lines is likely so low that it is non-measurable for Atlantic sturgeon, Atlantic salmon, and shortnose sturgeon. Similarly, any benthic disturbance would likely be extremely minimal and have very little, if any, effect on ESA-listed fish. The impacts resulting from the recovery of lost equipment are unlikely to occur for Atlantic salmon and would be **discountable**; impacts would not be expected to be meaningfully measured, detected, or evaluated for Atlantic sturgeon or shortnose sturgeon and would be **insignificant**. Effects of recovery of lost survey equipment under the Proposed Action therefore **may affect, not likely to adversely affec**t ESA-listed fish.

7 Effects of the Action on the Critical Habitat

In this section, BOEM considers the possible effect from the Proposed Action on the critical habitats found in the Action Area. The critical habitats associated with the following species will be considered for further analysis: North Atlantic right whale Unit 1 and Atlantic salmon – Gulf of Maine DPS. Detailed information about each critical habitat can be found in **Section 5.2**. Table 7-1 shows the stressors that may affect critical habitats for ESA-listed species considered in this BA.

Table 7-1. Stressors that are not likely to adversely affect designated critical habitat

Stressor		NARW Unit 1	Atlantic Salmon Gulf of Maine DPS
Underwater Noise	Geophysical Reconnaissance Survey Noise	NLAA	NE
	Active Acoustic Survey Noise	NLAA	NE
	Seafloor Habitat Characterization Survey Equipment Noise	NLAA	NE
	Vessel Noise	NLAA	NE
	Geotechnical Sampling Noise	NLAA	NE
	HRG Survey Noise	NLAA	NE
Vessel strike		NE	NE
Habitat Disturbance	Temporary Seafloor Disturbances	NE	NLAA
	Turbidity	NLAA	NLAA
	Behavioral Changes due to the Presence of Structures	NE	NE
Entanglement and Capture		NLAA	NE
Air Emissions		NE	NE
Lighting		NE	NE
Non-Routine Events	Storms	NE	NE
	Allisions and Collisions	NE	NE
	Spills	NLAA	NE
	Recovery of Lost Survey Equipment	NE	NLAA
Overall Effects Determination		NLAA	NLAA

DPS = distinct population segment; HRG = high-resolution geophysical; NARW = North Atlantic right whale; NE = no effect; NLAA = not likely to adversely affect

7.1 North Atlantic Right Whale Critical Habitat

Given the overlap between NARW critical habitat for the Gulf of Maine foraging habitat Unit 1 (**Section 5.2.1**) and the Action Area, all Project-related vessels and survey activities would operate entirely within designated NARW critical habitat. As mentioned above in **Section 5.2.1** the PBFs essential to the conservation of the North Atlantic right whale all address the factors associated with NARW prey concentrations and availability. Activities from the Proposed Action that would have **no effect** on NARW critical habitat Unit 1 PBFs include vessel strike, temporary seafloor disturbance, behavioral change due to structures, air emissions, lighting, storms, allisions and collisions, and recovery of lost survey equipment (**Table 7-1**).

Increases in underwater noise as a result of the vessel traffic, vessel noise, and associated survey activities (HRG surveys, geotechnical surveys, benthic sampling) are not expected to result in any long-term impacts to prey availability for NARW. As discussed above, the number of proposed Project-related vessels and associated survey noise would add to the existing high levels of commercial and recreational vessel traffic in the region. However, vessel transits and survey activities within Unit 1 as a result of the Proposed Action would not affect or modify the biological or physical oceanographic conditions associated with foraging area functions (i.e., the distribution and aggregations of *C. finmarchicus*).

Minimal data are available for zooplankton responses to anthropogenic sound. A 2022 study (Guihen et al. 2022) found an avoidance of Antarctic krill species to the presence of an autonomous glider carrying a single beam echosounder. However, these disturbances had small ranges (i.e., the observed avoidance response extended approximately 66 to 131 feet [20 to 40 meters] as the glider passed) and may be the result of several factors not limited to acoustic avoidance, including visual cues, wake and bow wave turbulence, and simulated bioluminescence (Guihen et al. 2022). Given this, any disturbances resulting from Project activities on the essential features and foraging resources within Unit 1 of the NARW critical habitat would be so low as to be undetected and **insignificant**. Therefore, the effects vessel transits and survey noise from the Proposed Action on NARW critical habitat **may affect, not likely to adversely affect** NARW critical habitat.

Other stressors that may have temporary impacts to NARW PBFs include turbidity associated with benthic sampling and the possibility of spills as a non-routine event. Turbidity could occur due to benthic disturbance from the Proposed Action as discussed in **Section 6.5.2** and would be the result of benthic cores and/or placement of met buoy moorings. NARWs feed almost exclusively on copepods (**Section 5.1.1.2**). Copepods exhibit diel vertical migration; that is, they migrate downward out of the euphotic zone at dawn, presumably to avoid being eaten by visual predators, and they migrate upward into surface waters at dusk to graze on phytoplankton at night (Baumgartner and Fratantoni 2008; Baumgartner et al. 2011). Baumgartner et al. (2011) conclude that there is considerable variability in this behavior and that it may be related to stratification and presence of phytoplankton prey with some copepods in the Gulf of Maine remaining at the surface and some remaining at depth. Because copepods even at depth are not in contact with the substrate, no burial or loss of copepods is anticipated during any project activity. No scientific literature could be identified that evaluated the effects on marine copepods resulting from exposure to TSS. Based on what is known about effects of TSS on other aquatic life, it is possible that high concentrations of TSS could negatively affect copepods. However, given that 1) the expected TSS levels are below those that are expected to result in effects on even the most sensitive species evaluated; 2) the sediment plume would be transient and temporary; and 3) elevated TSS plumes would occupy only a miniscule portion of the Action Area at any given time; any effects on copepod availability, distribution, or abundance on foraging whales would be so small that they could not be meaningfully evaluated, measured, or detected and **insignificant**. Therefore, increased turbidity associated with the Proposed Action **may affect, not likely to adversely affect** NARW critical habitat.

The only sampling gear that has the potential to affect NARW critical habitat is the plankton and larval lobster surveys net tows by capture of preferred NARW prey (*C. finmarchicus*). However, given the limited duration and extent of planktonic sampling associated with the Proposed Action, capture, removal, or dispersal of *C. finmarchicus* is expected to be so small that it cannot be meaningfully measured, evaluated, or detected. Any effects to NARW critical habitat PBFs are thus considered **insignificant**. Therefore, the Proposed Action sampling surveys **may affect, not likely to adversely affect** NARW critical habitat.

The potential for spills is discussed in **Section 6.9.3** resulting from unexpected collisions with met buoys and/or the highly unlikely event of vessel collisions. While the impact of any fuel/oil spill would be unfortunate, the small spatial scale of a spill, limited amounts of the spill, the highly dynamic nature of the marine oceanography, and the implementation of mitigation measures applied would likely be so low as to be undetected and **insignificant**. Therefore, effects of spills from the Proposed Action **may affect, not likely to adversely affect** NARW critical habitat.

7.2 Atlantic Salmon Critical Habitat – Gulf of Maine DPS

Activities included under the Proposed Action which could overlap with the Atlantic salmon designated critical habitat are surveys along potential cable routes in Sheepscot Bay (Sheepscot Bay Unit) and Project vessels which are expected to occur within the bays at the mouth of Sheepscot River and Medomak River (Medomak River Unit) (**Figure 5-12**). No additional overlap between Atlantic salmon critical habitat and project activities will occur under the Proposed Action. Activities from the Proposed Action that would have **no effect** on Atlantic salmon critical habitat PBFs include underwater noise, vessel strike, behavioral change due to structures, entanglement and capture, air emissions, lighting, storms, allisions and collisions, and spills (**Table 7-1**).

It is not expected that any Project vessels will transit upriver into Sheepscot River, so vessel activity would be limited to Sheepscot Bay for vessels utilizing ports in Boothbay, Maine. As shown in **Table 3-6**, only 5 vessels will utilize this home port, equating to a total of 442 round trips over the 6-year period between Quarter 1 2023 and anticipated RAP approval in February 2029 (which includes the survey period for all activities). Surveys along the proposed export cable routes in Sheepscot Bay would occur in the bay and river up to the tip of Westport, Maine, and come back down Back River to reach the Maine Yankee Substation (**Figure 3-1**), which overlaps with a portion of that critical habitat unit (**Figure 5-12**). Various survey activities (described in **Section 3.1.2**) would occur along the proposed export cable routes between Quarter 1 2023 and anticipated RAP approval in February 2029. In addition, only vessels utilizing ports in Bristol, Maine may overlap with the Medomak River Unit critical habitat. However, all transits will be in the bays surrounding Pemaquid Peninsula and no upriver transits are expected. A single commercial lobster boat would conduct up to 110 round trips over a 6-year period (September 2024 through RAP approval) from Bristol ports (**Table 3-6**).

The only activities that would potentially affect the PBFs of the critical habitat identified in **Section 5.2.2** are those that disturb the seafloor which are limited to vessel anchoring, coring samples taken to support the geotechnical surveys (**Section 3.1.2.3**), benthic grabs conducted in support of the benthic surveys (**Section 3.1.2.4**) and seafloor habitat characterization surveys (**Section 3.1.2.5**), and recovery of lost survey equipment (**Section 6.9.4**). Any potential vessel anchoring occurring within the critical habitat would be limited to vessels docked at the home port in Boothbay, Maine, which would comprise a nominal portion of the overall Sheepscot Bay unit critical habitat (**Figure 5-12**). Vessel anchoring is not anticipated in the Medomak River Unit critical habitat. Sampling activities which disturb the seafloor could disturb up to several square meters of area per sample taken over a maximum 7-month period for the geotechnical and benthic surveys, and over 12 trips per year for the seafloor habitat characterization surveys. However, it is worth noting that the survey effort described in **Section 3.1.2** includes surveys in the Research Lease Area and wet storage area as well as the proposed cable routes, so the total number of samples required for just the cable routes alone may be a smaller subset of this larger survey scope. Further, the area of impact associated with the recovery of lost survey equipment would be so small as to not be meaningfully detected. As discussed in **Section 6.5.1**, only temporary disturbances, which may include elevated turbidity, are expected, and after the survey activities are completed, the areas of temporary disturbance and elevated turbidity would return to the baseline state.

Given the limited extent of effects and the likelihood of rapid recovery to baseline conditions, the effects of seafloor disturbance and turbidity from the Proposed Action are likely to be **insignificant** and **may affect, not likely to adversely affect** Atlantic salmon critical habitat**.**

8 Summary of Effects Determinations and Conclusion

Table 8-1 summarizes the effects determinations for ESA-listed marine mammals, sea turtles, and fish species, and **Table 8-2** summarizes the effects determinations for critical habitat considered in this BA. The following three effects determinations were made:

A **may affect, not likely to adversely affect** determination was made when the Project stressors were determined to be **insignificant** or **discountable**:

- **Insignificant**: Effects relate to the size or severity of the effect and include effects that are undetectable, not measurable, or so minor they cannot be meaningfully evaluated. Insignificant is the appropriate effects conclusion when plausible effects are going to happen but will not rise to the level of constituting an adverse effect.
- **Discountable:** Effects that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and would be an adverse effect if it affected an ESA-listed species), but it is extremely unlikely to occur (NMFS and USFWS 1998).[6]

---

[6] When the terms "discountable" or "discountable effects" appear in this document, they refer to potential effects that are found to support a "not likely to adversely affect" conclusion because they are extremely unlikely to occur. The use of these terms should not be interpreted as having any meaning inconsistent with the ESA regulatory definition of "effects of the action."

Table 8-1. Effects determinations by stressor and species for effects from the Proposed Action

Stressor		Marine Mammals					Sea Turtles				Marine Fish		
		Fin Whale	**North Atlantic Right Whale**	**Sei Whale**	**Sperm Whale**	**Blue Whale**	**Green Sea Turtle (North Atlantic DPS)**	**Leatherback Sea Turtle**	**Loggerhead Sea Turtle (Northwest Atlantic DPS)**	**Kemp's Ridley Sea Turtle**	**Atlantic Sturgeon**	**Atlantic Salmon**	**Shortnose Sturgeon**
Underwater Noise	Geophysical Reconnaissance Survey Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	NE	NE	NE	NE
	Active Acoustic Survey Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	NE	NE	NE	NE
	Seafloor Habitat Characterization Survey Equipment Noise	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Vessel Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Geotechnical Sampling Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	HRG Survey Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Vessel Strike		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA
Habitat Disturbance	Temporary Seafloor Disturbances	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Turbidity	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Behavioral Changes due to the Presence of Structures	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Entanglement and Capture		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE
Air Emissions		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE
Lighting		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Non-Routine Events	Storms	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Allisions and Collisions	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Spills	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Recovery of Lost Survey Equipment	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Overall Effects Determination		NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA

DPS = distinct population segment; HRG = high-resolution geophysical; NARW = North Atlantic right whale; NE = no effect; NLAA = not likely to adversely affect

Table 8-2. Effects determinations by stressor and critical habitat for effects from the Proposed Action

Stressor		NARW Unit 1	Atlantic Salmon Gulf of Maine DPS
Underwater Noise	Geophysical Reconnaissance Survey Noise	NLAA	NE
	Active Acoustic Survey Noise	NLAA	NE
	Seafloor Habitat Characterization Survey Equipment Noise	NLAA	NE
	Vessel Noise	NLAA	NE
	Geotechnical Sampling Noise	NLAA	NE
	HRG Survey Noise	NLAA	NE
Vessel strike		NE	NE
Habitat Disturbance	Temporary Seafloor Disturbances	NE	NLAA
	Turbidity	NLAA	NLAA
	Behavioral Changes due to the Presence of Structures	NE	NE
Entanglement and Capture		NLAA	NE
Air Emissions		NE	NE
Lighting		NE	NE
Non-Routine Events	Storms	NE	NE
	Allisions and Collisions	NE	NE
	Spills	NLAA	NE
	Recovery of Lost Survey Equipment	NE	NLAA
Overall Effects Determination		NLAA	NLAA

DPS = distinct population segment; HRG = high-resolution geophysical; NARW = North Atlantic right whale; NE = no effect; NLAA = not likely to adversely affect

9 References

Agler, B.A., R.L. Schooley, S.E. Frohock, S.K. Katona, and I.E. Seipt. 1993. Reproduction of Photographically Identified Fin Whales, *Balaenoptera physalus*, from the Gulf of Maine. *Journal of Mammalogy* 74(3):577-587.

AKRF I, AECOM, Popper A. 2012. Essential Fish Habitat Assessment for the Tappan Zee Hudson River Crossing Project, Rockland and Westchester Counties, New York and the Historic Area Remediation Site, New York Bight Apex.

Albouy, C., Delattre, V., Donati, G., Frölicher, T.L., Albouy-Boyer, S., Rufino, M., Pellissier, L., Mouillot, D. and Leprieur, F., 2020. Global vulnerability of marine mammals to global warming. *Scientific reports*, *10*(1), p.548.

Aldvén D., E. Degerman, and J. Höjesjö. 2015. Environmental cues and downstream migration of anadromous brown trout (Salmo trutta) and Atlantic salmon (Salmo salar) smolts.

Altenritter, M. E., G. B. Zydlewski, M. T. Kinnison, J. D. Zydlewski, and G. S. Wippelhauser. 2018. Understanding the basis of shortnose sturgeon (Acipenser brevirostrum) partial migration in the Gulf of Maine. Canadian Journal of Fisheries and Aquatic Sciences 75(3):464–473.

Andersson, M. H., Dock-Åkerman, E., Ubral-Hedenberg, R., Öhman, M. C., & Sigray, P. (2007). Swimming behavior of roach (Rutilus rutilus) and three-spined stickleback (Gasterosteus aculeatus) in response to wind power noise and single-tone frequencies. Ambio, 36(8), 636.

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

André, M., Kaifu, K., Solé, M., van der Schaar, M., Akamatsu, T., Balastegui, A., Sánchez, A. M., & Castell, J. V. (2016). Contribution to the Understanding of Particle Motion Perception in Marine Invertebrates. In A. N. Popper & A. Hawkins (Eds.), The effects of noise on aquatic life II (pp. 47-55). Springer New York.

Aoki, K., M. Amano, M. Yoshioka, K. Mori, D. Tokuda, and N. Miyazaki. 2007. Diel diving behavior of sperm whales off Japan. *Marine Ecology Progress Series* 349:277-287.

Atlantic States Marine Fisheries Commission (ASMFC). 2017. *Atlantic Sturgeon Benchmark Stock Assessment and Peer Review Report*. Raleigh, North Carolina: Prepared by the ASMFC Atlantic Sturgeon Stock Assessment Peer Review Panel. Pursuant to NOAA Award No. NA15NMF4740069. 456 p.

Atlantic Sturgeon Status Review Team (ASSRT). 2007. *Status review of Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus)*. Report to the U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, Northeast Regional Office. 174 p.

Azzara, A. J., von Zharen, W. M., & Newcomb, J. J. (2013). Mixed-methods analytic approach for determining potential impacts of vessel noise on sperm whale click behavior. The Journal of the Acoustical Society of America, 134(6), 4566-4574.

Bailey, H., S.R. Benson, G.L. Shillinger, S.J. Bograd, P.H. Dutton, S.A. Eckert, S.J. Morreale, F.V. Paladino, T. Eguchi, and D.G. Foley. 2012. Identification of distinct movement patterns in Pacific leatherback turtle populations influenced by ocean conditions. *Ecological Applications* 22(3):735-747.

Bailey, H., A. Rice, J. Wingfield, K. Hodge, B. Estabrook, D. Hawthorne, A. Garrod, A. Fandel, L. Fouda, E. Mcdonald, E. Grzyb, W. Fletcher and A. Hoover. 2018. *Determining habitat use by marine mammals and ambient noise levels using passive acoustic monitoring offshore of Maryland*. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-018. 232 p.

Baille, L. M., & Zitterbart, D. P. (2022). Effectiveness of surface-based detection methods for vessel strike mitigation of North Atlantic right whales. Endangered Species Research, 49, 57-69.

Bain, M.B. 1997. Atlantic and Shortnose Sturgeons of the Hudson River: Common and Divergent Life History Attributes. *Environmental Biology of Fishes* 48:347–358.

Baker, K., and U. Howsen. 2021. *Data Collection and Site Survey Activities for Renewable Energy on the Atlantic Outer Continental Shelf. Biological Assessment*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. October 2018, Revised February 2021. 152 p.

Balazik, M. T., Reine, K. J., Spells, A. J., Fredrickson, C. A., Fine, M. L., Garman, G. C., & McIninch, S. P. (2012). The Potential for Vessel Interactions with Adult Atlantic Sturgeon in the James River, Virginia. North American Journal of Fisheries Management, 32(6), 1062-1069.

Balazs, G.H. 1985. Impact of ocean debris on marine turtles: entanglement and ingestion. In: *Proceedings of the workshop on the fate and impact of marine debris.* NOAA Technical memorandum 54. National Marine Fisheries Service, Honolulu, pp 387–429.

Balch, W.M., Drapeau, D.T., Bowler, B.C., Record, N.R., Bates, N.R., Pinkham, S., Garley, R. and Mitchell, C., 2022. Changing hydrographic, biogeochemical, and acidification properties in the Gulf of Maine as measured by the Gulf of Maine North Atlantic Time Series, GNATS, between 1998 and 2018. *Journal of Geophysical Research: Biogeosciences*, *127*(6), p.e2022JG006790.

Bardonnet, A., and J.-L. Baglinière. 2000. Freshwater Habitat of Atlantic salmon (*Salmo salar*). *Canadian Journal of Fisheries and Aquatic Sciences* 57(2):497-506.

Bartholomew, A. and Bohnsack, J.A., 2005. A review of catch-and-release angling mortality with implications for no-take reserves. Reviews in Fish Biology and Fisheries, 15, pp.129-154.

Bartol, S.M., J.A. Music, and M. Lenhardt. 1999. Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). *Copeia* 3:836-840.

Bartol S.M., and D.R. Ketten. 2006. Turtle and tuna hearing. In: Y Swimmer, R Brill (Eds.), Sea turtle and pelagic fish sensory biology: Developing techniques to reduce sea turtle bycatch in longline fisheries. U.S. Department of Commerce, National Oceanographic and Atmospheric Administration: Technical Memorandum NMFS-PIFSC-7. pp. 8.

Bartol, S.M., and Bartol, I.K. 2011. Hearing capabilities of loggerhead sea turtles (Caretta caretta) throughout ontogeny: An integrative approach involving behavioral and electrophysiological techniques. Final report; JIP Grant No.22 07-14. E&P Sound and Marine Life Programme. 37 pages.

Baum, E. 1997. *Maine Atlantic Salmon: A National Treasure*. Atlantic Salmon Unlimited, Hermon, ME. 224 pp.

Baumgartner, M.F. and Fratantoni, D.M., 2008. Diel periodicity in both sei whale vocalization rates and the vertical migration of their copepod prey observed from ocean gliders. *Limnology and Oceanography* 53(5part2): 2197-2209.

