Final Programmatic Environmental Impact Statement for Surveying and Mapping Projects in U.S. Waters for Coastal and Marine Data Acquisition

National Oceanic and Atmospheric Administration

National Ocean Service

November 2022

In memory of
Rear Admiral Richard T. Brennan, NOAA
August 15, 1968 – May 13, 2021

Dedicated to the memory of RDML Richard T. Brennan, who championed the development of this document. RDML Brennan was a passionate hydrographer, and also deeply committed to understanding and limiting the environmental impacts of NOAA's ocean and coastal mapping mission.

ABSTRACT

The National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) has prepared a Final Programmatic Environmental Impact Statement (PEIS) in accordance with the National Environmental Policy Act (NEPA, 42 U.S.C. § 4321, et seq.) to analyze the potential environmental impacts associated with NOS's recurring data collection projects to characterize submerged features (e.g., habitat, bathymetry, marine debris). The "action area" for these projects encompasses the United States (U.S.) territorial sea, the contiguous zone, the U.S. Exclusive Economic Zone (U.S. EEZ), U.S. rivers, States' offshore waters, and coastal and riparian lands. The Proposed Action evaluated is to continue NOS's surveying and mapping projects. The purpose of the Proposed Action is to gather accurate and timely data on the marine and coastal environment. The need for the Proposed Action is to ensure safety at sea, economic well-being, and the efficient stewardship of public trust resources. NOS projects would include surveys performed from crewed vessels and remotely operated or autonomous vehicles, operated by NOS field crews, other NOAA personnel on behalf of NOS, contractors, grantees, or permit/authorization holders. These crews and vehicles may use echo sounders and other active acoustic equipment and employ other equipment, including bottom samplers and conductivity, temperature, and depth instruments to collect the needed data. A project could also involve supporting activities, such as the use of divers and the installation of tide buoys.

NOS evaluated three alternatives: 1) the No Action Alternative (Alternative A), under which NOS would continue to gather accurate and timely data on the nature and condition of the marine and coastal environment, reflecting the technology, equipment, scope, and methods currently in use by NOS at the current level of effort (i.e., the status quo); 2) Alternative B, under which NOS would increase the adoption of new technologies to more efficiently perform surveying, mapping, charting and related data gathering; and 3) Alternative C, which also includes the adoption of new techniques and technologies and includes an overall funding increase of 20 percent. The three alternatives were analyzed using criteria and evaluation standards under the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR § 1500–1508 (1978)), and NOAA Administrative Order 216-6A. NOS's Preferred Alternative is Alternative B which includes conducting surveys and mapping for coastal and marine data collection with equipment upgrades, improved hydroacoustic devices, and new tide stations. No significant adverse impacts to habitats, biological resources, cultural and historic resources, socioeconomics, or environmental justice are expected under any alternative.

The Final PEIS has been prepared to: 1) inform NOS and the public on the physical, biological, economic, and social impacts of NOS mapping and surveying projects; and 2) assist NOS in deciding how to execute its mapping and surveying program over the next five years.

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ACRONYMS AND ABBREVIATIONS

ac	Acre
ACHP	Advisory Council on Historic Preservation
ACSPI	Aleut Community of St. Paul Island
ADCP	Acoustic Doppler Current Profiler
ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AIS	Automatic Identification System
AMMC	Aleut Marine Mammal Commission
ANILCA	Alaska National Interest Lands Conservation Act
ANO	Alaska Native Organization
APE	Area of Potential Effect
APPS	Act to Prevent Pollution from Ships
AR	Alaska Region
ARPA	Archaeological Resources Protection Act
AUV	Autonomous Underwater Vehicle
AWOIS	Automated Wreck and Obstruction Information System
BA	Biological Assessment
BEA	Bureau of Economic Analysis
BIA	Biologically Important Area
BLS	Bureau of Labor Statistics
BMP	Best Management Practice
BOEM	Bureau of Ocean Energy Management
C	Celsius
$C_6H_{12}O_6$	Glucose
C&S	Ceremonial and Subsistence
$CaCO_3$	Calcium carbonate
CBS	Chukchi/Bering Seas
CDA	Core Distribution Area
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH_4	Methane
CLFA	Compact Low Frequency Active
cm	Centimeter
CMP	Coastal Management Program
CO_2	Carbon Dioxide
CO_3^{2-}	Carbonate
CO	Carbon Monoxide
CO-OPS	Center for Operational Oceanographic Products and Services
CORA	Chippewa Ottawa Resource Authority
COVID-19	Coronavirus Disease 2019
CPA	Closest Point of Approach
CTD	Conductivity, Temperature, and Depth

CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dB	Decibel
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DOE	Department of Energy
DPS	Distinct Population Segment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EJ	Environmental Justice
ENOW	Economics National Ocean Watch
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
EWC	Eskimo Walrus Commission
F	Fahrenheit
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FMC	Fishery Management Council
FMP	Fisheries Management Plan
FR	Federal Register
FSA	Fur Seal Act
ft	Foot/Feet
FWPCA	Federal Water Pollution Control Act
G&G	Geological and Geophysical
GAR	Greater Atlantic Region
GDP	Gross Domestic Product
GEBCO	General Bathymetric Chart of the Oceans
GHG	Greenhouse Gas
GIS	Geographic Information System
GLIFWC	Great Lakes Indian Fish and Wildlife Commission
GOES	Geostationary Operational Environmental Satellite
GOMESA	Gulf of Mexico Energy Security Act
GPS	Global Positioning System
ha	Hectare
HAPC	Habitat Area of Particular Concern
HCO_3^-	Bicarbonate
HF	High-Frequency
HFAS	High Frequency Active Sonar
HFR	High Frequency Radar Systems
HMS	Highly Migratory Species
HRG	High Resolution Geophysical

HTF	Hypoxia Task Force
Hz	Hertz
IHA	Incidental Harassment Authorization
in	Inch
IOOS	Integrated Ocean Observing System
IPaC	Information for Planning and Consultation
IPHC	International Pacific Halibut Commission
ITR	Incidental Take Regulation
IUU	Illegal, Unreported, and Unregulated
IWC	International Whaling Commission
IWG-OCM	Interagency Working Group on Ocean and Coastal Mapping
kg	Kilogram
kHz	Kilohertz
km	Kilometer
km^2	Square Kilometer
lbs	Pounds
LED	Light Emitting Diode
LF	Low-frequency
LFA	Low Frequency Active
Lidar	Light Detection and Ranging
LNG	Liquified Natural Gas
LOA	Letter of Authorization
m	Meter
MARAD	Maritime Administration
MARPOL	Marine Pollution
MBES	Multibeam Echo Sounder
MBTA	Migratory Bird Treaty Act
MF	Mid-Frequency
MFAS	Mid-frequency Active Sonar
MHK	Marine and Hydrokinetic
mi	Mile
mi^2	Square Mile
MI	Michigan
mm	Millimeter
MMP	Marine Minerals Program
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MMT	Million Metric Tons
MN	Minnesota
MOA	Memorandum of Agreement
MPA	Marine Protected Area
mph	Miles per Hour
ms	Millisecond
MSA	Magnuson-Stevens Fishery Conservation and Management Act

MSD	Marine Sanitation Device
MSM	Marine Safety Manual
MW	Megawatt
MWWL	Microwave Water Level
N_2O	Nitrogen Dioxide
NAGPRA	Native American Graves Protection and Repatriation Act
NAO	NOAA Administrative Order
NAVO	Naval Oceanographic Office
NCCOS	National Centers for Coastal Ocean Science
NCCR	National Coastal Condition Report
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory
NFH	National Fish Hatchery
NGO	Non-Governmental Organization
NGS	National Geodetic Survey
NHO	Native Hawaiian Organization
NHPA	National Historic Preservation Act
nm	Nautical Mile
nm^2	Square Nautical Mile
NMFS	National Marine Fisheries Service
NMSA	National Marine Sanctuaries Act
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NOx	Nitrogen Oxides
NPS	National Park Service
NRHP	National Register of Historic Places
NRT	Navigation Response Team
NSF	National Science Foundation
NVIC	Navigation and Vessel Inspection Circular
NWLON	National Water Level Observation Network
O&G	Oil and Gas
O_3	Ozone
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OHA2	Omnibus EFH Amendment 2
OHC	Ocean Heat Content
OMAO	Office of Marine and Aviation Operations
ONMS	Office of National Marine Sanctuaries
OPAREA	Operating Areas
ORR	Office of Response and Restoration
OTEC	Ocean Thermal Energy Conversion
PBR	Potential Biological Removal
PCB	Polychlorinated Biphenyl
PCE	Primary Constituent Element

PEA	Programmatic Environmental Assessment
PEIS	Programmatic Environmental Impact Statement
PIR	Pacific Islands Region
PSA	Public Service Announcement
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
REC	Record of Environmental Consideration
rms	Root-mean-square
ROV	Remotely Operated Vehicles
SAR	Stock Assessment Report
SBS	Southern Beaufort Sea
SCUBA	Self-contained Underwater Breathing Apparatus
SDB	Satellite-derived Bathymetry
SEL	Sound Exposure Level
SER	Southeast Region
SHARC	Subsistence Halibut Registration Certificate
SHPO	State Historic Preservation Officer
SLA	Submerged Lands Act
SONAR	Sound Navigation and Ranging
SOx	Sulfur Oxides
SPL	Sound Pressure Level
SRS	Sanctuary Resource Statement
SURTASS	Surveillance Towed Array Sensor System
TAC	Total Allowable Catch
TCP	Traditional Cultural Place
THPO	Tribal Historic Preservation Officer
TTS	Temporary Threshold Shift
µm	Micrometer
µPa	Micropascal
U&A	Usual and Accustomed
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNOLS	University-National Oceanographic Laboratory System
U.S.	United States
U.S.C.	U.S. Code
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USV	Uncrewed Surface Vehicle
VOC	Volatile Organic Compound
VRP/SOPEP	Shipboard Oil Pollution Emergency Plan & Non-Tank Vessel Response Plan
vs	Versus
WCR	West Coast Region

WI	Wisconsin
XBT	Expendable Bathythermograph
yd	Yard

EXECUTIVE SUMMARY

INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) has prepared this Final Programmatic Environmental Impact Statement (PEIS) to analyze the potential environmental impacts associated with NOS's recurring data collection projects (surveying and mapping) to characterize underwater features (e.g., habitat, bathymetry, marine debris) throughout United States (U.S.) waters. Data obtained from these projects are used to produce many products, including charts and maps that are relied upon by mariners, scientists, the shipping and fishing industries, and countless other users in the U.S. and beyond.

The Proposed Action evaluated in this Final PEIS is to continue NOS's surveying and mapping projects over the next five years. These projects would include surveys performed from crewed vessels and remotely operated or autonomous vehicles. Field crews would include NOS personnel, other NOAA personnel on behalf of NOS, contractors, grantees, or permit/authorization holders. These crews and vehicles may use echo sounders and other active acoustic equipment and employ other equipment, including bottom samplers and conductivity, temperature, and depth instruments to collect the needed data. The "action area" for these projects includes the U.S. territorial sea; the contiguous zone; the U.S. Exclusive Economic Zone (U.S. EEZ); rivers; and states' offshore waters. The action area also includes coastal and riparian lands for activities such as the installation, maintenance, and removal of tide gauges. This analysis has been carried out to meet the requirements of the National Environmental Policy Act of 1969 (NEPA). NOS opted to prepare a programmatic NEPA document because the NOS mapping and surveying represents a suite of similar activities over a broad geographic region.

This Final PEIS evaluates three alternatives: 1) the No Action Alternative (Alternative A), under which NOS would continue to gather accurate and timely data on the nature and condition of the marine and coastal environment, reflecting the technology, equipment, scope, and methods currently in use by NOS at the current level of effort (i.e., the status quo); 2) Alternative B, under which NOS would increase the adoption of new technologies to more efficiently perform surveying, mapping, charting and related data gathering; and 3) Alternative C, which also includes the adoption of new techniques and technologies and includes an overall funding increase of 20 percent. The Final PEIS has been prepared to: 1) inform NOS and the public on the physical, biological, economic, and social impacts of NOS mapping and surveying projects; and 2) assist NOS in deciding how to execute its mapping and surveying program over the next five years.

This Final PEIS was prepared in accordance with NEPA (42 United States Code [U.S.C.] § 4321, et seq.); Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR § 1500–1508 (1978)); NOAA Administrative Order 216-6A and other relevant federal and state laws and regulations. NOS revised the Final PEIS from the June 2021 draft version to reflect feedback received through interagency coordination and consultation, stakeholder input, and public comments.

PUBLIC INVOLVEMENT

NOS published a "Notice of Availability of a Draft Programmatic Environmental Impact Statement for Surveying and Mapping Projects in U.S. Waters for Coastal and Marine Data Acquisition" in the *Federal Register* on June 25, 2021 to announce the availability of the Draft PEIS for public review. Agency and public comments were received on the Draft PEIS, which was available for public review from June 25, 2021 to November 22, 2021. During the public comment period for the Draft PEIS, NOS received 31 comment submissions from 30 commenters via Regulations.gov and email. Commenters included State Historic Preservation Officers (SHPOs), Tribal Historic Preservation Officers (THPOs), state Coastal Management program offices, federally recognized tribes, Alaska Native corporations, Alaska Native Organizations, Non-Governmental Organizations (NGOs), and members of the public. The comments addressed a range of issues including the following:

- Protection of cultural and historic resources;
- Federal consistency under the Coastal Zone Management Act (CZMA);
- Incorporation of mitigation measures;
- Environmental justice concerns pertaining to subsistence hunting and fishing in Alaska communities;
- Future coordination between NOS and key stakeholders, such as Alaska Eskimo Whaling Commission (AEWC), North Slope Borough Department of Wildlife Management, Calista Corporation in Alaska, Donlin Gold, Natural Resources Defense Council, Cultural Heritage Partners representing the Upper Mattaponi Indian Tribe, the Chickahominy Indian Tribe, and the Seneca Nation of New York;
- The NEPA process, scope of the PEIS, selection of a programmatic NEPA approach, alternatives to the Proposed Action, cumulative effects analysis, references and data cited in the effects analysis;
- Impacts to marine mammals, fish, habitats, birds, and sea turtles;
- Methodology and data consideration for the acoustic modeling;
- Impacts to socioeconomic resources such as fisheries; and
- Access to surveying and mapping data collected during NOS projects through data sharing.

NOS has thoroughly considered all of the input received and has responded to comments in Appendix C. Revisions to the Final PEIS have been made in response to comments where appropriate.

NOS developed a public webpage specifically for development of the Draft and Final PEIS, which can be found at https://oceanservice.noaa.gov/about/environmental-compliance/surveying-mapping.html. NOS will publish a Record of Decision no sooner than 30 days after publication of the U.S. Environmental Protection Agency's Notice of Availability for the Final PEIS in the Federal Register.

Coordination with Other Agencies

NOS coordinated with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) during preparation of this Final PEIS. NMFS has legal jurisdiction over most marine mammal species (through the Marine Mammal Protection Act [MMPA]), most threatened or endangered marine plant and animal species (through the Endangered Species Act [ESA]), and Essential Fish Habitat (through the Magnuson Stevens Fishery Conservation and Management Act [MSA]). USFWS has legal jurisdiction over certain marine mammal species including manatees, walruses, polar bears, and sea otters (through the MMPA), most threatened or endangered terrestrial plant and animal species (through the ESA), and over 1,000 species of birds (through the Migratory Bird Treaty Act [MBTA]).

Both agencies provided a comprehensive Technical Assistance Review prior to publication of the Draft PEIS. In coordinating with NOS, NMFS and USFWS participated in multiple meetings and reviews during the development of the Draft PEIS. On December 8, 2021, USFWS sent NOS a letter requesting additional information for completing consultation under Section 7 of the ESA for the Proposed Action. NOS provided the requested additional information and proposed revisions to the Draft PEIS on June 1, 2022. These revisions have been incorporated into the Final PEIS where appropriate.

NOS also initiated consultation with NMFS under the MMPA, ESA, and MSA and with USFWS under the MMPA. Additionally, in compliance with the National Marine Sanctuaries Act (NMSA), NOS prepared and submitted a Sanctuary Resource Statement (SRS) to the Office of National Marine Sanctuaries (ONMS) to address the required analyses necessary to initiate a consultation under Section 304(d) of the Act.

Table ES-1 summarizes the status of NOS coordination and consultation as of the publication of the Final PEIS:

Table ES-1. Consultation with Other Federal Agencies

Federal Agency	Statute	Documentation	Consultation Initiated/ Completed
Completed Consultations			
National Marine Fisheries Service Office of Habitat Conservation	Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat	Essential Fish Habitat Assessment	June 2, 2022 Final Response received from NMFS OHC on November 1, 2022
Ongoing Consultations			
National Marine Fisheries Service Office of Protected Resources	Endangered Species Act	Biological Assessment (Draft PEIS)	August 26, 2021 Ongoing
Office of National Marine Sanctuaries	National Marine Sanctuaries Act	Sanctuary Resource Statement	June 1, 2022 Ongoing
National Marine Fisheries Service Office of Protected Resources	Marine Mammal Protection Act	Letter of Authorization Application	June 3, 2022 Ongoing
U.S. Fish and Wildlife Service	Endangered Species Act	Biological Assessment (Draft PEIS)	June 1, 2022 Ongoing
U.S. Fish and Wildlife Service	Marine Mammal Protection Act	Incidental Take Regulation Request	September 12,2022 Ongoing

Coordination with Tribes

On June 28, 2021, NOS sent letters to tribes notifying them of the availability of the Draft PEIS and inviting them to request government-to-government consultation under Executive Order (EO) 13175, Consultation and Coordination with Indian Tribal Governments. Federally recognized tribes are American Indian or Alaska Native tribal entities recognized as having a government-to-government relationship with the U.S., with the responsibilities, powers, limitations, and obligations attached to that designation, and are eligible for funding and services from the Bureau of Indian Affairs. See 86 FR 7554, updated by 87 FR

4636, for the full list of 574 federally recognized tribes. NOS recognizes its unique relationship with tribes and trust responsibility with tribal governments as set forth in the U.S. Constitution, treaties, statutes, executive orders, and court decisions. It is the policy of NOAA to consult on a government-to-government basis with federally recognized tribal governments when the federal actions and decisions have tribal implications.

NOS did not receive any requests from federally recognized tribes to initiate government-to-government consultation on the Draft PEIS. Additionally, no requests were received to initiate government-to-corporation consultation from any Alaska Native corporation. NOS intends to notify individual federally recognized tribes consistent with EO 13175 before conducting any project that may have tribal implications. Federally recognized tribes are welcome to request government-to-government consultation at any time for a project that may have tribal implications. The consultation and coordination process would be conducted in accordance with NOAA's Procedures for Government-to-Government Consultation with Federally Recognized Indian Tribes and Alaska Native Corporations (NOAA 13175 policy, November 12, 2013).

Revisions Since the Draft PEIS

NOS updated the Draft PEIS to include additional mitigation measures designed to minimize the impacts of surveying and mapping activities on the human environment. Additional mitigation measures incorporated into the Final PEIS are expected to result in a reduction of adverse environmental impacts analyzed in the Draft PEIS.

Due to the timing of the consultations and the publication of the Final PEIS, the temporal scope of the Proposed Action has been reduced from six years (2022-2027) to five years (2023-2027). The annual numbers for project activities and project miles are expected to remain consistent with those estimated in the Draft PEIS; however, since the Final PEIS covers one less year than the Draft PEIS, the total estimated survey effort has decreased.

NOS, in coordination with the National Marine Fisheries Service, has incorporated additional data sources into the determination of marine mammal density, and has made technical corrections to the acoustic exposure estimates. The updated data are included in the Final PEIS.

Purpose and Need Statement

The purpose of the Proposed Action is to gather accurate and timely data on the marine and U.S. coastal environment. The need for the Proposed Action is to provide the public and private sectors with nautical charts, benthic habitat condition maps, current and tide charts, and other products necessary for safe navigation, economic security, and environmental sustainability. The public and decision-makers need these products to ensure safety at sea, economic well-being, and the efficient stewardship of public trust resources.

Proposed Action and Alternatives

Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

Under Alternative A, NOS would continue to operate a variety of equipment and technologies to gather accurate and timely data on the nature and condition of the marine and coastal environment. This alternative reflects the technology, equipment, scope, and methods currently in use by NOS, at the level of effort reflecting NOS fiscal year 2019 funding levels. NOS operations were widely disrupted during the 2020 field season due to the COVID-19 pandemic. Therefore, the PEIS relies on 2019 as the baseline year for Alternative A as it is the most recent example of typical field operations that would be enacted if NOS chose to continue historical levels of project effort.

Alternative B: NOS Preferred Alternative – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations

Alternative B consists of Alternative A plus the more widespread adoption of new techniques and technologies (such as remotely operated vehicles (ROVs), microwave water level (MWWL) radar sensors, etc.) to more efficiently perform surveying, mapping, charting and related data gathering. Specific examples of adaptive methods and equipment that NOS programs are likely to adopt under Alternative B in the next five years include:

- Greater use of ROVs with echo sounder technologies;
- Greater use of autonomous underwater vehicles (AUVs) and uncrewed surface vehicles (USVs) with echo sounder technologies;
- Conversion of one or more existing 10-m (33 feet) crewed survey boats into USVs;
- Greater use of more efficient, wide-beam sonar systems (i.e., phase-differencing bathymetric systems) for nearshore hydrographic surveys;
- Increased field operations in the National Marine Sanctuary system with associated requirements for hydroacoustic charting, surveying, mapping and associated activities; and
- Installation, operation, and maintenance of additional water level stations, including transitioning to mostly microwave water level (MWWL) radar sensors and upgraded storm strengthening to make stations more climate resilient.

Under Alternative B, all of the activities and equipment operation described in Alternative A would continue, many at a higher level of effort. The nature of these actions would not change, but the overall level of activity would be increased.

Alternative B is NOS's preferred alternative because it takes advantage of newer, more efficient technology, responds to the needs of anticipated new marine sanctuaries, and more effectively addresses the nation's needs for coastal and marine data.

Alternative C: Upgrades and Improvements with Greater Funding Support

Like Alternative B, Alternative C adopts new techniques and technologies to encourage greater program efficiencies regarding surveying, mapping, charting, and related data gathering activities. In addition, Alternative C would consist of NOS program implementation with an overall funding increase of 20 percent relative to Alternative B. Under Alternative C, all of the activities and equipment operation described in Alternative B would continue, many at a higher level of effort. The nature of these actions would not change, but the overall level of activity would be augmented.

Table ES-2 compares the three alternatives.

Table ES-2. Comparison of NOS Annual Planned Surveying and Mapping Activities under Alternatives A, B, and C*

Activity	Described in Section	Alternative A	Alternative B	Alternative C
Crewed vessel operations	2.4.1	518,000 nm (959,000 km)	577,000 nm (1,070,000 km)	637,000 nm (1,180,000 km)
Anchoring**	2.4.2	55 projects	59 projects	64 projects
ROV/USV/ASV movement	2.4.3	28,600 nm (53,000 km)	86,300 nm (160,000 km)	102,300 nm (189,000 km)
Use of echo sounders	2.4.4	479,000 nm (887,000 km)	534,000 nm (988,000 km)	589,000 nm (1,090,000 km)
Use of sub-bottom profilers	2.4.4	3,210 nm (5,940 km)	5,310 nm (9,830 km)	7,710 nm (14,300 km)
Use of mobile ADCPs	2.4.5	5,890 nm (10,900 km)	11,200 nm (20,700 km)	15,200 nm (28,200 km)
Stationary ADCPs installed/visited for maintenance/removed	2.4.5	37 installed/78 maintenance visits/33 removed	39 installed /79 maintenance visits /33 removed	40 installed /79 maintenance visits /33 removed
Use of acoustic communication systems	2.4.6	24 projects	33 projects	39 projects
Sound speed data collection	2.4.7	56 projects	64 projects	71 projects
Drop/towed cameras/video system operation	2.4.8	31 projects	36 projects	41 projects
Bottom sample collection	2.4.9	54 projects	61 projects	68 projects
Use of passive listening systems***	2.4.10	21 projects	24 projects	29 projects
SCUBA operations	2.4.11	248 projects	254 projects	269 projects
Tide gauges installed/visited for maintenance/removed	2.4.12	32 installed /305 maintenance visits /30 removed	37 installed /305 maintenance visits /35 removed	40 installed /305 maintenance visits /38 removed
GPS reference system installation	2.4.13	12 installed	13 installed	15 installed

*All numbers are approximate and represent an annual level of effort. Projects for each activity were reported by NOS agencies without respect to the combination of activities within projects (e.g., a project involving both crewed vessel operation and echo sounder use would be reported as one crewed vessel project and one echo sounder project).

** NOS estimates that 20 percent of crewed vessel projects include an anchoring component.

***In addition to the projects presented in the table, NOS's Center for Operational Oceanographic Products and Services uses passive listening systems on an as-needed basis. This entails the use of transponder or interrogator sensors during the deployment or retrieval of ADCPs.

ENVIRONMENTAL CONSEQUENCES

Table ES-3 presents a summary of the assessed environmental consequences associated with Alternatives A, B, and C for the resources analyzed in the Final PEIS. A more complete description of impacts is provided in Chapter 3. All environmental consequences from each of the alternatives are anticipated to be adverse, ranging from negligible to moderate, and insignificant, except for the environmental consequences to socioeconomic resources which are anticipated to be indirect, beneficial, and moderate. The primary difference in impacts among the alternatives is one of scale, with the impacts from Alternative B the same or slightly, but not appreciably, larger than those under Alternative A, and from Alternative C the same or slightly, but not appreciably, larger than those under Alternatives A and B for each impact causing factor.

NOS identified the potential for acoustic disturbance to marine mammals as an area warranting detailed analysis. In this Final PEIS, NOS finds that, after conducting quantitative acoustic impacts modeling, impacts on marine mammals under all alternatives are expected to be limited to behavioral disturbances that would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. For a few individual high-frequency cetaceans, potential impacts from underwater acoustic sources include injury exposures in the form of hearing loss.

Table ES-3. Summary Comparison of Impacts

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
Habitats	Impacts to habitats from water column disruptions under Alternative A would continue to be **adverse** and **negligible.** Impacts to habitats from activities involving physical disturbance to bottom substrate; sedimentation, turbidity and chemical contaminants; increased ambient underwater sound levels; and onshore activities under Alternative A would continue to be **adverse** and **negligible** to **minor.** The impact on habitats from invasive species dispersal facilitated by activities under Alternative A would likely continue to be **adverse** and **minor.** Impacts to habitat areas resulting from Alternative A would not cause long-term changes in the availability of space, shelter, cover, or nutrients necessary for dependent species.	Impacts of Alternative B on habitats throughout the action area would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. Impacts to habitat areas resulting from Alternative A would not cause long-term changes in the availability of space, shelter, cover, or nutrients necessary for dependent species and would not substantially increase in intensity with the increased level of effort of Alternative B. Overall, impacts to habitats under Alternative B would be **adverse**, **minor**, and **insignificant**.	Impacts of Alternative C on habitats throughout the action area would be the same or slightly, but not appreciably, larger than those under Alternatives A and B for each impact causing factor. Impacts to habitat areas resulting from Alternatives A and B would not cause long-term decreases in the availability of space, shelter, cover, or nutrients necessary for dependent species and would not substantially increase in intensity with the increased level of effort of Alternative C. Overall, impacts to habitats under Alternative C would be **adverse**, **minor**, and **insignificant**.

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	Overall, impacts to habitats under Alternative A would continue to be **adverse, minor**, and **insignificant.**		
Marine Mammals	Impacts on marine mammals (cetaceans, pinnipeds, sirenians, and fissipeds) from trash and debris and air emissions under Alternative A would continue to be **adverse** and **negligible.** Impacts from human activity under Alternative A would continue to be **adverse** and **negligible** on cetaceans and sirenians and **adverse** and **minor** on pinnipeds and fissipeds**.** Impacts on marine mammals (cetaceans, pinnipeds, sirenians, and fissipeds) from accidental oil, fuel, or chemical spills under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts on marine mammals (cetaceans, pinnipeds, sirenians, and fissipeds) from active underwater acoustic sources, vessel and equipment sound, vessel presence and movement of equipment in the	Impacts of Alternative B on marine mammals would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. Impacts to marine mammals resulting from Alternative A would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts of Alternative B on marine mammals, including ESA-listed species, and habitat, including designated critical habitat, would be **adverse, minor,** and **insignificant.**	Impacts of Alternative C on marine mammals would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. Impacts to marine mammals resulting from Alternatives A and B would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts of Alternative C on marine mammals, including ESA-listed species, and habitat, including designated critical habitat, would be **adverse, minor,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	water under Alternative A would continue to be **adverse** and **minor.** Impacts on pinnipeds and fissipeds from air emissions under Alternative A would continue to be **adverse** and **negligible**. Although a vessel strike is very unlikely, debilitating injury or mortality of one or a few individuals could occur and impacts would be **adverse** and **moderate,** or greater if an ESA-listed species is affected. If a walrus stampede occurs due to vessel or aircraft disturbance, the impact could be **adverse** and **moderate** or greater. If polar bears are disturbed at denning sites or if polar bear-human interactions occur, the impact could be **adverse** and **moderate**. Potential impacts from underwater acoustic sources include injury exposures in the form of hearing loss (PTS) on cetaceans, but such injury would be rare and confined to a few individual high-frequency cetaceans. It would also include behavioral		

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	disruption exposures of cetaceans, pinnipeds, sirenians and fissipeds, but the amount of time individuals may exceed the behavioral exposure threshold would be on average less than a few minutes. Impacts to marine mammals resulting from Alternative A would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Overall, impacts of Alternative A on marine mammals, including ESA-listed species, and habitat, including designated critical habitat, would continue to be **adverse, minor,** and **insignificant.**		
Sea Turtles	Impacts to sea turtles and their habitats from active underwater acoustic sources, vessel and equipment sound, and onshore activities under Alternative A would continue to be **adverse** and **negligible.**	Impacts of Alternative B on sea turtles and their habitats would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor.	Impacts of Alternative C on sea turtles and their habitats would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor.

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	Impacts to sea turtles and their habitats from vessel presence and movement, underwater activities, and air emissions under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts to sea turtles and their habitats from accidental oil, fuel, or chemical spills would continue to be **adverse** and **negligible** to **minor.** Although the effects of impact causing factors on sea turtles and their habitats range from **negligible** to **moderate**, moderate impacts could occur in the very unlikely event of an accidental spill of oil, fuel, or chemicals. Likewise, in the very unlikely event of a vessel strike, injury or death to sea turtles would also constitute a **moderate** or greater impact. Impacts to sea turtles resulting from Alternative A would not cause long-term changes in habitat availability and use, sea turtle behavior, or energy expenditures.	Impacts to sea turtles resulting from Alternative A would not cause long-term changes in habitat availability and use, sea turtle behavior, or energy expenditures and would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts on sea turtles and their habitat, including designated critical habitat, would be **adverse, minor,** and **insignificant**.	Impacts to sea turtles resulting from Alternatives A and B would not cause long-term changes in habitat availability and use, sea turtle behavior, or energy expenditures and would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts on sea turtles and their habitat, including designated critical habitat, would be **adverse, minor,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	Overall, impacts under Alternative A on sea turtles and their habitats, including designated critical habitat, would continue to be **adverse, minor,** and **insignificant.**		
Fish	Impacts to fish and their habitats from vessel wake and turbulence; vessel sound; accidental spill of oil, fuel, or chemicals; and disturbance of the ocean/lake/river bottom under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts to fish and their habitats from active underwater acoustic sources and air emissions under Alternative A would continue to be **adverse** and **minor.** Impacts to fish resulting from Alternative A may include some stress responses without permanent physiological damage, and may disturb breeding, feeding, or other activities but without any impacts on population levels; additionally, there would not be long-term changes in	Under Alternative B, impacts on fish and fish habitat would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. Impacts to fish resulting from Alternative A may include some stress responses without permanent physiological damage, and may disturb breeding, feeding, or other activities but without any impacts on population levels; additionally, there would not be long-term changes in habitat availability and use or in fish behavior. These impacts would not substantially increase in intensity with the increased survey effort of Alternative B.	Impacts of Alternative C on fish and fish habitat would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. Impacts to fish resulting from Alternatives A and B may include some stress responses without permanent physiological damage, and may disturb breeding, feeding, or other activities but without any impacts on population levels; additionally, there would not be long-term changes in habitat availability and use or in fish behavior. These impacts would not substantially increase in intensity with the increased survey effort of Alternative C.

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	habitat availability and use or in fish behavior. Overall, impacts of Alternative A on fish, including ESA-listed species, and fish habitat, including designated critical habitat, would continue to be **adverse, minor,** and **insignificant.**	Overall, impacts of Alternative B on fish, including ESA-listed species, and fish habitat, including designated critical habitat, would be **adverse, minor,** and **insignificant.**	Overall, impacts of Alternative C on fish, including ESA-listed species, and fish habitat, including designated critical habitat, would be **adverse, minor,** and **insignificant.**
Aquatic Macroinvertebrates	Impacts to aquatic macroinvertebrates and their habitats from underwater acoustic sources, vessel sound, and air emissions under Alternative A would continue to be **adverse** and **negligible.** Impacts to aquatic macroinvertebrates and their habitats from vessel wake and underwater turbulence; accidental spill of oil, fuel, or chemicals; and disturbance of the ocean/lake/river bottom under Alternative A would continue to be **adverse** and **negligible** to **minor.** Overall, impacts of Alternative A on aquatic macroinvertebrates, including ESA-listed species, and habitats, including designated critical habitat,	Under Alternative B, impacts on aquatic macroinvertebrates and their habitats would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts of Alternative B on aquatic macroinvertebrates, including ESA-listed species, and habitats, including designated critical habitat, would be **adverse, minor,** and **insignificant.**	Under Alternative C, impacts on aquatic macroinvertebrates and their habitats would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts of Alternative C on aquatic macroinvertebrates, including ESA-listed species, and habitats, including designated critical habitat, would be **adverse, minor,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	would continue to be **adverse, minor,** and **insignificant.**		
Essential Fish Habitat (EFH)	Impacts to EFH from disturbance of the water column under Alternative A would continue to be **adverse** and **negligible.** Impacts to EFH from physical impacts to bottom habitat; increase in sedimentation, turbidity, or chemical contamination; dispersal of invasive species; and increase in ambient sound under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts to EFH resulting from Alternative A would be infrequent, geographically widely distributed, and likely to elicit a minimal or temporary response from prey species or cause short-term changes to physical characteristics (i.e., changes in water quality). Overall, impacts of Alternative A on EFH would continue to be **adverse, minor,** and i**nsignificant.**	Under Alternative B, impacts on EFH would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. Impacts to EFH resulting from Alternative A would be infrequent, geographically widely distributed, and likely to elicit a minimal or temporary response from prey species or cause short-term changes to physical characteristics (i.e., changes in water quality). These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts of Alternative B on EFH would be **adverse, minor,** and **insignificant**.	Under Alternative C, impacts on EFH would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. Impacts to EFH resulting from Alternatives A and B would be infrequent, geographically widely distributed, and likely to elicit a minimal or temporary response from prey species or cause short-term changes to physical characteristics (i.e., changes in water quality). These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts of Alternative C on EFH would be **adverse, minor,** and **insignificant**.

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
Seabirds, Shorebirds and Coastal Birds, and Waterfowl	Impacts to birds and their habitats from active underwater acoustic sources and vessel and equipment sound under Alternative A would continue to be **adverse** and **negligible.** Impacts to birds and their habitats from aircraft sound, vessel presence and movement, underwater activities, onshore activities, and air emissions under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts to birds and their habitats from accidental oil, fuel, or chemical spills would continue to be **adverse** and **minor** to **moderate.** Although the effects of impact causing factors on birds and their habitats range from **negligible** to **moderate**, moderate impacts could occur in the very unlikely event of an accidental spill of oil, fuel, or chemicals. Likewise, in the very unlikely event of a vessel strike, injury or death to birds could constitute greater impacts.	Under Alternative B, impacts on birds and their habitats would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. Impacts to birds resulting from Alternative A would generally persist only for the duration of an activity and would not be expected to cause any long-term changes in habitat use and availability or energy expenditure outside of the natural range of variation. These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts on of Alternative B on birds, including ESA-listed species, and habitats, including designated critical habitat, would be **adverse, minor,** and **insignificant.**	Under Alternative C, impacts on birds and their habitats would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. Impacts to birds resulting from Alternatives A and B would generally persist only for the duration of an activity and would not be expected to cause any long-term changes in habitat use and availability or energy expenditure outside of the natural range of variation. These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts on of Alternative C on birds, including ESA-listed species, and habitats, including designated critical habitat, would be **adverse, minor,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	Impacts to birds resulting from Alternative A would generally persist only for the duration of an activity and would not be expected to cause any long-term changes in habitat use and availability or energy expenditure outside of the natural range of variation. Overall, impacts on of Alternative A on birds, including ESA-listed species, and habitats, including designated critical habitat, would continue to be **adverse, minor,** and **insignificant.**		
Cultural and Historic Resources	Impacts to cultural and historic resources from installation, maintenance, and removal of tide gauges, buoys, and GPS reference stations under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts to cultural and historic resources from bottom sampling under Alternative A would continue to be both **adverse** and **beneficial, permanent,** and **negligible** to **minor.** Beneficial impacts would occur if a resource were discovered that led to	Under Alternative B, impacts on cultural and historic resources would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts of Alternative B to cultural and historic resources would be **adverse, moderate,** and **insignificant.**	Under Alternative C, impacts on cultural and historic resources would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts of Alternative C to cultural and historic resources would be **adverse, moderate,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	the identification of a culturally-significant artifact or a previously undocumented historic site. Impacts to cultural and historic resources from anchoring under Alternative A would continue to be **adverse, permanent,** and **negligible** to **moderate.** Impacts on subsistence hunting and fishing, including Traditional Cultural Places, under Alternative A would continue to be **adverse** and **negligible** to **moderate.** Although the effects of impact causing factors on cultural and historic resources range from **negligible** to **moderate**, moderate impacts that could occur if the integrity of a resource is diminished would be very unlikely. Overall, impacts of Alternative A to cultural and historic resources would continue to be **adverse, moderate,** and **insignificant.**		

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
Socioeconomic Resources	The economic impacts of ocean data procured under Alternative A on health and safety, recreational economic activity, transportation, and energy-related activities would continue to be **indirect, beneficial,** and **moderate**. Impacts to commercial fishing under Alternative A would continue to be **adverse** and **negligible**. Data collected under Alternative A would continue to improve the quality and quantity of ocean data and data products. Overall, Alternative A would continue to have **indirect, beneficial**, and **moderate** impacts on the ocean economy.	The economic benefits of impacts of Alternative B would be the same or slightly, but not appreciably, larger than those discussed above under Alternative A. These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, Alternative B would have **indirect, beneficial**, and **moderate** impacts on the ocean economy.	The economic benefits of impacts of Alternative C would be the same or slightly, but not appreciably, larger than those under Alternatives A and B. These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, Alternative C would have **indirect, beneficial**, and **moderate** impacts on the ocean economy.
Environmental Justice	Impacts of underwater acoustic sources on subsistence hunting of marine mammals under Alternative A would continue to be **adverse** and **moderate**, and the impacts to subsistence fishing communities would continue to be **adverse** and **minor**.	Under Alternative B, impacts on environmental justice would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. These impacts would not substantially increase in intensity with the	Under Alternative C, impacts on environmental justice would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. These impacts would not substantially increase in intensity

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	Impacts of vessel and equipment noise on subsistence hunting of marine mammals under Alternative A would continue to be **adverse** and **minor**, and the impacts to subsistence fishing communities would continue to be **adverse** and **negligible**. Impacts of vessel and equipment presence and movement on subsistence hunting of marine mammals under Alternative A would continue to be **adverse** and **moderate**, and the impacts to subsistence fishing communities would continue to be **adverse** and **negligible**. Impacts of human activities and accidental leakage or spillage of oil, fuel, and chemicals on subsistence hunting and fishing under Alternative A would continue to be **adverse** and **minor**. Impacts of marine trash and debris and air emissions on subsistence hunting and fishing activities under	increased survey effort of Alternative B. Overall, impacts of Alternative B on environmental justice would continue to be **adverse, minor** to **moderate,** and **insignificant.**	with the increased survey effort of Alternative C. Overall, impacts of Alternative C on environmental justice would continue to be **adverse, minor** to **moderate,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	Alternative A would continue to be **adverse** and **negligible**. The availability of new mapping and charting information under Alternative A would have **beneficial** effects on EJ communities. Overall, impacts of Alternative A on environmental justice would continue to be **adverse, minor** to **moderate,** and **insignificant.**		

1.0 INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) has prepared this Final Programmatic Environmental Impact Statement (PEIS) to analyze the potential environmental impacts associated with NOS's recurring projects throughout United States (U.S.) coastal and marine waters to characterize underwater features (e.g., habitat, bathymetry, marine debris). Data obtained from these projects are used to produce many products, including charts and maps that are relied upon by mariners, scientists, shipping and fishing industries, and countless other users in the U.S. and beyond.

The Proposed Action evaluated in this Final PEIS is to continue NOS data collection projects in the U.S. territorial sea, the contiguous zone, the U.S. Exclusive Economic Zone (U.S. EEZ), U.S. rivers, and states' offshore waters, and some supporting activities in coastal and riparian lands such as the installation of tide gauges. These areas are referred to as the "action area" in this document. These projects would include surveys performed from crewed vessels and remotely operated or autonomous vehicles. Field crews would include NOS personnel, other NOAA personnel on behalf of NOS, contractors, grantees, or permit/authorization holders. These crews and vehicles may use echo sounders and other active acoustic equipment and employ other equipment, including bottom samplers and conductivity, temperature, and depth instruments to collect the needed data. A project could also involve supporting activities, such as the use of divers and the installation of tide buoys.

This Final PEIS was prepared in accordance with the National Environmental Policy Act (NEPA) (42 United States Code [U.S.C.] § 4321, et seq.); Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR §§ 1500–1508 (1978)); NOAA Administrative Order 216-6A[1]; and other relevant federal and state laws and regulations. While the CEQ regulations implementing NEPA were revised as of September 14, 2020 (85 FR 43304, July 16, 2020) and further revised as of May 20, 2022 (87 FR 23453, April 20, 2022), NOS prepared this Final PEIS using the 1978 CEQ regulations because this environmental review began on December 19, 2016, when NOS published a Notice of Intent (NOI) to conduct scoping. This Final PEIS discloses the direct, indirect, and cumulative environmental impacts that would result from the Proposed Action to ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken.

1.1 REVISIONS SINCE THE DRAFT PEIS

NOS is committed to incorporating the best available information into the Final PEIS. NOS revised the PEIS since the June 2021 draft version to reflect feedback received through interagency coordination and consultation, stakeholder input, and public comments. A description of stakeholder input and public comments can be found in Section 1.5, Public Involvement. NOS has included responses to all public comments in Appendix C.

1.1.1 Incorporation of Mitigation Measures

The Draft PEIS has been updated to include additional mitigation measures to be implemented on each project as appropriate to minimize the impacts of surveying and mapping activities. NOS developed a suite of robust mitigation measures in coordination with subject matter experts, field crews, and in

[1] NOAA Administrative Order (NAO) 216-6A establishes NOAA's policy and procedures for compliance with NEPA; the CEQ regulations; Executive Order (EO) 12114, Environmental Effects Abroad of Major Federal Actions; EO 11988 and 13690, Floodplain Management; and EO 11990 Protection of Wetlands.

consultation with the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and the Office of National Marine Sanctuaries (ONMS). Following publication of the Draft PEIS, NOS initiated interagency coordination and consultation under the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), Magnuson-Stevens Fishery Conservation and Management Act (MSA) for Essential Fish Habitat (EFH), and the National Marine Sanctuaries Act (NMSA). Through these processes, NOS and regulators identified additional mitigation measures that further minimize the impacts of project activities on protected species. These mitigation measures have been incorporated into the effects analysis in the appropriate resource sections in Chapter 3 of the Final PEIS. The full list of mitigation measures is included in Appendix D.

The incorporation of mitigation measures in the Final PEIS as a result of interagency coordination and consultation does not represent a significant change to the Proposed Action or new information relevant to environmental concerns and therefore, per 40 Code of Federal Regulations (CFR) 1502.9(d)(4), NOS is not required to publish a supplemental to the Draft PEIS. Additional mitigation measures incorporated into the Final PEIS generally result in a reduction of any adverse environmental impacts previously analyzed.

1.1.2 Change to Temporal Scope

Due to the timing of the consultations and publication of the Final PEIS, the temporal scope of the Proposed Action has been reduced from six years (2022-2027) to five years (2023-2027). For 2022 projects, NOS used existing procedures for project-specific NEPA and environmental compliance. NOS has completed environmental reviews for all 2022 projects either planned or underway. The annual numbers for project activities and project miles are expected to remain consistent with those estimated in the Draft PEIS; however, since the Final PEIS covers one less year than the Draft PEIS, the total estimated survey effort has decreased. This change has been reflected throughout the Final PEIS.

The change to the temporal scope would result in an overall reduction to the effects for all resources analyzed in the Final PEIS. NOS has determined that the environmental effects are generally not additive over time. Therefore, the reduction in the temporal scope does not represent a significant change to the effects analysis for the Proposed Action or new information relevant to environmental concerns. Per 40 CFR 1502.9(d)(4), NOS is not required to publish a supplemental to the Draft PEIS.

1.1.3 Updated Acoustic Exposure Estimates

NOS, in coordination with NMFS, has updated the inputs to the acoustic model used to estimate marine mammal exposures to NOS underwater sound sources for the Final PEIS by using more current marine mammal abundance and density data. The acoustic model was also revised to account for the change in temporal scope and to correct a technical error. The updated exposure estimates are discussed in Section 3.5.2.

1.2 The Mission, Priorities, and Organization of the National Ocean Service

NOS is the nation’s leading authority on hydrography, shoreline mapping, and nautical charts; water levels, tides, and currents; and geodetic positioning. The NOS mission is “to provide science-based solutions through collaborative partnerships to address evolving economic, environmental, and social pressures on our ocean and coasts” (NOS, No Date-a).

The NOS priorities are:

- Safe and efficient transportation and commerce;

- Preparedness and risk reduction; and
- Stewardship, recreation, and tourism.

To advance these priorities, NOS performs, funds, and authorizes a wide variety of work including research, education, technical assistance, data collection, software development, oversight, disaster response, and resource stewardship.

NOS provides data, tools, and services that support coastal economies and their contribution to the national economy. Approximately 40 percent of the U.S. population lives and works in coastal areas. Many U.S. coastal areas are undergoing substantial changes and face a variety of challenges, including port congestion and navigation hazards, recurrent flooding and beach erosion, pollution and algal blooms, habitat loss, and risk of catastrophic impacts from coastal storms and tsunamis. NOS works across all levels of government and with academic and private-sector partners to prepare America's coastal communities to address these challenges, reduce risks, and ensure thriving coastal communities and economies now and in the future (NOS, 2017a).

NOS is organized into eight program offices. These are:

- Office of Coast Survey (Coast Survey): carries out NOAA's surveying and charting responsibility in over 3 million square nautical miles (nm^2) of U.S. waters. The program collects hydrographic data and creates and maintains nautical charts and other products to support safe navigation for commercial shipping, fishing, recreational boaters, and state and local governments.
- Center for Operational Oceanographic Products and Services (CO-OPS): provides accurate, reliable, and timely water level, current, and other oceanographic measurements that support safe and efficient maritime commerce, sound coastal management, and recreation.
- National Centers for Coastal Ocean Science (NCCOS): conducts and funds research in support of NOS core priorities of coastal change vulnerability, mitigation, and restoration; marine spatial ecology; stressor impacts and mitigation; and social science.
- Office for Coastal Management (OCM): implements the Coastal Zone Management Act (CZMA), the nation's guiding legislation for keeping the natural environment, built environment, quality of life, and economic prosperity of our coastal areas in balance.
- Office of National Marine Sanctuaries (ONMS): oversees the National Marine Sanctuary System, comprising 14 national marine sanctuaries and two marine national monuments. Together, these protected areas encompass more than 600,000 square miles of marine, riverine, and Great Lakes waters.
- Office of Response and Restoration (ORR): provides expertise in preparing for, evaluating, and responding to threats to coastal environments, including oil and chemical spills, hazardous waste releases, and marine debris.
- Integrated Ocean Observing System (IOOS): a national-regional partnership that provides observational coastal data, forecasts, and new tools to improve safety, enhance the economy, and protect the environment. IOOS provides integrated ocean information in near real time, as well as retrospectively, which improves NOAA's ability to understand and predict coastal storms, wave heights, and sea level change.