Baumgartner, M.F., N.S.J. Lysiak, C. Schuman, J. Urban-Rich, and F.W. Wenzel. 2011. Diel vertical migration behavior of Calanus finmarchicus and its influence on right and sei whale occurrence. *Marine Ecology Progress Series* 423:167-184.

Baumgartner, M.F., F.W. Wenzel, N.S. Lysiak, and M.R. Patrician. 2017. North Atlantic right whale foraging ecology and its role in human-caused mortality. *Marine Ecology Progress Series* 581:165-181.

Beardsall, J.W., McLean, M.F., Cooke, S.J., Wilson, B.C., Dadswell, M.J., Redden, A.M. and Stokesbury, M.J., 2013. Consequences of incidental otter trawl capture on survival and physiological condition of threatened Atlantic sturgeon. Transactions of the American Fisheries Society, 142(5), pp.1202-1214.

Benson, P., & Enterline, C. (2021). Interim 2021 Memo Report: Seafloor Mapping and Field Sampling in Casco Bay, Maine.

Bevan, E., T. Wibbels, B. Najera, L. Sarti, F. Martinez, J. Cuevas, B. Gallaway, L. Pena, and P. Burchfield. 2016. Estimating the historic size and current status of the Kemp's ridley sea turtle (*Lepidochelys kempii*) population. *Ecosphere* 7(3):e01244.

Biodiversity of the Central Coast. 2022. Eelgrass, common eelgrass, Zostera marina. Available at: https://www.centralcoastbiodiversity.org/eelgrass-bull-zostera-marina.html. Accessed December 28, 2022.

Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. In: P. L. Lutz and J. A. Musick (Eds.), *The biology of sea turtles*. Boca Raton, Florida: CRC Press. pp. 213-246.

Bonfil, R., S. Clarke, and H. Nakano. 2008. Chapter 11: The Biology and Ecology of the Oceanic Whitetip Shark, *Carcharhinus longimanus*. In: M. D. Camhi, E. K. Pikitch and B. E. A (Eds.), *Sharks of the Open Ocean: Biology, Fisheries and Conservation*. online: Blackwell Publishing Ltd. pp. 128-139.

Booth, D.T., A. Dunstan, I. Bell, R. Reina, and J. Tedeschi. 2020. Low male production at the world's largest green turtle rookery. *Marine Ecology Progress Series* 653:181-190.

Borobia, M., P. Gearing, Y. Simard, J. Gearing, and P. Béland. 1995. Blubber fatty acids of finback and humpback whales from the Gulf of St. Lawrence. *Marine Biology* 122:341-353.

Bradbury, J.W., and S.L. Vehrencamp. 1998. Principles of animal communication.

Breece, M. W., Fox, D. A., Haulsee, D. E., Wirgin, I. I., & Oliver, M. J. (2018). Satellite driven distribution models of endangered Atlantic sturgeon occurrence in the mid-Atlantic Bight. ICES Journal of Marine Science, 75(2), 562-571.

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

Brown, M.W., Fenton, D., Smedbol, K., Merriman, C., Robichaud-Leblanc, K. and Conway, J.D., 2009. Recovery Strategy for the North Atlantic Right Whale (Eubalaena glacialis) in Atlantic Canadian Waters [Final]. Species at Risk Act Recovery Strategy Series. *Fisheries and Oceans Canada. vi+ 66p*.

Brown, J. J., and Murphy, G.W. 2010. Atlantic sturgeon vessel-strike mortalities in the Delaware Estuary. Fisheries, 35(2), 72-83.

Buckstaff, K. C. 2006. Effects of watercraft noise on the acoustic behavior of bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida. *Marine Mammal Science* **20**: 709– 725.

Budelmann, B. U. (1992). Hearing in Nonarthropod Invertebrates. In D. B. Webster, A. N. Popper, & R. R. Fay (Eds.), The Evolutionary Biology of Hearing (pp. 141-155). Springer New York. https://doi.org/10.1007/978-1-4612-2784-7_10.

Budelmann, B. U., & Williamson, R. (1994). Directional sensitivity of hair cell afferents in the Octopus statocyst. The Journal of Experimental Biology, 187(1), 245. http://jeb.biologists.org/content/187/1/245.abstract.

Bureau of Ocean Energy Management (BOEM). 2013. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts. Revised Environmental Assessment. (OCS EIS/EA BOEM 2013-1131).

Bureau of Ocean Energy Management (BOEM). 2021a. Commercial and Research Wind Lease and Grant Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf of the New York Bight. Final Environmental Assessment. OCS EIS/EA BOEM 2021-073. https://www.boem.gov/sites/default/files/documents//NYBightFinalEA_BOEM_2021-073.pdf. Accessed November 28, 2022.

Bureau of Ocean Energy Management (BOEM). 2021b. BOEM Offshore Wind Energy Facilities Emission Estimating Tool - Version 2.0 User's Guide, BOEM 2021-046. https://www.boem.gov/sites/default/files/documents/about-boem/BOEM-Wind-Power-User-Guide-V2.pdf.

Bureau of Ocean Energy Management (BOEM). 2021c. Wind Energy Research Lease on the Atlantic Outer Continental Shelf Offshore Maine. Draft Environmental Assessment. https://www.boem.gov/sites/default/files/documents/renewable-energy/OREP-Data-Collection-BA-Final.pdf

Bureau of Ocean Energy Management (BOEM). 2023a. Data Collection and Site Survey Activities for Renewable Energy on the Atlantic Outer Continental Shelf. Revised Biological Assessment. (OCS EIS/EA BOEM 2013-045). https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/GoME-RL-EA.pdf

Bureau of Ocean Energy Management (BOEM). 2023b. *Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585*. U.S. Department of the Interior, BOEM Office of Renewable Energy Programs. Effective Date: March 27, 2023. 22 p. https://www.boem.gov/sites/default/files/documents/about-boem/Fishery-Survey-Guidelines.pdf.

Burek, K.A., F.M. Gulland, and T.M. O'Hara. 2008. Effects of climate change on Arctic marine mammal health. *Ecological Applications* 18(sp2):S126-S134.

Burge, C.A., Mark Eakin, C., Friedman, C.S., Froelich, B., Hershberger, P.K., Hofmann, E.E., Petes, L.E., Prager, K.C., Weil, E., Willis, B.L. and Ford, S.E. 2014. Climate change influences on marine infectious diseases: implications for management and society. *Annual Review of Marine Science* 6:249-277.

Burgess D. 2022. State of Maine comments on BOEM’s Request for Interest (RFI) in commercial leasing for wind energy development on the Gulf of Maine Outer Continental Shelf [official communication; letter from State of Maine, Governor’s Energy Office on 2022 Oct 3].

Burke, V.J., E.A. Standora, and S.J. Morreale. 1993. Diet of juvenile Kemp’s ridley and loggerhead sea turtles from Long Island, New York. *Copeia* 1993(4):1176-1180.

Burke, V. J., Morreale, S. J., & Standora, E. A. (1994). Diet of the Kemp's ridley sea turtle, Lepidochelys kempii, in New York waters. *Fishery Bulletin*, *92*(1), 26-32.

Byles, R.A. 1988. *The Behavior and Ecology of Sea Turtles in Virginia*. Unpublished Ph.D. dissertation, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA. 112 pp. Available: https://scholarworks.wm.edu/cgi/viewcontent.cgi?article=2161&context=etd. Accessed April 7, 2023.

Caillouet Jr, C.W., S.W. Raborn, D.J. Shaver, N.F. Putman, B.J. Gallaway, and K.L. Mansfield. 2018. Did Declining Carrying Capacity for the Kemp's Ridley Sea Turtle Population Within the Gulf of Mexico Contribute to the Nesting Setback in 2010− 2017? *Chelonian Conservation and Biology* 17(1):123-133.

Cardona, L., Martins, S., Uterga, R. and Marco, A., 2017. Individual specialization and behavioral plasticity in a long-lived marine predator. *Journal of Experimental Marine Biology and Ecology 497*, pp.127-133.

Carey, D. A., Wilber, D. H., Read, L. B., Guarinello, M. L., Griffin, M., & Sabo, S. (2020). Effects of the Block Island Wind Farm on Coastal Resources. Oceanography, 33(4), 70-81.

Carlson, J.K., and S. Gulak. 2012. Habitat use and movement patterns of oceanic whitetip, bigeye thresher and dusky sharks based on archival satellite tags. *Collective Volumes of Scientific Papers, ICCAT* 68(5):1922-1932.

Carr, A., and D. Caldwell. 1956. The ecology and migrations of Sea Turtles, I. Results of field work in Florida, 1955. *American Museum Novitates* 1793:1–23.

Castellote, M., Clark, C. W., & Lammers, M. O. (2012). Acoustic and behavioural changes by fin whales (Balaenoptera physalus) in response to shipping and airgun noise. Biological Conservation, 147(1), 115-122.

Celi, Monica, Francesco Filiciotto, Giulia Maricchiolo, Lucrezia Genovese, Enza Maria Quinci, Vincenzo Maccarrone, Salvatore Mazzola, Mirella Vazzana, and Giuseppa Buscaino. "Vessel noise pollution as a human threat to fish: assessment of the stress response in gilthead sea bream (Sparus aurata, Linnaeus 1758)." *Fish Physiology and biochemistry* 42 (2016): 631-641.

Cetacean and Turtle Assessment Program (CETAP). 1982. *A Characterization of Marine Mammals and Turtles in the Mid- and North-Atlantic Areas of the U.S. Outer Continental Shelf*. Kingston, Rhode Island: University of Rhode Island, Sponsored by the U.S. Department of the Interior, Bureau of Land Management. Contract #AA552-CT8-48. 576 p.

Cholewiak, D., DeAngelis, A. I., Palka, D., Corkeron, P. J., & Van Parijs, S. M. (2017). Beaked whales demonstrate a marked acoustic response to the use of shipboard echosounders. Royal Society Open Science, 4(12), 170940.

Chorney NE, Warner G, MacDonnell J, McCrodan A, Deveau T, McPherson C, O'Neill C, Hannay D, Rideout B (2011) Underwater sound measurements. In: Reiser CM, Funk DW, Rodrigues R, Hannay D (eds) Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore, Inc., in the Alaskan Chukchi and Beaufort Seas, July–October 2010: 90-day report. LGL Report P1171E-1, LGL Alaska Research Associates, Inc., Anchorage, AK, and JASCO Applied Sciences, Victoria, BC, Canada, for Shell Offshore, Inc., Houston, TX; National Marine Fisheries Service, Silver Spring, MD; and US Fish and Wildlife Service, Anchorage, AK

Christensen, I., T. Haug, and N. Øien. 1992. A review of feeding and reproduction in large baleen whales (Mysticeti) and sperm whales Physeter macrocephalus in Norwegian and adjacent waters. *Fauna Norvegica Series A* 13:39-48.

Clapham, P.J., and I.E. Seipt. 1991. Resightings of independent fin whales, *Balaenoptera physalus*, on maternal summer ranges. *Journal of Mammalogy* 72(4):88-790.

Clarke, R. 1956. Marking whales from a helicopter. *Norsk Hvalfangst-Tidende* 45:311-318.

Clark, C. W., and G. J. Gagnon. 2002. Low-frequency vocal behaviors of baleen whales in the North Atlantic: Insights from integrated undersea surveillance system detections, locations, and tracking from 1992 to 1996. U.S. Navy Journal of Underwater Acoustics 52:609–640.

Clark, C. W., Ellison, W. T., Southall, B. L., Hatch, L., Van Parijs, S. M., Frankel, A. S., & Ponirakis, D. (2009). Acoustic masking in marine ecosystems: Intuitions, analysis, and implication. Marine Ecology Progress Series, 395, 201-222.

Cole, T. V. N., D. L. Hartley, and R. L. Merrick. 2005. *Mortality and serious injury determinations for large whale stocks along the United States eastern seaboard, 1999–2003*. National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Collie, J.S., S.J. Hall, M.J. Kaiser, and I.R. Poiner. 2000. "A quantitative analysis of fishing impacts on shelf-sea benthos." Journal of animal ecology 69(5):785-798.

Collins, M. R., and T. I. J. Smith. 1997. Distributions of shortnose and Atlantic sturgeons in South Carolina. North American Journal of Fisheries Management 17:995–1000

Collins, M. R., Smith, T. I., Post, W. C., & Pashuk, O. (2000). Habitat utilization and biological characteristics of adult Atlantic sturgeon in two South Carolina rivers. Transactions of the American Fisheries Society, 129(4), 982-988.

Comtois, S., C. Savenkoff, M.-N. Bourassa, J.-C. Brêthes, and R. Sears. 2010. *Regional distribution and abundance of blue and humpback whales in the Gulf of St. Lawrence*. Direction des Sciences, Pêches et Océans Canada, Institut Maurice-Lamontagne.

Conn, P., & Silber, G. (2013). Vessel speed restrictions reduce risk of collision-related mortality for North Atlantic right whales. Ecosphere, 4(4), 1-16.

Cooke, J.G. 2020. *Eubalaena glacialis* (errata version published in 2020). The IUCN Red List of Threatened Species 2020: e.T41712A178589687. Available: https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T41712A178589687.en. Accessed April 6, 2023.

Corwin, J. T. (1981). Postembryonic production and aging of inner ear hair cells in sharks. *Journal of Comparative Neurology*, *201*(4), 541-553.

Cranford, T.W., and P. Krysl. 2015. Fin Whale Sound Reception Mechanisms: Skull Vibration Enables Low-Frequency Hearing. *PLOS ONE* 10(1):e0116222.

Cremer, M. J., Barreto, A. S., Hardt, F. A. S., Tonello Júnior, A. J., & Mounayer, R. (2009). Cetacean occurrence near an offshore oil platform in southern Brazil [Tursiops truncatus; Balaenoptera acutorostrata; Oil platform; Aggressive interaction]. Biotemas, 22(3), 247-251.

Crocker, S. E., & Fratantonio, F. D. (2016). Characteristics of Sounds Emitted During High-Resolution Marine Geophysical Surveys. (OCS Study BOEM 2016-044. NUWC-NPT Technical Report 12,203, 24 March 2016).

Cronin, T.W., J.I. Fasick, L.E. Schweikert, S. Johnsen, L.J. Kezmoh, and M.F. Baumgartner. 2017. "Coping with Copepods: Do Right Whales (Eubalaena Glacialis) Forage Visually in Dark Waters?" Philosophical Transactions of the Royal Society B 372: 20160067.

Crowe, L.M., M.W. Brown, P.J. Corkeron, P.K. Hamilton, C. Ramp, S. Ratelle, A.S. Vanderlaan, and T.V. Cole. 2021. In plane sight: a mark-recapture analysis of North Atlantic right whales in the Gulf of St. Lawrence. *Endangered Species Research* 46:227-251.

CSA Ocean Sciences Inc. (CSA) and Exponent. 2019. *Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance in Southern New England*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Headquarters. Sterling (VA). OCS Study BOEM 2019-049. 59 p.

Dadswell, M.J. 2006. "A Review of the Status of Atlantic Sturgeon in Canada, with Comparisons to Populations in the United States and Europe." Fisheries 31: 218–229.

Danie, D.S., J. Trial, and J.G. Stanley. 1984. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic), Atlantic Salmon*. Vol. 82. No. 11. National Coastal Ecosystems Team, Division of Biological Services, Research and Development, Fish and Wildlife Service, US Department of the Interior, 1984.

Davies, T. W., Coleman, M., Griffith, K. M., & Jenkins, S. R. (2015). Night-time lighting alters the composition of marine epifaunal communities. Biology Letters, 11(4), 20150080.

Davis, G.E., M.F. Baumgartner, J.M. Bonnell, J. Bell, C. Berchok, J. Bort Thornton, S. Brault, G. Buchanan, R.A. Charif, D. Cholewiak, C.W. Clark, P. Corkeron, J. Delarue, K. Dudzinski, L. Hatch, J. Hildebrand, L. Hodge, H. Klinck, S. Kraus, B. Martin, D.K. Mellinger, H. Moors-Murphy, S. Nieukirk, D.P. Nowacek, S. Parks, A.J. Read, A.N. Rice, D. Risch, A. Sirovic, M. Soldevilla, K. Stafford, J.E. Stanistreet, E. Summers, S. Todd, A. Warde, and S.M. Van Parijs. 2017. Long-term passive acoustic recordings track the changing distribution of North Atlantic right whales (*Eubalaena glacialis*) from 2004 to 2014. *Scientific Reports* 7(1):13460.

Davis, G.E., M.F. Baumgartner, P.J. Corkeron, J. Bell, C. Berchok, J.M. Bonnell, J.B. Thornton, S. Brault, G.A. Buchanan, D.M. Cholewiak, C.W. Clark, J. Delarue, L.T. Hatch, H. Klinck, S.D. Kraus, B. Martin, D.K. Mellinger, H. Moors-Murphy, S. Nieukirk, D.P. Nowacek, S.E. Parks, D. Parry, N. Pegg, A.J. Read, A.N. Rice, D. Risch, A. Scott, M.S. Soldevilla, K.M. Stafford, J.E. Stanistreet, E. Summers, S. Todd, and S.M. Van Parijs. 2020. Exploring movement patterns and changing distributions of baleen whales in the western North Atlantic using a decade of passive acoustic data. *Global Change Biology* 2020(00):1-29.

Dernie, K.M., M.J. Kaiser, and R.M. Warwick. 2003. “Recovery Rates of Benthic Communities Following Physical Disturbance.” Journal Of Animal Ecology 72: 1043–1056.

Department of Fisheries and Oceans Canada (DFO). 2017. *Oceanic Conditions in the Atlantic Zone in 2016*. Canadian Science Advisory Secretariat. Report No.: Science Advisory Report 2017/013. 26 p.

Department for Business, Enterprise and Regulatory Reform. 2008. Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Industry. Technical report. January 2008. Accessed: January 26, 2023. Retrieved from: https://tethys.pnnl.gov/sites/default/files/publications/Cabling_Techniques_and_Environmental_Effects.pdf.

De Robertis, A., & Handegard, N. O. (2013). Fish avoidance of research vessels and the efficacy of noise-reduced vessels: a review. ICES Journal of Marine Science, 70(1), 34-45.

DiMatteo, Andrew D., Sparks, Laura M. (2023a) Sea Turtle Distribution and Abundance on the East Coast of the United States. Technical Report prepared for Naval Undersea Warfare Center Division Newport.

DiMatteo A, Roberts JJ, Jones D, Garrison L, Hart KM, Kenney RD, Khan C, McLellan WA, Lomac-MacNair K, Palka D, Rickard ME, Roberts K, Zoidis AM, and Sparks L. (2023b). Sea turtle density surface models along the United States Atlantic coast. Manuscript in prep.

Dionne, P. E., Zydlewski, G. B., Kinnison, M. T., Zydlewski, J., & Wippelhauser, G. S. (2013). Reconsidering residency: Characterization and conservation implications of complex migratory patterns of shortnose sturgeon (*Acispenser brevirostrum*). *Canadian Journal of Fisheries and Aquatic Sciences*, *70*(1), 119–127. https://doi.org/10.1139/cjfas-2012-0196.

Dixon, HJ, Dempson, JB, Sheehan, TF, Renkawitz, MD, Power, M. Assessing the diet of North American Atlantic salmon (*Salmo salar* L.) off the West Greenland coast using gut content and stable isotope analyses. *Fish Oceanogr*. 2017; 26: 555– 568. https://doi.org/10.1111/fog.12216

Dobbs, K. M. (2017). 2017 Seafloor Sediment Sampling: Southport Island to Monhegan Island, Gulf of Maine.

Dolman, S., Williams-Grey, V., Asmutis-Silvia, R., & Issac, S. (2006). Vessel Collisions and Cetaceans: What Happens When They Don't Miss the Boat.

Doney, S. C., Fabry, V. J., Feely, R. A., & Kleypas, J. A. (2009). Ocean acidification: the other CO2 problem? Washington Journal of Environmental Law & Policy, 6(2), 1-41.

Dovel, W., and T. Berggren. 1983. Atlantic sturgeon of the Hudson estuary, New York. *New York Fish and Game Journal* 30(2):140-172.

Dow Piniak, W.E., D.A. Mann, S.A. Eckert, and C.A. Harms. 2012. Amphibious Hearing in Sea Turtles. In: A. N. Popper and A. Hawkins (Eds.), *The Effects of Noise on Aquatic Life. Advances in Experimental Medicine and Biology*. New York, NY: Springer. pp. 83-87.

Dunton, K.J., A. Jordaan, K.A. McKown, D.O. Conover, and M.G. Frisk. 2010. Abundance and distribution of Atlantic sturgeon (*Acipenser oxyrinchus*) within the Northwest Atlantic Ocean, determined from five fishery-independent surveys. *Fisheries Bulletin* 108(4): 450-465.