- Office of National Geodetic Survey (NGS): provides the nation with geodetic and geographic positioning services through a common reference framework, the National Spatial Reference System, for establishing the coordinate positions of all geographic and geospatial data.

Of the eight programs listed above, all but one (NGS) perform activities that are addressed in this Final PEIS. Appendix A, Summary of NOS Program Offices and Their Use of Active Acoustic Data Collection Technology, contains more information on each office's mission and history.

1.3 Purpose and Need

The purpose of the Proposed Action is to gather accurate and timely data on the marine and U.S. coastal environment.

The need for the Proposed Action is to provide the public and private sectors with nautical charts, benthic habitat condition maps, current and tide charts, and other products necessary for safe navigation, economic security, and environmental sustainability. The public and decision-makers need these products to ensure safety at sea, economic well-being, and the efficient stewardship of public trust resources. **Figure 1.3-1** presents the geographic areas of U.S. surveying and mapping data needs.

1.3.1 Safe Navigation

The Coast and Geodetic Survey Act (33 U.S.C. §§ 883a et seq.) and the Hydrographic Services Improvement Act as amended (33 U.S.C. § 892) make surveying and charting a principal responsibility of NOAA. This includes rivers, states' offshore waters, the U.S. territorial sea, contiguous zone and the U.S. EEZ. NOS uses survey data to create products that support safe navigation for commercial shipping, the fishing industry, recreational boaters, and military and government functions such as law enforcement. Many coastal areas are highly dynamic, with shifting shoals and wrecks, and eroding or accreting shorelines, all of which require routine measurement to ensure safe navigation.

1.3.2 Economic Security

The nation's economic security requires timely and accurate data on the natural environment. Shipping on America's network of coastal waterways, navigable channels, ports, and marine terminals is a primary mode of moving goods around the country. This waterborne highway system also connects U.S. producers to the global marketplace. Water transportation jobs and establishments contributed $33 billion and 467,000 jobs to the U.S. economy in 2016 (OCM, 2016a). By value, vessels carry 46 and 35 percent of U.S. imports and exports, respectively (USCB, 2018). To accommodate the tonnage of goods such as petroleum, iron, coal, and grain being transported by ship, cargo vessels have become larger and have deeper drafts. Port authorities, mariners, and coastal communities depend on accurate navigational information provided by NOS to make informed decisions. Alaskan and U.S. Arctic waters, more of which are becoming navigable given the changing sea ice conditions, are especially important survey targets (NOAA, 2018a). Alaska's approximately 55,000 kilometers (km) (34,000 miles [mi]) of coastline contain oil, natural gas, minerals, fish, and other resources that will play an important future role in the U.S. economy, all of which must transit Alaska's waterways to reach domestic and international markets.

1.3.3 Environmental Sustainability

NOS coastal and marine data support ecosystem stewardship. Bathymetric base layers provide valuable information about essential habitat for fish and marine mammals. Survey data provide the extent of coral reef tracts, which helps federal, state, and local governments make informed decisions about anchorages, fishing areas, and other natural resource management issues. For example, coastal and marine resource managers rely on survey data to conserve, preserve, and restore ecological resources, including critical habitat for endangered seabirds, coral, seagrass, fish, sea turtle, and marine mammal species. National marine sanctuaries also rely on surveys to identify and monitor underwater cultural and historical resources such as shipwrecks. NOS ORR collects data to track and map oil plumes and to characterize fish and plankton presence. Finally, NOS coastal and marine data provide baseline resource information against which coastal managers can measure changes to the environment over time.

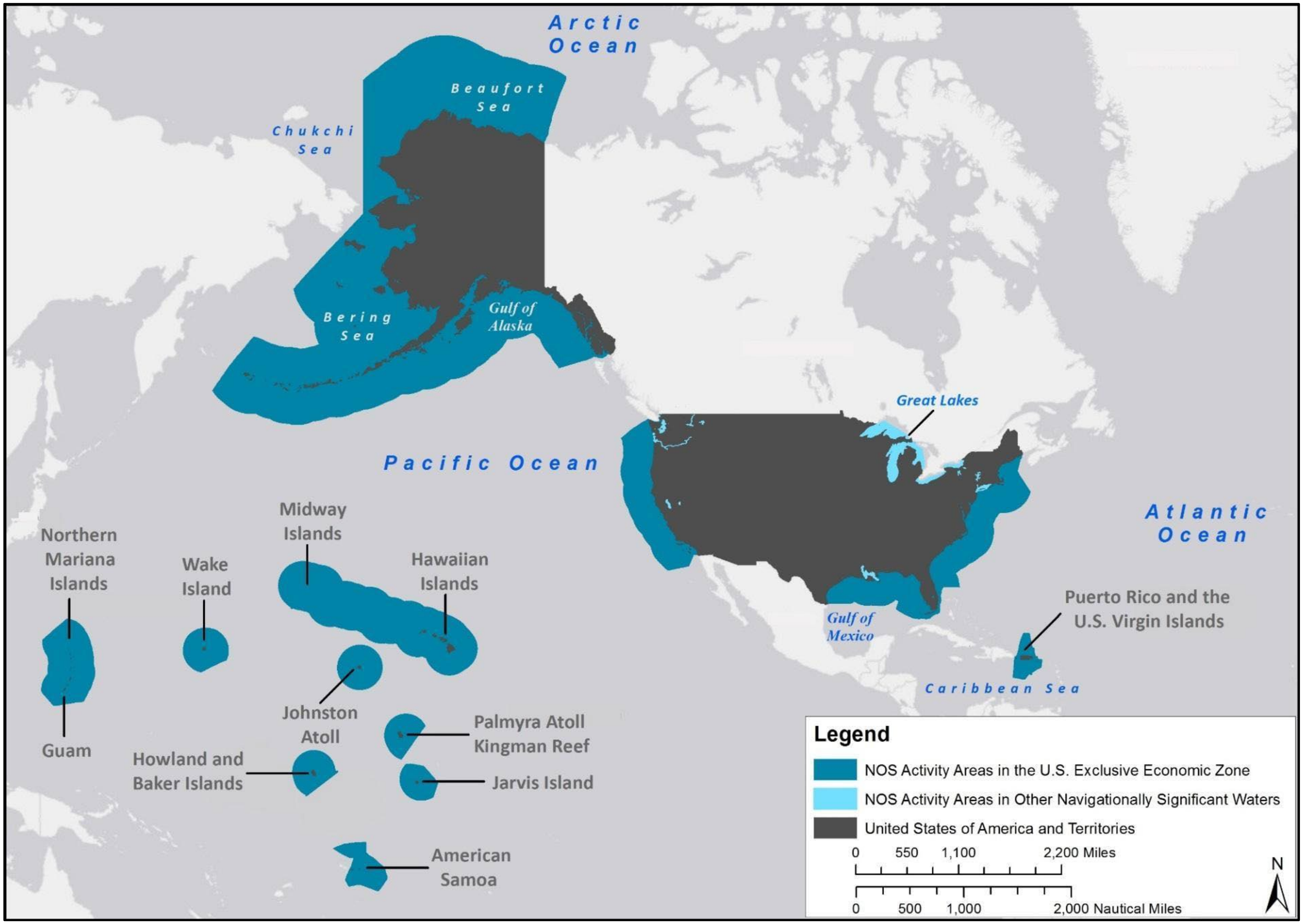


Figure 1.3-1. Action Area for Surveying and Mapping Activities Conducted by the National Ocean Service

1.4 Programmatic Scope

The CEQ indicates that programmatic NEPA analysis can "address the general environmental issues relating to broad decisions, such as those establishing policies, plans, programs, or suite of projects, and can effectively frame the scope of subsequent site- and project-specific Federal actions'' (CEQ, 2014). CEQ guidance also provides that "[a]gencies may prepare a single NEPA document to support both programmatic and project-specific proposals." *Ibid.*

NOS determined that a programmatic approach was appropriate for the Proposed Action because NOS conducts, authorizes, permits, and funds a suite of similar, ongoing data collection activities associated with recurring projects across a wide geographic area to characterize underwater features (e.g., habitat, bathymetry, marine debris). This Final PEIS analyzes the environmental impacts of a suite of surveying and mapping data collection activities. The analysis will be used to inform NOS leadership and the public on the environmental impacts of these activities before a decision is made on how to execute each project.

1.4.1 Subsequent Project-Specific Consideration of Environmental Impacts

This Final PEIS is a comprehensive document that provides detailed analyses of the environmental effects for the suite of surveying and mapping data collection activities based on regional conditions, habitat types, species, and other factors. However, the Final PEIS does not identify the specific time or place for individual projects or activities over the next five years. The analysis in the Final PEIS demonstrates that NOS has sufficient information to analyze the potential effects of projects regardless of their timing and location. NOS anticipates that the majority of future projects encompassed in the Proposed Action would not require additional, site- or project-specific effects analysis; however, NOS will initiate project-specific consultations under Section 106 of the National Historic Preservation Act (NHPA) before commencing any activity with the potential to affect cultural or historic resources.

The analysis in the Final PEIS will be used to inform NOS and the public on the environmental impacts of the surveying and mapping program before a decision is made on how to execute each project. All projects will require a project-specific review and approval before proceeding. NOS will consider the applicability of the Final PEIS to all individual proposed projects through the preparation of a "Record of Environmental Consideration" (REC). RECs are signed statements submitted with project documentation to explain that the project has received an environmental compliance review. Within NOS, a REC is typically prepared for any action covered by existing programmatic analysis under NEPA. NOS will complete a REC prior to the start of a project to document whether the project falls within the scope of the activities and effects detailed in the Final PEIS. NOS will also review the project to ensure that all applicable mitigation measures are incorporated into project plans and instructions. Prior to project approval, NOS will review compliance requirements for all other applicable environmental laws such as ESA, MMPA, NHPA, Coastal Zone Management Act (CZMA), NMSA, and MSA for EFH. NOS will ensure its responsibilities for government-to-government consultation with federally recognized tribes are met (EO 13175). Any additional compliance requirements will be fulfilled prior to project approval, as needed.

If NOS determines that all applicable environmental requirements for the proposed project have been satisfied, then the REC will be signed by the appropriate NOS authority. NOS will proceed with the proposed project only after the REC has been signed and it has been determined that no additional review or analysis is required. If NOS determines that any of the project activities are outside of the scope of the Final PEIS, an additional project or site-specific NEPA effects analysis and environmental compliance review will be conducted to satisfy NEPA requirements prior to commencing any activity.

1.5 PUBLIC INVOLVEMENT

NOS published a "Notice of Availability of a Draft Programmatic Environmental Impact Statement for Surveying and Mapping Projects in U.S. Waters for Coastal and Marine Data Acquisition" in the *Federal Register* on June 25, 2021 to announce the availability of the Draft PEIS for public review. Following the publication of the Draft PEIS, the NOS Environmental Compliance Coordinator presented a brief overview of the Draft PEIS to the Alaska Eskimo Whaling Commission (AEWC), including information about NOS, the Proposed Action, expected impacts to marine mammals and subsistence hunting and fishing, and compliance with the MMPA. In response to preliminary feedback received from AEWC members and other Alaska Native community members, NOS extended the original 60-day public comment period deadline by 90 days from August 24, 2021 to November 22, 2021 to accommodate the Alaskan subsistence hunting and fishing season. The extension of the public comment period was published in the *Federal Register* on August 24, 2021.

NOS prepared a comprehensive public involvement and outreach plan outlining the development and distribution of materials to inform the public and solicit input on the scope of the Proposed Action and related impact analysis. In conjunction with publication of the Draft PEIS, an interested party letter inviting public comment on the draft was distributed via email or U.S. mail to federal agencies; states and territories; Non-Governmental Organizations (NGOs); tribes; regional organizations; Alaska regional and village corporations; Native Hawaiian Organizations (NHOs); and NOS grantees, partners, and permit/authorization recipients with potential interest in the Proposed Action. Potentially interested tribes include those in geographic proximity to the action area (i.e., located in coastal states, Great Lakes states, or along major navigable rivers) as well as tribes with historic, religious, or cultural connections to coastal and marine resources regardless of proximity to the action area. In addition to contacting interested parties directly, the availability of the Draft PEIS was advertised in newspapers in coastal cities throughout the U.S. and posted on NOAA and NOS social media platforms. These announcements directed readers to the project website at https://oceanservice.noaa.gov/about/environmental-compliance/surveying-mapping.html. The website provides helpful information detailing key components of the Draft PEIS including an overview of the Proposed Action, fact sheets about the resources analyzed, and instructions on how to comment on the document. In order to reach communities in Alaska without reliable internet access, in addition to newspaper advertisements, NOS developed a Public Service Announcement (PSA) that was broadcasted by public radio stations to reach a broad geographic range along the Alaska coast. NOS sent a physical copy (a CD, USB drive, or hard copy) of the Draft PEIS to individuals or communities upon request, to ensure that the Draft would be made available at community centers, libraries, and other public facilities as needed.

During the public comment period for the Draft PEIS, NOS received 31 comment submissions from 30 commenters via Regulations.gov and email. Commenters included State Historic Preservation Officers (SHPOs), Tribal Historic Preservation Officers (THPOs), state Coastal Management program offices, federally recognized tribes, Alaska Native corporations, Alaska Native Organizations (ANOs), NGOs, and members of the public. The comments addressed a range of issues including the following:

- Protection of cultural and historic resources;
- Federal consistency under CZMA;
- Incorporation of mitigation measures;
- Environmental justice concerns pertaining to subsistence hunting and fishing in Alaska communities;

- Future coordination between NOS and other key stakeholders, such as AEWC, North Slope Borough Department of Wildlife Management, Calista Corporation in Alaska, Donlin Gold, Natural Resources Defense Council, Cultural Heritage Partners representing the Upper Mattaponi Indian Tribe, the Chickahominy Indian Tribe, and the Seneca Nation of New York;
- The NEPA process, scope of the PEIS, selection of a programmatic NEPA approach, alternatives to the Proposed Action, cumulative effects analysis, references and data cited in the effects analysis;
- Impacts to marine mammals, fish, habitats, birds, and sea turtles;
- Methodology and data consideration for the acoustic modeling;
- Impacts to socioeconomic resources such as fisheries; and
- Access to surveying and mapping data collected during NOS projects through data sharing.

NOS has thoroughly considered all of the input received and has responded to comments in Appendix C. Revisions to the Final PEIS have been made in response to comments where appropriate.

The Final PEIS is available for review on the project website https://oceanservice.noaa.gov/about/environmental-compliance/surveying-mapping.html. NOS will publish a Record of Decision no sooner than 30 days after publication of the U.S. Environmental Protection Agency's (EPA) Notice of Availability for the Final PEIS in the Federal Register.

1.5.1 Tribal Government-to-Government Consultation

On June 28, 2021, NOS sent letters to tribes notifying them of the availability of the Draft PEIS and inviting them to seek government-to-government consultation under EO 13175, Consultation and Coordination with Indian Tribal Governments. Federally recognized tribes are American Indian or Alaska Native tribal entities recognized as having a government-to-government relationship with the U.S., with the responsibilities, powers, limitations, and obligations attached to that designation, and are eligible for funding and services from the Bureau of Indian Affairs. See 86 FR 7554, updated by 87 FR 4636, for the full list of 574 federally recognized tribes. NOS recognizes its unique relationship with tribes and trust responsibility with tribal governments as set forth in the U.S. Constitution, treaties, statutes, executive orders, and court decisions. It is the policy of NOAA to consult on a government-to-government basis with federally recognized tribal governments when the federal actions and decisions have tribal implications.

NOS did not receive any requests from federally recognized tribes to initiate government-to-government consultation on the Draft PEIS. Additionally, no requests were received to initiate government-to-corporation consultation from any Alaska Native Corporation. NOS intends to notify individual federally recognized tribes consistent with EO 13175 before conducting any project that may have tribal implications. Federally recognized tribes are welcome to request government-to-government consultation at any time for a project that may have tribal implications. The consultation and coordination process would be conducted in accordance with NOAA's Procedures for Government-to-Government Consultation with Federally Recognized Indian Tribes and Alaska Native corporations (NOAA 13175 policy, November 12, 2013).

1.6 Coordination and Consultation with Other Federal Agencies

NOS coordinated with NMFS and USFWS during preparation of this Final PEIS. NMFS has legal jurisdiction over most marine mammal species (through the MMPA), most threatened or endangered marine plant and animal species (through the ESA), and Essential Fish Habitat (through the MSA). USFWS has legal jurisdiction over certain marine mammal species including manatees, walruses, polar bears, and sea otters (through the MMPA), most threatened or endangered terrestrial plant and animal species (through the ESA), and over 1,000 species of birds (through the Migratory Bird Treaty Act [MBTA]).

Both agencies provided a comprehensive Technical Assistance Review prior to publication of the Draft PEIS. In coordinating with NOS, NMFS and USFWS participated in multiple meetings and reviews during the development of the Draft PEIS.

NOS initiated consultation with USFWS under the ESA on August 21, 2021. On December 8, 2021, USFWS sent NOS a letter requesting additional information for completing consultation under Section 7 of the ESA for the Proposed Action. NOS provided the requested additional information and proposed revisions to the Draft PEIS on June 1, 2022. These revisions have been incorporated into the Final PEIS where appropriate.

NOS also initiated consultation with NMFS under the MMPA, ESA, and MSA and with USFWS under the MMPA. Additionally, in compliance with the NMSA, NOS prepared and submitted a Sanctuary Resource Statement (SRS) to ONMS to address the required analyses necessary to initiate a consultation under Section 304(d) of the Act. Section 3.3 discusses the full list of applicable environmental review requirements that NOS is integrating with the NEPA analysis included in this PEIS.

Table 1.6-1 summarizes the status of NOS coordination and consultation as of the date of this Final PEIS.

Table 1.6-1. Consultation with Other Federal Agencies

Federal Agency	Statute	Documentation	Consultation Initiated/ Completed
Completed Consultations			
National Marine Fisheries Service Office of Habitat Conservation	Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat	Essential Fish Habitat Assessment	June 2, 2022 Final Response received from NMFS OHC on November 1, 2022
Ongoing Consultations			
National Marine Fisheries Service Office of Protected Resources	Endangered Species Act	Biological Assessment (Draft PEIS)	August 26, 2021 Ongoing
Office of National Marine Sanctuaries	National Marine Sanctuaries Act	Sanctuary Resource Statement	June 1, 2022 Ongoing
National Marine Fisheries Service Office of Protected Resources	Marine Mammal Protection Act	Letter of Authorization Application	June 3, 2022 Ongoing
U.S. Fish and Wildlife Service	Endangered Species Act	Biological Assessment (Draft PEIS)	August 21, 2021 Ongoing
U.S. Fish and Wildlife Service	Marine Mammal Protection Act	Incidental Take Regulation Request	September 12, 2022 Ongoing

2.0 DESCRIPTION OF THE PROPOSED ACTION AND THE ALTERNATIVES

The National Environmental Policy Act (NEPA) requires federal agencies to analyze a proper range of reasonable alternatives to satisfy the Purpose and Need (see Section 1.3). To be considered a reasonable alternative, the National Ocean Service (NOS) determined that a proposed alternative must:

- Be technically feasible;
- Not violate any federal statute or regulation;
- Be consistent with reasonably foreseeable funding levels; and
- Meet national, regional, and local data needs.

Based on these criteria, NOS identified two action alternatives that meet the stated purpose of the proposed federal action and thus have been analyzed in detail. These alternatives are presented in Sections 2.5.2 and 2.5.3.

NOS also analyzed a "No Action" alternative that allows the reader to compare the potential impacts of either action alternative with the effects that would occur if NOS continued coastal and marine data collection at current levels using current technology and methods (i.e., the status quo). The No Action alternative is presented in Section 2.5.1.

2.1 Alternatives Considered but Eliminated from Further Analysis

Early in the NEPA planning process, NOS considered a range of alternatives to the Proposed Action before arriving at the three alternatives presented in this Programmatic Environmental Impact Statement (PEIS). The alternatives presented below were eliminated from further analysis because they did not meet one or more of the screening criteria listed above.

2.1.1 Protected Species Avoidance

NOS considered whether to discontinue hydroacoustic surveying, mapping, charting, or related data gathering in waters with known populations of federally protected species such as marine mammals. Protected species avoidance would include complete avoidance of all Biologically Important Areas (BIAs) such as preferred breeding, feeding, and nursery grounds or migratory routes. BIAs are discussed in Section 3.5.1.1.2 of the PEIS. BIAs indicate locations where particular species engage in biologically important behaviors either year-round or seasonally. BIAs were created to help the National Oceanic and Atmospheric Administration (NOAA), other federal agencies, and the public in the analyses and planning used to characterize and minimize the impacts of anthropogenic activities on cetaceans and to achieve conservation and protection goals. BIAs occur in every region throughout the NOS action area, but they do not present the totality of important habitat throughout the marine mammals' full range. Recognition of an area as biologically important for some species activity does not cause the area to rise to the designation of critical habitat under the Endangered Species Act (ESA). The stated intention is for the BIAs to serve as a resource management tool and for their currently identified boundaries to be considered dynamic and subject to change based on any new information.

Time-area restrictions for BIAs would significantly impact the ability to collect data during suitable conditions for using acoustic sources, result in lost survey time, and affect the crew's ability to work safely. For example, BIAs in Alaska are located throughout Alaska as shown below (**Figure 2.1-1**); some are seasonal and other are year-round. Prohibiting data collection in these areas would not allow NOS to meet the purpose and need for the Proposed Action.

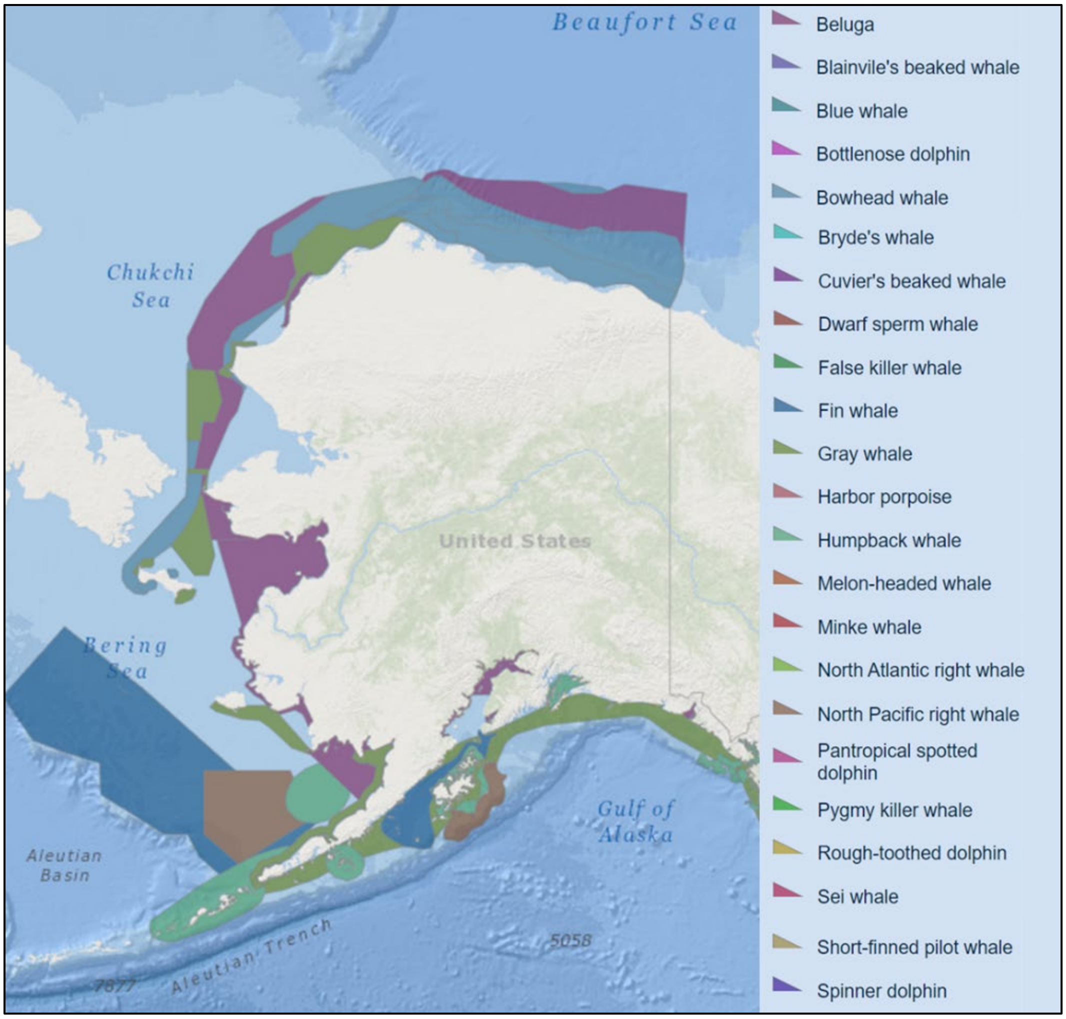


Figure 2.1-1. Biologically Important Areas in Alaska

NOS also considered the necessity and practicality of additional mitigation measures for BIAs. In coordination with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS), NOS has developed mitigation measures that include maintaining safe distances from marine mammals achieved by decreasing vessel speeds, vessel maneuvering, and observing time-area restrictions in specific protected species habitats (e.g., North Atlantic right whale). NOS already uses the lowest power appropriate to perform surveys, and employs mitigation measures including protected species observers (PSOs) to ensure that marine mammals are not within the vicinity of the vessel when active acoustics are being used. During nighttime operations, NOS uses the appropriate lighting to comply with navigation rules and best safety practices. All project areas would be continually monitored for protected species by posted crewmembers during vessel operations.

Any further mitigation, including entirely prohibiting mapping and surveying data collection or time-area restriction within the BIAs as discussed above, is unwarranted and impracticable due to safety concerns. For example, such restrictions could force NOS crews to operate at times and locations where sea conditions prevent safe vessel operation. Additionally, time-area restrictions for BIAs affect data collection and continuity and result in lost survey time NOS believes that the implementation of mitigation measures to further reduce the minor and temporary expected impacts will provide substantial protection for marine mammals during NOS surveying and mapping activities and complete avoidance of protected species and BIAs is unnecessary.

This alternative would prevent NOS from providing the coastal and marine data necessary for safe navigation, economic security, and environmental sustainability in large parts of U.S. waters. Therefore, NOS rejected this alternative because it did not allow national, regional, and local data needs to be met.

2.1.2 Use of Lidar Exclusively

Bathymetric Light Detection and Ranging (lidar) technology measures depths of nearshore waters using laser pulses emitted from a scanner on board a low-altitude airplane typically flying at speeds of 140 to 175 knots. The aircraft typically flies at altitudes of 300 to 365 meters (m) (1,000 to 1,200 feet [ft]) for up to five hours per flight. Lidar systems used for bathymetry emit visible green laser pulses to measure the timed sea floor bottom return, and near-infrared laser pulses measure the sea surface return. Depth is determined by the time of the return back to the lidar sensor from the energy reflected off the sea floor.

Lidar technology can efficiently survey large areas, identify features in a short period of time, and safely survey nearshore areas that are hazardous to mariners. However, lidar has distinct limitations in deeper water and under challenging environmental conditions. Variables such as water clarity (turbidity), sea state, and sea surface limit the effectiveness of bathymetric lidar. In particular, lidar does not produce good results when used in turbid waters. Under non-ideal conditions, lidar systems often fail to identify small, potentially hazardous objects on the sea floor. Even in the best conditions, reliable laser “returns” from the sea floor diminish in waters deeper than 20 to 30 m (65-98 ft).

NOS rejected this alternative because it does not meet national, regional, and local data needs, and thus fails to meet the stated purpose and need. Relying on lidar exclusively would not meet the accuracy standards needed for reliable charts, maps, and other products.

NOS may use lidar on individual projects, where appropriate, such as for shoreline verification. However, these lidar surveys are not within the scope of this document.

2.1.3 Use of Satellite-Derived Bathymetry Exclusively

Satellite-derived bathymetry (SDB) refers to data from optical satellite imagery. SDB begins with using multi-spectral satellite imagery, such as Landsat, Sentinel-2 and WorldView2, and calculating a ratio between green and blue color bands. Because of the optical nature of green light to attenuate faster in the water column than blue light, the blue/green band ratio can help to infer relative depths of the water. Using control points, SDB results can be referenced to chart datum. Unlike “active” depth measurement techniques that measure depths directly using “time-of-flight”, such as echo sounders or lidar, where controlled signals are transmitted and the return time is measured and used to calculate the water depth, SDB is a “passive” technology and is simply measuring the reflected sunlight intensity that is used to infer the water depth.

Similar to optical systems like lidar, environmental conditions (e.g., water turbidity, cloud cover, and sun glint) can degrade accuracy, which prevents SDB from being used exclusively as a replacement for hydroacoustic methods. Therefore, NOS rejected this alternative because it does not meet national, regional, and local data needs, and thus fails to meet the purpose and need for this Proposed Action.

NOS may use SDB as a reconnaissance tool on a case-by-case basis for investigating coastal areas before performing a high-resolution hydrographic survey with traditional methods. However, this use of SDB is not within the scope of this document.

2.2 COMPONENTS OF THE ALTERNATIVES: PROJECTS AND ACTIVITIES

NOS collects data in United States (U.S.) waters each year by undertaking a number of discrete surveying and mapping projects, which comprise the alternatives evaluated in this Final PEIS. Projects include, but are not limited to, hydrographic surveys, marine debris surveys, tide gauge installation, and benthic habitat characteristic surveys. A project would typically consist of several individual components, which are referred to in this document as "activities." **Figure 2.2-1** depicts many of the activities which are combined by NOS program offices to compose a given project.

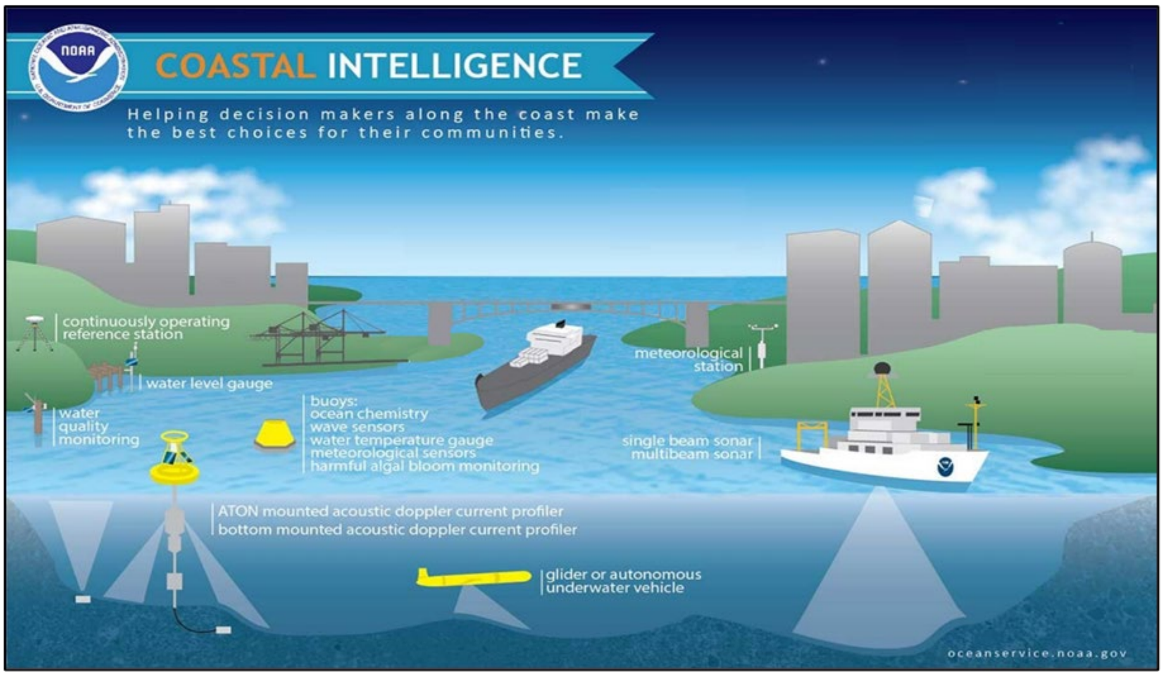


Figure 2.2-1. Common Activities Used in NOS Projects

The nature and scope of projects can vary based on the combination of activities. For example, a habitat characteristic survey could consist of crewed vessel use, diving using Self-contained Underwater Breathing Apparatus (SCUBA), Remotely Operated Vehicle (ROV) use, multibeam echo sounder use, and bottom sampling. The individual activities are described in Section 2.4 below.

Another example is an NOS Office of Coast Survey (Coast Survey) hydrographic survey project performed to update nautical charts for waters off the coast of California. Once planners identify the area that requires updating, a vessel such as the NOAA Ship *Rainier* would be tasked with the project, sailing from its home port in Newport, Oregon to the project area. Once there, the ship's crew would map the sea floor of the project area with multibeam echo sounders while also collecting water column data, and determine seafloor type by collecting and examining sediment. Once all of the required data are collected, *Rainier* might return to port, or head directly to its next project. In this example, the survey project includes the activities of crewed vessel operation (Section 2.4.1), echo sounder use (Section 2.4.4), conductivity, temperature, and depth (CTD) instrument use (Section 2.4.7), and collection of bottom grab samples (Section 2.4.9).

Some NOS projects involve or include terrestrial work. For example, a field crew from the NOS Center for Operational Oceanographic Products and Services (CO-OPS) may take a small boat to a coastal area where planners have determined that more precise data on local tides and currents are needed. Upon arrival, the crew would determine where a new tide gauge station should be located (such as on an existing pier) and what type of gauge is needed. A SCUBA diver would enter the water to install the underwater elements of the pressure sensor for the tide gauge. The crew would install other components, and then test the gauge to ensure that it is operating correctly before leaving the site. The activities for this project therefore include crewed vessel operation (Section 2.4.1), tide gauge installation (Section 2.4.12), and SCUBA operations (Section 2.4.11).

The responsible NOS program office(s) sets the goals and purpose of a given project and determines the specific equipment and protocols to be used. For instance, Coast Survey conducts hydrographic surveys using a combination of high-frequency side scan sonar and single beam and multibeam echo sounders. During a Coast Survey hydrographic survey, a vessel equipped with one or more echo sounders "mows the lawn" at a slow speed to ensonify (or visualize) the sea floor bottom and ensure full coverage of the sea floor within the project area. Coast Survey conducts surveys primarily in shallower waters critical for safe navigation, where depths are low and the need for precision is high. As a result, Coast Survey uses primarily high-frequency (40 to 1,000 kilohertz [kHz]) echo sounders during survey operations, but may use low- to mid- frequency echo sounders in deeper areas where high resolution charting is not necessary. When large ships are surveying for an NOS mapping project, they often operate the echo sounders 24 hours per day. Surveys using small vessels are typically shorter in duration (8 to 12 hours). These survey protocols are determined by project needs. Other program offices similarly select equipment and protocols commensurate with the goals of a given project.

In many cases, a single NOS program office is responsible for a project; in other cases, multiple NOS offices may cooperate, or an office may work with colleagues from other parts of NOAA or other federal agencies. For example, Coast Survey routinely collaborates with the Office of Marine and Aviation Operations (OMAO), a NOAA component separate from NOS, to have vessels such as NOAA Ship *Fairweather* undertake a project with a crew of NOAA Corps officers, OMAO civilian mariners, and Coast Survey scientists.

Although NOS projects occur year-round, the timing of a given project may be limited by seasonal environmental conditions of its location. For example, projects in the Arctic or Bering Sea typically take place between June and September to avoid dangerous, icy conditions, while projects in the West Coast, Northeast, and Mid-Atlantic regions most often take place between March and November. Projects in the Southeast or Gulf of Mexico are conducted year-round. The total duration of a project can vary from a few days to several months over multiple years. For Coast Survey hydrographic surveys, actual time surveying averages approximately 15 days per month over the course of a survey project, although larger ships can often survey 20 to 25 days per month under good conditions. When possible, program offices coordinate the location and timing of projects to ensure that areas are not unnecessarily repeatedly surveyed. This ensures that the potential environmental impacts directly resulting from the projects are not exacerbated by repeated surveys within a given area.

2.3 SCOPE

In this Final PEIS, scope refers to both the geographic and temporal range of the Proposed Action. Geographic scope is the spatial extent of the areas potentially affected by the Proposed Action. Temporal scope is the timeframe over which the Proposed Action is evaluated. NOS determined the scope of this document on the basis of the current extent of NOS project work and the ability of NOS program offices to reliably predict their future level of activity. Activities which occur outside of the parameters outlined in the below subsections were not considered in the analyses.

2.3.1 Geographic Scope

The "action area" for this Final PEIS encompasses the U.S. territorial sea; the contiguous zone; the U.S. Exclusive Economic Zone (U.S. EEZ); rivers; states' offshore waters; and coastal and riparian lands for projects such as the installation, maintenance, and removal of tide gauges. This includes the U.S. portions of the Great Lakes and internal waters such as Lakes Tahoe, Mead, Champlain, Okeechobee, and parts of major rivers such as the Mississippi, Missouri, Hudson, and Columbia rivers. NOS projects would occur within freshwater bodies far less frequently than in marine environments and would likely only occur within or near the habitat of most freshwater species on a limited basis or not at all. From 2016 to 2021, less than three percent of NOS projects occurred in freshwater. Vessels and uncrewed surface vehicles used by NOS may transit through international waters to get to project sites, but no data collection occurs in international waters.

The action area assessed in this Final PEIS is organized and analyzed by geographic regions (**Figure 2.3-1**). The regions are:

- Greater Atlantic Region, which includes the U.S. portions of the Great Lakes, New England and the mid-Atlantic;
- Southeast Region, which includes the southern portion of the U.S. Eastern Seaboard, the U.S. Caribbean Islands (Puerto Rico and the U.S. Virgin Islands), and the Gulf of Mexico;
- West Coast Region, which includes coastal California, Oregon, and Washington;
- Alaska Region, which includes Alaskan waters and the Arctic; and
- Pacific Islands Region, which includes Hawai'i and the Pacific territories of the U.S.

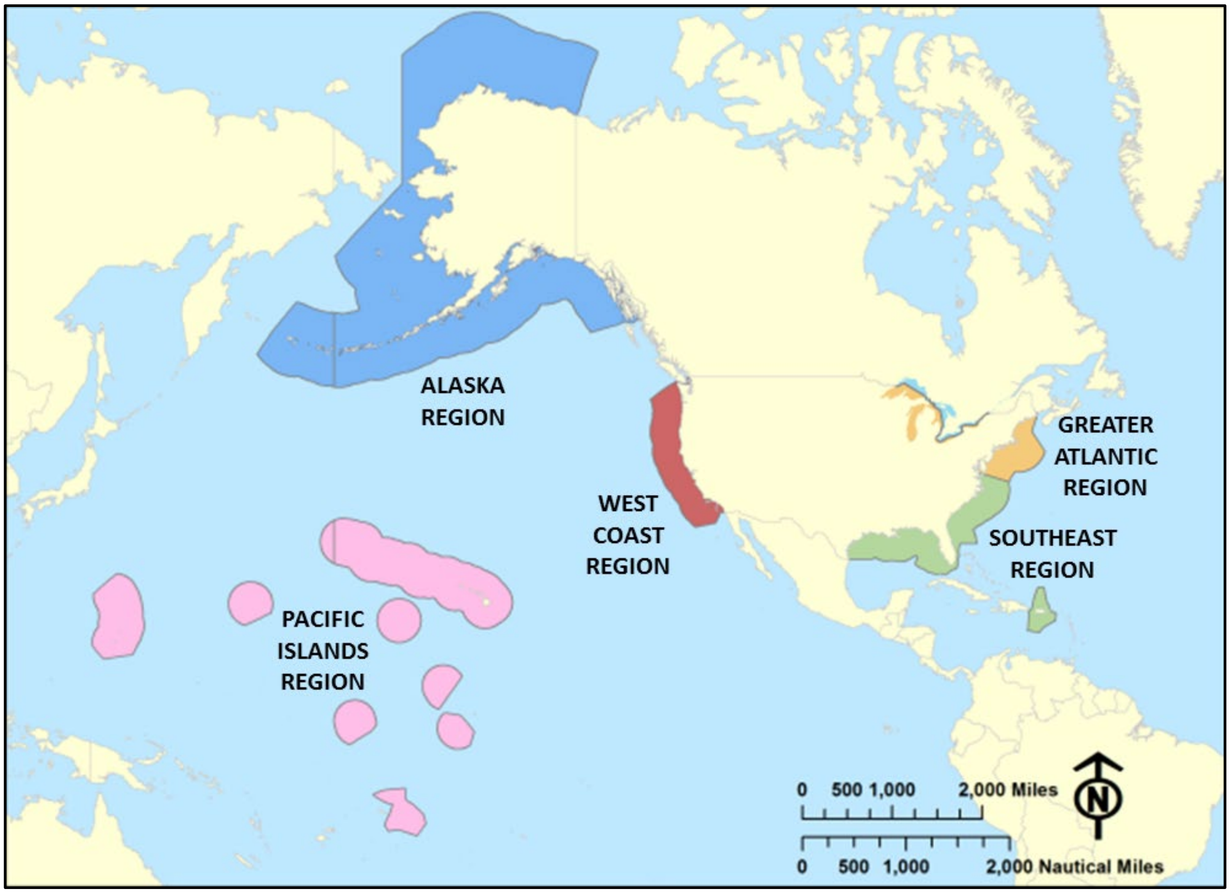


Figure 2.3-1. Geographic Scope of Final PEIS

2.3.2 Temporal Scope

As with any planning process, the confidence with which an agency can foresee and evaluate its actions, and the environmental effects of those actions, decreases at longer time intervals. Changes in spending levels, the environment, the data needs of the public, and technologies and field methods available to NOS can all change how surveying projects are executed. Based on NOS experience with these factors, this Final PEIS analyzes data collection activities for a time period of five years. For the purposes of this Final PEIS, a specific project could take place at any time of year.

Consistent with Council on Environmental Quality (CEQ) guidance that "[NEPA documents] that are more than five years old should be carefully reexamined to determine if the criteria in Section 1502.9 compel preparation of a [NEPA] supplement." (CEQ, 1981), NOS would reevaluate the Final PEIS to determine if the analysis contained within remains sufficient, or if new analysis is required. If necessary, this new analysis may take the form of a supplemental PEIS, a new PEIS, or more extensive project-level analysis.

2.4 Activities Common to All Alternatives

Under all alternatives, NOS would operate a variety of equipment and technologies to gather accurate and timely data on the nature and condition of the marine and coastal environment. In the context of project activities, references to NOS include NOS personnel, other NOAA personnel on behalf of NOS, and NOS contractors, grantees, partners, and permit/authorization recipients. The subsections below describe the technology, equipment, and techniques which would be used in NOS projects regardless of the selected alternative. This Final PEIS would also cover activities not specifically listed below as long as the relevant NOS program office(s) determined that the activities are comparable in operating characteristics (e.g., similar source level ranges, intensities, and frequencies) and extent of use (e.g., similar likelihood, duration, and frequency of use).

2.4.1 Project-Related Crewed Vessel Operations

Collecting coastal and marine data requires NOS to be able to reach the environments of interest. The most common platform for this purpose is a crewed sea-going surface vessel (remotely operated and autonomous vehicles are considered in Section 2.4.3). These vessel operations may take place these vessels under one of four arrangements:

- The vessel may be operated directly by NOS or by a partner funded under a contract or other financial assistance award;
- The vessel may be operated by OMAO for an NOS project; or
- The vessel may be owned and/or operated by an entity external to NOS under a contract by NOS or a partner. These are referred to as “contractor vessels” or “chartered vessels.”
- The vessel may be owned and/or operated by an entity external to NOS under a permit or authorization issued by NOS under the National Marine Sanctuaries Act (NMSA).

Vessels used range from small, unpowered personal watercraft to large research ships. For example, Navigation Response Team (NRT) vessels are typically 9-m (28-ft) boats towed by a truck to the general project area (**Figure 2.4-1**). There are also larger vessels such as NOAA Ship *Rainier*, a 1,600-metric-ton (1,800-ton), 70-m (231-ft) hydrographic ship crewed by OMAO officers and sailors (**Figure 2.4-2**). Ships such as *Rainier* also typically carry one or more “launches” – small boats that are deployed into the water directly from the ship. Chartered vessels can be of various sizes and types, depending on the project needs and availability. NOS uses the term “ship” for vessels with sleeping accommodations, or berthing capacity, that may anchor overnight during a project. NOS uses the term “boat” for vessels without berthing capacity that would anchor only in an emergency.

Figure 2.4-1. A Navigation Response Team Boat Being Placed in the Water

Figure 2.4-2. NOAA Ship *Rainier* in Alaska, with its Survey Launches

Survey vessels would travel to and from project sites and during projects as required. Vessel transit speeds vary by location, but are typically lower than 25 knots. Vessels are typically limited to speeds of 13 knots during survey activities. Depending on the duration of a project, a vessel might return to port periodically for fuel, supplies, or crew changes. NOS does not routinely have contractor vessels perform long transits; local contractors are hired for projects. This document analyzes the environmental impact of all vessel transits (i.e., movements) to the project area, during the project, and back to a port for all projects undertaken or funded by NOS. Vessel transits and project activities may occur at either day or night. Based upon comparison with Global Positioning System (GPS) data collected from automatic identification system (AIS) transponders onboard commercial vessels in 2017, vessels used for NOS projects account for a very small proportion of U.S. vessel traffic[2]. **Figure 2.4-3** shows the estimated regional distribution of NOS activities for the five-year timeframe of the PEIS based on nautical miles of vessel movement, regardless of the selected alternative.

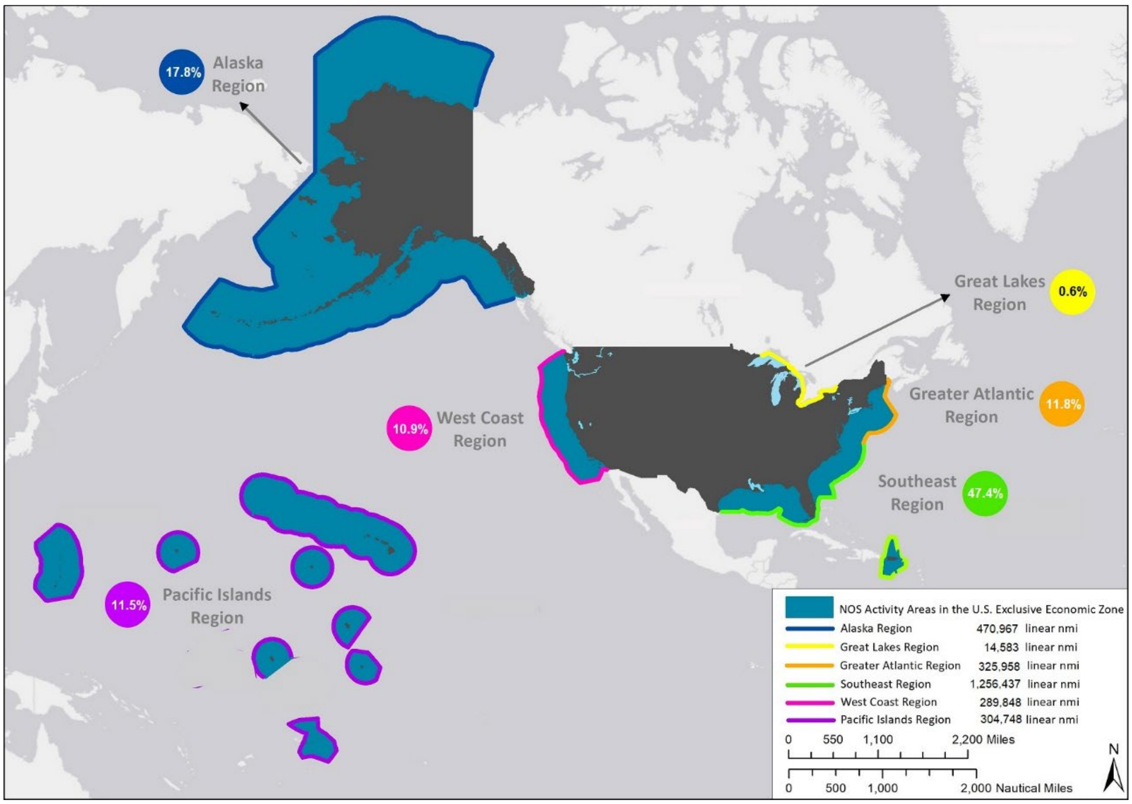


Figure 2.4-3. Geographic Distribution of NOS Crewed Vessel Operations Based on Five Years of Projected Funding

Note that this Final PEIS does not consider the following:

- Vessel operations that are not related to NOS projects, such as transits to a new homeport or to a dry dock, to a non-NOS project, or from a non-NOS project to a port;
- Vessel construction, acquisition, repairs, maintenance, or upgrades, such as the installation of new scientific equipment; or

[2] Compared to AIS data for commercial vessels in 2017, vessels used or funded by NOS account for 0.3 percent of all nautical miles traveled within the U.S. EEZ. However, because AIS transponders are not required for recreational vessels and recreational boating data were not available for inclusion in this analysis, vessels used and funded by NOS likely represent orders of magnitude less than 0.3 percent of total vessel use within the EEZ.