Dunton, K.J., A. Jordaan, D.O. Conover, K.A. McKown, L.A. Bonacci, and M.G. Frisk. 2015. Marine distribution and habitat use of Atlantic sturgeon in New York lead to fisheries interactions and bycatch. Marine and Coastal Fisheries 7(1):18-32.

Eckert, K.L., B.P. Wallace, J.G. Frazier, S.A. Eckert, and P.C.H. Pritchard. 2012. *Synopsis of the Biological Data on the Leatherback Sea Turtle* (*Dermochelys coriacea*). Biological Technical Publication BTP-R4015-2012. Washington, DC.: U.S. Department of the Interior, U.S. Fish and Wildlife Service.

Edwards, E.F., C. Hall, T.J. Moore, C. Sheredy, and J.V. Redfern. 2015. Global distribution of fin whales *Balaenoptera physalus* in the post-whaling era (1980–2012). *Mammal Review* 45(4):197-214.

Engås, A., Løkkeborg, S., Ona, E., & Soldal, A. V. (1996). Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (Melanogrammus aeglefinus). Canadian Journal of Fisheries and Aquatic Sciences, 53(10), 2238-2249.

Epperly, S., L. Avens, L. Garrison, T. Henwood, W. Hoggard, J. Mitchell, J. Nance, J. Poffenberger, C. Sasso, E. Scott-Denton, and C. Yeung. 2002. *Analysis of Sea Turtle Bycatch in the Commercial Shrimp Fisheries of Southeast U.S. Waters and the Gulf of Mexico*. NOAA Technical Memorandum NMFS-SEFSC-490:1–88.

Erbe, C. 2002. *Hearing Abilities of Baleen Whales*. Defence R&D Canada. DRDC Atlantic CR 2002-065, October 2002. 40 p.

Erbe, C. 2013. International Regulation of Underwater Noise. *Acoustics Australia* 41(1):12-19.

Erbe C, Reichmuth C, Cunningham K, Lucke K, Dooling R. 2016. Communication masking in marine mammals: A review and research strategy. *Marine Pollution Bulletin* 103(1-2):15-38.

Erbe, C., R. Dunlop, K.C.S. Jenner, M.-N.M. Jenner, R.D. McCauley, I. Parnum, M. Parsons, T. Rogers, and C. Salgado-Kent. 2017. Review of Underwater and In-Air Sounds Emitted by Australian and Antarctic Marine Mammals. *Acoustics Australia* 45(2):179-241.

Erbe, C., Marley, S. A., Schoeman, R. P., Smith, J. N., Trigg, L. E., & Embling, C. B. (2019). The Effects of Ship Noise on Marine Mammals - A Review. Frontiers in Marine Science, 6(606), 1-21.

Erickson, D. L., A. Kahnle, M. J. Millard, E. A. Mora, M. Bryja, A. Higgs, J. Mohler, M. DuFour, G. Kenney, J. Sweka, and E. K. Pikitch. 2011. Use of pop-up satellite archival tags to identify oceanic-migratory patterns for adult Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus* Mitchell, 1815. *Journal of Applied Ichthyology* 27:356-365.

Farmer, N.A., L.P. Garrison, C. Horn, M. Miller, T. Gowan, R.D. Kenney, M. Vukovich, J.R. Willmott, J. Pate, D.H. Webb, and T.J. Mullican. 2022. The Distribution of Giant Manta Rays in The Western North Atlantic Ocean Off The Eastern United States. *Scientific Reports* 12:6544.

Farr, E.R., M.R. Johnson, M.W. Nelson, J.A. Hare, W.E. Morrison, M.D. Lettrich, B. Vogt, C. Meaney, U.A. Howson, P.J. Auster, F.A. Borsuk, D.C. Brady, M.J. Cashman, P. Colarusso, J.H. Grabowski, J.P. Hawkes, R. Mercaldo-Allen, D.B. Packer, and D.K. Stevenson. 2021. An Assessment of Marine, Estuarine, and Riverine Habitat Vulnerability to Climate Change in the Northeast U.S. *PLoS ONE* 16(12):e0260654.

Fasick, J.I., M.F. Baumgartner, T.W. Cronin, B. Nickle, and L.J. Kezmoh. 2017. “Visual Predation During Springtime Foraging of The North Atlantic Right Whale (Eubalaena Glacialis).” Marine Mammal Science 33(4): 991–1013.

Fay, R. 2009. Soundscapes and the sense of hearing of fishes. *Integrative Zoology* 4(1):26-32.

Fay, R. R., & Popper, A. N. 2000. Evolution of hearing in vertebrates: the inner ears and processing. *Hearing research*, *149*(1-2), 1-10.

Fay, C., Bartron, M., Craig, S., Hecht, A., Pruden, J., Saunders, R., Sheehan, T., & Trial, J. 2006. *Status Review for Anadromous Atlantic Salmon (Salmo salar) in the United States (2006)*.

Fernandes, S.J., G.B. Zydlewski, J.D. Zydlewski, G.S. Wippelhauser, and M.T. Kinnison. 2010. Seasonal distribution and movements of shortnose sturgeon and Atlantic sturgeon in the Penobscot River Estuary, Maine. *Transactions of the American Fisheries Society* 139:1436–1449.

Ferrari, M. C., McCormick, M. I., Meekan, M. G., Simpson, S. D., Nedelec, S. L., & Chivers, D. P. 2018. School is out on noisy reefs: the effect of boat noise on predator learning and survival of juvenile coral reef fishes. Proceedings of the Royal Society B: Biological Sciences, 285(1871), 20180033.

Filiciotto, F., Vazzana, M., Celi, M., Maccarrone, V., Ceraulo, M., Buffa, G., Arizza, V., de Vincenzi, G., Grammauta, R., Mazzola, S., & Buscaino, G. 2016. Underwater noise from boats: Measurement of its influence on the behaviour and biochemistry of the common prawn (Palaemon serratus, Pennant 1777). Journal of Experimental Marine Biology and Ecology, 478, 24-33.

Finkbeiner EM, Wallace BP, Moore JE, Lewison RL, Crowder LB, Read AJ. 2011. Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. Biological Conservation. 144(11):2719–2727.

Finley, K. J., Miller, G. W., Davis, R. A., & Greene, C. R. 1990. Reactions of belugas, Delphinapterus leucas, and narwhals, Monodon monoceros, to ice-breaking ships in the Canadian high arctic. Canadian Bulletin of Fisheries And Aquatic Sciences, 224, 97-117.

Finneran, J.J. 2016. *Auditory Weighting Functions and TTS/PTS Exposure Functions for Marine Mammals Exposed to Underwater Noise*. Marine Mammal Scientific and Vet Support Branch of the Biosciences Division, Space and Naval Warfare Systems Center, San Diego, CA. Technical Report 3026. 134 p.

Finneran, J.J., and A.K. Jenkins. 2012. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis*. San Diego, California: Space and Naval Warfare Systems Center Pacific. Technical Report. 65 p.

Finneran, J.J., E.E. Henderson, D.S. Houser, K. Jenkins, S. Kotecki, and J. Mulsow. 2017. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*. Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 p.

Fisheries Hydroacoustic Working Group (FHWG). 2008. Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities. (12 June 2008).

Foley, A., B. Schroeder, and S. MacPherson. 2008. Post-nesting migrations and resident areas of Florida loggerheads. Pages 75-76 in Kalb, H., A. Rohde, K. Gayheart, and K. Shanker (compilers). Proceedings of the Twenty-fifth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-582. 234 p.

Frankel, A.S. 2009. Sound Production. In: W. F. Perrin, B. Würsig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals (Second Edition)*. London: Academic Press. pp. 1056-1071.

Friedland, K. D., Manning, J. P., Link, J. S., Gilbert, J. R., Gilbert, A. T., & O'Connell, A. F. 2012. Variation in wind and piscivorous predator fields affecting the survival of Atlantic salmon, Salmo salar, in the Gulf of Maine: ATLANTIC SALMON IN THE GULF OF MAINE. *Fisheries Management and Ecology*, *19*(1), 22–35. https://doi.org/10.1111/j.1365-2400.2011.00814.x.

Garrison, L. P., Adams, J., Patterson, E. M., & Good, C. P. (2022). Assessing the risk of vessel strike mortality in North Atlantic right whales along the US East Coast.

Gende, S. M., Hendrix, A. N., Harris, K. R., Eichenlaub, B., Nielsen, J., & Pyare, S. (2011). A Bayesian approach for understanding the role of ship speed in whale–ship encounters. Ecological Applications, 21(6), 2232-2240.

Gende, S. M., Vose, L., Baken, J., Gabriele, C. M., Preston, R., & Hendrix, A. N. (2019). Active Whale Avoidance by Large Ships: Components and Constraints of a Complementary Approach to Reducing Ship Strike Risk. Frontiers in Marine Science, 6(592), 19. https://doi.org/10.3389/fmars.2019.00592.

Gerdes, D., E. Isla, R. Knust, K. Mintenbeck, and S. Rossi. 2008. "Response of Antarctic benthic communities to disturbance: first results from the artificial Benthic Disturbance Experiment on the eastern Weddell Sea Shelf, Antarctica." Polar Biology 31: 1469-1480.

Germano J, Parker J, Charles J. 1994. Monitoring Cruise at the Massachusetts Bay Disposal Site, August 1990. Waltham, Massachusetts: US Army Corps of Engineers. Report No.: DAMOS Contribution No. 92.

Gill, A.B., I. Gloyne-Phillips, K.J. Neal, and J.A. Kimber. 2005. *The Potential Effects of Electromagnetic Fields Generated by Sub-Sea Power Cables Associated with Offshore Wind Farm Developments on Electrically and Magnetically Sensitive Marine Organisms – A Review*. No. COWRIE-EM FIELD 2-06-2004. Final report prepared by Cranfield University and the Centre for Marine and Coastal Studies Ltd. For Collaborative Offshore Wind Energy Research into the Environment.

Gless, J. M., Salmon, M., & Wyneken, J. (2008). Behavioral responses of juvenile leatherbacks Dermochelys coriacea to lights used in the longline fishery. Endangered Species Research, 5, 239-247.

Godley, B., S. Richardson, A. Broderick, M. Coyne, F. Glen, and G. Hays. 2002. Long-term satellite telemetry of the movements and habitat utilisation by green turtles in the Mediterranean. *Ecography* 25(3):352-362.

Greater Atlantic Regional Fisheries Office (GARFO). 2020. Lobster Management Areas. Accessed December 5, 2023. Retrieved from: https://www.fisheries.noaa.gov/resource/map/lobster-management-areas.

Greater Atlantic Regional Fisheries Office (GARFO). 2023a. Greater Atlantic Region Statistical Areas. Accessed December 5, 2023. Retrieved from: https://www.fisheries.noaa.gov/resource/map/greater-atlantic-region-statistical-areas.

Greater Atlantic Regional Fisheries Office (GARFO). 2023b. Section 7 Species Presence Table: Shortnose Sturgeon in the Greater Atlantic Region. Accessed December 5, 2023. Retrieved from: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-species-presence-table-shortnose-sturgeon-greater.

Greene, C.H., and A.J. Pershing. 2000. The response of *Calanus finmarchicus* populations to climate variability in the Northwest Atlantic: basin-scale forcing associated with the North Atlantic Oscillation. *ICES Journal of Marine Science* 57:1536-1544.

Gregory R.S., and C.D. Levings. 1998. Turbidity reduces predation on migrating juvenile Pacific salmon. *Transactions of the American Fisheries Society* 127(2): 275-285.

Griffin, R.B. 1999. Sperm whale distributions and community ecology associated with a warm-core ring off Georges Bank. *Marine Mammal Science* 15(1):33-51.

Griffin, L.P., Griffin, C.R., Finn, J.T., Prescott, R.L., Faherty, M., Still, B.M., & Danylchuk, AJ. 2019. Warming seas increase cold-stunning events for Kemp’s ridley sea turtles in the northwest Atlantic. *PLOS ONE*, *14*(1), e0211503. https://doi.org/10.1371/journal.pone.0211503.

Grunwald, C., Stabile, J., Waldman, J.R., Gross, R. and Wirgin, I., 2002. Population genetics of shortnose sturgeon Acipenser brevirostrum based on mitochondrial DNA control region sequences. *Molecular Ecology*, *11*(10), pp.1885-1898.

Grunwald, C., L. Maceda, J. Waldman, J. Stabile, and I. Wirgin. 2008. Conservation of Atlantic sturgeon Acipenser oxyrinchus oxyrinchus: delineation of stock structure and distinct population segments. *Conservation Genetics* 9:1111-1124.

Guarinello ML, Carey DA. 2022. Multi-modal approach for benthic impact assessments in moraine habitats: A case study at the Block Island Wind Farm. Estuaries and Coasts. 45:1107–1122 doi:10.1007/s12237-020-00818-w.

Gudger, E. W. (1922). The most northerly record of the capture in Atlantic waters of the United States of the giant ray, Manta birostris. Science, 55(1422), 338-340.

Guerra, M., Dawson, S., Brough, T., and Rayment, W. (2014). Effects of boats on the surface and acoustic behaviour of an endangered population of bottlenose dolphins. Endanger. Spec. Res. 24, 221–236. doi: 10.3354/esr00598

Guihen D., J.A. Brearley, and S. Fielding. 2022. Antarctic krill likely avoid underwater gliders. *Deep Sea Research Part I: Oceanographic Research Papers* 179: 103680.

Guilbard, F., J. Munro, P. Dumont, D. Hatin, and R. Fortin. 2007. *Feeding ecology of Atlantic sturgeon and lake sturgeon co-occurring in the St. Lawrence estuarine transition zone*. In: American Fisheries Society Symposium, 56, 85-104.

Gulf of Maine Association. 2023. Contaminants: Pollution in Our Waters. https://www.gulfofmaine.org/public/state-of-the-gulf-of-maine/contaminants/. Accessed June 23, 2023.

Gulf of Maine Research Institute (GMRI). 2023. Gulf of Maine Warming Update: 2022 the Secon-Hottest Year on Record. Available: https://www.gmri.org/stories/warming-22/#:~:text=SST%20conditions%20in%20the%20Gulf,of%20the%20world%27s%20ocean%20surface. Accessed May 30, 2023.

Gulland, F.M.D., J.D. Baker, M. Howe, E. LaBrecque, L. Leach, S.E. Moore, R.R. Reeves, and P.O. Thomas. 2022. A review of climate change effects on marine mammals in United States waters: Past predictions, observed impacts, current research and conservation imperatives. *Climate Change Ecology* 3.

Hain, J. H. W., M. A. M. Hyman, R. D. Kenney, and H. E. Winn. 1985. The role of cetaceans in the shelf-edge region of the northeastern United States. *Marine Fisheries Review* 47:13–17.

Hain, J.H., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. The fin whale, *Balaenoptera physalus*, in waters of the northeastern United States continental shelf. *Reports of the International Whaling Commission* 42:653-669.

Hall, A. J., McConnell, B. J., Schwacke, L. H., Ylitalo, G. M., Williams, R., & Rowles, T. K. (2018). Predicting the effects of polychlorinated biphenyls on cetacean populations through impacts on immunity and calf survival. *Environmental Pollution*, *233*, 407-418.

Halvorsen MB, Casper BM, Woodley CM, Carlson TJ, Popper AN (2011) Predicting and mitigating hydroacoustic impacts on fish from pile installations. NCHRP Report Research Results Digest 363, Project 25-28, National Cooperative Highway Research Program, Transportation Research Board, National Academy of Sciences, Washington, D.C.

Hamilton, P. K., & Kraus, S. D. (2019). Frequent encounters with the seafloor increase right whales' risk of entanglement in fishing groundlines. Endangered Species Research, 39, 235-246. https://doi.org/10.3354/esr00963

Handegard, N.O., Michalsen, K., & Tjøstheim, D. (2003). Avoidance behaviour in cod (Gadus morhua) to a bottom-trawling vessel. *Aquatic Living Resources*, *16*(3), 265-270.

Harding, H., Bruintjes R., Radford, AN., Simpson, SD. 2016. *Measurement of Hearing in the Atlantic salmon (Salmo salar) using Auditory Evoked Potentials, and effects of Pile Driving Playback on salmon Behaviour and Physiology: Scottish Marine and Freshwater Science Vol 7 No 11*. https://doi.org/10.7489/1701-1.

Harding, G.C.H. & Burbidge, C. (2013). State of the Gulf of Maine Report: Toxic Chemical Contaminants Theme Paper. The Gulf of Maine Council on the Marine Environment. https://policycommons.net/artifacts/1216017/toxic-chemical-contaminants/1769118/.

Harding H. R., Gordon T. A. C., Wong K., McCormick M. I., Simpson S. D., Radford A. N. (2020). Condition-dependent responses of fish to motorboats. *Biol. Lett.* 16 (11).

Hare, J.A., W.E. Morrison, M.W. Nelson, M. Stachura, E.J. Teeters, R.B. Griffis, M.A. Alexander, J.D. Scott, L. Alade, R.J. Bell, A.S. Chute, K.L. Curti, T.H. Curtis, D. Kircheis, J.F. Kocik, S.M. Lucey, C.T. McCandless, L.M. Milke, D.E. Richardson, E. Robillard, H.J. Walsh, M.C. McManus, K.E. Marancik, and C.A. Griswold. 2016. A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast US Continental Shelf. *PLoS ONE* 11(2):e0146756.

Hassel, A., Knutsen, T., Dalen, J., Skaar, K., Løkkeborg, S., Misund, O. A., Østensen, Ø., Fonn, M., & Haugland, E. K. (2004). Influence of seismic shooting on the lesser sandeel (Ammodytes marinus). ICES Journal of Marine Science, 61(7), 1165-1173.

Hastie, G.D., B. Wilson, L.H. Tufft, and P.M. Thompson. 2003. Bottlenose dolphins increase breathing synchrony in response to boat traffic. Marine Mammal Science 19(1):74-084.

Hatch, L.T., C.M. Wahle, J. Gedamke, J. Harrison, B. Laws, S.E. Moore, J.H. Stadler, and S.M. Van Parijs. 2016. Can you hear me here? Managing acoustic habitat in US waters. *Endangered Species Research* 30:171-186.

Haver S.M., J. Gedamke, L.T. Hatch, R.P. Dziak, S. Van Parijs, M.F. McKenna, J. Barlow, C. Berchok, E. DiDonato, B. Hanson, J. Haxel, M. Holt, D. Lipski, H. Matsumoto, C. Meinig, D.K. Mellinger, S.E. Moore, E.M. Oleson, M.S. Soldevilla, and H. Klinck. 2018. Monitoring long-term soundscape trends in U.S. Waters: The NOAA/NPS Ocean Noise Reference Station Network. *Marine Policy* 90: 6-13.

Haver S.M., M.E.H. Fournet, R.P. Dziak, C. Gabriele, J. Gedamke, L.T. Hatch, J. Haxel, S.A. Heppell, M.F. McKenna, D.K. Mellinger, and S.M. Van Parijs. 2019. Comparing the Underwater Soundscapes of Four U.S. National Parks and Marine Sanctuaries. *Frontiers in Marine Science* 6.

Haver, S. M., Adams, J. D., Hatch, L. T., Van Parijs, S. M., Dziak, R. P., Haxel, J., et al. (2021). Large vessel activity and low-frequency underwater sound benchmarks in United States waters. *Front. Mar. Sci.* 8.

Hawkins, A. D., & Johnstone, A. D. F. 1978. The hearing of the Atlantic Salmon, Salmo salar. *Journal of Fish Biology*, *13*(6), 655–673. https://doi.org/10.1111/j.1095-8649.1978.tb03480.x.

Hawkins, A. D., Hazelwood, R. A., Popper, A. N., & Macey, P. C. (2021). Substrate vibrations and their potential effects upon fishes and invertebrates. Journal of the Acoustical Society of America, 149(4), 2782.

Hawkins, A.D., L. Roberts, S. Cheesman. 2014. "Responses of free-living coastal pelagic fish to impulsive sounds." *The Journal of the Acoustical Society of America* 135(5):3101-3116.

Haxel J., X. Zang, J. Martinez, B. Polagye, G. Staines, Z.D. Deng, M. Wosnik, and P. O'Byrne. 2022. Underwater Noise Measurements around a Tidal Turbine in a Busy Port Setting. Journal of Marine Science and Engineering 10(5): 632-648.

Hayes, S.A., E. Josephson, K. Maze-Foley, P.E. Rosel, and (eds.). 2017. *US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2016*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center. Technical Memorandum NMFS-NE 241. 274 p.

Hayes, S.A., E. Josephson, K. Maze-Foley, P.E. Rosel, B. Byrd, S. Chavez-Rosales, T.V.N. Cole, L.P. Garrison, J. Hatch, A. Henry, S.C. Horstman, J. Litz, M.C. Lyssikatos, K.D. Mullin, C. Orphanides, R.M. Pace, D.L. Palka, J. Powell, and F.W. Wenzel. 2020. *US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2019*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NOAA Technical Memorandum NMFS-NE-264, July 2020. 479 p.