- Any chartered vessel operations that are not undertaken as part of an NOS contract or cooperative agreement.

These forms of crewed vessel use are neither under NOS control nor connected to NOS projects, and therefore are not considered here.

2.4.2 Anchoring

When a vessel is not collecting data, it may anchor either within the project area or nearby. Small boats and survey launches used for NOS projects return to port or to the ship each day and do not typically anchor, except in an emergency. During any NOS project, a vessel may anchor to avoid adverse weather or in the unlikely event of an equipment malfunction, regardless of vessel size. For multi-day efforts, ships may anchor within or near the project area to reduce the transit time to the project area and to save fuel.

The choice of anchoring location is at the discretion of the ship's officers, who select the anchor location based on depth, protection from seas and wind, and bottom type. Preferred bottom types are sticky mud or sand, as those characteristics allow the flukes of the anchor to dig into the bottom and hold the chain in place. NOS would not anchor in known areas of coral, except in an emergency. When working in an un-surveyed area or in an area that has not been surveyed in many years, the ship will try to anchor in bays where data have already been collected, providing the ship with better information on where to drop the anchor. Existing mooring buoys are used when available. Ships are typically anchored for a time period of hours, but during weather events (e.g., tropical storm or hurricane) ships may anchor for multiple days.

2.4.3 Operation of Remotely Operated Vehicles (ROVs), Uncrewed Surface Vehicles (USVs), and Autonomous Underwater Vehicles (AUVs)

In addition to crewed vessels, NOS proposes to use remotely operated and uncrewed vehicles to collect data. ROVs are controlled remotely at all times by a human operator and are often tethered to a crewed vessel. Autonomous vehicles operate with various levels of autonomy and include Uncrewed Surface Vehicles (USVs) and Autonomous Underwater Vehicles (AUVs). These systems use a variety of propulsion sources, including diesel, diesel/electric, battery, solar, buoyancy driven, and wave-gliding propulsion systems.

USVs often look similar to boats, ranging in size from the 1.8-m (6-ft) Teledyne Z-Boat (**Figure 2.4-4**) to the 7.7-m (25-ft) USV iXblue Drix (**Figure 2.4-5**).

Figure 2.4-4. Teledyne Z-Boat

Figure 2.4-5. USV iXblue Drix

AUVs often have a "torpedo"-like appearance, and can range in size from small systems deployed by two to three people, such as the 1.7-m (6-ft) REMUS-100 (**Figure 2.4-6**), or larger systems requiring winches or other deployment equipment, such as the 5.5-m (18-ft) REMUS-600 (**Figure 2.4-7**).

Figure 2.4-6. REMUS-100 AUV

Figure 2.4-7. REMUS-600 AUV

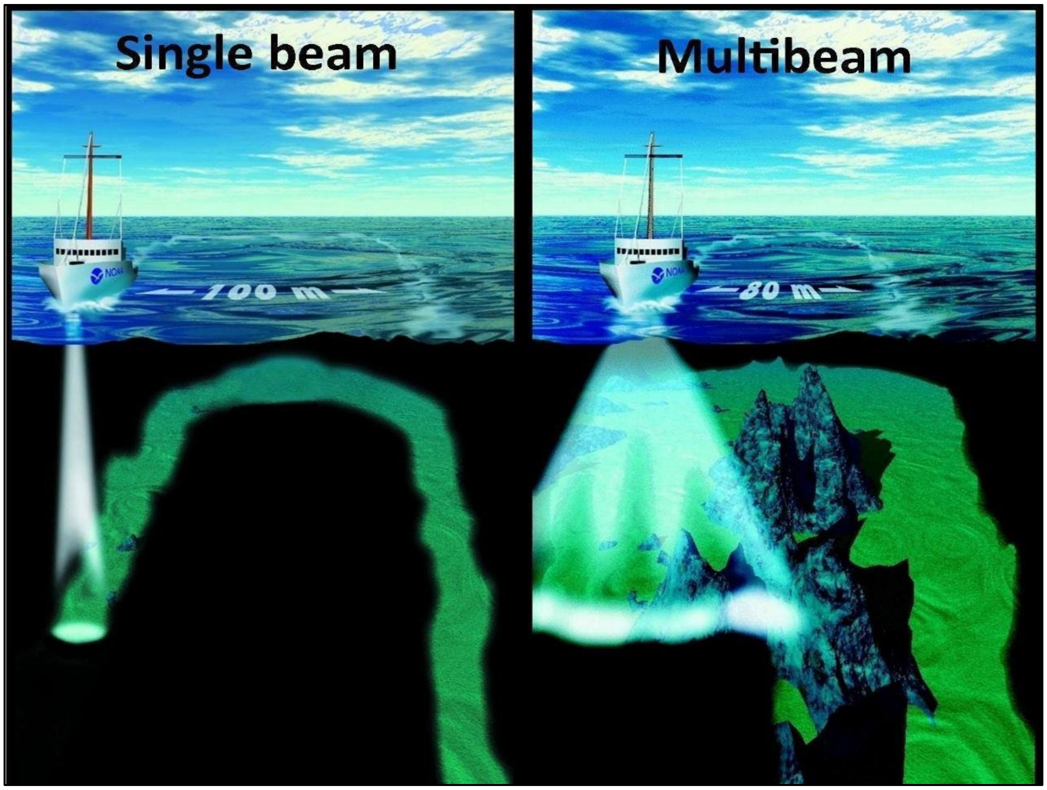
2.4.4 Use of Echo Sounders

NOS echo sounders (also referred to as sonars [sound navigation and ranging]) are typically attached to a crewed vessel, ROV, USV, or AUV, and are one of the most common categories of active acoustics used in ocean navigation, remote sensing, and ocean and habitat mapping. In rare instances, NOS may place echo sounders directly on the sea floor or the echo sounders may be operated by divers.

Echo sounders transmit a repeated series of short sound signals (on the order of milliseconds) into the water column. These signals continue until they reach an object of a different acoustic impedance (typically the sea floor, but also potentially objects in the water column) and reflect back to the echo sounder's receiver; echo sounders do not transmit while listening for an echo. By measuring the amount of time for the sound to return from the sea floor or object, the depth of the water (or the distance to the object) can be determined. Echo sounders used for mapping can generally be divided into three categories: single beam systems, multibeam systems, and side-scan sonars.

Single beam echo sounders transmit one focused acoustic beam, typically directly below the vessel (**Figure 2.4-8**). Sub-bottom profilers are a specific type of single beam echo sounder, designed to penetrate sea floor sediments and reveal sub-surface features. The sound energy emitted by the sub-bottom profiler is typically of a lower frequency than other echo sounders. These lower frequencies allow the sound signal to penetrate the sea floor and reflect back to the vessel when it encounters different types of buried sediments and rock (NOAA, 2014a). Single beam systems relied on by NOS, including sub-bottom profilers, are typically mounted on the bottom of the vessel hull.

Multibeam echo sounders transmit a fan of acoustic energy and can resolve individual depths across the return beam (**Figure 2.4-8**). Multibeam systems are the most commonly employed echo sounders for mapping the sea floor, as they allow for "full bottom coverage" of the area of interest. Many multibeam systems are capable of recording data on acoustic backscatter – data artifacts that may interfere with the accuracy of depth soundings. Multibeam backscatter is intensity data collected from multibeam systems that can be processed to create low-resolution imagery. Backscatter is co-registered with the bathymetry data and is often used to assist with bathymetric data interpretation. Multibeam systems are typically mounted on the bottom of the vessel hull.



Note the greatly improved bottom coverage of the multibeam system which reduces the time and number of vessels required to survey a given area.

Figure 2.4-8. Artist's Rendering of Single Beam and Multibeam Echo Sounder Operation

Side-scan sonars (sometimes referred to as "imaging sonars") are a specialized system for detecting objects on the sea floor that typically use fans of acoustic energy to look down and to the side of the sensor platform (**Figure 2.4-9**). In a side scan, the transmitted energy is formed into the shape of a fan that sweeps the sea floor from directly under the unit to either side, typically to a distance of 100 m (328 ft). The strength of the return echo is continuously recorded, creating a "picture" of the ocean bottom (**Figure 2.4-10**). For example, objects that protrude from the bottom create a light area (strong return) and shadows from these objects are dark areas (little or no return). Side-scan systems are either mounted underneath the vessel or towed behind the vessel on a cable (NOAA, 2018b).

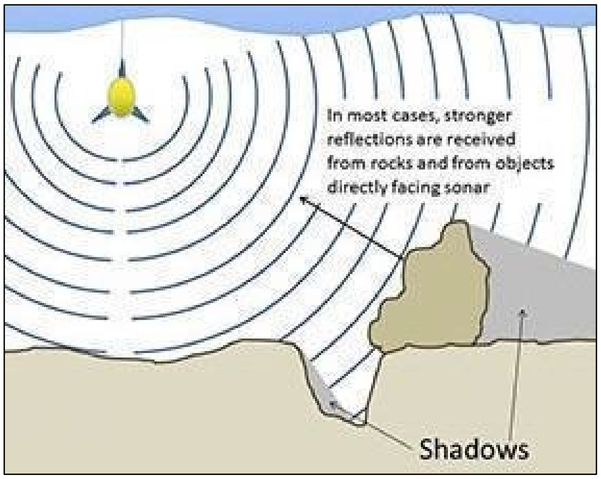


Figure 2.4-9. Diagram of Side Scan Sonar Operation

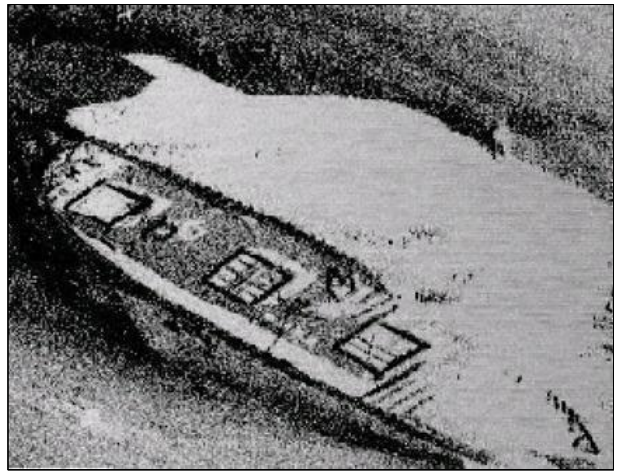


Figure 2.4-10. A Side Scan Sonar Image of Herbert D. Maxwell, a Schooner that Sank in the Chesapeake Bay on May 16, 1910

Different echo sounders are designed to produce sound at different frequencies. Single beam echo sounders used by NOS can range from 0.5 kHz up to 200 kHz or more. Multi-beam echo sounders used by NOS typically range from 12 kHz up to 900 kHz or more. Side scan sonars used by NOS typically range from 300 kHz to 1600 kHz.

In general, higher-frequency echo sounders provide higher precision than lower frequency systems. However, because higher frequency sound is absorbed in seawater much faster than lower frequencies, high frequency systems are limited in range and are therefore used in shallower water. Lower frequency echo sounders, by comparison, are typically used in deeper water. The source level of these echo sounders can range as high 247 decibels (dB) re: 1 microPascal (µPa) m.[3]

2.4.5 Use of Acoustic Doppler Current Profilers (ADCPs)

Acoustic Doppler Current Profilers (ADCPs) are active acoustic systems used to measure the velocity of water by measuring the relative shifts in sound frequency (i.e., the Doppler shift) associated with relative motion. These profilers provide detailed and important data on oceanographic conditions, including current patterns, waves, and turbulence. ADCPs (**Figure 2.4-11**) are often operated from tethered systems, buoys, or fixed moorings. Mobile ADCPs are hull mounted. The majority of these systems used by NOS operate at high to extremely high frequency (75-1,200 kHz) and are moderate in terms of source levels (< 160-180 dB re: 1 µPa m).

[3] Here and throughout this document, source levels are expressed in decibels with a reference pressure of 1 micropascal (dB re: 1 µPa m).

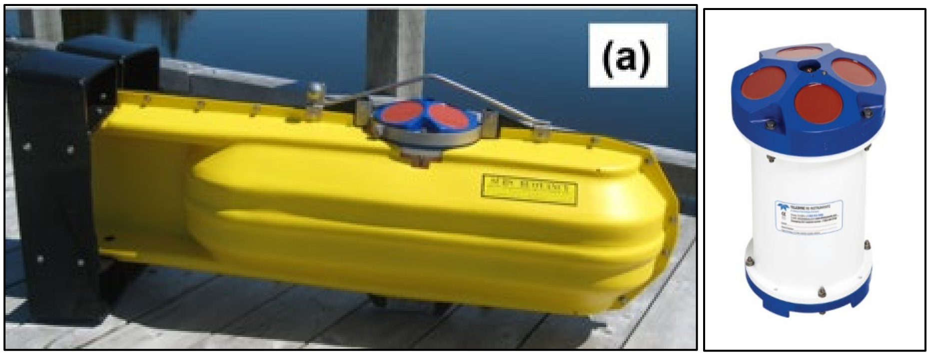


Figure 2.4-11. Example of Subsurface ADCP Buoys Currently in Use by NOS (shown: Streamlined Underwater Buoyancy System Model A2 Coastal ADCP)

2.4.6 Use of Acoustic Communication Systems

Many underwater devices and platforms communicate with one another by emitting and receiving sound, such as simple “pingers”, altimeters, and acoustic telemetry systems, including acoustic modems. Pingers are typically used to indicate the location of an underwater device and have short-duration chirp signals in the 10s of kHz range at moderate source levels (160 to 180 dB re: 1 µPa m). Acoustic modems may include encoded (modulated) signals relaying navigational or operational data more easily which can then be decoded by receivers. These systems are commonly used in sub-surface operations, between remotely deployed buoys, in navigational channels, or on sub-surface vehicles. Because they are commonly used to communicate data over km or greater ranges, NOS typically uses mid-frequency ranges (10s of kHz) at moderate to relatively high source levels (160 to 200 dB re: 1 µPa m). Sound Velocity Profilers are active acoustic devices that measure sound speed for echo sounding corrections using the two-way travel time of a very high frequency sound signal across a short distance.

2.4.7 Use of Sound Speed Data Collection Equipment

NOS collects sound speed data throughout mapping surveys to determine the speed of sound in the water column at a given location and time, which allows crews to correct for refraction errors in the echo sounder data. Taken together, the two-way travel time of the acoustic signal from a single beam or multibeam echo sounder and the speed of sound in water determine sea floor depths.

Sound speed data are collected periodically in one of three ways. In the first method, every one to four hours a survey technician slowly lowers a sound speed profiler – known as a CTD instrument – from a stationary vessel to the sea floor and back (**Figure 2.4-12**). Passive collection of conductivity, temperature, and depth with CTD systems involves remote sampling of these parameters that are used in oceanographic sampling and to inform site-specific sound propagation models. CTDs do not produce and measure sound, but rather measure environmental conditions that can be used to reconstruct how sound propagates through the water column.

A second method involves a moving vessel profiler, which is automatically lowered and raised through the water column at regular intervals while the vessel is in motion (**Figure 2.4-13**). Mobile vessel profilers are submerged for time periods ranging in minutes.

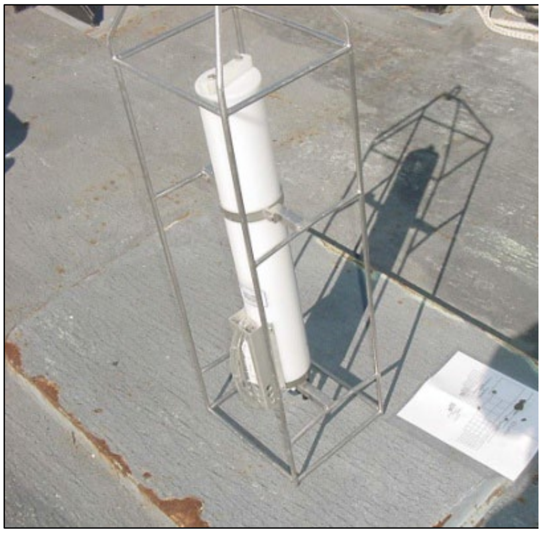


Figure 2.4-12. CTD Instrument

Figure 2.4-13. Moving Vessel Profiler Mounted on the Fantail of a Ship

A third method is the use of expendable bathythermographs (XBTs) for profiling the water column. An XBT is a probe dropped from a ship that measures the temperature as it falls through the water (**Figure 2.4-14**). A resistance in the head of the probe and a very thin twin-wire, connecting the probe to the equipment on the ship, compose the electronic circuit for measuring the water temperature. The probe is designed to fall at a known rate, so that the depth of the temperature profile can be inferred from the time since it entered the water. Deployments can be made using manual or automatic launchers (**Figure 2.4-15**).

When XBTs are used, a small portion of the probe (5 to 8 centimeters [cm] (2 to 3 inches [in]) long and approximately 0.7 kilograms (kg) (1.5 pounds [lbs]) remains on the sea floor. The probes, constructed of metal and plastic, fall to the sea floor and detach from the connecting line. The connecting line then retracts back to the vessel.

Figure 2.4-14. XBT Probe

Figure 2.4-15. XBT Hand Launcher

2.4.8 Operation of Drop/Towed Cameras and Magnetometers

NOS uses drop/towed cameras for delineation and identification of sea floor habitats (i.e., ground truthing) through visual observations. Magnetometers, passive instruments which measure changes in the magnetic field of the earth, also are commonly drop/towed to survey cultural heritage sites and to geologically characterize the sea floor. Drop/towed cameras and magnetometers are launched from the ship or small boats and lowered on a cable using a power winch or by hand using a line. Drop/towed cameras and magnetometers are tethered at all times and are operated at approximately 1 m (3 ft) above the sea floor usually on predetermined transects. The total time of equipment submersion varies by project, but typically occurs on the scale of hours.

2.4.9 Collection of Bottom Grab Samples

Some NOS surveys require the collection of sea floor sediment samples by lowering a grab sampler at a rate of about 1 m per second (3 ft per second) through the water column to the sea floor. Bottom samples are collected for a variety of reasons (for example, selecting anchorages, ground truthing the sea floor, and verifying benthic habitat maps). Typically, crews use a clamshell bottom snapper (6” by 6”) or similar type of grab sampler or sediment corer to obtain samples of the surface sediment layer (approximately the first 5 cm (2 in) of sediment). As the sampler is lowered, two hinged upper lids swing open to let water pass through. When the sampler reaches the bottom, the overlapping spring-loaded scoops are tripped on the line, and the lids close to contain the sediment and prevent sample washout. Corers such as box corers work similarly but can sample different volumes and depths of sediment. Depending on the goals of a particular project, the sediment sample is collected, analyzed, and photographed, and under some circumstances released from the sampler underwater.

Samples are characterized by color, type of bottom material and other characteristics. Field personnel may have a bottom sample plan as a guideline of sampling density, but sampling can also occur based on ground-truthing needs identified in the mapping products, and researchers are given discretion on the exact location of sampling. Crews do not typically collect samples in waters deeper than 80 m (262 ft). Additionally, in areas surveyed within the last 30 years, the surveyor might not need to collect samples at all. In some cases, the surveyor can use backscatter or side scan data acquired during the survey operation to determine the best place to sample. Grab samples may also be used for current survey site reconnaissance.

2.4.10 Use of Passive Listening Systems

Passive listening systems are hydrophones that receive sounds present in the environment from either natural sources or active acoustic systems. These systems do not produce sound but record it for monitoring and research purposes. Passive listening systems are often integrated into the housing of other equipment, such as ADCPs, or moored in place to the sea floor. NOS does not use expendable passive listening systems.

2.4.11 SCUBA Operations

Some projects include deploying SCUBA divers. NOS conducts SCUBA operations to verify and validate benthic habitat classifications, collect samples, conduct fish and benthic habitat surveys, or install or retrieve small sensors or other scientific instrumentation, including installation of tide gauges. In-water diver activities include benthic and fish monitoring that would be conducted usually on hard bottom and coral reef habitats and near cultural and historic resources such as shipwrecks.

Divers are deployed from crewed vessels, typically small boats, and traverse small areas in support of specific tasks. The majority of NOS dives are performed by CO-OPS and Coast Survey for tide gauge installation, maintenance, or removal (73 percent), which requires relatively quick dives that are only a small component of the entire installation process. Twenty-one percent of NOS dives are performed by the Office of National Marine Sanctuaries (ONMS); the National Centers for Coastal Ocean Science (NCCOS) and Office of Response and Restoration (ORR) together account for the remaining six percent.

2.4.12 Installation, Maintenance, and Removal of Tide Gauges

A tide gauge is a device fitted with sensors that continuously record the height of the surrounding water level. These data are critical for many coastal activities, including safe navigation, sound engineering, and habitat restoration/preservation. Local and national networks of tide gauges measure water levels, provide the vertical reference system required to describe water level variations, and help develop tidal predictions. A tide gauge measures the changes in water levels and transmits the data by satellite to a computer database for processing. The tide gauge station consists of a sensor, data collection platform, solar panels, and satellite transmitter. The four types of gauge conformations listed below are the most commonly used by NOS:

- An **acoustic sensor** uses sound waves to measure the distance between the sensor and the water level surface (**Figure 2.4-16**). It is most often used when an existing pier or dock is available on which to mount the sensor and includes a protective well that houses the sounding tube. These sensors typically emit 1.05 kHz acoustic signals at low source levels (-45 dB re: 1 µPa m). Both short-term and long-term acoustic tide gauges include some or all of the following non-permanent equipment: tide house (located on a pier), data collection platform, sensor (typically an “aquatrak”) housed in a 30” x 30” portable plastic case, benchmarks, and satellite transmitter (tripod station with antenna and solar panel). A long-term acoustic tide station typically includes some or all of the following equipment: primary and backup water level sensors; primary and backup data collection platforms; a Geostationary Operational Environmental Satellite (GOES) transmitter and antenna; GPS antenna; batteries; solar panels; water temperature sensors; mast or tower on which to mount wind sensors; barometric pressure sensor; and air temperature sensor. The acoustic sensor requires a 6-inch-diameter polyvinyl chloride protective well to house the sounding tube; the well is attached to the pier with stainless steel brackets to maintain sensor stability.

- A **pressure sensor** measures the pressure of the water column above an underwater orifice that is securely attached to maintain its position (**Figure 2.4-17**). It is used when there is little infrastructure available or as a backup sensor. A constant supply of air is pumped through a tube to the orifice to establish a zero point from which to measure the changes in pressure in the water column.

Figure 2.4-16. Pier-mounted Acoustic Sensor Tide Gauge Station

Figure 2.4-17. Pressure Sensor Tide Gauge Station (and Tubing)

- A **microwave water level radar sensor** (MWWL) uses radar waves to measure the distance from the sensor to the water (**Figure 2.4-18**). It is used when the existing infrastructure allows its installation in a location overlooking the water surface. This is the only type of sensor that is not in direct contact with the water. Station components may include some or all of the following equipment as noted in the acoustic sensor above: primary and backup water level sensors; primary and backup data collection platforms; a GOES transmitter and antenna; GPS antenna; batteries; solar panels; water temperature sensors; mast or tower on which to mount wind sensors; barometric pressure sensor; and air temperature sensor.
- A **GPS tide buoy** employs a GPS receiver that measures both horizontal and vertical position using GPS technology (**Figure 2.4-19**). It is used primarily during hydrographic surveys to obtain data in remote locations without existing infrastructure on which to mount a gauge. Some buoys may also be used to collect current data observations with a mounted acoustic sensor in an identified region. These buoys are acoustic mounted sensors on either an existing navigation buoy (i.e., owned by the U.S. Coast Guard [USCG]) or buoys deployed with ADCPs as noted in Section 2.4.5. They are also used to collect data in shipping channels. Examples of tide buoys are the two Hydrolevel™ GPS tide buoys currently owned by the Coast Survey Development Laboratory. They are approximately 26” in diameter, weigh 58 kgs (128 lbs), have amber USCG light emitting diode (LED) lights visible from 3 miles away, and use sealed lithium batteries. A typical mooring configuration includes 45 to 68 kgs (100 to 150 lbs) of anchoring mass (usually a combination of a

23-kg (50-lb) primary anchor and several 7-kg (15-lb) "mushroom" anchors) and a heavy chain, with a total footprint of approximately 1 square meter (3 ft).

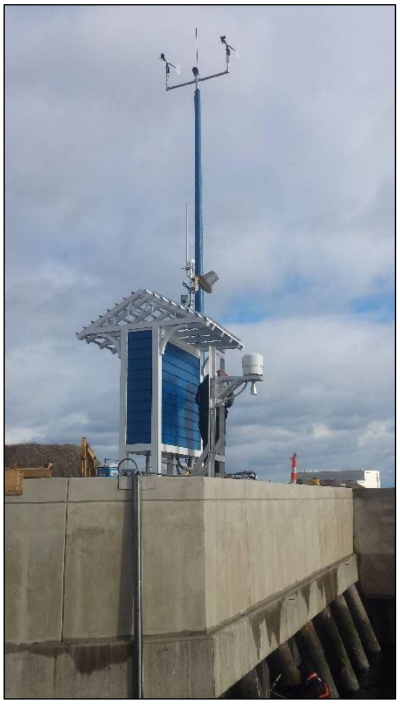


Figure 2.4-18. Microwave Sensor and Instrument in Bridgeport, Connecticut

Figure 2.4-19. A GPS Tide Buoy

Although some of these tide gauges are operated only for the duration of a single project, most NOS tide gauges belong to a larger network of more permanent gauges. NOS (through CO-OPS) manages a permanent observing system of over 200 long-term, continuously operating data-collection platforms called the National Water Level Observation Network (NWLON). The NWLON measures tide levels and other oceanographic and meteorological parameters. The observing stations contribute to NOAA's forecast models which provide tsunami and storm surge warnings. Some tide gauge stations also include additional co-located sensors, such as High Frequency Radar Systems (HFR), which collect currents data and support currents prediction models collected by boat or mounted ADCPs.

Approximately one quarter of the NWLON is located in the Great Lakes (non-tidal), providing water level data for the international management of those water resources. The NWLON provides the national standards for tide and water level reference datums used for nautical charting, coastal engineering, international treaty regulation, and boundary determination. CO-OPS also installs and operates approximately 100 short-term water level stations annually in support of a variety of programs including hydrographic and shoreline mapping projects, marine boundary determination, real time navigation systems, coastal habitat and marsh restoration projects, and other projects (NOAA, No Date-e).

2.4.12.1 Tide Gauge / Tide Buoy Installation

Tide gauge installation occurs primarily out of the water. Tide gauges are typically secured to existing piers, docks, and bulkheads. Rocks are the most common natural structures used to secure sensors in remote locations for short-term stations. Equipment includes primary and backup systems for sensors, data processing, and data transmission. All equipment is installed to last several years before needing service or replacement. Short-term stations typically involve one primary system with no backups. They are less extensive, easier to install and remove, and usually only stay in place for the length of the data collection period (1 to 3 months). Geodetic "benchmarks" must be installed near each water level station and are long-term reference points to which the tidal datums can be related through standard surveying techniques.

A long-term station requires a network of ten benchmarks to "level" to the tide gauge during operations, while a short-term station only requires five benchmarks. The larger number of marks required for a long-term station is proportional to the investment made over time in the data collection and tidal datums determined. Additional marks ensure that there are at least five marks, even if future construction destroys several marks at once. The benchmarks are spaced at least 61 m (200 ft) apart to strengthen the leveling data and reduce the chance of losing several marks at a time. They are typically established in a variety of permanent structures, including surface markers, or deep driven stainless-steel rods when existing structures are not available.

A field crew of three to six people installs the equipment. Crews travel to most gauge sites over land, but a few locations – especially in remote areas of Alaska – can only be reached by boat, seaplane or helicopter. Installation equipment includes both hand and power tools. When a tide gauge is installed on land it is located beyond the mean high tide line, so any disturbed sediments from installation do not reach the water.

During tide buoy installation, a buoy is tethered to the anchoring hardware with a 15-m (50 ft), 2.5-cm (1-in) diameter rubber cord, followed by a section of 0.5-cm (3/16-in) Amsteel rope. The rubber cord attaches to the bottom of the buoy, and the rope attaches the rubber cord to the anchor. The combined length of the rubber cord and the rope exceeds the nominal water depth by a factor of approximately two (i.e., "mooring scope"). The GPS buoy is deployed by floating the buoy away from the vessel to the extent of the rubber cord and rope. The anchor is then lowered slowly to the point where the rope attaches to the rubber cord, at which point the anchor is released. Tide buoys are typically operated for one month before being removed.

2.3.12.2 Tide Gauge / Tide Buoy Maintenance

Once installed, tide gauges operate autonomously, collecting data on water levels and transmitting the data by satellite to a computer database for processing. The gauge operates under its own power - typically solar, sometimes with a battery back-up. Short-term stations may be operational for as little as one month, or they may operate for up to one year. Personnel would return to the long-term stations periodically for water level measurements and maintenance, typically once per year. Maintenance visits would also be used to equip existing tide gauges with MWWL sensors and upgraded weather/storm-proofing.

Very little maintenance of tide buoys is required. NOAA tide buoys are programmed to send out a "health message" email to a predetermined distribution list at regular intervals via satellite. For example, Coast Survey tide buoys send messages hourly. If the buoy reports its position outside of a certain radius ("watch circle"), it issues a separate alert. Field personnel respond to situations where the buoy breaks its mooring or stops sending messages. Occasionally the batteries must be replaced or recharged, and field personnel must retrieve the buoy with a small boat and bring it back to the ship or shore. When they bring the buoy on board, the team attaches a temporary float to the end of the mooring so that it can be reused after the buoy batteries have been refreshed. At the end of the survey, the field personnel recover all components of the buoy.

2.4.12.3 Tide Gauge / Tide Buoy Removal

Long-term stations, such as those of the NWLON, remain in operation indefinitely. They receive a preventative maintenance visit once a year that involves a standard inspection of all equipment, leveling from sensors to benchmarks to determine sensor stability, GPS observations, and diving operations to inspect the underwater components if present. Emergency repair visits would address failed components. Temporary gauges would only be repaired in the event of a specific equipment failure.

Once a temporary tide gauge is no longer needed, field personnel would be sent to remove the gauge. Personnel level the gauges when they remove them. SCUBA diving may or may not be involved, depending on the location and the type of sensor installed. Field personnel would also remove a long- or short-term gauge upon project completion. All equipment is removed from the site, although the benchmarks would remain as established spatial reference points. To recover a tide buoy, the buoy float is brought aboard the vessel along with the length of rubber cord. The total anchoring hardware is then hauled in by rope.

2.4.13 Installation of GPS Reference Stations

NOS installs GPS reference stations to support ellipsoidally referenced surveys, where height and depth are measured with respect to a geodetic datum ("ellipsoid") rather than to a tidal datum. Ellipsoidally referenced surveys improve the efficiency of hydrographic surveys by removing the requirement for concurrent water level observations and hydrographic survey data collection.

Equipment used in ellipsoidally referenced surveys includes a ship-based inertially-aided GPS system and a shore-based GPS reference station. If an existing network, such as the Continually Operating Reference Stations, is not available, field personnel must establish a new network by using a tripod, an antenna, a receiver housed in a hardened waterproof "suitcase," and data storage connected to a radio modem for remote downloads. If electrical service is not available at the reference station site, the network system requires a set of 12-volt marine, deep-cycle rechargeable batteries and a solar panel array. The site chosen on shore must provide an obstruction-free view to GPS satellites and accommodate line-of-sight radio communications. No equipment maintenance is required, although if no remote data download capability is available, field personnel must visit the site periodically to download data vital for survey processing.

2.5 Alternatives A, B, and C

NOS identified a "No Action" alternative (Alternative A), which represents the actions and resulting effects that would occur given continued coastal and marine data collection at current levels of effort using current technology and methods (i.e., the status quo), and two action alternatives (Alternatives B and C) that satisfy the purpose and need for the action as outlined in Section 1.3. These alternatives use many of the same technologies, equipment, and methods for surveying and mapping (as described in Section 2.4) and differ from each other primarily in their overall level of survey effort.

2.5.1 Alternative A: No Action - Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

CEQ regulations (40 Code of Federal Regulations [CFR] 1502.14) require the assessment of the No Action alternative in Environmental Impact Statements. The No Action alternative provides the baseline condition of the existing environment from which to compare all other alternatives. In the case of an ongoing agency action, the No Action alternative represents adherence to current management direction or intensity.

Under Alternative A, NOS would continue to conduct the activities listed in Section 2.4 to gather accurate and timely data on the nature and condition of the marine and coastal environment. This alternative reflects the technology, equipment, scope, and methods currently in use by NOS, at the level of effort reflecting NOS fiscal year 2019[4] funding levels. The level of activity for Alternative A is described in **Table 2.6-1** in terms of nautical miles of survey effort and the overall number of projects that would continue to occur using each activity.

2.5.2 Alternative B: Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations - NOS Preferred Alternative

NOS constantly seeks to improve the design and implementation of coastal and marine data collection. Alternative B therefore consists of Alternative A plus the more widespread adoption of new techniques and technologies (such as ROVs, MWWL sensors, etc.) to more efficiently perform surveying, mapping, charting and related data gathering. The introduction of these technologies, combined with continued, more traditional data collection methods, would allow NOS to perform more projects covering more survey miles annually than would be possible under Alternative A. Specific examples of adaptive methods and equipment that NOS programs are likely to promote, plan for, and adopt under Alternative B in the next five years include:

- Greater use of ROVs with echo sounder technologies;
- Greater use of AUVs with echo sounder technologies;
- Conversion of one or more existing 10-m (33 ft) crewed survey boats into USVs;
- Greater use of more efficient, wide-beam sonar systems (phase-differencing bathymetric systems) for nearshore hydrographic surveys;
- Expanded geographic distribution of projects that use hydroacoustic sampling methodologies;
- Increased field operations in the National Marine Sanctuary system with associated requirements for hydroacoustic charting, surveying, mapping and associated activities; and
- Installation, operation, and maintenance of additional water level stations by CO-OPS, including transitioning to mostly MWWL sensors and upgraded storm strengthening to make stations more climate resilient.

Under Alternative B, all of the activities described in Alternative A would continue, many at a higher level of effort. The nature of these actions would not change from those described above in Section 2.4, but the overall level of activity would be increased as described in **Table 2.6-1**.

NOS identified Alternative B as the preferred alternative because it takes advantage of newer, more efficient technology, provides increased support for national marine sanctuaries, and more effectively addresses the nation's needs for coastal and marine data.

[4] NOS is using 2019 as the baseline year for funding, as that was the last year of normal NOS operations prior to COVID-19 disruptions.

2.5.3 Alternative C: Upgrades and Improvements with Greater Funding Support

Like Alternative B, Alternative C adopts new techniques and technologies to encourage greater program efficiencies regarding surveying, mapping, charting, and related data gathering activities. In addition, Alternative C would consist of NOS program implementation with an overall funding increase of 20 percent relative to Alternative B.

Under Alternative C, all of the activities described in Alternative B would continue, many at a higher level of effort. The nature of these actions would not change from those described above in Section 2.4, but the overall level of activity would be augmented as described in **Table 2.6-1**.

2.6 Comparison of Alternatives

In order to compare the alternatives, NOS collected data on the projected number of projects and activities that would be conducted annually by its program offices under the three alternatives selected for analysis. In some cases, the exact number of times an activity would take place is not known in advance. For example, a crew's decision to deploy an anchor is based on schedule constraints, fuel supplies, safety, weather, availability of anchorages, and other concerns. Similarly, the decision to deploy a sound speed data collection instrument can be contingent upon data gathered during the survey itself. Therefore, these activities were enumerated by the number of projects where the equipment would be expected to be used based on a review of previous NOS projects. This approach allows the reader to compare the prevalence of these activities by alternative, as shown in **Table 2.6-1**.

It is also important to note that project estimates for each activity were reported by NOS program offices non-exclusively. As noted in Section 2.2, a single project typically consists of multiple activities. For example, a single Coast Survey project may include the activities of vessel operation, echo sounder operation, anchor deployment, and sound speed data collection. Non-exclusive reporting allows for more robust comparisons of activities between the alternatives, but it results in a greater total number of projects reported from that which would actually occur. For example, one nautical mile of data collection for a mapping survey project is reported as both one mile of the "crewed vessel use" activity and one mile of the "echo sounder use" activity, as the vessel and the echo sounder are operated simultaneously. As another example, many tide gauge installation projects would be counted as both a tide gauge installation activity and as a SCUBA dive activity, as the installation of many gauges requires diving to install the pressure gauge component of a tide gauge.

While both the total number of nautical miles surveyed by crewed vessels and the discrete number of projects increase by approximately 10 percent between each subsequent alternative, the magnitude of individual activities does not increase uniformly between alternatives, reflecting priorities in funding allocation and technology use. For example, ROV/USV/AUV use increases 201.7 percent from Alternative A to B and 18.5 percent from Alternative B to C. The proportionally greater increase in ROV activity compared to that of overall crewed vessel activities demonstrates the building movement towards uncrewed survey activities and the overall commitment of NOS agencies towards methodological innovation and efficiency. Likewise, mobile ADCP use increases 90.2 percent from Alternative A to B and 35.7 percent from Alternative B to C, also reflecting NOS commitment to improved technology and efficiency.

It is important to note that the high number of SCUBA operations reported is related to the high number of tide gauge installation/maintenance/removal projects, as the majority of SCUBA projects (approximately 73 percent) are tide gauge projects. Tide gauge projects usually involve short SCUBA dives that are not a large component of the overall project.

Table 2.6-1. Comparison of Annual NOS Planned Surveying and Mapping Activities under Alternatives A, B, and C

Activity	Described in Section	Alternative A	Percent Increase from Alternative A to Alternative B	Alternative B	Percent Increase from Alternative B to Alternative C	Alternative C
Crewed vessel operations	2.4.1	518,000 nm (959,000 km)	11.4%	577,000 nm (1,070,000 km)	10.4%	637,000 nm (1,180,000 km)
Anchoring**	2.4.2	55 projects	6.9%	59 projects	8.1%	64 projects
ROV/USV/AUV movement	2.4.3	28,600 nm (53,000 km)	201.7%	86,300 nm (160,000 km)	18.5%	102,300 nm (189,000 km)
Use of echo sounders	2.4.4	479,000 nm (887,000 km)	11.5%	534,000 nm (988,000 km)	10.3%	589,000 nm (1,090,000 km)
Use of sub-bottom profilers	2.4.4	3,210 nm (5,940 km)	65.4%	5,310 nm (9,830 km)	45.2%	7,710 nm (14,300 km)
Use of mobile ADCPs	2.4.5	5,890 nm (10,900 km)	90.2%	11,200 nm (20,700 km)	35.7%	15,200 nm (28,200 km)
Stationary ADCPs installed/visited for maintenance/removed	2.4.5	37 installed/78 maintenance visits/33 removed	5.4%/1.3%/0%	39 installed /79 maintenance visits /33 removed	2.6%/0%/0%	40 installed /79 maintenance visits /33 removed
Use of acoustic communication systems	2.4.6	24 projects	37.5%	33 projects	18.2%	39 projects
Sound speed data collection	2.4.7	56 projects	14.3%	64 projects	10.9%	71 projects
Drop/towed camera operation	2.4.8	31 projects	16.1%	36 projects	13.9%	41 projects
Bottom sample collection	2.4.9	54 projects	13.0%	61 projects	11.5%	68 projects
Use of passive listening systems***	2.4.10	21 projects	14.3%	24 projects	20.8%	29 projects
SCUBA operations	2.4.11	248 projects	2.4%	254 projects	5.9%	269 projects

Activity	Described in Section	Alternative A	Percent Increase from Alternative A to Alternative B	Alternative B	Percent Increase from Alternative B to Alternative C	Alternative C
Tide gauges installed/visited for maintenance/removed	2.4.12	32 installed /305 maintenance visits /30 removed	15.6%/0%/16.7%	37 installed /305 maintenance visits /35 removed	8.1%/0%/8.6%	40 installed /305 maintenance visits /38 removed
GPS reference system installation	2.4.13	12 installed	8.3%	13 installed	15.4%	15 installed

*All numbers are approximate and represent an annual level of effort. Projects for each activity were reported by NOS agencies without respect to the combination of activities within projects (e.g., a project involving both crewed vessel operation and echo sounder use would be reported as one crewed vessel project and one echo sounder project).

**NOS estimates that 20 percent of crewed vessel projects include an anchoring component.

***In addition to the projects presented in the table, CO-OPS uses passive listening systems on an as-needed basis. This entails the use of transponder or interrogator sensors during the deployment or retrieval of ADCPs.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Chapter 3 describes the current environment for resources that may be affected by Alternative A (No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels), Alternative B (Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations), and Alternative C (Upgrades and Improvements with Greater Funding Support), and the potential environmental consequences associated with the alternatives.

Sections 3.4 through 3.13 discuss the resources analyzed, and Section 3.14 discusses the resources that were considered but dismissed from further analysis. The resources analyzed and dismissed are listed below:

Resources Analyzed

- Habitats
- Marine Mammals
- Sea Turtles
- Fish
- Aquatic Macroinvertebrates
- Essential Fish Habitat
- Seabirds, Shorebirds and Coastal Birds, and Waterfowl
- Cultural and Historic Resources
- Socioeconomic Resources
- Environmental Justice

Resources Dismissed

- Air and Water Quality
- Soils and Geology
- Airborne Noise for Human Receptors
- Select Freshwater Taxa

UNDERWATER SOUND

The ambient marine and freshwater soundscape is composed of different types of sound:

1. natural biological sounds,
2. natural physical sounds, and
3. human-made sounds.

Natural biological sounds include sounds produced by fish, birds, marine mammals, invertebrates, and other animals that produce and use sound to perform various life functions. Natural physical sounds include sounds produced by the physical environment such as sounds from rain, lightning, wind, waves, the movement and breaking of ice, volcanic eruptions, earthquakes, and other physical phenomena. Human-made sounds include those from human activity such as sounds from vessel engines, oil and gas exploration (seismic airguns), drilling, construction, dredging (excavating), fishing, sonar, and echo sounders (NOAA, 2016). Since human-made sounds are relatively new to aquatic soundscapes and are considered unwanted, these sounds are interchangeably referred to as noise.

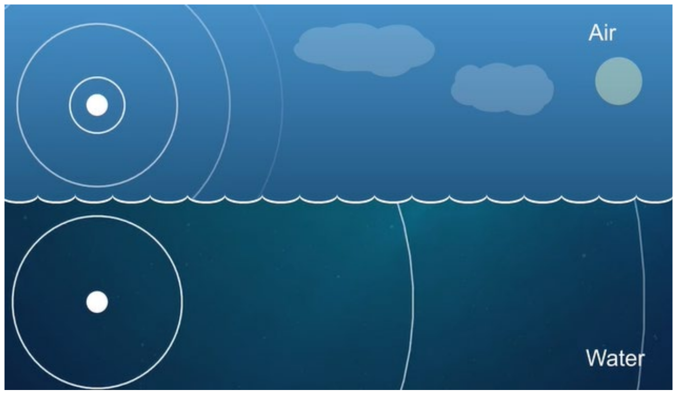
Unlike other means of communication used by animals on land involving the senses, such as visual communication and chemical communication (e.g., smell), sound propagates faster and farther underwater than in air. The properties of sound enable its production and reception to be highly efficient means of communication over the vast distances that make up the marine environment. Aquatic animals have evolved to rely on sound as a primary method for communication and for gaining information about the surrounding environment (NOAA, 2016). Therefore, understanding how to characterize and assess sound is critical to analyzing the impact of noise on aquatic animals.

Sound refers to vibrations which cause pressure changes that travel as a wave through a medium, such as air or water. In air, sounds are typically characterized by pitch and intensity. Although sounds in air and sounds in water are compared using the same metrics, the physical differences between air and water result in the same sound having different speed, pitch, and intensity.

- *Speed.* In general, sound travels much faster and farther in water than in air. Sound travels faster in denser mediums; however, the density of seawater varies with the water's salinity (salt concentration), temperature, and pressure (depth). On average, sound travels at about 1,500 meters per second (m/s) (3,500 miles per hour [mph]) in seawater compared to 340 m/s (760 mph) in air.
- *Pitch.* The pitch of a sound is the frequency, or repetition rate, of the sound wave and is measured in hertz (Hz) and kilohertz (kHz). Sound waves with higher frequencies are perceived as higher pitch sounds. The frequency of sound impacts the distance a given sound travels, in general, low frequency sounds travel farther than high frequency sounds. Some sounds, particularly low-frequency ones, can travel hundreds of kilometers underwater.
- *Intensity*. The intensity, or loudness, of a sound is represented as the amplitude of the sound wave which is the change in pressure as the sound wave passes. Sound waves with larger amplitudes are perceived as louder sounds. Intensity also depends on characteristics of the medium in which the sound is traveling. Since intensity depends on both the sound and the medium, intensity is typically measured in decibels (dB), which is a relative unit on a logarithmic scale that compares the sound pressure to a reference pressure. The reference pressure is different for different mediums. In air, decibels use a reference

pressure of 20 microPascals (µPa) such that they are scaled to the range of human hearing, so by definition, a 0 dB sound in air is the lowest limit of human hearing. Humans perceive a 10 dB increase as a doubling of loudness. In water, decibels are scaled using a reference pressure of 1 µPa. Since dB in air and dB in water use different reference pressures, sound intensity reported in dB in air is not the same as sound intensity reported in underwater dB (DOSITS, No Date-a).

The figure below provides a simple representation of how sound travels in air compared to water.



Source: DOSITS, No Date-a

Sound Traveling in Air Versus Water

The table below compares sound intensity in air to sound intensity in water for common sounds.

Intensity Comparison for Typical Airborne and Underwater Sounds

Sound	Sound Intensity in Air (dB re 20 µPa)	Sound Intensity Underwater (dB re 1 µPa)
Threshold of human hearing (1,000 Hz)	0	26*
Very quiet living room	40	66*
Normal speech (1 meter)	60	86*
Jet airliner (10 meters)	104	130*
Fin whale call (100 meters)	114*	140
Human threshold of pain (at ear drum)	140	166*
Some military artillery	160	186*
Beluga echolocation call (1 meter)	194*	220

Source: NRC, 1994

*Nominal levels after conversion to alternate medium.

The potential impact of underwater sound on receptors is related to both the characteristics of the sound received and the sensitivity of the receptor. As sound emanates from a source, the intensity of the sound decreases with distance from the source; thus, receptors located further from a source receive lower intensities of sound. Just as humans have a limited range of perceptible sound frequencies outside of which sounds are undetectable, marine animals have different ranges of perceptible sounds and rely on the use of sound for different activities. The vast majority of sounds generated by NOS activities would be outside the frequency range of human sound perception both in air and underwater; however, some marine animals (e.g., marine mammals) can perceive and potentially be impacted by these sounds. Given the great differences between how a single sound is received and processed by different marine animal receptors, NOS determined that the impact of sound would be best assessed at the receptor level for the biological resources of marine mammals, sea turtles, fish, aquatic macroinvertebrates, and birds.