Hayes, S.A., E. Josephson, K. Maze-Foley, P.E. Rosel, and J.E. Wallace. 2022. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessment Reports 2021*. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. May 2022. 386 p.

Hayes S.A., E. Josephson, K. Maze-Foley K, P.E. Rosel, J. McCordic, and J.E. Wallace. 2023. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessment Reports 2022. Woods Hole, MA: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center. June 2023. 262 p.

Hays, G.C., V.J. Hobson, J.D. Metcalfe, D. Righton, and D.W. Sims. 2006. Flexible foraging movements of leatherback turtles across the North Atlantic ocean. *Ecology* 87(10):2647-2656.

Hays, G.C., A. Christensen, S. Fossette, G. Schofield, J. Talbot, and P. Mariani. 2014. Route optimization and solving Zermelo's navigation problem during long distance migration in cross flows. *Ecology Letters* 17:137-143.

Hazel, J., Lawler, I. R., Marsh, H., & Robson, S. (2007). Vessel speed increases collision risk for the green turtle Chelonia mydas. Endangered Species Research, 3(2), 105-113.

Heithaus, M.R., J.J. McLash, A. Frid, L.W. Dill, and G.J. Marshall. 2002. Novel insights into green sea turtle behavior using animal-borne video cameras. *Journal of the Marine Biological Association of the UK* 82(6):1049–1050.

Henderson, D., B. Hu, and E. Bielefeld. 2008. Patterns and mechanisms of noise-induced cochlear pathology. In: Schacht, J., A. N. Popper, and R. R. Fay (Eds.). *Auditory Trauma, Protection, and Repair*. Springer, New York. pp. 195217.

Henry AG, Garron M, Morin D, Reid A, Ledwell W, Cole TVN. 2020. Serious Injury and Mortality Determinations for Baleen Whale Stocks along the Gulf of Mexico, United States East Coast, and Atlantic Canadian Provinces, 2013-2017. Woods Hole, MA: U.S. Department of Commerce, Northeast Fisheries Science Center Reference Document 20-06. Accessed: February 20, 2022. Retrieved from: https://repository.library.noaa.gov/view/noaa/25359.

Henwood TA, Stuntz WE. 1987. Analysis of sea turtle captures and mortalities during commercial shrimp trawling. Fishery Bulletin. 85(4):813-817.

Hildebrand, J.A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. *Marine Ecology Progress Series* 395:5-20.

Hill, A. N., Karniski, C., Robbins, J., Pitchford, T., Todd, S., & Asmutis-Silvia, R. (2017). Vessel collision injuries on live humpback whales, Megaptera novaeangliae, in the southern Gulf of Maine. Marine Mammal Science, 33(2), 558-573.

Hirsch ND, DiSalvo LH, Peddicord R. 1978. Effects of Dredging and Disposal on Aquatic Organisms. Vicksburg, Mississippi: US Army Corps of Engineers. Report No.: Technical Report DS-78-5.

Holles, S., Simpson, S. D., Radford, A. N., Berten, L., & Lecchini, D. (2013). Boat noise disrupts orientation behaviour in a coral reef fish. Marine Ecology Progress Series, 485, 295-300.

Holmes, L. J., McWilliam, J., Ferrari, M. C., & McCormick, M. I. (2017). Juvenile damselfish are affected but desensitize to small motor boat noise. Journal of Experimental Marine Biology and Ecology, 494, 63-68.

Holt, M. M., Noren, D. P., Veirs, V., Emmons, C. K., & Veirs, S. (2009). Speaking up: Killer whales (Orcinus orca) increase their call amplitude in response to vessel noise. *The Journal of the Acoustical Society of America*, *125*(1), EL27-EL32.

Holt, M. M., Noren, D. P., Dunkin, R. C., & Williams, T. M. (2015). Vocal performance affects metabolic rate in dolphins: implications for animals communicating in noisy environments. Journal of Experiment Biology, 218(Pt 11), 1647-1654.

Holt, M. M., Tennessen, J. B., Hanson, M. B., Emmons, C. K., Giles, D. A., Hogan, J. T., & Ford, M. J. (2021). Vessels and their sounds reduce prey capture effort by endangered killer whales (Orcinus orca). Marine Environmental Research, 170, 105429.

Houser, D. S., Yost, W., Burkard, R., Finneran, J. J., Reichmuth, C., and Mulsow, J. 2017. A review of the history, development and application of auditory weighting functions in humans and marine mammals. *The Journal of the Acoustical Society of America* 141(3): 1371-1413.

Hu, M. Y., Yan, H. Y., Chung, W.-S., Shiao, J.-C., & Hwang, P.-P. (2009). Acoustically evoked potentials in two cephalopods inferred using the auditory brainstem response (ABR) approach. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 153(3), 278-283.

Hudak, C.A., Stamieszkin, K. and Mayo, C.A., 2023. North Atlantic right whale Eubalaena glacialis prey selection in Cape Cod Bay. *Endangered Species Research*, *51*, pp.15-29.

James, M., C. Ottensmeyer, S. Eckert, and R. Myers. 2006. Changes in diel diving patterns accompany shifts between northern foraging and southward migration in leatherback turtles. *Canadian Journal of Zoology* 84(5):754-765.

Jaquet, N., and H. Whitehead. 1996. Scale-dependent correlation of sperm whale distribution with environmental features and productivity in the South Pacific. *Marine Ecology Progress Series* 135:1-9.

Jensen, A. S. and Silber, G.K. 2004. Large whale ship strike database. NOAA Technical Memorandum NMFSOPR. January 2004. 37 p.

Jepson, Paul D., Rob Deaville, Jonathan L. Barber, Àlex Aguilar, Asunción Borrell, Sinéad Murphy, Jon Barry et al. "PCB pollution continues to impact populations of orcas and other dolphins in European waters." *Scientific reports* 6, no. 1 (2016): 18573.

Ji, R., Z. Feng, B.T. Jones, C. Thompson, C. Chen, N.R. Record, and J.A. Runge. 2017. Coastal amplification of supply and transport (CAST): a new hypothesis about the persistence of Calanus finmarchicus in the Gulf of Maine. *ICES Journal of Marine Science* 74(7):1865-1874.

Johnson, J.H., D.S. Dropkin, B.E. Warkentine, J.W. Rachlin, and W.D. Andrews. 1997. Food habits of Atlantic sturgeon off the central New Jersey coast. *Transactions of the American Fisheries Society* 126:166–170.

Johnson, A., G. Salvador, J. Kenney, J. Robbins, S. Kraus, S. Landry, and P. Clapham. 2005. "Fishing gear involved in entanglements of right and humpback whales." Marine Mammal Science 21(4): 635-645.

Johnson, C., G. Harrison, B. Casault, J. Spry, W. Li, and E. Head. 2017. *Optical, Chemical, and Biological Oceanographic Conditions on the Scotian Shelf and in the Eastern Gulf of Maine in 2015*. Dartmouth (NS): Fisheries and Oceans Canada. 69 p.

Johnson, A. 2018. The Effects of Turbidity and Suspended Sediments on ESA-Listed Species from Projects Occurring in the Greater Atlantic Region. Greater Atlantic Region Policy Series 18-02. NOAA Fisheries Greater Atlantic Regional Fisheries Office – http://www.greateratlantic.fisheries.noaa.gov/policyseries/. 106p.

Jones, S. 2011. Microbial Pathogens and Biotoxins. State of the Gulf of Maine Report. Gulf of Maine Council on the Marine Environment. Online access: https://gulfofmaine.org/public/state-of-the-gulf-of-maine/.

Jonsson, N., and Jonsson, B. 2003. Energy allocation among developmental stages, age groups, and types of Atlantic salmon (Salmo salar) spawners. Can. J. Fish. Aquat. Sci. 60: 506–516.

Kaifu, K., Akamatsu, T., & Segawa, S. (2008)hu. Underwater sound detection by cephalopod statocyst. Fisheries Science, 74(4), 781-786.

Kaplan, M.B., T.A. Mooney, J. Partan, and A.R. Solow. 2015. Coral reef species assemblages are associated with ambient soundscapes. *Marine Ecology Progress Series*. 533:93-107.

Kaplan, M. B., & Mooney, T. A. (2016). Coral reef soundscapes may not be detectable far from the reef. Scientific Reports, 6, 31862.

Kastak, D., Mulsow, J., Ghoul, A., and Reichmuth, C. 2008. Noise-induced permanent threshold shift in a harbor seal. *The Journal of the Acoustical Society of America* 123(5): 2986-2986.

Kates Varghese, H., Miksis-Olds, J., DiMarzio, N., Lowell, K., Linder, E., Mayer, L., & Moretti, D. (2020). The effect of two 12 kHz multibeam mapping surveys on the foraging behavior of Cuvier's beaked whales off of southern California. Journal of the Acoustical Society of America, 147(6), 3849.

Kates Varghese, H., Lowell, K., Miksis-Olds, J., DiMarzio, N., Moretti, D., & Mayer, L. (2021). Spatial Analysis of Beaked Whale Foraging During Two 12 kHz Multibeam Echosounder Surveys. Frontiers in Marine Science, 8. https://doi.org/10.3389/fmars.2021.654184

Kawakami, T. 1980. A review of sperm whale food. *Scientific Reports of the Whales Research Institute* 32:199-218.

Kazyak, D.C., S.L. White, B.A. Lubinski, R. Johnson, and M. Eackles. 2021. Stock composition of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) encountered in marine and estuarine environments on the US Atlantic Coast. *Conservation Genetics* 22(5):767-781.

Kelley D. E., Vlasic J. P., Brillant S. W. (2020). Assessing the Lethality of Ship Strikes on Whales Using Simple Biophysical Models. Mar. Mam. Sci. 2020, 1–17. doi: 10.1111/mms.12745.

Kenney, R.D., and H.E. Winn. 1986. Cetacean high-use habitats of the northeast United States continental shelf. *Fishery Bulletin* 84(2): 345-357.Kenney, R.D., G.P. Scott, T.J. Thompson, and H.E. Winn. 1997. Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem. *Journal of Northwest Atlantic Fishery Science* 22.

Kenny AJ, Rees HL. 1994. The Effects of Marine Gravel Extraction on the Macrobenthos: Early Post-dredging Recolonization. Marine Pollution Bulletin. 28(7):442-447. doi:10.1016/0025-326X(94)90130-9.

Kenyon, T. N. (1996). Ontogenetic changes in the auditory sensitivity of damselfishes (Pomacentridae). *Journal of Comparative Physiology A*, *179*, 553-561.

Ketten, D.R. 1994. Functional Analyses of Whale Ears: Adaptations for Underwater Hearing. *I.E.E.E Proceedings in Underwater Acoustics* I: 264 – 270.

Ketten, D.R. 1998. Marine mammal auditory systems: a summary of audiometric and anatomical data and its implications for underwater acoustic impacts. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center. NOAA-TM-NMFS-SWFSC-256. 97 p.

Ketten, D. R., Merigo, C., Chiddick, E., Krum, H., and Melvin, E. F. 1999. Acoustic fatheads: parallel evolution of underwater sound reception mechanisms in dolphins, turtles, and sea birds. *The Journal of the Acoustical Society of America* 105(2): 1110-1110.

Ketten, D. R., & Bartol, S. M. (2005). Functional Measures of Sea Turtle Hearing. (ONR 13051000).

Kieffer, M.C., and B. Kynard. 1993. Annual movements of shortnose and Atlantic sturgeon in the Merrimack River, Massachusetts. *Transactions of the American Fisheries Society* 122:1088-1133.

King, T.L., Lubinski, B.A. and Spidle, A.P., 2001. Microsatellite DNA variation in Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and cross-species amplification in the Acipenseridae. *Conservation Genetics*, *2*(2), pp.103-119.

King, K., Joblon, M., McNally, K., Clayton, L., Pettis, H., Corkeron, P., & Nutter, F. 2021. Assessing North Atlantic Right Whale (Eubalaena glacialis) Welfare. Journal of Zoological and Botanical Gardens, 2(4), 728-739.

Kipple, B., & Gabriele, C. (2003). Glacier Bay watercraft noise. (Technical Report NSWCCDE-71-TR-2003/522). Bremerton, Washington

Kipple, B., & Gabriele, C. (2004). Glacier Bay watercraft noise - noise characterization for tour, charter, private, and government vessels. (Technical Report NSWCCDE-71-TR2004/545). Bremterton, Washington

Kite-Powell, H.L., Knowlton, A., & Brown, M. (2007). Modeling the effect of vessel speed on right whale ship strike risk. Project report for NOAA/NMFS Project NA04NMF47202394, 8.

Knowlton, A.R., Hamilton, P.K., Marx, M.K., Pettis, H.M., & Kraus, S.D. (2012). Monitoring North Atlantic right whale Eubalaena glacialis entanglement rates: a 30 yr retrospective. Marine Ecology Progress Series, 466, 293-302.

Kocik, J. F., Hawkes, J. P., & Sheehan, T. F. 2009. Assessing Estuarine and Coastal Migration and Survival of Wild Atlantic Salmon Smolts from the Narraguagus River, Maine Using Ultrasonic Telemetry. *American Fisheries Society Symposium* 69, 293–310.

Kohler, N.E., J.G. Casey, and P.A. Turner. 1998. NMFS cooperative shark tagging program, 1962-93: an atlas of shark tag and recapture data. *Marine Fisheries Review* 60(2):1-1.

Kraus, S.D., M.W. Brown, H. Caswell, C.W. Clark, M. Fujiwara, P.H. Hamilton, R.D. Kenney, A.R. Knowlton, S. Landry, C.A. Mayo, W.A. McLellan, M.J. Moore, D.P. Nowacek, D.A. Pabst, A.J. Read, and R.M. Rolland. 2005. North Atlantic Right Whales in Crisis. Science 309:561–562.

Kraus, S.D., S. Leiter, K. Stone, B. Wikgren, C. Mayo, P. Hughes, R.D. Kenney, C.W. Clark, A.N. Rice, B. Estabrook, and J. Tielens. 2016a. *Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles*. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. Report No.: OCS Study BOEM 2016-054. 118 p.

Kraus, S.D., S. Leiter, K. Stone, B. Wikgren, C. Mayo, P. Hughes, R.D. Kenney, C.W. Clark, A.N. Rice, B. Estabrook and J. Tielens. 2016b. Recent Scientific Publications Cast Doubt on North Atlantic Right Whale Future. *Frontiers in Marine Science* 3:00137

Kraus C, Carter L. 2018. Seabed recovery following protective burial of subsea cables - Observations from the continental margin. Ocean Engineering. 157:251-261. doi:10.1016/j.oceaneng.2018.03.037.

Kritzer, J.P., DeLucia, M.-B., Greene, E., Shumway, C., Topolski, M.F., Thomas-Blate, J., Chiarella, L.A., Davy, K. B., & Smith, K. (2016). The importance of benthic habitats for coastal fisheries. BioScience, 66(4), 274-284. LaBrecque, E., C. Curtice, J. Harrison, S.M. Van Parijs, and P.N. Halpin. 2015. Biologically Important Areas for cetaceans within U.S. waters - East coast region. *Aquatic Mammals* 41(1):17-29.

LaBrecque, E., Curtice, C., Harrison, J., Van Parijs, S.M. and Halpin, P.N., 2015. 2. Biologically important areas for cetaceans within US waters-East Coast region. *Aquatic Mammals*, *41*(1), p.17.

Lacroix, G.L., & Knox, D. (2005). Distribution of Atlantic salmon (*Salmo salar*) postsmolts of different origins in the Bay of Fundy and Gulf of Maine and evaluation of factors affecting migration, growth, and survival. *Canadian Journal of Fisheries and Aquatic Sciences*, *62*(6), 1363–1376.

Lacroix, G.L., Knox, D., Sheehan, T.F., Renkawitz, M.D., & Bartron, M.L. 2012. Distribution of U.S. Atlantic Salmon Postsmolts in the Gulf of Maine. *Transactions of the American Fisheries Society* 141(4): 934–942.

Ladich, F., and A.H. Bass. 2011. Vocal behavioral of fishes. In: A.P. Farrell (Ed.), Encyclopedia of fish physiology: from genome to environment. San Diego (CA): Academic Press.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet, and M. Podesta. 2001. Collisions Between Ships and Whales. *Marine Mammal Science* 17(1):35-75.

Lavender, A.L., S.M. Bartol, and I.K Bartol. 2012. Hearing capabilities of loggerhead sea turtles (*Caretta caretta*) throughout ontogeny. In: *The effects of noise on aquatic life* (pp. 89-92). Springer New York.

Lavender, A.L., S.M. Bartol, and I.K. Bartol. 2014. Ontogenetic investigation of underwater hearing capabilities in loggerhead sea turtles (*Caretta caretta*) using a dual testing approach. *The Journal of Experimental Biology* 217(14):2580-2589.

Leatherwood, S., R.R. Reeves, W.F. Perrin, W.E. Evans, and L. Hobbs. 1982. *Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification*. U.S. Department of Commerce, NOAA, NMFS. NOAA Technical Report NMFS Circular 444. 257 p.

Leiter, S.M., K.M. Stone, J.L. Thompson, C.M. Accardo, B.C. Wikgren, M.A. Zani, T.V.N. Cole, R.D. Kenney, C.A. Mayo, and S.D. Kraus. 2017. North Atlantic right whale Eubalaena glacialis occurrence in offshore wind energy areas near Massachusetts and Rhode Island, USA. *Endangered Species Research* 34:45-59.

Lenhardt, M. (2002). Sea turtle auditory behavior. The Journal of the Acoustical Society of America, 112(5), 2314-2314.

Lesage, V., Barrette, C., Kingsley, M. C. S., & Sjare, B. (1999). The Effect of Vessel Noise on the Vocal Behavior of Belugas in the St. Lawrence River Estuary, Canada. Marine Mammal Science, 15(1), 65-84. https://doi.org/10.1111/j.1748-7692.1999.tb00782.x

Lesage, V., J.-F. Gosselin, M. Hammill, M.C. Kingsley, and J. Lawson. 2007. *Ecologically and Biologically Significant Areas (EBSAs) in the Estuary and Gulf of St. Lawrence, a Marine Mammal Perspective*. Canadian Science Advisory Secretariat.

Lesage, V., K. Gavrilchuk, R.D. Andrews, and R. Sears. 2017. Foraging areas, migratory movements and winter destinations of blue whales from the western North Atlantic. *Endangered Species Research* 34:27-43.

Lesage, V., J.-F. Gosselin, J.W. Lawson, I. McQuinn, H. Moors-Murphy, S. Plourde, R. Sears, and Y. Simard. 2018. *Habitats important to blue whales (Balaenoptera musculus) in the western North Atlantic*. Fisheries and Oceans Canada Canadian Science Advisory Secretariat. Res. Doc. 2016/080. 56 p.

Lettrich, M.D., Asaro, M.J., Borggaard, D.L., Dick, D.M., Griffis, R.B., Litz, J.A., Orphanides, C.D., Palka, D.L., Soldevilla, M.S., Balmer, B. and Chavez, S., et al. 2023. Vulnerability to climate change of United States marine mammal stocks in the western North Atlantic, Gulf of Mexico, and Caribbean. *Plos one*, *18*(9), p.e0290643.

Lillis A, Eggleston DB, Bohnenstiehl DR. 2013. Oyster larvae settle in response to habitat-associated underwater sounds. PLoS One. 8(10):e79337.

Lillis A, Bohnenstiehl DR, Eggleston DB. 2015. Soundscape manipulation enhances larval recruitment of a reef-building mollusk. PeerJ. 3:e999.

Limpus CJ. 2006. Marine turtle conservation and Gorgon gas development, Barrow Island, western Australia. In Gorgon Gas Development Barrow Island Nature Reserve, Chevron Australia. Perth, Western Australia: Environmental Protection Agency (Western Australia). 20 p.

Lohrasbipeydeh, H., T. Dakin, T.A. Gulliver, and A. Zielinski. 2013. Characterization of sperm whale vocalization energy based on echolocation signals. In: 2013 OCEANS-San Diego. pp. 1-5.

Løkkeborg, S., Ona, E., Vold, A., & Salthaug, A. (2012). Sounds from seismic air guns: gear- and species-specific effects on catch rates and fish distribution. Canadian Journal of Fisheries and Aquatic Sciences, 69(8), 1278-1291.

Love, O.P., McGowan, P.O., and Sheriff, M.J. (2013). Maternal adversity and ecological stressors in natural populations: the role of stress axis programming in individuals, with implications for populations and communities. *Funct. Ecol.* 27, 81–92. doi: 10.1111/j.1365-2435.2012.02040.x

Lovell, J.M., M.M. Findlay, R.M. Moate, J.R. Nedwell, and M.A. Pegg. 2005a. The inner ear morphology and hearing abilities of the Paddlefish (*Polyodon spathula*) and the Lake Sturgeon (*Acipenser fulvescens*). *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology* 142(3):286-296.

Lovell, J. M., Findlay, M. M., Moate, R. M., & Yan, H. Y. (2005b). The hearing abilities of the prawn Palaemon serratus. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 140(1), 89-100.