3.1 Affected Environment Methodology

The affected environment summarizes the current physical, biological, social, and economic environments of the "action area," which includes the United States (U.S.) territorial sea; the contiguous zone; the U.S. Exclusive Economic Zone (EEZ); rivers; states' offshore waters; and coastal and riparian lands for projects such as the installation, maintenance, and removal of tide gauges. This includes the U.S. portions of the Great Lakes and internal waters including Lakes Tahoe, Mead, Champlain, Okeechobee, and major rivers such as the Mississippi, Missouri, Hudson, and Columbia rivers. For each resource, the affected environment describes the elements or components of the resource that may be potentially affected by the alternatives.

3.2 Environmental Consequences Methodology

The environmental consequences analysis considers how the condition of a resource would change as a result of implementing each of the alternatives and describes the impacts in terms of types (direct, indirect, cumulative, beneficial, adverse), context, intensity, and significance. The types of impacts are defined in Section 3.2.1 and the development of significance criteria is described in Section 3.2.2 below. The impacts analysis is performed using a framework that follows a logical sequence of analytical steps for each resource under each alternative:

- **Impact Causing Factors.** Evaluate proposed activities to identify which elements of the activities could lead to impacts - the impact causing factors. A systematic consideration of causes and effects is used to derive the impact causing factors from known actions and characteristics that define the activities.
- **Detailed Analysis of Impacts.** Evaluate the impact causing factors to produce a detailed analysis of the impacts. Assess the context and intensity of the impacts from each impact causing factor, then evaluate the impacts from all impact causing factors to define significance for the alternative.
- **Significance Criteria.** Develop and apply criteria that are standards for evaluating the significance of the impacts caused by the proposed activities.

3.2.1 Types of Impacts

According to the Council on Environmental Quality's (CEQ) National Environmental Policy Act (NEPA) Regulations at 40 Code of Federal Regulations (CFR) 1500-1508 (1978), direct and indirect effects are defined as:

Direct effects: Effects that are caused by the action and occur at the same time and place (40 CFR 1508.1(g)(1)).

Indirect effects: Effects that are caused by the action and occur later in time or are farther removed in distance but are still reasonably foreseeable. Indirect effects also include "induced changes" in the human and natural environments (40 CFR 1508.1(g)(2)).

For example, the ability of the water to sustain aquatic life may become temporarily impaired in the event of an accidental fuel or hazardous materials spill. Indirect impacts are those follow-on effects induced by the initial impact; for example, fuel or hazardous materials spills could lead to species population reduction or displacement, adversely affecting commercial harvest of marine species.

Identified impacts may be either adverse or beneficial. The CEQ Guidelines that govern NEPA implementation describe the need for identifying and differentiating between adverse and beneficial impacts, but do not offer a definition of these terms. This Final Programmatic Environmental Impact Statement (PEIS) considers both adverse and beneficial impacts as defined below:

Adverse impacts: Those impacts having a negative and harmful effect on the analyzed resource. An adverse impact causes a change that moves the resource away from a desired condition or detracts from its appearance or condition.

Beneficial impacts: Those impacts having a positive and supportive effect on the analyzed resource. A beneficial impact constitutes a positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.

Cumulative impacts: Effects on the environment from the incremental impact of the Proposed Action when added to other past, present, and reasonably foreseeable future actions. See Chapter 4 for more information on cumulative impacts.

3.2.2 Significance Criteria

Significance criteria provide a structured framework for assessing impacts, supporting conclusions regarding the significance of effects, and comparing effects between alternatives. For this Final PEIS, the National Ocean Service (NOS) developed significance criteria for each resource by defining the context and intensity of potential impacts and dividing those impacts into four categories. NOS then designated the significance conclusion for each category of impacts. The significance criteria for each resource analyzed are provided in Sections 3.4 through 3.13.

3.2.2.1 Context and Intensity

As defined in 40 CFR 1508.27, determining the significance of impacts requires a consideration of both context and intensity. Context means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Both short- and long-term effects are relevant. Intensity refers to the severity of impact. See Section 1508.27 for the list of factors that can contribute to the intensity of an impact.

3.2.2.2 Impact Descriptor

Four impact descriptors are used to categorize the context and intensity of impacts: negligible, minor, moderate, and major. Because context and intensity vary by resource, the four impact descriptors are defined in the methodology section for each resource (Sections 3.4 through 3.13).

3.2.3 Mitigation Measures

Pursuant to the CEQ regulations, agencies must analyze appropriate means to mitigate adverse effects that are not already included in the Proposed Action. See, e.g., 40 CFR 1502.16(a) (9) and 1502.14(e). This Final PEIS incorporates additional mitigation measures in the appropriate resource sections, and they are presented in full in Appendix D. NOS has developed the mitigation measures to be implemented on each project as appropriate to minimize the impacts of project activities on sensitive species, habitats, cultural and historic resources, and subsistence hunting and fishing. The additional mitigation measures in the Final PEIS were developed in coordination with subject matter experts and field crews and with the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), and the Office of National Marine Sanctuaries (ONMS).

3.3 Regulatory Background

In addition to NEPA, other federal environmental laws, regulations, and Executive Orders (EOs) may be applicable to individual projects described in this PEIS. In accordance with CEQ regulations for implementing NEPA, NOS is integrating the requirements of NEPA with all other applicable environmental review requirements to the fullest extent practicable. NOS sought to incorporate the findings and conclusions from other regulatory agencies in this NEPA analysis. The full list of potentially applicable legal requirements is included in this section, with a detailed summary of selected requirements. A summary of the current status of consultation with other federal agencies as of the publication of this Final PEIS is provided in **Table 1.6-1** in Chapter 1.

NOS is committed to public transparency and working with local, state, tribal, and federal partners to reduce environmental impacts from NOS projects. Although state and local statutes and regulations (particularly procedural requirements like permitting) are not typically binding on federal agencies, it is NOS's intent to comply with substantive state and local requirements to the maximum extent practicable.

3.3.1 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 United States Code [U.S.C.] §§ 1361 et seq.), as amended, prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens in international waters. The MMPA defines "take" as: "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal" (16 U.S.C. § 1362). Harassment means "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild; or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering" (16 U.S.C. § 1362).

Section 101(a)(5)(A-D) of the MMPA provides a mechanism for allowing, upon request, the "incidental" but not intentional taking 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. Jurisdiction for MMPA is shared by USFWS and NMFS (collectively, the Services). NMFS is responsible for the protection of whales, dolphins, porpoises, seals, and sea lions. The USFWS is responsible for the protection of walruses, manatees, sea otters, and polar bears.

Authorization for incidental takes may be granted if the Services find that the taking would be of small numbers, would have no more than a "negligible impact" on those marine mammal species or stocks, and would not have an "unmitigable adverse impact" on the availability of the species or stock for "subsistence" uses. For species under the jurisdiction of NMFS, incidental take authorizations may be issued as either: 1) regulations and associated Letters of Authorization (LOAs), or 2) Incidental Harassment Authorizations (IHAs). LOAs are available for actions with potential to result in serious injury or mortality. LOAs are issued by region and can be valid for up to five consecutive years. An IHA is also issued by region, can only be valid for one year, and is limited to authorizing take by harassment. For species under the jurisdiction of USFWS, an Incidental Take Regulation (ITR) can be issued for a period of up to five years and can cover all forms of incidental take.

NOS submitted an LOA Application to the NMFS Office of Protected Resources (OPR) for the Proposed Action on June 3, 2022. NOS submitted an ITR request to USFWS on September 12, 2022.

3.3.2 Endangered Species Act

The Endangered Species Act (ESA) of 1973 as amended (16 U.S.C. §§ 1531, et seq.), provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range, and the conservation of the ecosystems on which they depend. The ESA directs all federal agencies to work to conserve endangered and threatened species and to use their authorities to further the purposes of the Act. Jurisdiction is shared by the Services. Generally, NMFS manages marine species, while the USFWS manages land and freshwater species. USFWS has jurisdiction over certain marine species, such as sea otters, manatees, and sea birds.

A species (or subspecies) is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species (or subspecies) is considered threatened if it is likely to become an endangered species within the foreseeable future. When listing a species as threatened or endangered, the Services also designate critical habitat for the species to the maximum extent prudent and determinable (16 U.S.C. § 1533(a)(3)).

Under Section 7(a)(2) of the ESA, each federal agency shall, in consultation with the Services, ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. The ESA requires federal agencies to consult or confer with the Services when a federal agency's action "may affect" a protected species or critical habitat, whether that effect is adverse or beneficial. Consultation is initiated by the preparation of a Biological Assessment (BA) by the federal agency. Informal consultation is available if an action "may affect, but is not likely to adversely affect" protected species or designated critical habitat. The Services provide a letter of concurrence, which completes informal consultation. Formal consultation is required if adverse effects are anticipated. Formal consultation is concluded by the preparation of a Biological Opinion by the Services. If jeopardy is not likely, the agency may authorize incidental take of protected species in an incidental take statement.

NOS prepared the Draft PEIS to serve as a BA for Section 7 consultation with NMFS and USFWS. NOS initiated consultation with NMFS OPR under Section 7 of the ESA on August 26, 2021. NOS initiated consultation with USFWS under Section 7 of the ESA on August 21, 2021. On December 8, 2021, USFWS sent NOS a letter requesting additional information for completing consultation under Section 7 of the ESA for the Proposed Action. NOS provided the requested additional information and proposed revisions to the Draft PEIS on June 1, 2022. These revisions have been incorporated into the Final PEIS where appropriate. Through the ESA consultation process, NOS developed additional mitigation measures to minimize impacts to sensitive species which have been incorporated into appropriate resource sections and listed in Appendix D.

For NOS projects being proposed in freshwater, an ESA species list will be requested from the USFWS Information for Planning and Consultation (IPaC) report system. From this information, NOS will determine if any ESA-listed species are present in a proposed project area that have not already been addressed in this Final PEIS and therefore, not in the programmatic ESA consultation. If any such species are identified, NOS will consider possible impacts to ESA-listed species in the context of that specific project. If appropriate, NOS will then initiate Section 7 consultation with the appropriate USFWS field office(s).

3.3.3 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), enacted in 1976, is the primary law governing marine fisheries management in U.S. federal waters and is administered by NMFS. The MSA (16 U.S.C. § 1801, et seq.) encourages the conservation and restoration of essential fish habitat (EFH) and resources. EFH describes all waters and substrates necessary for fish for spawning, breeding, feeding, or growth to maturity. Section 305(b) of the MSA (16 U.S.C. § 1855(b)) requires federal agencies to consult with the Secretary of Commerce on all actions, or Proposed Actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH.

“Adverse effect” is defined in the EFH regulations as: “any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.”

EFH consultation is managed by NMFS’s Office of Habitat Conservation. If adverse effects are anticipated, NMFS will recommend measures to avoid, minimize, or offset any adverse impacts associated with the activity to ensure no reduction in the quality or quantity of EFH occurs as a result of the proposed activity.

NOS submitted an EFH Assessment to NMFS’s Office of Habitat Conservation on June 2, 2022 and received a final response from NMFS on November 1, 2022. Through the EFH consultation process, NOS developed additional mitigation measures to minimize impacts to sensitive species and habitats which have been incorporated into appropriate resource sections and listed in Appendix D.

3.3.4 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) (16 U.S.C. §§ 703-712) is the primary legislation in the U.S. established to conserve migratory birds and requires the protection of migratory birds and their habitats. It implements the U.S. commitment to four bilateral treaties or conventions with Canada, Japan, Mexico, and Russia for protection of a shared migratory bird resource. The MBTA prohibits, with certain exceptions, pursuing, hunting, taking, capturing, killing, or selling migratory birds or any part, nest, egg, or product of migratory birds. Migratory birds protected under the MBTA include those that are native to the U.S. which are listed in 50 CFR § 10.13. The USFWS has jurisdiction over the species protected by the MBTA.

On January 7, 2021, a new rule (the January 7 rule) (86 FR 1134), effective on March 8, 2021, was proposed to restrict the scope of the MBTA to cover only intentional killings or injuring of birds; however, on May 7, 2021, the USFWS proposed a new rule (86 FR 24573) to revoke the January 7 rule. The effect of the May 7 proposed rule would be to return to implementing the MBTA as prohibiting incidental take as well as intentional take. The May 7 rule took effect on December 3, 2021 (86 FR 54642).

NOS has assessed the potential for incidental takes and described mitigation measures that will be implemented in Section 3.10.

3.3.5 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) (16 U.S.C. §§ 1456 et seq) was enacted in 1972 to encourage coastal states, Great Lakes states, and U.S. Territories and Commonwealths (collectively referred to as "coastal states" or "states") to be proactive in managing natural resources for their benefit and the benefit of the nation. The CZMA is a voluntary program for states; currently, all U.S. coastal states participate except Alaska, which voluntarily withdrew from the program in 2011. Section 307 of the CZMA is known as the "federal consistency" provision.

The federal consistency provision requires federal actions (inside or outside a state's coastal zone) that affect any land or water use or natural resource of a state's coastal zone, to be consistent with the enforceable policies of the state coastal management program (CMP). The term "effect on any coastal use or resource" means any reasonably foreseeable effect on any coastal use or resource resulting from the activity, including direct and indirect (cumulative and secondary) effects. The federal consistency regulations at 15 CFR Part 930 set forth detailed timeframes and procedures. The consistency requirements apply to both federal agency activities (15 CFR Part 930, Subpart C), and federal license or permit activities (Subpart D), but the consistency review is different for each type of federal agency action.

Federal agency activities (Subpart C) are activities and development projects performed by a federal agency, or a contractor for the benefit of a federal agency. For federal agency projects occurring inside or outside a state's coastal zone, for states or territories with approved CMPs, the federal agency must submit a Consistency Determination to the state if the federal agency determines the activity may have reasonably foreseeable effects on the state's coastal uses or resources. If there are no reasonably foreseeable effects, the federal agency may be required to provide a Negative Determination to the state (detailed in 15 CFR § 930.35). If the state objects to the federal agency's consistency determination, the federal agency may proceed with its action if it finds that its action is consistent to the maximum practicable with the enforceable policies of the state's CMP.

NOS provided Consistency Determination letters to all coastal states and territories with approved CMPs in August 2022. The Consistency Determination letters evaluate the coastal effects of proposed activities according to the relevant enforceable policies of the state or territory to make a consistency determination under CZMA.

If NOS relies on this PEIS for issuing a permit or authorization to a non-federal entity, the permit applicant must submit a Consistency Certification under Subpart D to the state CMP. All federal license or permit activities occurring in the coastal zone are deemed to affect coastal uses or resources if the state CMP has listed the particular federal license, permit or authorization in the state CMP "federal consistency list" approved by the National Oceanic and Atmospheric Administration (NOAA). The federal consistency regulations also identify situations in which an applicant may need to submit a Consistency Certification to the state even if the proposed license or permit activity is not included on the state's federal consistency list. If an applicant is required to submit a Consistency Certification to a state, then the federal agency cannot authorize the proposed activity unless and until the state has concurred with the applicant's Consistency Certification.

3.3.6 National Historic Preservation Act and Other Cultural Resource Regulations

The National Historic Preservation Act of 1966 (NHPA) is the primary federal statute addressing the management of historic properties. Section 106 of the NHPA (54 U.S.C. § 300101 et seq.) requires federal agencies to take into account the effects of their undertakings on historic properties in accordance with regulations issued by the Advisory Council on Historic Preservation (ACHP) at 36 CFR Part 800. Historic properties are properties that are included in the National Register of Historic Places or that meet the criteria for the National Register. If an agency's undertaking could affect historic properties, the agency must identify the appropriate State Historic Preservation Officer/Tribal Historic Preservation Officer (SHPO/THPO) to consult with during the process. It should also plan to involve the public, and identify other potential consulting parties. The agency must identify historic properties in the area of potential effects. If the agency finds that no historic properties are present or affected, it provides documentation to the SHPO/THPO and, barring any objection in 30 days, proceeds with its undertaking. If effects are found, consultation usually results in a Memorandum of Agreement (MOA), which outlines agreed-upon measures that the agency will take to avoid, minimize, or mitigate the adverse effects.

NOS will initiate project-specific consultations under Section 106 of the NHPA before commencing any activity with the potential to affect cultural or historic resources. On June 28, 2021, NOS sent letters to tribes notifying them of the availability of the Draft PEIS and inviting them to request government-to-government consultation under EO 13175, Consultation and Coordination with Indian Tribal Governments. NOS recognizes its unique relationship with tribes and trust responsibility with tribal governments as set forth in the U.S. Constitution, treaties, statutes, EOs, and court decisions. It is the policy of NOAA to consult on a government-to-government basis with federally recognized tribal governments when the federal actions and decisions may affect tribal interests. NOS also consults with Alaska Native corporations on the same basis as federally recognized tribes under EO 13175. This consultation and coordination process would be conducted in accordance with NOAA's Procedures for Government-to-Government Consultation with Federally Recognized Indian Tribes and Alaska Native Corporations (NOAA 13175 policy, November 12, 2013).

NOS did not receive any requests from federally recognized tribes to initiate government-to-government consultation on the Draft PEIS. Additionally, no requests were received to initiate government-to-corporation consultation from any Alaska Native corporation. NOS intends to notify individual federally recognized tribes and Alaska Native corporations consistent with EO 13175 before conducting any project that may have tribal implications. Federally recognized tribes are welcome to request government-to-government consultation at any time for a project that may have tribal implications.

Additional regulations that apply to work in tribal lands and waters and near submerged cultural resources include the Archaeological Resources Protection Act of 1979 (ARPA) (16 U.S.C. §§ 470aa et seq) and the Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C. §§ 3001 et seq).

ARPA was enacted "to secure, for the present and future benefit of the American people, the protection of archaeological resources and sites which are on public lands and Indian lands, and to foster increased cooperation and exchange of information between governmental authorities, the professional archaeological community, and private individuals" (16 U.S.C. § 470aa(b)). ARPA requires a permit for activities directed at archaeological resources located on public lands (16 U.S.C. § 470cc(a)). ARPA's definition of public lands expressly excludes the outer continental shelf (16 U.S.C. § 470bb(3)(B)); therefore, with regards to the marine environment, the permit system established under ARPA only applies within federal marine protected areas and submerged lands to which the U.S. retained title and which were not transferred under the Submerged Lands Act (SLA) or other laws.

NAGPRA describes the rights of Native American lineal descendants, Indian tribes, and Native Hawaiian organizations with respect to the treatment, repatriation, and disposition of Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony, referred to collectively in the statute as cultural items, with which they can show a relationship of lineal descent or cultural affiliation. NAGPRA regulates the intentional excavation or inadvertent discovery of Native American human remains and cultural items on Federal or tribal lands (25 U.S.C. §§ 3002(c)-(d)). NAGPRA requires a permit for the intentional removal from or excavation of Native American cultural items from federal or tribal lands (25 USC 3002(c)) and in the case of an inadvertent discovery, NAGPRA requires that the person must stop the activity in the area of the inadvertent discovery and make a reasonable effort to protect the cultural items, (25 U.S.C. § 3002(d)). Federal lands under NAGPRA include lands owned or controlled by Federal agencies (25 U.S.C. § 3001(5)); this includes submerged lands within the outer continental shelf and EEZ.

3.3.7 National Marine Sanctuaries Act

The National Marine Sanctuaries Act (NMSA) (16 U.S.C. § 1431 et seq.) authorizes the Secretary of Commerce to designate and manage areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries.

ONMS serves as the trustee for a network of National Marine Sanctuaries encompassing more than 1,553,993 square kilometers (km^2) (600,000 square miles [mi^2]) of marine and Great Lakes waters from Washington state to the Florida Keys, and from Lake Huron to American Samoa. The network includes 15 National Marine Sanctuaries.

The NMSA prohibits injury to sanctuary resources. Each sanctuary has individual regulations that include prohibited activities. ONMS has the authority to issue permits for prohibited activities for the purpose of research, education, or management. NOS program offices would obtain all necessary permits to conduct any prohibited activities in national marine sanctuaries, consistent with regulations at 15 CFR 922.

Section 304(d) of the NMSA requires interagency consultation between NOAA and federal agencies taking actions, including authorization of private activities, "likely to destroy, cause the loss of, or injure a sanctuary resource." In addition, federal agencies are required to consult on Proposed Actions that "may affect" the resources of Stellwagen Bank National Marine Sanctuary. Consultation is initiated by submitting a sanctuary resource statement (SRS) to the ONMS describing the potential effects of the activity on sanctuary resources. If the ONMS finds injury is likely, it must recommend "reasonable and prudent alternatives" for the agency to implement to protect sanctuary resources.

NOS submitted an SRS to ONMS on June 1, 2022 that includes a programmatic-level evaluation of impacts from the NOS Preferred Alternative (Alternative B) on each sanctuary.

3.3.8 Executive Orders

Compliance with the following EOs has been considered in the preparation of this PEIS:

- EO 12114: Environmental Effects Abroad of Major Federal Actions. NOS crewed vessels (Section 2.4.1) and autonomous vehicles (Section 2.4.3) may transit through waters outside the U.S. EEZ; however, no data collection will occur outside the U.S. EEZ.
- EO 11988: Floodplain Management. For more information on floodplains and terrestrial habitat impacts, see Section 3.4, Habitats).
- EO 11990: Protection of Wetlands. For more information on wetlands, habitats (Section 3.4).

- EO 13158: Marine Protected Areas. NOS has determined that the impact of NOS activities on individual Marine Protected Areas (MPAs) and resources within MPAs would be the same as the impacts on the resources within the applicable geographic region evaluated in this PEIS.
- EO 13175: Consultation and Coordination with Indian Tribal Governments. NOS has invited tribes to comment on the Draft PEIS. For more information on the consideration of tribal resources see Cultural and Historic Resources (Section 3.11) and Environmental Justice (Section 3.13).
- EO 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. For more information see Environmental Justice (Section 3.13).
- EO 13112: Invasive Species. For more information on invasive species see Habitats (Section 3.4), Aquatic Macroinvertebrates (Section 3.8), and Essential Fish Habitat (Section 3.8).
- EO 13693: Planning for Federal Sustainability in the Next Decade. The preparation of this PEIS will enable NOS to more meaningfully and efficiently consider the environmental effects of NOS surveying and mapping projects. For more information on how Alternatives B and C will adopt new techniques and technologies to encourage greater program efficiencies see Chapter 2, Sections 2.5.2 and 2.5.3.
- EO 14008: Tackling the Climate Crisis at Home and Abroad. For more information on climate change see Section 4.1.4, Climate Change and cumulative effects on the environment (Section 4.2).
- EO 13186: Responsibilities of Federal Agencies to Protect Migratory Birds. For more information on birds see Seabirds, Shorebirds and Coastal Birds, and Waterfowl (Section 3.10).
- EO 13352: Facilitation of Cooperative Conservation. For more information on how the Proposed Action would support natural resource management and NOS coordination with other federal agencies see Sections 1.3.3 and 1.6, respectively.

3.4 HABITATS

This section describes the effects of NOS operations on definable habitat types throughout the action area. Note that this section does not include a discussion of EFH as defined by the MSA. The discussion and analysis of EFH is presented in Section 3.9.

3.4.1 Affected Environment

Essential habitat features are the defining characteristics of species' habitats that allow the species within a habitat to function in equilibrium. Essential habitat features may include, but are not limited to:

1) Space for individual and population growth and for normal behavior;
2) Food, water, air, light, minerals, and other nutritional or physiological requirements;
3) Cover or shelter; and
4) Sites for breeding, reproduction, or rearing and development of offspring (USFWS, 2017a).

Five habitat types can be found in the action area: freshwater, estuarine, shallow marine, oceanic, and terrestrial. **Figure 3.4-1** illustrates and defines the physical characteristics for each of these five habitats as defined for the purposes of this analysis.

Freshwater: Areas located between the headwaters and the head-of-tide, with negligible salinity (NMFS, 2015a) are classified as freshwater habitat types. The headwaters are the inland source from which a river originates within a basin or watershed; head-of-tide is the inland limit of water affected by tides. Diadromous fish species are those that spend a portion of their life cycle in both fresh water and salt water. These fish species require freshwater habitat as both a supporting environment for early stages of the life cycle and as spawning grounds during later adult stages; the quantity and quality of these areas are of equal importance to these fish as that of marine areas. The majority of waterfowl species also occupy freshwater habitats.