Lovell, J. M., Moate, R. M., Christiansen, L., & Findlay, M. M. (2006). The relationship between body size and evoked potentials from the statocysts of the prawn Palaemon serratus. Journal of Experimental Biology, 209(13), 2480. https://doi.org/10.1242/jeb.02211.

Lutcavage, M. E., Plotkin, P.T., Witherington, B., Lutz, P. L., & Musick, J. A. (1997). The biology of sea turtles. Human Impacts on Sea Turtle Survival. CRC Press.

Madsen, P., and A. Surlykke. 2013. Functional convergence in bat and toothed whale biosonars. *Physiology* 28(5):276-283.

Maine Department of Environmental Protection. 2024. Maine statutory water classification. Augusta, ME: Maine Department of Environmental Protection, Bureau of Water Quality, Division of Environmental Assessment. [accessed 5 April 2024]. https://maine.maps.arcgis.com/apps/webappviewer/index.html?id=397738f1d21d42589ab7ac989e2db568.

Maine Department of Marine Resources (DMR). 2022a. Maine Coastal Mapping Initiative. Accessed: March 28, 2024. Retrieved from: https://www.maine.gov/dmr/programs/maine-coastal-program/coastal-science-and-research/maine-coastal-mapping-initiative.

Maine Department of Marine Resources (DMR). 2022b. What We Do at the Maine Coastal Mapping Initiative. Accessed: February 29, 2024. Retrieved from: https://www.maine.gov/dmr/programs/maine-coastal-program/coastal-science-and-research/maine-coastal-mapping-initiative/what-the-mcmi-does.

Maine Department of Marine Resources (DMR). 2022c. DMR Larval Lobster Surveys. Accessed: March 28, 2024. Retrieved from: https://www.maine.gov/dmr/science/species-information/maine-lobster/lobster-life-stages-and-dmr-surveys/larval-lobster-surveys.

Maine Department of Marine Resources (DMR). 2022d. Large Whale Species of New England. [accessed May 31 2023]. https://www.maine.gov/dmr/science/species-information/protected-species-in-the-gulf-of-maine/large-whale-species-of-new-england

Maine Department of Marine Resources (DMR). 2023a. Where to Fish Along Maine’s Coast. [Accessed 17 May 2023]. https://www.maine.gov/dmr/fisheries/recreational/anglers-guide/where-to-fish.

Maine Department of Marine Resources (DMR). 2023b. Maine’s Saltwater For-Hire Fleet Listing. [Accessed 17 May 2023]. https:www.maine.gov/dmr/fisheries/recreational/charter-head-boats-for-hire .

Mann, D. A., Higgs, D. M., Tavolga, W. N., Souza, M. J., & Popper, A. N. (2001). Ultrasound detection by clupeiform fishes. The Journal of the Acoustical Society of America, 109(6), 3048-3054.

Marine Geospatial Ecology Lab (MGEL). 2022. Habitat-based marine mammal density models for the U.S. Atlantic. Duke University, Marine Geospatial Ecology Laboratory. Accessed June 2023. https://seamap.env.duke.edu/models/Duke/EC/.

Marine Geospatial Ecology Lab (MGEL). Duke University. 2023. Mapping Tool for Sea Turtle Density for the U.S. Atlantic. OBIS-SEAMAP. Accessed 05 September 2023. https://seamap.env.duke.edu/models/mapper/NUWC_EC

Marn, N., M. Jusup, T. Legović, S.A.L.M Kooijman, and T. Klanjšček. 2017. Environmental effects on growth, reproductive, and life history traits of loggerhead sea turtles. *Ecological Modelling* 360:163-178.

Martin, K.J., S.C. Alessi, J.C. Gaspard, A.D. Tucker, G.B. Bauer, and D.A. Mann. 2012. Underwater hearing in the loggerhead turtle (*Caretta caretta*): A comparison of behavioral and auditory evoked potential audiograms. *Journal of Experiment Biology* 215(17):3001-3009.

Martin, J., Sabatier, Q., Gowan, T. A., Giraud, C., Gurarie, E., Calleson, C. S., Ortega-Ortiz, J. G., Deutsch, C. J., Rycyk, A., & Koslovsky, S. M. (2016). A quantitative framework for investigating risk of deadly collisions between marine wildlife and boats. Methods in Ecology and Evolution, 7(1), 42-50.

Mate, B.R., Nieukirk, S. Mesecar, R., and Martin, T. 1992. Application of remote sensing methods for tracking large cetaceans: North Atlantic right whales (*Eubalaena glacialis*). US Department of the Interior, Minerals Management Service, Alaska and Atlantic OCS Regional Offices. 183 p.

Mayo, C., B. Letcher, and S. Scott. 2001. Zooplankton filtering efficiency of the baleen of a North Atlantic right whale, *Eubalaena glacialis*. *Journal of Cetacean Research and Management* 2: 225-229-.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000a. Marine Seismic Suveys - A Study of Environmental Implications. *APPEA Journal* 40(1):692-708.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000b. Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. Curtin University of Technology, Centre for Marine Science and Technology, Bentley, Australia.

McConnell, A., Routledge, R., & Connors, B. (2010). Effect of artificial light on marine invertebrate and fish abundance in an area of salmon farming. Marine Ecology Progress Series, 419, 147-156.

McKenna, M. F., Ross, D., Wiggins, S. M., & Hildebrand, J. A. (2012). Underwater radiated noise from modern commercial ships. The Journal of the Acoustical Society of America, 131(1), 92-103.

McKenna, M. F., Calambokidis, J., Oleson, E. M., Laist, D. W., & Goldbogen, J. A. (2015). Simultaneous tracking of blue whales and large ships demonstrates limited behavioral responses for avoiding collision. Endangered Species Research, 27(3), 219-232.

McPherson, C. R., Wood, M., & Racca, R. (2016). Potential Impacts of Underwater Noise from Operation of the Barossa FPSO Facility on Marine Fauna, ConocoPhillips Barossa Project. (Technical Report 01117, Version 1.0).

McWilliam, J.N., and H.D. Hawkins. 2013. A comparison of inshore marine soundscapes. *Journal of Experimental Marine Biology and Ecology* 446:166-176

Meister, A.L. 1984. The marine migrations of tagged Atlantic salmon (*Salmo salar L.*) of USA origin. *ICES Document CM*, *1000*. 28 pp.

Meyer, M., R.R. Fay, and A.N. Popper. 2010. Frequency tuning and intensity coding of sound in the auditory periphery of the lake sturgeon, Acipenser fulvescens. *Journal of Experimental Biology* 213(9):1567-1578.

Meyer-Gutbrod, E.L., C.H. Greene, P.J. Sullivan, and A.J. Pershing. 2015. Climate-associated changes in prey availability drive reproductive dynamics of the North Atlantic right whale population. *Marine Ecology Progress Series* 535:243-258.

Meyer-Gutbrod, E.L., and C.H. Greene. 2018. Uncertain recovery of the North Atlantic right whale in a changing ocean. *Global Change Biology* 24(1):455-464.

Meyer-Gutbrod, E.L., C.H. Greene, K.T.A. Davies, and D.G. Johns. 2021. Ocean regime shift is driving collapse of the North Atlantic right whale population. *Oceanography* 34(3):22-31.

Michel, J., A.C. Bejarano, C.H. Peterson, and C. Voss 2013. Review of Biological and Biophysical Impacts from Dredging and Handling of Offshore Sand. OCS Study BOEM 2013-0119. Herndon, Virginia: U.S. Department of the Interior, Bureau of Ocean Energy Management. 258 p.

Mickle, M.F., and D.M. Higgs. 2022. Towards a new understanding of elasmobranch hearing. *Marine Biology* 169(1).

Mikkelsen, L., Johnson, M., Wisniewska, D. M., van Neer, A., Siebert, U., Madsen, P. T., & Teilmann, J. (2019). Long-term sound and movement recording tags to study natural behavior and reaction to ship noise of seals. Ecology and Evolution, 9(5), 2588-2601.

Miller, M.H. & Klimovich, C. 2017. Endangered Species Act status review report: Giant manta ray (Manta birostris) and reef manta ray (Manta alfredi). National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland.

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

Mitchell, M.R., G. Harrison, K. Pauley, A. Gagné, G. Maillet, and P. Strain. 2002. Atlantic Zonal Monitoring Program Sampling Protocol. Canadian Technical Report of Hydrography and Ocean Sciences 223. Available: https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/265754.pdf. Accessed June 1, 2023

Mohr FC, Lasley B, Bursian S (2008) Chronic oral exposure to bunker C fuel oil causes adrenal insufficiency in ranch mink (Mustela vison). Arch Environ Contam Toxicol 54: 337−347

Montgomery JC. 2006. Sound as an orientation cue for the pelagic larvae of reef fishes and decapod crustaceans. Advances in Marine Biology. 51:143-196.

Mooney, T.A., Hanlon, R.T., Christensen-Dalsgaard, J., Madsen, P.T., Ketten, D.R., & Nachtigall, P.E. (2010). Sound detection by the longfin squid (Loligo pealeii) studied with auditory evoked potentials: sensitivity to low-frequency particle motion and not pressure. The Journal of Experimental Biology, 213(21), 3748.

Mooney, T.A., Yamato, M., & Branstetter, B.K. (2012). Hearing in cetaceans: from natural history to experimental biology. *Advances in marine biology*, *63*, 197-246.

Moser, M.L., and S.W Ross. 1995. Habitat use and movements ofshortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124:225-234

Moser ML, Bain M, Collins MR, Haley N, Kynard B, J.C. O'Herron II, Rogers G, Squiers TS. 2000. A protocol for use of shortnose and Atlantic sturgeons. Report No.: NOAA Technical Memorandum-NMFS-PR-18.

Mueller-Blenkle, C., McGregor, P. K., Gill, A. B., Andersson, M. H., Metcalfe, J., Bendall, V., Sigray, P., Wood, D. T., & Thomsen, F. (2010). Effects of pile-driving noise on the behaviour of marine fish.

Murphy, Sinéad, Robin J. Law, Robert Deaville, James Barnett, Matthew W. Perkins, Andrew Brownlow, Rod Penrose, Nicholas J. Davison, Jonathan L. Barber, and Paul D. Jepson. "Organochlorine contaminants and reproductive implication in cetaceans: a case study of the common dolphin." *Marine mammal ecotoxicology* (2018): 3-38.

Musick JA, Limpus CJ. 1996. Habitat Utilization and Migration in Juvenile Sea Turtles In: Lutz PL, Musick JA (Eds.), The Biology of Sea Turtles. New York, NY: CRC Press. pp. 137-163.

National Aeronautics and Space Administration (NASA). 2023. The Effects of Climate Change. Available at: https://climate.nasa.gov/effects/. Accessed April 5, 2023.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 1991. *Recovery Plan for the U.S. Population of the Atlantic Green Turtle*. Washington, D.C.: U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, and U.S. Department of the Interior, U.S. Fish and Wildlife Service. 59 p.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 1992. *Recovery plan for leatherback turtles in the U.S. Caribbean, Atlantic, and Gulf of Mexico*. Washington, D.C.: U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, and U.S. Department of the Interior, U.S. Fish and Wildlife Service. 69 p.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 1998. Endangered Species Consultation Handbook. Procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act. March 1998. 315 p. Available:https://www.fws.gov/sites/default/files/documents/endangered-species-consultation-handbook.pdf. Accessed July 18, 2023.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2007a. *Green sea turtle (Chelonia mydas) 5-year review: Summary and evaluation*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service and U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C 105 p.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2007b. *Kemp's Ridley Sea Turtle (Lepidochelys kempii) 5-Year Review: Summary and Evaluation*. U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources and U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southwest Region. 50 p.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2008. *Recovery plan for the northwest Atlantic population of the loggerhead sea turtle (Caretta caretta)*. Washington, D.C.: U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service. 325 p.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2013. *Leatherback Sea Turtle (Dermochelys coriacea), 5-Year Review: Summary and Evaluation*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, MD, and U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 93 p.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015a. *Green Turtle (Chelonia mydas) Status Review under the U.S. Endangered Species Act.* Report of the Green Turtle Status Review Team.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015b. *Kemp's Ridley Sea Turtle (Lepidochelys kempii) 5-Year Review: Summary and Evaluation*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service Office of Protected Resources and U.S. Department of the Interior, U.S. Fish and Wildlife Service Southwest Region. July 2015. 63 p.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2019. Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (Salmo salar), Final Plan for the 2009 ESA listing. Available: https://media.fisheries.noaa.gov/dam-migration/final_recovery_plan2.pdf. Accessed June 1, 2023.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2020a. *Endangered Species Act status review of the leatherback turtle (Dermochelys coriacea) 2020*. U.S. National Marine Fisheries Service and U.S. Fish and Wildlife Service. August 2020. 396 p.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2020b. Atlantic salmon (*Salmo salar*) 5-Year Review: Summary and Evaluation, 2020. Available: https://media.fisheries.noaa.gov/2020-11/20201122_ATS%205%20year%20review_508.pdf?VersionId=null. Accessed June 1, 2023.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2023. Loggerhead Sea Turtle (Caretta caretta) Northwest Atlantic Ocean DPS 5-Year Review: Summary and Evaluation. U.S. National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2023. 66 p.

National Marine Fisheries Service (NMFS). 2011. *Programmatic Informal Consultation – mid-Atlantic WEAs*. Gloucester, MA: National Marine Fisheries Service, Northeast Region. September 20, 2011. 48 p. Available at: https://www.boem.gov/sites/default/files/documents/renewable-energy/MidAtlanticRegional_NMFS_Concurrence.pdf. Accessed April 6, 2023.

National Marine Fisheries Service (NMFS). 2014. *Draft Programmatic Environmental Assessment for Fisheries Research Conducted and Funded by the Northeast Fisheries Science Center*. December 2014. Prepared by URS Group, Anchorage, Alaska. 657 pp.

National Marine Fisheries Service (NMFS). 2016. Endangered Species Act Section 7 consultation on the continued prosecution of fisheries and ecosystem research conducted and funded by the Northeast Fisheries Science Center and the issuance of a Letter of Authorization under the Marine Mammal Protection Act for the incidental take of marine mammals pursuant to those research activities. PCTS ID: NER-2015-12532.

National Marine Fisheries Service (NMFS). 2017. *Designation of Critical Habitat for the Gulf of Maine, New York Bight, and Chesapeake Bay Distinct Population Segments of Atlantic Sturgeon ESA Section 4(b)(2) Impact Analysis and Biological Source Document with the Economic Analysis and Final Regulatory Flexibility Analysis Finalized June 3, 2017*. NMFS Greater Atlantic Regional Fisheries Office. 244 p.

National Marine Fisheries Service (NMFS). 2018. *2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. NOAA Technical Memorandum NMFS-OPR-59. 167 p.

National Marine Fisheries Service (NMFS). 2019. *Fin Whale (Balaenoptera physalus) 5-Year Review: Summary and Evaluation*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources. February 2019. 40 p.

National Marine Fisheries Service (NMFS). 2021a. Office of Science and Technology, Commercial Landings Query. Available: www.fisheries.noaa.gov/foss. Accessed May 26, 2023.

National Marine Fisheries Service (NMFS). 2021b. Sturgeon and Sea Turtle Take Standard Operating Procedure. Available: https://media.fisheries.noaa.gov/2021-11/Sturgeon-Sea-Turtle-Take-SOPs-external-11032021.pdf. Accessed June 1, 2023.

National Marine Fisheries Service (NMFS). 2022a. Giant Manta Ray. Retrieved from https://www.fisheries.noaa.gov/species/giant-manta-ray.

National Marine Fisheries Service (NMFS). 2022b. Kemp's Ridley turtle (*Lepidochelys kempii*) Species Page. Available: https://www.fisheries.noaa.gov/species/kemps-ridley-turtle. Accessed April 7, 2023.

National Marine Fisheries Service (NMFS). 2022c. Loggerhead Turtle. Available: https://www.fisheries.noaa.gov/species/loggerhead-turtle. Accessed June 29, 2023.

National Marine Fisheries Service (NMFS). 2022d. Gulf of Maine Distinct Population Segment of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). 5-Year Review: Summary and Evaluation. NMFS, GARFO, Gloucester, MA. 34 p. Available at: https://media.fisheries.noaa.gov/2022-02/Atlantic%20sturgeon%20GOM%205-year%20review_FINAL%20SIGNED.pdf.

National Marine Fisheries Service (NMFS). 2023a. LMA 1 Restricted Area. Available: https://www.fisheries.noaa.gov/resource/map/lma-1-restricted-area. Accessed February 28, 2024.

National Marine Fisheries Service (NMFS). 2023b. Oceanic Whitetip Shark (*Carcharhinus longimanus*) Species Page. Available: https://www.fisheries.noaa.gov/species/oceanic-whitetip-shark. Accessed April 6, 2023.

National Marine Fisheries Service (NMFS). 2023c. Sei Whale (*Balaenoptera borealis*) Species Page. Available: https://www.fisheries.noaa.gov/species/sei-whale. Accessed April 6, 2023.

National Marine Fisheries Service (NMFS). 2023d. Blue whale (*Balaenoptera musculus*) Species Page. Available: https://www.fisheries.noaa.gov/species/blue-whale. Accessed April 5, 2023.

National Marine Fisheries Service (NMFS). 2023e. Green Turtle. Available: https://www.fisheries.noaa.gov/species/green-turtle. Accessed June 29, 2023.

National Marine Fisheries Service (NMFS). 2023f. Sea Turtle Stranding and Salvage Network. Available at: https://www.fisheries.noaa.gov/national/marine-life-distress/sea-turtle-stranding-and-salvage-network#:~:text=The%20Network%20is%20a%20cooperative,to%20inform%20conservation%20management%20and. Accessed April 7, 2023.

National Marine Fisheries Service (NMFS). 2023g. Leatherback Turtle (*Dermochelys coriacea*) Species Page. Available: https://www.fisheries.noaa.gov/species/leatherback-turtle. Accessed April 7, 2023.

National Marine Fisheries Service (NMFS). 2023h. Atlantic Sturgeon (*Acipenser oxyrhynchus*) Species Page. Available: https://www.fisheries.noaa.gov/species/atlantic-sturgeon. Accessed April 5, 2023.

National Marine Fisheries Service (NMFS). 2023i. Atlantic Salmon (*Salmo salar*) Species Page. Available: https://www.fisheries.noaa.gov/species/atlantic-salmon-protected. Accessed May 31, 2023.

National Marine Fisheries Service (NMFS). 2023j. National Marine Fisheries Service: Summary of Endangered Species Act Acoustic Thresholds (Marine Mammals, Fishes, and Sea Turtles). Available: https://www.fisheries.noaa.gov/s3/2023-02/ESA%20all%20species%20threshold%20summary_508_OPR1.pdf. Accessed April 7, 2023.

National Marine Fisheries Service (NMFS). 2024a. Draft 2023 Atlantic Marine Mammal Stock Assessment. Available: https://www.fisheries.noaa.gov/s3/2024-01/Draft-2023-MMSARs-Public-Comment.pdf. Accessed March 29, 2024.

National Marine Fisheries Service (NMFS). 2024b. North Atlantic Right Whale calving season 2024. Available: https://www.fisheries.noaa.gov/national/endangered-species-conservation/north-atlantic-right-whale-calving-season-2024. Accessed May 7 2024

National Marine Fisheries Service (NMFS). 2024c. 2017–2024 North Atlantic Right Whale Unusual Mortality Event. Available: https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2024-north-atlantic-right-whale-unusual-mortality-event. Accessed May 7 2024

National Marine Fisheries Service (NMFS). 2024d. Marine Mammal Unusual Mortality Events. Available: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-unusual-mortality-events. Accessed May 6,2024

National Oceanic and Atmospheric Administration (NOAA) and National Centers for Environmental Information (NCEI). 2023. Passive Acoustic Data Viewer. https://www.ncei.noaa.gov/maps/passive-acoustic-data/. Accessed July 7, 2023.

National Oceanic and Atmospheric Administration (NOAA). 2021. Final environmental impact statement, regulatory impact review, and final regulatory flexibility analysis for amending the Atlantic Large Whale Take Reduction Plan: Risk reduction rule. Prepared by NOAA's National Marine Fisheries Service and Industrial Economics, Incorporated.

National Oceanic and Atmospheric Administration (NOAA). 2023. Biologically Important Area Map. Available: https://experience.arcgis.com/experience/192436ba3fc547afbab5aa31f0403a63. Accessed February 28, 2024.

National Oceanic and Atmospheric Administration (NOAA). n.d. Magnetic Field Calculators: Magnetic Field Estimated Values. Available: https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml#igrfwmm. Accessed April 6, 2023.

National Park Service (NPS). 2023. Kemp's ridley sea turtles. Available: https://www.nps.gov/pais/learn/nature/kridley.htm. Accessed April 7, 2023.

NRC (National Research Council). 1990. Decline of the sea turtles: Causes and prevention. Washington, D.C.: National Academy Press. 259 p. Copyright protected.

NatureServe. 2023. *Chelonia mydas* – (Linnaeus, 1785): Green Sea Turtle. NatureServe Explorer. Available: http://explorer.natureserve.org/servlet/NatureServe?searchName=chelonia+mydas. Accessed April 7, 2023.

Nedelec, S. L., Campbell, J., Radford, A. N., Simpson, S. D., & Merchant, N. D. (2016). Particle motion: the missing link in underwater acoustic ecology. Methods in Ecology and Evolution, 7(7), 836-842.

Nedelec, S. L., Radford, A. N., Pearl, L., Nedelec, B., McCormick, M. I., Meekan, M. G., & Simpson, S. D. (2017). Motorboat noise impacts parental behaviour and offspring survival in a reef fish. Proceedings of the Royal Society B: Biological Sciences, 284(1856), 20170143.

Nedwell, J.R., A.W. Turnpenny, J. Lovell, S.J. Parvin, R. Workman, and J.A.L. Spinks. 2007. *A validation of the dBht as a measure of the behavioural and auditory effects of underwater noise*. Report No. 534R1231 prepared by Subacoustech Ltd. for the UK Department of Business, Enterprise and Regulatory Reform under Project No. RDCZ/011/0004. Available: https://tethys.pnnl.gov/sites/default/files/publications/Nedwell-et-al-2007.pdf. Accessed April 7, 2023.

Nelson, M., M. Garron, R. L. Merrick, R. M. Pace III, and T. Cole. 2007. *Mortality and serious injury determinations for baleen whale stocks along the United States eastern seaboard and adjacent Canadian Maritimes, 2001 - 2005*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Neo, Y. Y., Seitz, J., Kastelein, R. A., Winter, H. V., ten Cate, C., & Slabbekoorn, H. (2014). Temporal structure of sound affects behvioral recovery from noise impact in European seabass. Biological Conservation, 178, 65-73.

Nichols, T. A., Anderson, T. W., & Širović, A. (2015). Intermittent noise induces physiological stress in a coastal marine fish. *PLoS One*, *10*(9), e0139157.

Nightingale, B., Longcore, T., & Simenstad, C. A. (2006). Artificial night lighting and fishes. Ecological consequences of artificial night lighting, 11, 257-276.

Normandeau Associates Inc. 2014. Understanding the habitat value and function of shoal/ridge/trough complexes to fish and fisheries on the Atlantic and Gulf of Mexico Outer Continental Shelf. Bedford, New Hampshire: US Department of the Interior, Bureau of Ocean Energy Management. 116 pp.

Northeast Fisheries Science Center (NEFSC). N.d. Ecology of the Northeast US Continental Shelf: Zooplankton. Available: https://apps-nefsc.fisheries.noaa.gov/nefsc/ecosystem-ecology/zooplankton.html. Accessed April 6, 2023.

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2011. Preliminary Summer 2010 Regional Abundance Estimate of Loggerhead Turtles (Caretta caretta) in Northwestern Atlantic Ocean Continental Shelf Waters. NEFSC, Woods Hole, MA and SEFSC, Miami FL, April 2011. NEFSC Ref Doc 11-03.

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2018. *2018 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US waters of the Western North Atlantic Ocean – AMAPPS II*. NEFSC and SEFSC, Woods Hole, MA. 120 p.

Northeast Regional Ocean Council. 2024. Northeast ocean data portal. [accessed 5 April 24]. https://www.northeastoceandata.org/.

Novak, A. J., Carlson, A. E., Wheeler, C. R., Wippelhauser, G. S., & Sulikowski, J. A. (2017). Critical Foraging Habitat of Atlantic Sturgeon Based on Feeding Habits, Prey Distribution, and Movement Patterns in the Saco River Estuary, Maine. *Transactions of the American Fisheries Society*, *146*(2), 308–317. https://doi.org/10.1080/00028487.2016.1264472

Nowacek, D. P., Johnson, M. P., & Tyack, P. L. (2004). North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli. Proceedings of the Royal Society B: Biological Sciences, 271(1536), 227-231.

Nowacek S. M., Wells R. S., Solow A. R. (2006). Short term effects of boat traphic on bottlenose dolphins, Tursiops truncatus, in Sarasota Bay, Florida. Marine Mammal Science, 17, 673-688

O'Brien, O., D.E. Pendleton, L.C. Ganley, K.R. McKenna, R.D. Kenney, E. Quintana-Rizzo, C.A. Mayo, S.D. Kraus, and J.V. Redfern. 2022. Repatriation of a historical North Atlantic right whale habitat during an era of rapid climate change. *Scientific Reports* 12(1):1-10.

Okuyama, J., Benson, S.R., Dutton, P.H. and Seminoff, J.A., 2021. Changes in dive patterns of leatherback turtles with sea surface temperature and potential foraging habitats. *Ecosphere*, *12*(2), p.e03365.

Olsen, E., W. P. Budgell, E. Head, L. Kleivane, L. Nottestad, R. Prieto, M. A. Silva, H. Skov, G. A. Víkingsson, G. Waring, and N. Oien. 2009. First satellite-tracked long-distance movement of a sei whale (*Balaenoptera borealis*) in the North Atlantic. *Aquatic Mammals* 35(3):313–318.

Orr T, Herz S, Oakley D. 2013. Evaluation of Lighting Schemes for Offshore Wind Facilities and Impacts to Local Environments. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2013-0116. 429 p.

OSPAR Commission. 2009. Assessment of the environmental impact of underwater noise. Biodiversity Series. 41 p. Available: https://qsr2010.ospar.org/media/assessments/p00436_JAMP_Assessment_Noise.pdf. Accessed April 7, 2023.

Pace, R., & Silber, G. (2005). Simple analyses of ship and large whale collisions: Does speed kill Abstract. Sixteenth Biennial Conf. Biol. Mar. Mamm., San Diego.

Pace, R.M. 2021. *Revisions and Further Evaluations of the Right Whale Abundance Model: Improvements for Hypothesis Testing*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NOAA Technical Memorandum NMFS-NE-269. 54 p.

Packard, A., Karlsen, H. E., & Sand, O. (1990). Low frequency hearing in cephalopods. Journal of Comparative Physiology A, 166(4), 501-505.

Palka, D.L., S. Chavez-Rosales, E. Josephson, D. Cholewiak, H.L. Haas, L. Garrison, M. Jones, D. Sigourney, G. Waring, M. Jech, E. Broughton, M. Soldevilla, G. Davis, A. DeAngelis, C.R. Sasso, M.V. Winton, R.J. Smolowitz, G. Fay, E. LaBrecque, J.B. Leiness, Dettloff, M. Warden, K. Murray, and C. Orphanides. 2017. *Atlantic Marine Assessment Program for Protected Species: 2010-2014*. Washington, DC: U.S. Department of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region. OCS Study BOEM 2017-071. 211 p.

Palka, D., L. Aichinger Dias, E. Broughton, S. Chavez-Rosales, D. Cholewiak, G. Davis, A. DeAngelis, L. Garrison, H. Haas, J. Hatch, M. Jech, E. Josephson, L. Mueller-Brennan, C. Orphanides, N. Pegg, C. Sasso, D. Sigourney, M. Soldevilla, and H. Walsh. 2021. *Atlantic Marine Assessment Program for Protected Species: FY15 – FY19*. US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-051. 330 p.

Papale, E., S. Prakash, S. Singh, A. Batibasaga, G. Buscaino, and S. Piovano. 2020. Soundscape of green turtle foraging habitats in Fiji, South Pacific. *PloS One* 15, no. 8: e0236628.

Parks, S.E., M.W. Brown, L.A. Conger, P.K. Hamilton, A.R. Knowlton, S.D. Kraus, C.K. Slay, and P.L. Tyack. 2007. Occurrence, Composition, and Potential Functions of North Atlantic Right Whale (Eubalaena Glacialis) Surface Active Groups. *Marine Mammal Science* 23(4):868-887.

Parks, S. E., Cusano, D.A., Van Parijs, S.M., & Nowacek, D.P. (2019). Acoustic crypsis in communication by North Atlantic right whale mother-calf pairs on the calving grounds. Biology Letters, 15, 20190485.

Parsons, M.J., Erbe, C., Meekan, M.G., & Parsons, S.K. (2021). A Review and Meta-Analysis of Underwater Noise Radiated by Small (<25 m Length) Vessels. Journal of Marine Science and Engineering, 9(8), 827.

Patel, S.H., M.V. Winton, J.M. Hatch, H.L. Haas, V.S. Saba, G. Fay, and R.J. Smolowitz. 2021. Projected shifts in loggerhead sea turtle thermal habitat in the Northwest Atlantic Ocean due to climate change. *Scientific Reports* 11(1):1-12.

Patrício, A.R., M.R. Varela, C. Barbosa, A.C. Broderick, P. Catry, L.A. Hawkes, A. Regalla, and B.J. Godley. 2019. Climate change resilience of a globally important sea turtle nesting population. *Global Change Biology* 25(2):522-535.

Pauly, D., A. Trites, E. Capuli, and V. Christensen. 1998. Diet composition and trophic levels of marine mammals. *ICES journal of Marine Science* 55(3):467-481.

Payne, P.M., D.N. Wiley, S.B. Young, S. Pittman, P.J. Clapham, and J.W. Jossi. 1990. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in selected prey. *Fishery Bulletin* 88(4):687-696.

Pelletier, D., D. Roos, and S. Ciccione. 2003. Oceanic survival and movements of wild and captive-reared immature green turtles (*Chelonia mydas*) in the Indian Ocean. *Aquatic Living Resources* 16(1):35-41.

Pendleton, D.E., P.J. Sullivan, M.W. Brown, T.V.N. Cole, C.P. Good, C.A. Mayo, B.C. Monger, S. Phillips, N.R. Record, and A.J. Pershing. 2012. Weekly predictions of North Atlantic right whale *Eubalaena glacialis* habitat reveal influence of prey abundance and seasonality of habitat preferences. *Endangered Species Research* 18(2):147-161.

Perry, S.L., D.P. DeMaster, and G.K. Silber. 1999. The Sperm whale. *Marine Fisheries Review* 61:59-74.

Pershing, A.J., Alexander, M.A., Brady, D.C., Brickman, D., Curchitser, E.N., Diamond, A.W., McClenachan, L., Mills, K.E., Nichols, O.C., Pendleton, D.E. and Record, N.R., 2021. Climate impacts on the Gulf of Maine ecosystem: A review of observed and expected changes in 2050 from rising temperatures. *Elem Sci Anth*, *9*(1), p.00076.

Pershing, A.J., Alexander, M.A., Hernandez, C.M., Kerr, L.A., Le Bris, A., Mills, K.E., Nye, J.A., Record, N.R., Scannell, H.A., Scott, J.D. and Sherwood, G.D., 2015. Slow adaptation in the face of rapid warming leads to collapse of the Gulf of Maine cod fishery. *Science*, *350*(6262), pp. 809-812.

Petereit J., J. Saynisch-Wagner, C. Irrgang, and M. Thomas. 2019. Analysis of Ocean Tide-Induced Magnetic Fields Derived From Oceanic In Situ Observations: Climate Trends and the Remarkable Sensitivity of Shelf Regions. *Journal of Geophysical Research: Oceans* 124(11): 8257-8270.

Pentony M. 2022. Request for Competitive Interest (RFCI) and Request for Interest (RFI) for possible commercial wind energy leasing on the outer continental shelf (OCS) in the Gulf of Maine, Docket No. BOEM–2022–0041 and Docket No. BOEM–2022–0040 [official communication; letter from National Oceanic and Atmospheric Administration on 2022 Oct 3].

Pettis HM and Hamilton PK. 2024. North Atlantic right whale consortium. 2023 Annual report card. Boston (MA) and Shutesbury (MA): North Atlantic Right Whale Consortium. 17 p.

Pierce, Graham J., Maria B. Santos, Sinead Murphy, Jennifer A. Learmonth, Alan F. Zuur, Emer Rogan, Paco Bustamante et al. "Bioaccumulation of persistent organic pollutants in female common dolphins (Delphinus delphis) and harbour porpoises (Phocoena phocoena) from western European seas: Geographical trends, causal factors and effects on reproduction and mortality." *Environmental Pollution* 153, no. 2 (2008): 401-415.

Pijanowski, B.C., L.I. Villanueva-Rivera, S.L. Dumyahn, A. Farina, B.L. Krause, B.M. Napoletano, S.H. Gage, and N. Pieretti. 2011. Soundscape ecology: the science of sound in the landscape. *BioScience* 61(3):203-216.

Pike, D.G., G.A. Víkingsson, T. Gunnlaugsson, and N. Øien. 2009. A note on the distribution and abundance of blue whales (Balaenoptera musculus) in the Central and Northeast North Atlantic. *NAMMCO Scientific Publications* 7:19-29.

Piniak WED (2012) Acoustic ecology of sea turtles: implications for conservation by acoustic ecology of sea turtles: implications for conservation. PhD thesis, Duke University, DurhamPiniak, W.E.D., D.A. Mann, C.A. Harms, T.T. Jones, and S.A. Eckert. 2016. Hearing in the Juvenile Green Sea Turtle (*Chelonia mydas*): A Comparison of Underwater and Aerial Hearing Using Auditory Evoked Potentials. *PLoS One* 11(10):e0159711.

Plotkin, P.T., M.K. Wicksten, and A.F. Amos. 1993. Feeding ecology of the loggerhead sea turtle, *Caretta caretta*, in the northwestern Gulf of Mexico. *Marine Biology* 115(1):1–15

Popper, A. N., Salmon, M., & Horch, K. W. (2001). Acoustic detection and communication by decapod crustaceans. Journal of Comparative Physiology A, 187(2), 83-89.

Popper, A.N. 2005. *A Review of Hearing by Sturgeon and Lamprey* Prepared for the U.S. Army Corps of Engineers, Portland District. 12 August 2005. 23 p.

Popper, A.N., & Hastings, M.C. (2009). The effects of anthropogenic sources of sound on fishes. Journal of Fish Biology, 75(3), 455-489. https://doi.org/10.1111/j.1095-8649.2009.02319.x

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, M.B. Halvorsen, S. Løkkeborg, P.H. Rogers, B.L. Southall, D.G. Zeddies, and W.N. Tavolga. 2014. Sound Exposure Guidelines. In: (Eds.), *ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. pp. 33-51.

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

Popper A.N., A.D. Hawkins, and M.B. Halvorsen. 2019. *Anthropogenic sound and fishes*. Olympia (WA): WA-RD 891.1.

Popper, A.N., and A.D. Hawkins. 2019. An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes. *Journal of Fish Biology* 94(5):692-713.

Popper A.N., A.D. Hawkins, and J.A. Sisneros. 2022. Fish hearing "specialization" - A re-valuation. *Hearing research* 108393.

Prieto, R., M.A. Silva, G.T. Waring, and J.M. Gonçalves. 2014. Sei whale movements and behaviour in the North Atlantic inferred from satellite telemetry. *Endangered Species Research* 26(2):103-113.

Purser, J., & Radford, A.N. (2011). Acoustic Noise Induces Attention Shifts and Reduces Foraging Performance in Three-Spined Sticklebacks (Gasterosteus aculeatus). PLoS One, 6(2), e17478.

Putland, R.L., Merchant, N.D., Farcas, A., & Radford, C.A. (2017). Vessel noise cuts down communication space for vocalizing fish and marine mammals. Global Change Biology, 24(4), 1708-1721.

Quick, N., Scott-Hayward, L., Sadykova, D., Nowacek, D., & Read, A. (2017). Effects of a scientific echo sounder on the behavior of short-finned pilot whales (Globicephala macrorhynchus). Canadian Journal of Fisheries and Aquatic Sciences, 74(5), 716-726.

Radford CA, Jeffs AG, Montgomery JC. 2007. Directional swimming behavior by five species of crab postlarvae in response to reef sound. Bulletin of Marine Science. 80(2):369-378.

Radford, C.A., A.G. Jeffs, C.T. Tindle, and J.C. Montgomery. 2008. Temporal patterns in ambient noise of biological origin from a shallow water temperate reef. *Oecologia* 156(4):921-929.

Read, A. J., Drinker, P., & Northridge, S. (2006). Bycatch of marine mammals in U.S. and global fisheries. Conservation Biology, 20(1), 163-169.

Reese, A, Stolen, M, Findlay, CR, Smith, J, Varghese, H, Levenson, J. 2023 Potential Lifecycle Impacts of Renewable Energy Construction and Operations on Endangered Sea Turtles with a focus on the Northwest Atlantic. Cocoa (FL): U.S. Department of the Interior, Bureau of Ocean Energy Management. 106 p. Report No.: OCS Study BOEM 20xx-xxx. Contract No.: 140M0121F0014.

Reeves, R.R., P.J. Clapham, R.L. Brownell, Jr., and G.K. Silber. 1998. *Recovery Plan for the Blue Whale (*Balaenoptera musculus*)*. Silver Spring (MD): U.S. Department of Commerce, National Marine Fisheries Service. 48 p.

Reichmuth, C., J.M. Sills, J. Muslow, and A. Ghoul. 2019. Long-term evidence of noise-induced permanent threshold shift in a harbor seal (*Phoca vitulina*). *The Journal of the Acoustical Society of America* 146(4):2552-2561.

Renkawitz, M. D., Sheehan, T. F., & Goulette, G. S. 2012. Swimming Depth, Behavior, and Survival of Atlantic Salmon Postsmolts in Penobscot Bay, Maine. *Transactions of the American Fisheries Society* 141(5): 1219–1229.

Renkawitz, M. D., Sheehan, T. F., Dixon, H. J., & Nygaard, R. (2015). Atlantic salmon (*Salmo salar*) feeding ecology and energy acquisition at West Greenland. *Marine Ecology Progress Series*, 538, 197–211.

Reygondeau G, and G. Beaugrand. 2011. Future climate-driven shifts in distribution of *Calanus finmarchicus*. *Global Change Biology* 17:756−766.

Rheuban, J.E., M.T. Kavanaugh, and S.C. Doney. 2017. Implications of Future Northwest Atlantic Bottom Temperatures on the American Lobster (*Homarus americanus*) Fishery. *Journal of Geophysical Research: Oceans* 122:9387–9398.

Rice A.N., J.T. Tielens, B.J. Estabrook, C.A. Muirhead, A. Rahaman, M. Guerra, and C.W. Clark. 2014. Variation of ocean acoustic environments along the western North Atlantic coast: A case study in context of the right whale migration route. *Ecological Informatics* 21(89-99).

Rice, A.N., S.C. Farina, A.J. Makowski, I.M. Kaatz, P.S. Lobel, W.E. Bemis, and A.H. Bass. 2022. Evolutionary Patterns in Sound Production across Fishes. *Ichthyology & Herpetology* 110(1).

Richardson, W., C. Greene Jr., C. Malme, and D. Thomson. 1995. *Marine mammals and noise*. San Diego, CA: Academic Press. 575 pp.

Ridgway, S. H., Wever, E. G., McCormick, J. G., Palin, J., & Anderson, J. H. 1969. Hearing in the giant sea turtle, Chelonia mydas. Proc. Nat. Acad. Sci., 64, 884-890.

Ridgway, S.H., and D.A. Carder. 2001. Assessing hearing and sound production in cetaceans not available for behavioral audiograms: Experiences with sperm, pygmy sperm, and gray whales. *Aquatic Mammals* 27(3):267-276.

Roberts, J.J., T. Yack, and P.N. Halpin. 2023. Marine mammal density models for the U.S. Navy Atlantic Fleet Training and Testing (AFTT) study area for the Phase IV Navy Marine Species Density Database (NMSDD). Document version 1.3. Report prepared for Naval Facilities Engineering Systems Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, North Carolina. Available at: https://seamap.env.duke.edu/seamap-models-files/Duke/Reports/AFTT_Marine_Mammal_Density_Models_2022_v1.3.pdf. Accessed March 29, 2024.

Robertson M.J., D.A. Scruton, and K.D. Clarke. 2007. Seasonal Effects of Suspended Sediment on the Behavior of Juvenile Atlantic Salmon. *Transactions of the American Fisheries Society* 136(3): 822-828.

Rockwood, R.C., Calambokidis, J., & Jahncke, J. (2017). High mortality of blue, humpback and fin whales from modeling of vessel collisions on the US West Coast suggests population impacts and insufficient protection. PLoS One, 12(8), e0183052.

Rogers, Lauren A., Matthew T. Wilson, Janet T. Duffy-Anderson, David G. Kimmel, and Jesse F. Lamb. 2021. "Pollock and “the Blob”: Impacts of a marine heatwave on walleye pollock early life stages." *Fisheries Oceanography* 30, no. 2 (2021): 142-158.

Rolland, R.M., Parks, S.E., Hunt, K.E., Castellote, M., Corkeron, P.J., Nowacek, D.P., Wasser, S.K., & Kraus, S.D. (2012). Evidence that ship noise increases stress in right whales. Proceedings of Royal Society B, 279(1737), 2363-2368. https://doi.org/10.1098/rspb.2011.2429

Ross CH, Runge JA, Roberts, Brady DC, Tupper B, Record NR. 2023. Estimating North Atlantic right whale prey based on Calanus finmarchicus thresholds. Mar. Ecol. Prog. Ser. 703: 1–16

Ruckdeschel, C.A., and C.R. Shoop. 1988. Gut Contents of Loggerheads: Findings, Problems and New Questions. *In Proceedings of the Eighth Annual Workshop on Sea Turtle Biology and Conservation.* NOAA Technical Memorandum NMFS-SEFC-214. pp. 97-98

Runge, J.A., R. Ji, C.R. Thompson, N.R. Record, C. Chen, D.C. Vandemark, J.E. Salisbury, and F. Maps. 2015. Persistence of Calanus finmarchicus in the western Gulf of Maine during recent extreme warming. *Journal of Plankton Research* 37(1):221-232.

Ruppel, C.D., Weber, T.C., Staaterman, E.R., Labak, S.J., & Hart, P.E. (2022). Categorizing Active Marine Acoustic Sources Based on Their Potential to Affect Marine Animals. Journal of Marine Science and Engineering, 10(9), 1-46.

Samson, J.E., Mooney, T.A., Gussekloo, S.W.S., & Hanlon, R.T. (2014). Graded behavioral responses and habituation to sound in the common cuttlefish Sepia officinalis. The Journal of Experimental Biology, 217(24), 4347.

Sapp, A. 2010. “Influence of small vessel operation and propulsion system on loggerhead sea turtle injury.” M.S. Thesis, Georgia Institute of Technology. May 2010. Accessed: December 28, 2022.

Sasso, C.R., and S.P. Epperly. 2006. “Seasonal sea turtle mortality risk from forced submergence in bottom trawls.” Fisheries Research 81: 86-88.

Saunders J.C., S.P. Dear, and M.E. Schneider. 1985. The anatomical consequences of acoustic injury: A review and tutorial. *Journal of the Acoustical Society of America* 78:833–860.

Savoy, T., and D. Pacileo. 2003. Movements and Important Habitats of Subadult Atlantic Sturgeon in Connecticut Waters. *Transactions of the American Fisheries Society* 132(1):1-8.

Schilling, M. R., I. Seipt, M. T. Weinrich, S. E. Frohock, A. E. Kuhlberg, and P. J. Clapham. 1992. Behavior of individually identified sei whales, Balaenoptera borealis, during an episodic influx into the southern Gulf of Maine in 1986. Fish. Bull., U.S. 90(4): 749-755.

Schleimer, A., C. Ramp, J. Delarue, A. Carpentier, M. Berube, P.J. Palsboll, R. Sears, and P.S. Hammond. 2019. Decline in abundance and apparent survival rates of fin whales (*Balaenoptera physalus*) in the northern Gulf of St. Lawrence. *Ecology and Evolution* 9(7):4231-4244.

Schmid, J.R. 1998. Marine turtle populations on the west-central coast of Florida: Results of tagging studies at the Cedar Keys, Florida, 1986–1995. *Fishery Bulletin* 96:589-602.

Schoeman, R.P., Patterson-Abrolat, C., & Plön, S. (2020). A global review of vessel collisions with marine animals. Frontiers in Marine Science, 7, 292.

Scott, T.M., and S.S. Sadove. 1997. Sperm whale, *Physeter macrocephalus*, sightings in the shallow shelf waters off Long Island, New York. *Marine Mammal Science* 13(2): 317–321.

Sears, R., and J. Calambokidis. 2002. *Update COSEWIC status report on the Blue Whale Balaenoptera musculus in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 32 p.

Sears, R., and F. Larsen. 2002. Long range movements of a blue whale (Balaenoptera musculus) between the Gulf of St. Lawrence and West Greenland. *Marine Mammal Science* 18(1):281-285.

Seidov, D., Mishonov, A. and Parsons, R. 2021. Recent warming and decadal variability of Gulf of Maine and Slope Water. *Limnology and Oceanography*, *66*(9), pp.3472-3488.

Seminoff, J.A., C.D. Allen, G.H. Balaz, P.H. Dutton, T. Eguchi, H.L. Haas, S.A. Hargrove, M.P. Jensen, D.L. Klemm, A.M. Lauritsen, S.L. MacPherson, P. Opay, E.E. Possardt, L.L. Pultz, E.E. Seney, K.S. Van Houtan, and R.S. Waples. 2015. *Status Review of the Green Turtle (Chelonia mydas) Under the U.S. Endangered Species Act.* U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries. NOAA Technical Memorandum, NOAA-NMFS-SWFSC-539. 571 p.

Seney, E.E., and J.A. Musick. 2007. Historical diet analysis of loggerhead sea turtles (*Caretta caretta*) in Virginia. *Copeia* 2007(2):478–489.

Sergeant, D. E. 1977. Stocks of fin whales, Balaenoptera physalus L. in the north Atlantic ocean. - Rep. Int. Whal. Commn. 27: 460-473.

Shaver DJ, Schroeder BA, Byles RA, Burchfield PM, Peña J, Márquez R, et al. Movements and home ranges of adult male Kemp's ridley sea turtles (*Lepidochelys kempii*) in the Gulf of Mexico investigated by satellite telemetry. *Chelonian Conserv. Biol.* 2005;4:817–827

Shaver, D. J., & Rubio, C. (2008). Post-nesting movement of wild and head-started Kemp's ridley sea turtles Lepidochelys kempii in the Gulf of Mexico. Endangered Species Research, 4(1-2), 43-55. https://www.int-res.com/abstracts/esr/v4/n1-2/p43-55/

Sherman, S.A., K. Stepanek, and J. Sowles. 2005. Maine – New Hampshire Inshore Groundfish Trawl Survey Procedures and Protocols. Available: https://www.maine.gov/dmr/sites/maine.gov.dmr/files/docs/proceduresandprotocols.pdf. Accessed June 1, 2023.

Shimada, T., Limpus, C., Jones, R., & Hamann, M. (2017). Aligning habitat use with management zoning to reduce vessel strike of sea turtles. Ocean & Coastal Management, 142, 163-172.

Shoop, C.R., and R.D. Kenney. 1992. Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. *Herpetological Monographs* 6(1992):43-67.

Shortnose Sturgeon Status Review Team. 2010. *Biological assessment of shortnose sturgeon, Acipenser brevirostrum*. Report to U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service. 417 p.

Simpson SD, Meekan MG, Montgomery JC, McCauley RD, Jeffs AG. 2005. Homeward sound. Science. 308:221.

Simpson, Stephen D., Andrew N. Radford, Sophie L. Nedelec, Maud CO Ferrari, Douglas P. Chivers, Mark I. McCormick, and Mark G. Meekan. "Anthropogenic noise increases fish mortality by predation." *Nature communications* 7, no. 1 (2016): 10544.

Slabbekoorn, H., Bouton, N., van Opzeeland, I., Coers, A., ten Cate, C., & Popper, A. N. (2010). A noisy spring: the impact of globally rising underwater sound levels on fish. Trends in Ecology & Evolution, 25(7), 419-427.

Slater, M., A. Shultz, and R. Jones. 2010. *Estimated ambient electromagnetic field strength in Oregon's coastal environment*. Prepared by Science Applications International Corp. for Oregon Wave Energy Trust. September 10, 2010. 26 p.

Smith, P.E. 1985. Year-class strength and survival of O-group clupeioids. Can. J. Fish. Aquat. Sci. 42 (Suppl. 1):69-82.

Smith, T., and J. Clugston. 1997. Status and management of Atlantic sturgeon, *Acipenser oxyrinchus*, in North America. *Environmental Biology of Fishes* 48(1):335-346.

Solé, M., Lenoir, M., Durfort, M., López-Bejar, M., Lombarte, A., & André, M. (2013). Ultrastructural Damage of Loligo vulgaris and Illex coindetii statocysts after Low Frequency Sound Exposure. PLoS One, 8(10), e78825.

Solé, M., Lenoir, M., Fortuño, J. M., Durfort, M., van der Schaar, M., & André, M. (2016). Evidence of Cnidarians sensitivity to sound after exposure to low frequency underwater sources [Article]. Scientific Reports, 6, 37979.

Solé, M., Sigray, P., Lenoir, M., van der Schaar, M., Lalander, E., & André, M. (2017). Offshore exposure experiments on cuttlefish indicate received sound pressure and particle motion levels associated with acoustic trauma [Article]. Scientific Reports, 7, 45899.

Solé, M., Lenoir, M., Durfort, M., Fortuño, J.-M., Van der Schaar, M., De Vreese, S., & André, M. (2021). Seagrass Posidonia is impaired by human-generated noise. Communications Biology, 4(1), 1-11.

Southall, B.J., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. *Aquatic Mammals* 33(44):411-521.

Southall, B.L., J.J. Finneran, C. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals* 45(2):125-232.

Southall, B.L., D.P. Nowacek, A.E. Bowles, V. Senigaglia, L. Bejder, and L. Tyack Peter. 2021. Marine Mammal Noise Exposure Criteria: Assessing the Severity of Marine Mammal Behavioral Responses to Human Noise. *Aquatic Mammals* 47(5):421-464.

Sprogis, K. R., Videsen, S., & Madsen, P. T. (2020). Vessel noise levels drive behavioural responses of humpback whales with implications for whale-watching. Elife, 9, e56760.

Staaterman, E., Paris, C. B., & Kough, A. S. (2014). First evidence of fish larvae producing sounds. *Biology letters*, *10*(10), 20140643.

Staaterman, E., Gallagher, A. J., Holder, P. E., Reid, C. H., Altieri, A. H., Ogburn, M. B., … Cooke, S.J. (2020). Exposure to boat noise in the field yields minimal stress response in wild reef fish. *Aquatic Biology*, 29, 93– 103.

Stacy, N.I., C.J. Innis, and J.A. Hernandez. 2013. Development and evaluation of three mortality prediction indices for cold-stunned Kemp's ridley sea turtles (*Lepidochelys kempii*). *Conservation Physiology* 1(2013):1-9.

Stadler, J. H., & Woodbury, D. P. (2009, 23-26 August 2009). Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria Proceedings of Inter-Noise 2009: Innovations in Practical Noise Control, Ottawa, Canada.

Stanistreet, J.E., D.P. Nowacek, J.T. Bell, D.M. Cholewiak, J.A. Hildebrand, L.E. Hodge, S.M. Van Parijs, and A.J. Read. 2018. Spatial and seasonal patterns in acoustic detections of sperm whales *Physeter macrocephalus* along the continental slope in the western North Atlantic Ocean. *Endangered Species Research* 35:1-13.

Stanley, J.A., Radford, C.A., & Jeffs, A.G. (2012). Location, location, location: finding a suitable home among the noise. *Proceedings of the Royal Society B: Biological Sciences*, *279*(1742), 3622-3631.

Stanley JA, Hesse J, Hinojosa IA, Jeffs AG. 2015. Inducers of settlement and moulting in post-larval spiny lobster. Oecologia. 178(3):685-697.

Stanley, J.A., Van Parijs, S.M., & Hatch, L.T. (2017). Underwater sound from vessel traffic reduces the effective communication range in Atlantic cod and haddock. *Scientific Reports*, *7*(1), 14633.

Stanley, J. A., Caiger, P.E., Phelan, B., Shelledy, K., Mooney, T.A., & Van Parijs, S.M. (2020). Ontogenetic variation in the auditory sensitivity of black sea bass (Centropristis striata) and the implications of anthropogenic sound on behavior and communication. Journal of Experiment Biology, 223(13), 1-11. https://doi.org/10.1242/jeb.219683

Stantec Consulting Services, Inc. 2023. Application for Incidental Harassment Authorization for the Non-Lethal Taking of Marine Mammals Site Characterization Surveys in Maine Research Array. Prepared for Pine Tree Offshore Wind, October 24, 2023.

Stein, A.B., K.D. Friedland, and M. Sutherland. 2004a. Atlantic sturgeon marine distribution and habitat use along the northeastern coast of the United States. *Transactions of the American Fisheries Society* 133(3):527-537.

Stein, A.B., K.D. Friedland, and M. Sutherland. 2004b. Atlantic sturgeon marine bycatch and mortality on the continental shelf of the Northeast United States. *North American Journal of Fisheries Management* 24(1):171-183.

Stephenson, John R., Andrew J. Gingerich, Richard S. Brown, Brett D. Pflugrath, Zhiqun Deng, Thomas J. Carlson, Mike J. Langeslay, Martin L. Ahmann, Robert L. Johnson, and Adam G. Seaburg. 2010. "Assessing barotrauma in neutrally and negatively buoyant juvenile salmonids exposed to simulated hydro-turbine passage using a mobile aquatic barotrauma laboratory." *Fisheries Research* 106, no. 3: 271-278.

Stevenson, L. A., Roznik, E. A., Alford, R. A., & Pike, D. A. (2014). Host-specific thermal profiles affect fitness of a widespread pathogen. Ecology and Evolution, 4(21), 4053-4064.

Sullivan L, Brosnan T, Rowles TK, Schwacke L, Simeone C, Collier TK. 2019. Guidelines for assessing exposure and impacts of oil spills on marine mammals. Silver Springs (MD): U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. NOAA Technical Memorandum NMFS-OPR-62. 92 p.

Sutcliffe, W., and P.F. Brodie. 1977. *Whale distribution in Nova Scotia waters*. Fisheries and Marine Service, Bedford Institute of Oceanography.

Takeshita, Ryan, Laurie Sullivan, Cynthia Smith, Tracy Collier, Ailsa Hall, Tom Brosnan, Teri Rowles, and Lori Schwacke. "The Deepwater Horizon oil spill marine mammal injury assessment." *Endangered Species Research* 33 (2017): 95-106.

Tetra Tech Inc. 2015. USCG final environmental impact statement for the Port Ambrose Project deepwater port application. Washington (DC): U.S. Coast Guard Vessel and Facility Operating Standards. 549 p. Report No.: USCG-2013-0363.

Thompson, C. 2010. The Gulf of Maine in Context: State of the Gulf of Maine Report. Gulf of Maine Council on the Marine Environment and Fisheries and Oceans Canada, Dartmouth, Nova Scotia, Canada. 56 pp. http://www.gulfofmaine.org/state-of-the-gulf/docs/the-gulf-of-maine-in-context.pdf

Todd, V.L., Todd, I.B., Gardiner, J.C., Morrin, E.C., MacPherson, N.A., DiMarzio, N.A., & Thomsen, F. (2015). A review of impacts of marine dredging activities on marine mammals. ICES Journal of Marine Science, 72(2), 328-340.

Tolotti, M.T., P. Bach, F. Hazin, P. Travassos, and L. Dagorn. 2015. Vulnerability of the oceanic whitetip shark to pelagic longline fisheries. *PLoS One* 10(10):e0141396.

Tran, D.D., Huang, W., Bohn, A.C., Wang, D., Gong, Z., Makris, N.C. and Ratilal, P., 2014. Using a coherent hydrophone array for observing sperm whale range, classification, and shallow-water dive profiles. *The Journal of the Acoustical Society of America*, *135*(6), pp.3352-3363.

Tsujii, K., Akamatsu, T., Okamoto, R., Mori, K., Mitani, Y., & Umeda, N. (2018). Change in singing behavior of humpback whales caused by shipping noise. PLoS One, 13(10), e0204112.

Turtle Expert Working Group (TEWG). 2007. *An Assessment of the Leatherback Turtles Population in the Atlantic Ocean*. NOAA Technical Memorandum NMFS-SEFSC-555. A Report of the Turtle Expert Working Group. U.S. Department of Commerce. April 2007.

Turtle Expert Working Group (TEWG). 2009. *An Assessment of the Loggerhead Turtle Population in the Western North Atlantic Ocean*. NOAA Technical Memorandum NMFS-SEFSC-575. U.S. Department of Commerce.

U.S. Army Corps of Engineers (USACE). 2023. WCSC Waterborne Commerce Statistics Center. Accessed: 2023 May 24. https://www.iwr.usace.army.mil/About/Technical-Centers/WCSC-Waterborne-Commerce-Statistics-Center-2/.

U.S. Atlantic Salmon Assessment Committee (USASAC). 2021. Annual Report of the U.S. Atlantic Salmon Assessment Committee. Report No. 33 – 2020 Activities. Virtual Meeting March 1 – 5, 2021. Prepared for U.S. Section to NASCO. 185 pp. https://repository.library.noaa.gov/view/noaa/30915.

U.S. Coast Guard (USCG). 2022. ISLE CGBI pollution substances spilled cube. Washington (DC): U.S. Coast Guard, Office of Investigations & Casualty Analysis.

U.S. Coast Guard (USCG). 2023. Port Access Route Study: Approaches to Maine, New Hampshire, and Massachusetts. Docket No. USCG-2022-0047. 347 pp. Available: https://www.navcen.uscg.gov/port-access-route-study-reports.

U.S. Environmental Protection Agency (USEPA). 2022a. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020. [accessed May 24 2023]. https://www.epa.gov/system/files/documents/2022-04/us-ghg-inventory-2022-main-text.pdf.

U.S. Environmental Protection Agency (USEPA). 2022b. Climate Change Indicators: Oceans. Available at: https://www.epa.gov/climate-indicators/oceans.

U.S. Fish and Wildlife Service (USFWS). 2023a. Environmental Conservation Online System. Green sea turtle (*Chelonia mydas*). Available: https://ecos.fws.gov/ecp/species/6199#:~:text=General%20Information,on%20the%20shell%20and%20limbs. Accessed April 5, 2023.

U.S. Fish and Wildlife Service (USFWS). 2023b. Environmental Conservation Online System. Leatherback sea turtle (*Dermochelys coriacea*). Available: https://ecos.fws.gov/ecp/species/1493. Accessed April 5, 2023

U.S. Fish and Wildlife Service (USFWS). 2023c. Environmental Conservation Online System. Loggerhead Sea Turtle (*Caretta caretta*). https://ecos.fws.gov/ecp/species/1110.

U.S. Fish and Wildlife Service (USFWS). 2023d. Environmental Conservation Online System. Kemp's ridley sea turtle (*Lepidochelys kempii*). https://ecos.fws.gov/ecp/species/5523.

United States Geological Survey (USGS). 2022. USGS Study Suggests Atlantic Sturgeon Spawning Population Declined by More than 99% in the Delaware River since the Late 1800s. https://www.usgs.gov/news/state-news-release/usgs-study-suggests-atlantic-sturgeon-spawning-population-declined-more-99. Accessed June 2023.

Vabø, R., Olsen, K., & Huse, I. (2002). The effect of vessel avoidance of wintering Norwegian spring spawning herring. Fisheries Research, 58(1), 59-77.

Vanderlaan, A. S., & Taggart, C. T. (2007). Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science, 23(1), 144-156.

Varela, M.R., Patrício, A.R., Anderson, K., Broderick, A.C., DeBell, L., Hawkes, L.A., Tilley, D., Snape, R.T., Westoby, M.J., & Godley, B.J. (2019). Assessing climate change associated sea-level rise impacts on sea turtle nesting beaches using drones, photogrammetry and a novel GPS system. Global Change Biology, 25(2), 753-762.

Vaudo J, Wetherbee B, Harvey G, Shivji M. 2022. Region-specific movements of oceanic whitetip sharks in the western North Atlantic Ocean revealed by long-term satellite tracking. 2022 Graduate Science Research Symposium.

Vermeij MJ, Van Moorselaar I, Engelhard S, Hörnlein C, Vonk SM, Visser PM (2010) The effects of nutrient enrichment and herbivore abundance on the ability of turf algae to overgrow coral in the Caribbean. PLoS One 5: e14312

Vires, G. (2011). Echosounder effects on beaked whales in the Tongue of the Ocean, Bahamas [Masters, Nicholas School of Environment of Duke University].

Waldman, J.R., Grunwald, C., Stabile, J. and Wirgin, I., 2002. Impacts of life history and biogeography on the genetic stock structure of Atlantic sturgeon Acipenser oxyrinchus oxyrinchus, Gulf sturgeon A. oxyrinchus desotoi, and shortnose sturgeon A. brevirostrum. *Journal of Applied Ichthyology*, *18*.

Walsh, M.G., Bain, M.B., Squiers, T., Waldman, J.R. and Wirgin, I., 2001. Morphological and genetic variation among shortnose sturgeon Acipenser brevirostrum from adjacent and distant rivers. *Estuaries*, *24*, pp.41-48.

Warden, ML 2011. Modeling loggerhead sea turtle (*Caretta caretta*) interactions with US MidAtlantic bottom trawl gear for fish and scallops, 2005-2008. Biol. Cons. 144: 2202-2212

Wardle, C. S., Carter, T. J., Urquhart, G. G., Johnstone, A. D. F., Ziolkowski, A. M., Hampson, G., & Mackie, D. (2001). Effects of seismic air guns on marine fish. Continental Shelf Research, 21(8), 1005-1027.

Waring, G. T., Fairfield, C. P., Ruhsam, C. M., & Sano, M. (1993). Sperm whales associated with Gulf Stream features off the north-eastern USA shelf. Fisheries Oceanography, 2(2), 101-105.Waring, G.T., R.M. Pace, J.M. Quintal, C.P. Fairfield, and K. Maze-Foley, Editors. 2004. Gulf of Mexico Marine Mammal Stock Assessments -- 2003. NOAA Technical Memorandum NMFS NE 182; 475 p.

Waring G.T., S.A. Wood, and E. Josephson. 2012. Literature search and data synthesis for marine mammals and sea turtles in the U.S. Atlantic from Maine to the Florida Keys. New Orleans, LA: U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. OCS Study BOEM 2012-109.

Waring, G. T., Josephson, E., Maze-Foley, K., Rosel, P. E., & (eds.). (2015). U.S. Atlantic and Gulf of Mexico marine mammal stock assessments – 2014. (NOAA Technical Memorandum NMFS-NE-231).

Wenzel, F., D. K. Mattila and P. J. Clapham 1988. Balaenoptera musculus in the Gulf of Maine. Mar. Mamm. Sci. 4(2): 172-175.

Whitt, A. D., Dudzinski, K., & Laliberté, J. R. (2013). North Atlantic right whale distribution and seasonal occurrence in nearshore waters off New Jersey, USA, and implications for management. Endangered Species Research, 20(1), 59-69.

Wibbels, T., and Bevan, E. (2019). *Lepidochelys kempii. The IUCN Red List of Threatened Species 2019 [Online].* Gland: IUCN.

Wilber DH, Clarke DG. 2001. Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management. 21:855–875.

Wiley, D. N., Mayo, C. A., Maloney, E. M., & Moore, M. J. (2016). Vessel strike mitigation lessons from direct observations involving two collisions between noncommercial vessels and North Atlantic right whales (Eubalaena glacialis). Marine Mammal Science, 32(4), 1501-1509.

Wilkens, J.L., A. W. Katzenmeyer, N.M. Hahn, and J.J. Hoover. 2015. Laboratory Test of Suspended Sediment Effects on Short-Term Survival and Swimming Performance of Juvenile Atlantic Sturgeon (Acipenser Oxyrinchus Oxyrinchus, Mitchill, 1815). Journal of Applied Ichthyology 31: 984-990.

Williams TM, Kendall TL, Richter BP, Ribeiro-French CR, John JS, Odell KL, Losch BA, Feuerbach DA, Stamper MA. 2017. Swimming and diving energetics in dolphins: a stroke-by-stroke analysis for predicting the cost of flight responses in wild odontocetes. J Exp Biol. 220(Pt 6):1135-1145. doi:10.1242/jeb.154245.

Williams, S. H., Gende, S. M., Lukacs, P. M., & Webb, K. (2016). Factors affecting whale detection from large ships in Alaska with implications for whale avoidance. Endangered Species Research, 30, 209-223.

Williams, T. M., Blackwell, S. B., Tervo, O., Garde, E., Sinding, M. H. S., Richter, B., & Heide-Jørgensen, M. P. (2022). Physiological responses of narwhals to anthropogenic noise: A case study with seismic airguns and vessel traffic in the Arctic. Functional Ecology, 36(9), 2251-2266.

Wilson, M., Hanlon, R. T., Tyack, P. L., & Madsen, P. T. (2007). Intense ultrasonic clicks from echolocating toothed whales do not elicit anti–predator responses or debilitate the squid Loligo pealeii. Biology Letters, 3(3), 225-227. https://doi.org/10.1098/rsbl.2007.0005

Winkler, C., Panigada, S., Murphy, S., & Ritter, F. (2020). Global Numbers of Ship Strikes: An Assessment of Collisions between Vessels and Cetaceans Using Available Data in the IWC Ship Strike Database. IWC B, 68.

Winton, M., Fay, G., Haas, H.L., Arendt, M., Barco, S., James, M.C., Sasso, C., & R.S. (2018). Estimating the distribution and relative density of satellite-tagged loggerhead sea turtles in the western North Atlantic using geostatistical mixed effects models. Marine Ecology Progress Series, 586, 217-232.

Wippelhauser, G.S., Sulikowski, J., Zydlewski, G.B., Altenritter, M.A., Kieffer, M., & Kinnison, M.T. (2017). Movements of Atlantic Sturgeon of the Gulf of Maine Inside and Outside of the Geographically Defined Distinct Population Segment. *Marine and Coastal Fisheries*, *9*(1), 93–107. https://doi.org/10.1080/19425120.2016.1271845.

Wippelhauser, G.S., Zydlewski, G.B., Kieffer, M., Sulikowski, J. and Kinnison, M.T., 2015. Shortnose Sturgeon in the Gulf of Maine: use of spawning habitat in the Kennebec system and response to dam removal. *Transactions of the American Fisheries Society*, *144*(4), pp.742-752.

Wirgin, I., Grunwald, C., Carlson, E., Stabile, J., Peterson, D.L. and Waldman, J., 2005. Range-wide population structure of shortnose sturgeon Acipenser brevirostrum based on sequence analysis of the mitochondrial DNA control region. *Estuaries*, *28*, pp.406-421.

Wisniewska, D.M., Johnson, M., Teilmann, J., Siebert, U., Galatius, A., Dietz, R., and Madsen, P.T. (2018). High rates of vessel noise disrupt foraging in wild harbour porpoises (Phocoena phocoena). Proceedings of the Royal Society B: Biological Sciences, 285(1872), 20172314.

Witherell, D., Ackley, D. and Coon, C., 2002. An overview of salmon bycatch in Alaska groundfish fisheries. *Alaska Fishery Research Bulletin*, *9*(1), pp.53-64.

Witzell, W.N., & Schmid, J.R. (2005). Diet of immature Kemp's ridley turtles (*Lepidochelys kempi*) from Gullivan Bay, Ten Thousand Islands, southwest Florida. Bulletin of Marine Science, 77(2), 191-200.

Woods Hole Oceanographic Institution (WHOI). 2022. Effects of noise on marine life: Study finds that turtles are among animals vulnerable to hearing loss. ScienceDaily. March 2. Retrieved June 8, 2022 from www.sciencedaily.com/releases/2022/03/220302190004.htm.

Wysocki, L.E., Dittami, J.P., & Ladich, F. (2006). Ship noise and cortisol secretion in European freshwater fishes. Biological Conservation, 128(4), 501-508.

Wysocki, L. E., Amoser, S., & Ladich, F. (2007). Diversity in ambient noise in European freshwater habitats: Noise levels, spectral profiles, and impact on fishes. The Journal of the Acoustical Society of America, 121(5), 2559-2566.

Young, C.N., Carlson, J.K., Hutchinson, M., Hutt, C., Kobayashi, D., McCandless, C.T., et al. (2017). Status review report: oceanic whitetip shark (*Carcharhinius longimanus*). Final Report to the National Marine Fisheries Service, Office of Protected Resources. December 2017. Silver Spring: National Marine Fisheries Service.

Young, C.N. and Carlson, J.K., 2020. The biology and conservation status of the oceanic whitetip shark (*Carcharhinus longimanus*) and future directions for recovery. Reviews in Fish Biology and Fisheries, 30(2), pp.293-312.

Yost WA (2000) Fundamental of hearing: an introduction. Elseivier Academic Press, San Diego

ZoBell, V.M., Frasier, K.E., Morten, J.A., Hastings, S.P., Peavey Reeves, L.E., Wiggins, S.M., and Hildebrand, J. A. (2021). Underwater noise mitigation in the Santa Barbara Channel through incentive-based vessel speed reduction. Scientific Reports, 11(1), 18391. https://doi.org/10.1038/s41598-021-96506-1.

Appendix A Standard Field Codes and Units

Beaufort Scale

Beaufort	Description of Sea State
0	Windless: Glassy sea surface, 0 knot winds, 0-meter swell
1	Calm, light air: Ripples, no white caps, 1-3 knot winds, 0.1-meter swells
2	Light breeze: Short, small wavelets that don't break, 4-6 knot winds, 0.2-0.3-meter swells
3	Gentle breeze: Large wavelets that begin to break, 7-10 knot winds, 0.6-1-meter swells
4	Moderate breeze: Small waves with frequent white caps, 11-16 knot winds, 1-1.5-meter swells
5	Fresh breeze: Long, moderate waves with many white caps, 17-21 knot winds, 2-2.5-meter swells
6	Strong breeze: Large waves with extensive foaming and some spray, 22-27 knot winds, 3-4-meter swells
7	Near gale: Sea heaps up, waves breaking, streaks forming, 28-33 knot winds, 4-4.5-meter swells
8	Gale: Moderately high waves of great length, well-marked streaks, 34-40 knot winds, 5.5-7.5-meter swells
9	Severe gale: High waves, dense streaking, spray may affect visibility, 41-47 knot winds, 7-10-meter swells
10	Storm: Very high waves with long over-hanging crests, sea becoming white with streaks, 48-55 knot winds, 9-12.5-meter swells
11	Violent storm: Exceptionally high waves, sea completely covered with foam, 56-63 knot winds, 11.5-12.5-meter swells
12	Hurricane: Air filled with foam and spray, sea completely white, no visibility, 63+ knot winds, 16+ meter swells

Units

Date	YYYY-MM-DD
Durations (e.g., start and end times) (Coordinated Universal Time, UTC)	YY-MM-DDT HH:MM
Wind Speed	Knots (kt)
Distance, height, and depth	Meters (m) or kilometers (km)
Position in Latitude and longitude	Decimal degrees (North American Datum of 1983 (NAD83); e.g., dd.ddddd, dd.ddddd
Bearing or direction of travel	Ship heading + clock face to animal

Cloud Cover Code	Percent (%) of sky covered with clouds:
1	<10%
2	10–50%
3	50–90%
4	>90%

Monitoring Equipment

Code	Equipment	Code	Equipment
HB	Hand-held Binoculars	IG	Infrared Goggles
BE	Big Eyes	CR	Crew Reported (any method)
NE	Naked Eye	PT	Passive Acoustic Towed Array
IC	Infrared Camera	PA	Passive Acoustic Moored/Stationary

Distance Finding

Code	Distance Finding Method
EST	Eye estimation
RET	Reticle
LAS	Laser range-finder
RFS	Range-finding stick or calipers

Species Identification

Code	ITIS	WoRMS APHIA	Common name	Scientific name
Marine Mammals				
ASDO	552460	137108	Atlantic spotted dolphin	*Stenella frontalis*
WSDO	180443	137100	Atlantic white-sided dolphin	*Lagenorhynchus acutus*
BLBW	180517	137122	Blainville's beaked whale	*Mesoplodon densirostris*
BLWH	180528	137090	Blue whale	*Balaenoptera musculus*
BODO	180426	137111	Bottlenose dolphin	*Tursiops truncatus*
BRWH	180525	242603	Bryde’s whale	*Balaenoptera edeni*
GOBW	180498	137127	Cuvier's beaked whale	*Ziphius cavirostris*
DSWH	180492	159025	Dwarf sperm whale	*Kogia sima*
FKWH	180463	137104	False killer whale	*Pseudorca crassidens*
FIWH	180527	137091	Fin whale	*Balaenoptera physalus*
BEBW	180509	137123	Gervais' beaked whale	*Mesoplodon europaeus*
HAPO	180473	137117	Harbor Porpoise	*Phocoena phocoena*
HUWH	180530	137092	Humpback whale	*Megaptera novaeangliae*
KIWH	180469	137102	Killer whale	*Orcinus orca*
MANA	180684	159504	Manatee	*Trichechus manatus*
MHWH	180459	137103	Melon-headed whale	*Peponocephala electra*
MIWH	180524	137087	Minke whale	*Balaenoptera acutorostrata*
RIWH	180537	159023	North Atlantic right whale	*Eubalaena glacialis*

Code	ITIS	WoRMS APHIA	Common name	Scientific name
NBWH	180504	343899	Northern bottlenose whale	*Hyperoodon ampullatus*
SPDO	180430	137105	Pantropical spotted dolphin	*Stenella attenuata*
SFPW	552461	137097	Pilot whale (shortfinned)	*Globicephala macrorhynchus*
LFPW	180466	137096	Pilot whale (longfinned)	*Globicephala melas*
PYKW	180461	137095	Pygmy killer whale	*Feresa attenuata*
PSWH	180491	137113	Pygmy sperm whale	*Kogia breviceps*
GRAM	180457	137098	Risso's dolphin	*Grampus griseus*
RTDO	180417	137110	Rough-toothed dolphin	*Steno bredanensis*
SEWH	180526	137088	Sei whale	*Balaenoptera borealis*
SADO	180438	137094	Short-beaked common dolphin	*Delphinus delphis*
SOBW	180515	137121	Sowerby's beaked whale	*Mesoplodon bidens*
SPWH	180488	137119	Sperm whale	*Physeter macrocephalus*
STDO	180434	137107	Striped dolphin	*Stenella coeruleoalba*
TRBW	180508	137126	True's beaked whale	*Mesoplodon mirus*
WBDO	180442	137101	White-beaked dolphin	*Lagenorhynchus albirostris*
Seals				
GRSE	180653	137080	Gray seal	Halichoerus grypus
HASE	180649	137084	Harbor seal	Phoca vitulina
HGSE	622022	159019	Harp seal	Pagophilus groenlandicus
HOSE	180657	137078	Hooded seal	Cystophora cristata
Sea Turtles				
LHST	173833	137206	Loggerhead sea turtle	*Caretta caretta*
LBST	173836	137207	Leatherback sea turtle	*Dermochelys coriacea*
KRST	551770	137208	Kemp's ridley sea turtle	*Lepidochelys kempii*
HBST	173843	137209	Hawksbill sea turtle	*Eretmochelys imbricata*
GRST	173830	137205	Green sea turtle	*Chelonia mydas*
Fish				
MARA	—	1026118	Giant manta ray	*Mobula birostris*
STUR	—	—	Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*
Unidentified Species				
UNID	—	—	Unidentified animal	—
UNBA	180403	2688	Unidentified baleen whale	—
UNBW	180493	136986	Unidentified beaked whale	—
UNTU	173828	136999	Unidentified turtle	—
UNLW	180403	2688	Unidentified large whale	—
UNTW	180404	148723	Unidentified odontocete	—
UNSE	—	—	Unidentified seal	—
KOGI	180490	159024	Unidentified Kogia spp.	—
PIWH	180464	137017	Unidentified pilot whale	—

Behavioral/State

Code	Behavior/state	Code	Behavior/state
14	acrobatic	78	milling
25	blowing	22	motionless at surface
12	bow riding	11	porpoising
13	breaching	90	SAG
05	injured (e.g., visible wound)	21	spy hopping
00	dead	19	surfacing
03	dead in fishing gear	17	swimming at surface (non-travel)
23	diving (mammal)	18	swimming below surface
69	diving (turtle)	20	tail slapping (lobtailing)
07	diving fluke up	16	travel (slow <1 kt)
92	entangled in lines, ropes, gear	07	travel (moderate 1–10 kt)
54	feeding	06	fast travel >10 kt
22	logging	94	undetermined

Appendix B QA/QC Checklist for Completing ESA Biological Assessments

- Cross-walk activities identified in the COP, Draft EIS, MMPA ITA application, and USACE permit with the activities identified in the description of the Proposed Action.
- Confirm all ESA listed species that the developer has requested take authorization for through the MMPA are addressed consistently in the BA.
- Cross-walk activities addressed in the Effects of the Action with the Description of the Proposed Action to ensure consistency and that no new information is being introduced in the Effects of the Action section.
- Confirm all mitigation and monitoring measures and/or special conditions identified by the developer in the COP and MMPA ITA application and that BOEM, USACE, USEPA or any other action agency is proposing to require and are considered part of the Proposed Action are clearly identified in the BA.
- Confirm that the action area takes into consideration all planned activities described in the BA (particularly vessel transit routes). Review the GARFO Section 7 mapper and the SERO section 7 mapper to confirm that all species and critical habitat that occur in the action area are addressed in the BA.
- Review the ESA Info Needs document to confirm that all necessary information has been included in the BA and that NMFS recommended acoustic thresholds are used. Note the Info Needs document is a living document and the online version should always be used to ensure the current version.
- Ensure the NMFS OPR Multi-species Noise Calculator “User Spreadsheet Tool” is used for in/nearshore pile driving when assessing effects to marine mammals, fish and sea turtles.

Appendix C NMFS/BOEM ESA/MMPA Alignment Process for Offshore Wind Energy Projects

C.1 ESA Milestone 1 - Preliminary Draft BA

Documents Required: Preliminary Draft BA from BOEM; Cooperating Agency Draft EIS; MMPA ITA application

- Submitted to GAR PRD at the beginning of the cooperating agency review of the Draft EIS (ESA Milestone 1).
- BOEM will ensure the description of the Proposed Action in the BA is consistent with the action described in the lessee's application for an MMPA Incidental Take Authorization (ITA).
  - Internal process notes:
    - NMFS PR1 crosswalks the MMPA application with the Draft EIS.
    - MMPA application and COP updates need to be reflected in both documents. Communicate to developer that this alignment is necessary.
    - Draft EIS and BA needs to reflect what is in the COP and MMPA application.
- The draft BA will include a clear description of all measures that are part of the Proposed Action and clearly identify them by category (e.g., measures proposed by US Wind, measures to be required by BOEM, measures proposed as special conditions of a USACE permit, measures to be included in the proposed MMPA ITA (to the extent that information is available at the time the BA is submitted to GAR PRD), etc.). This will help to identify which agency has relevant regulatory and/or enforcement authority for each measure.
- BOEM will reference PR1's consideration of an application for an MMPA ITA (as a Co-action Agency). At this stage, the BA will reference the LOA application PR1 has determined to be complete if PR1 has not yet published a proposed ITA.

C.2 ESA Milestone 2 - Consultation Initiation Package

Documents Required: Final BA from BOEM; Draft EIS; draft proposed MMPA ITA from PR1

Consideration of Mitigation Measures

In addition to describing the avoidance/minimization/monitoring measures that are part of the Proposed Action (e.g., included in US Wind's proposal and/or measures proposed to be required by BOEM through COP approval or in the USACE permit), the BA will reference PR1's proposed ITA and state that it incorporates the proposed ITA's marine mammal mitigation and monitoring measures for the period of time to be covered by the ITA unless there is a conflict or different level of protection provided by similar measures such that:

- Any measure BOEM is considering that is more protective of marine mammals would take precedence over a similar measure in the ITA for purposes of the Section 7 analysis;
- Any measure PR1 is proposing that is more protective of marine mammals would take precedence over a similar measure identified by BOEM for purposes of the Section 7 analysis (in consideration of the duration of the ITA).

C.3 ESA/MMPA Coordination Points for GARFO/PR1/BOEM

- Prior to submitting comments on the preliminary draft BA, GAR PRD will coordinate with PR1 on the scope of the Proposed Action considered in the draft BA (including mitigation and monitoring measures) to identify any potential inconsistencies between the action as described in the preliminary draft BA and the MMPA ITA application. Any such inconsistencies will be provided to BOEM in GAR PRD's comments to BOEM on the draft BA. As necessary, following the submission of comments on the preliminary draft BA, BOEM and NMFS (GAR PRD and PR1) will work to expeditiously resolve inconsistencies between the action as described in the draft BA and the MMPA ITA application, with the goal of resolving any issues in in the revised BA submitted to GAR PRD. This will include resolving any issues related to the activities and species considered and with the proposed mitigation and monitoring conditions being considered by PR1 for the proposed ITA.
- As necessary, before the revised BA is submitted, a coordination meeting will be held to review the scope of the Proposed Action (i.e., the activities to be considered in the ESA consultation) and measures proposed to be required by BOEM and PR1 through their respective authorities.
    - The goal of this meeting is to identify and resolve any inconsistencies and addresses any other questions/concerns regarding the marine mammal mitigation and monitoring measures prior to initiation of the ESA consultation so that GAR PRD has a clear understanding of how to analyze the "effects of the action" (i.e., the effects of BOEM's action plus the effects of PR1's ITA as well as other actions/activities that would not occur but for BOEM's action).
    - This meeting should occur as early as practicable prior to the date GAR PRD is scheduled to confirm it has all the information it needs to initiate consultation with respect to established FAST-41 deadlines.
- BOEM, PR1, and GAR PRD agree that consultation will not be initiated until any identified inconsistencies and other questions/concerns regarding marine mammal mitigation and monitoring measures are resolved to the extent possible given the different statutory requirements. This will also need to take FAST-41 deadlines into account.
- Once consultation is initiated, GAR PRD will share a draft "Description of the Proposed Action" including the proposed mitigation measures considered part of the Proposed Action, with BOEM and PR1 for review and identification of any concerns or inconsistencies with each agency's understanding of the Proposed Action. BOEM will ensure review of other action agencies (i.e., USACE, USEPA, USCG). This will be done as early as possible during the consultation period.

As mitigation measures evolve during the consultation period, BOEM, GAR PRD, and PR1 will continue coordination and discussion as necessary.