Estuarine: Areas located in a semi-enclosed coastal body of water extending from head-of-tide to a free connection with the open sea where saline sea water is mixed with fresh water are classified as estuarine habitat types (NMFS, 2015a). Estuaries typically have brackish conditions, with variable salinities (depending on the tide stage) in between fresh water and sea water. Many protected species and commercially or recreationally harvested fish species occupy estuarine habitats at one or more stages of their respective life cycles.

Shallow Marine: Areas less than 200 meters (m) (656 feet [ft]) in bottom depth and located between the outer boundary of an estuary or coast (continent or island) and the outer boundary of the U.S. EEZ, usually 200 nautical miles (nm) (370 kilometers [km]) from shore are classified as shallow marine habitat types (NMFS, 2015a). Shallow marine habitats support important structural features, such as seagrass beds and coral reefs, which provide shelter, food, and space for a large number of marine vertebrate and invertebrate species.

Oceanic: Areas greater than 200 m (656 ft) in bottom depth and located between the outer boundary of an estuary or coast (continent or island) and the outer boundary of the U.S. EEZ are classified as oceanic habitat types (NMFS, 2015a). Oceanic habitats support a large number of marine vertebrate and invertebrate species, including protected species.

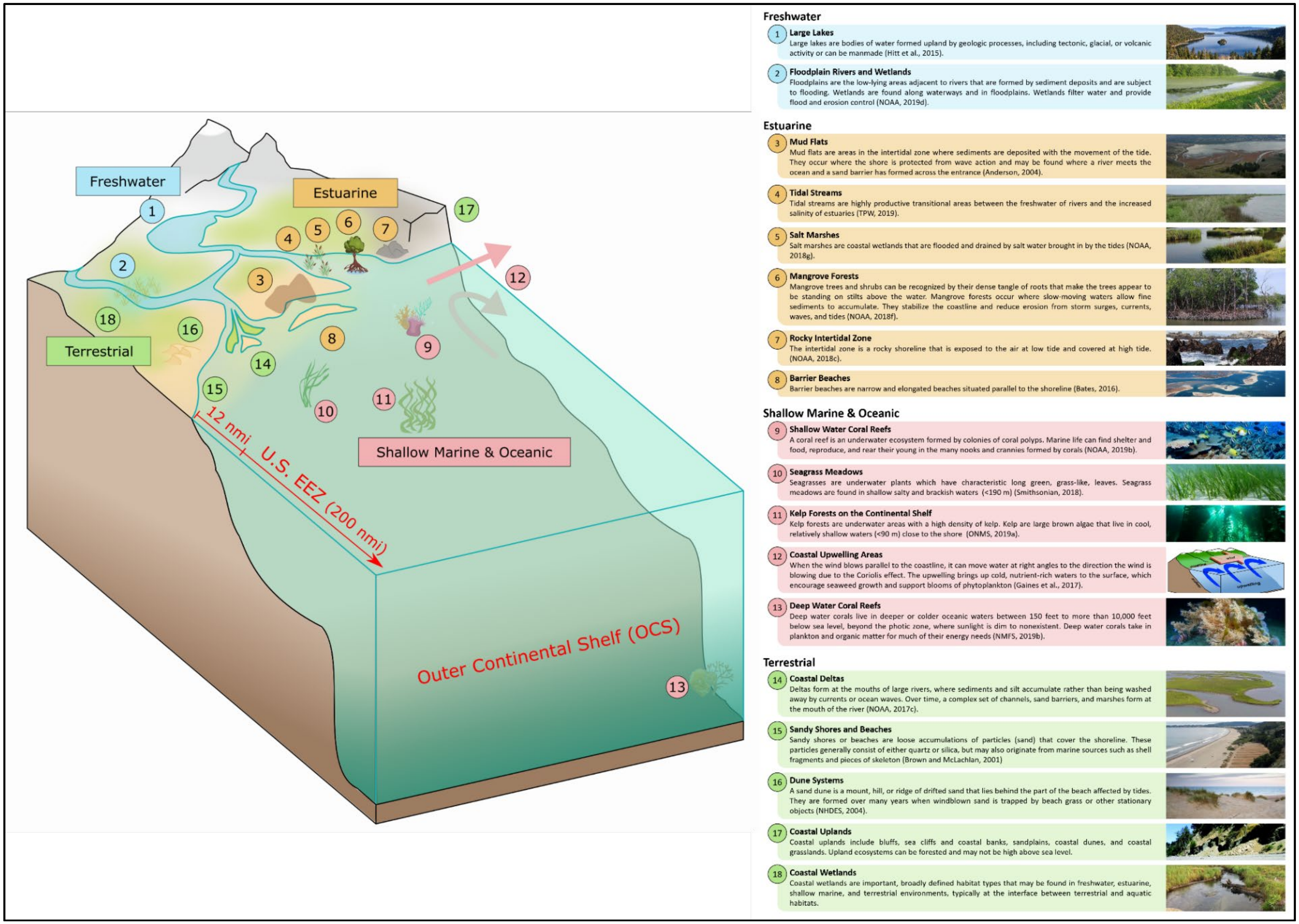
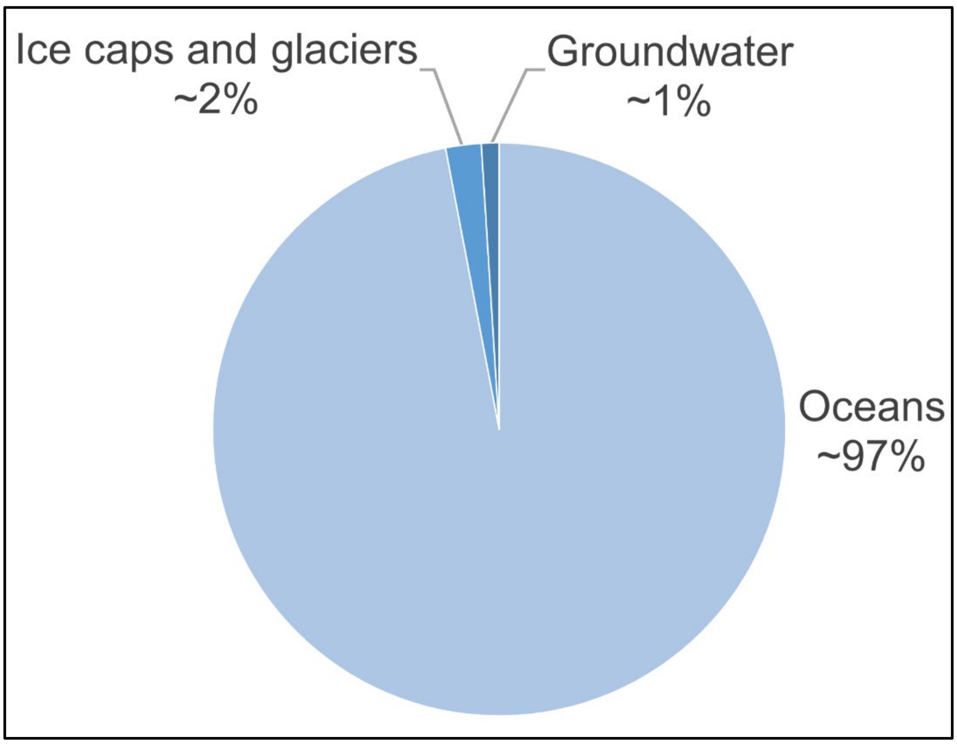


Figure 3.4-1. Habitat Types and Features Present in the Action Area

Terrestrial: Areas located on land, such as coastal deltas, sandy shores or beaches, dune systems, coastal uplands, bluffs/cliffs and headlands, and coastal wetlands are classified as terrestrial habitat types for the purposes of this analysis. Shorelines and coastal wetland habitats provide many dependent species of seabirds, shorebirds, and waterfowl with food, shelter, resting sites, and breeding or nesting areas. Sandy shores and beaches also serve as important nesting habitat for all ESA-listed sea turtles occurring within the EEZ. Terrestrial areas also serve as haul out locations where large numbers of pinnipeds mate, breed, and rear young; they also furnish denning sites for fissipeds such as polar bears.

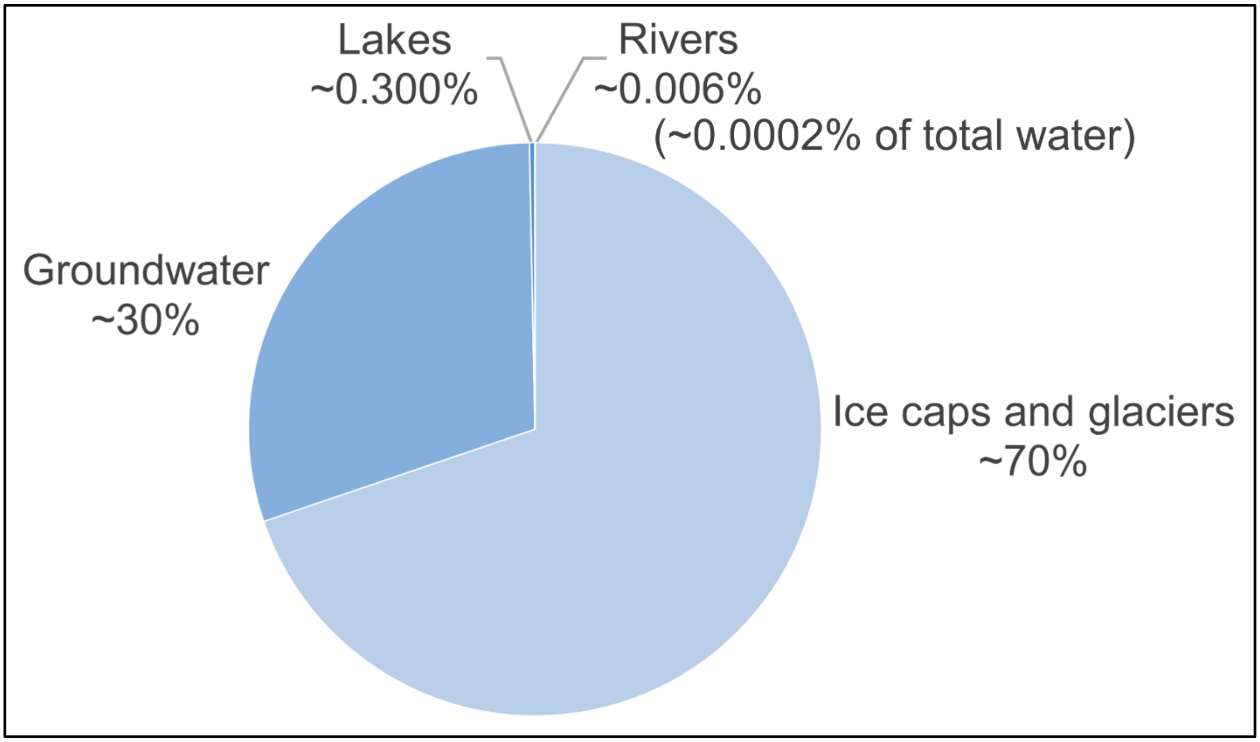
3.4.1.1 Freshwater Areas

Freshwater habitat types consist of rivers, marshes, streams, lakes and ponds that do not have any saltwater concentration. There is only a limited quantity of fresh water available globally to support freshwater habitats. Only three percent of water on the planet is fresh water, as shown in **Figure 3.4-2**. Of this three percent, only a very small proportion of the Earth's fresh water is available as habitat; the majority of global fresh water is frozen in polar ice caps and glaciers or located below the surface of the Earth as groundwater and has only very limited habitat value (**Figure 3.4-3**). Freshwater lakes and rivers make up approximately 0.3 percent of total water and compose such a small proportion of total global water composition that they are not visible in **Figure 3.4-2**.



Source: Hitt et al., 2015

Figure 3.4-2. Global Composition of Water



Source: Hitt et al., 2015

Figure 3.4-3. Global Composition of Freshwater

Despite their limited availability, freshwater habitats support a substantial number of described species and are extremely important ecologically (Hitt et al., 2015), as illustrated by **Table 3.4-1**. The Great Lakes constitute the largest freshwater ecosystem in the world and support approximately 3,500 species of plants and animals, including over 170 species of fish (SeaGrant, 2022).

Table 3.4-1. Comparison of Area and Percent of Described Species for Freshwater, Terrestrial, and Marine Ecosystems

Ecosystem Type	Percent Earth Area	Percent Described Species *
Freshwater	0.8	2.4
Terrestrial	28.4	77.5
Marine	70.8	14.7

Source: Hitt et al., 2015

* Total does not sum to 100 percent because symbiotic species are excluded.

Trends in the quantity and quality of freshwater habitat type areas are assessed and reported through surveys such as the Wadeable Streams Assessment, which shows that in 2004 more than 50 percent of the nation's rivers and streams were in poor biological condition (NMFS, 2015a). Between 2004 and 2013, the proportion of total quality freshwater habitat available in the action area for macroinvertebrates decreased from 27.4 percent to 20.5 percent of all freshwater habitat areas. During this time period, the proportion of freshwater areas in good phosphorous condition also declined (i.e., phosphorous concentrations rose) from 52.8 percent to 34.2 percent, although the proportion of freshwater areas in good nitrogen and in-stream fish habitat condition rose from 46.6 to 55.4 percent and 51.7 to 68.9 percent, respectively (NMFS, 2015a).

3.4.1.2 Estuarine Areas

Estuarine habitat types occur in areas where oceanic salt water mixes with terrestrial freshwater outflows. Estuaries are generally partially enclosed or isolated from open ocean waters, and commonly consist of channels, sloughs, and mud and sand flats. River mouths, lagoons, and bays often contain estuarine habitat features and support at least one life stage for many marine taxa, including macroinvertebrates, fish, and birds. These areas are particularly sensitive to human activities on surrounding lands**.** For example, diking, filling, and other human activities have affected over 70 percent of the estuarine habitat in the Pacific Northwest and California. Generally, estuarine conditions are poorest in the Gulf of Mexico and Greater Atlantic region (EPA, 2012). However, restoration efforts throughout the action area, such as the removal and relocation of dikes and levees, are ongoing and beginning to restore many degraded estuaries (NMFS, 2015a).

Many estuarine areas experience high levels of eutrophication from agricultural or urban runoff, as illustrated in **Figure 3.4-4**. High concentrations of nutrients such as nitrogen and phosphates from fertilizer or detergent runoff can potentially spawn algal blooms within estuaries, which reduce dissolved oxygen (DO), increase turbidity, and generally degrade the habitat value of affected waters.

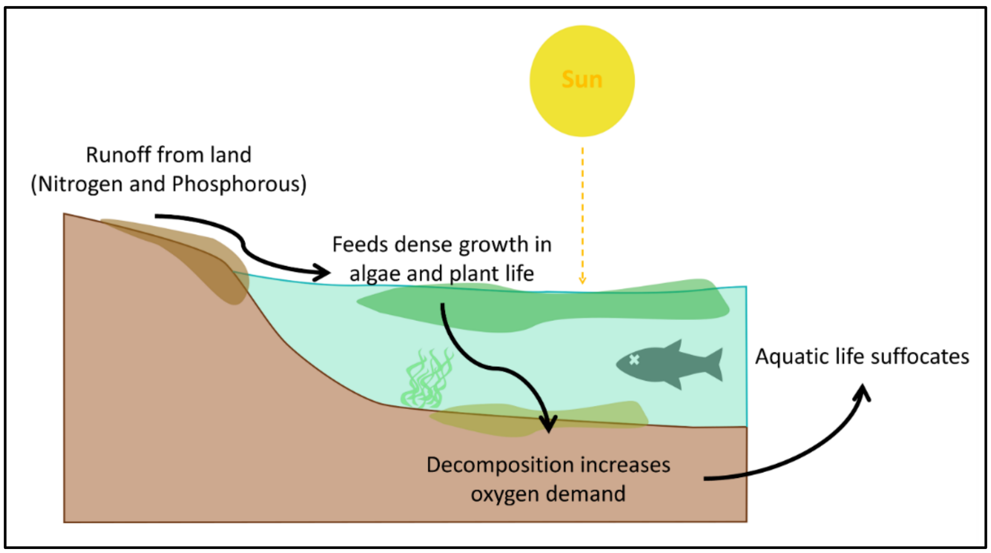
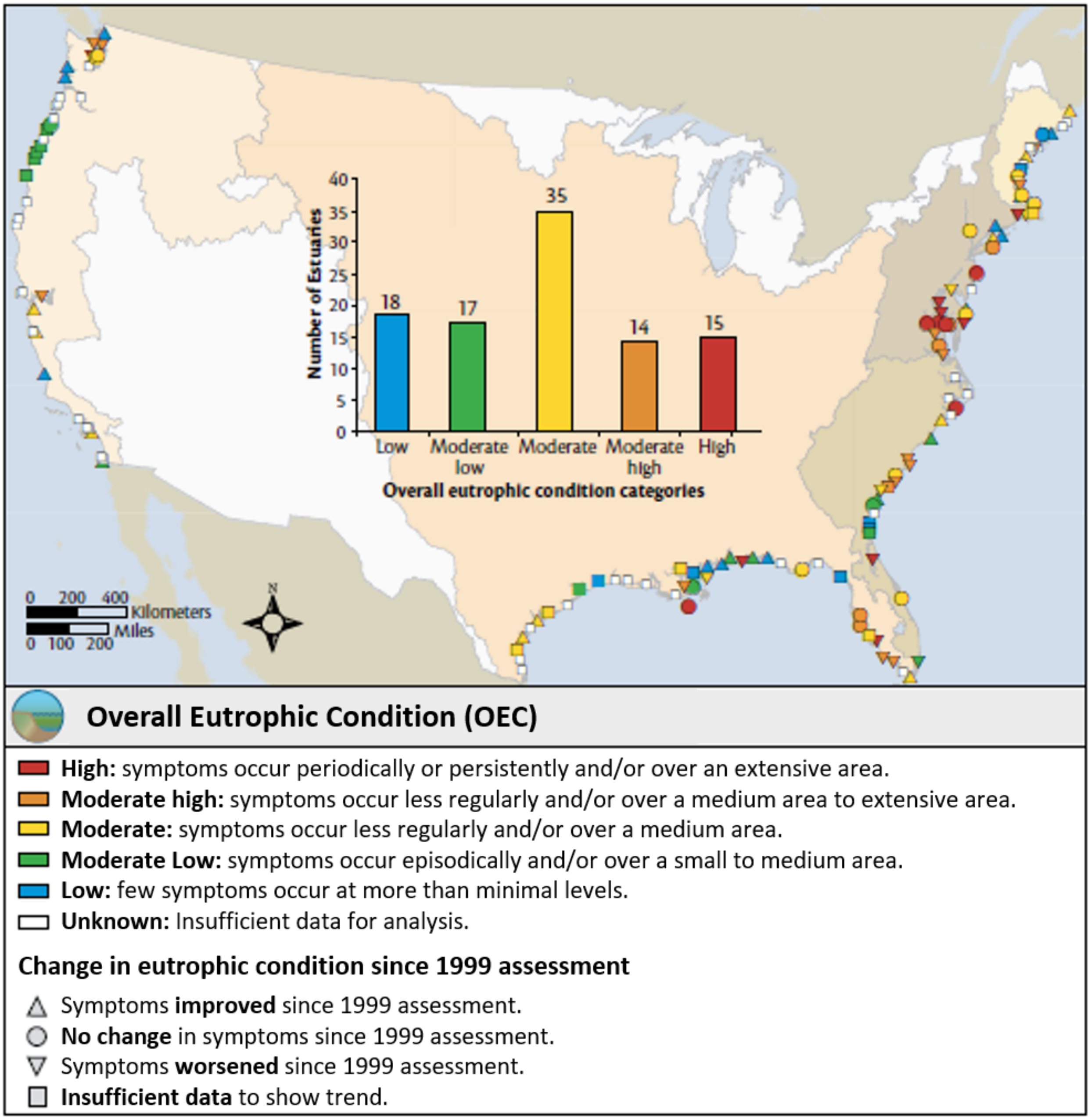


Figure 3.4-4. Eutrophication Process

The 2007 National Estuarine Eutrophication Assessment (Bricker et al., 2007) has characterized overall eutrophication condition from low to high in numerous estuaries nationwide through their collective expression of characteristic symptoms including increased chlorophyll *a*, macroalgae and nuisance/toxic blooms, decreased dissolved oxygen, and submerged aquatic vegetation loss. **Figure 3.4-5** depicts the eutrophication status of these major estuarine habitats in the continental U.S.



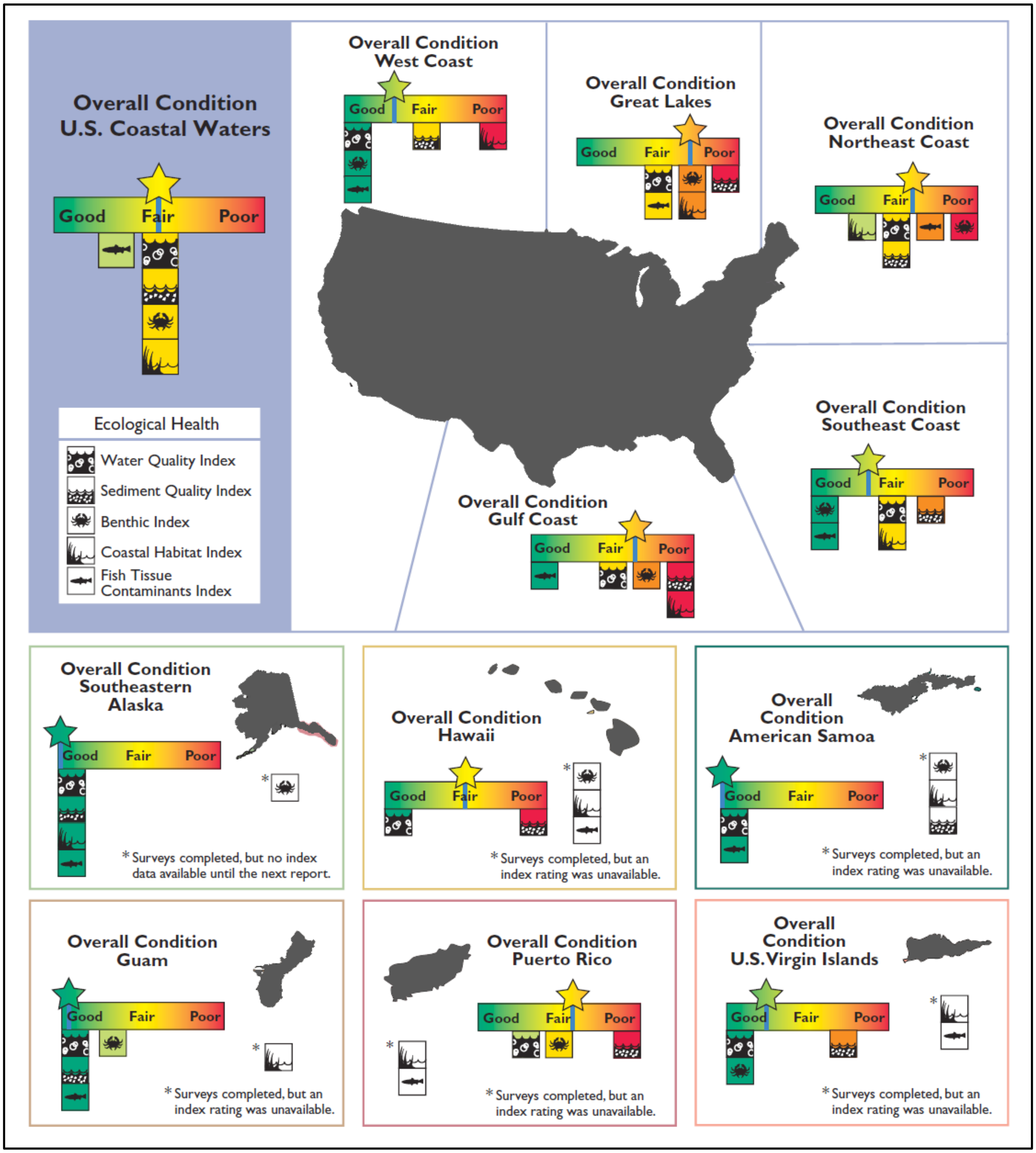
Source: Bricker et al., 2007

*Data for Alaska and Hawai'i are not available.

Figure 3.4-5. Eutrophic Habitat Condition of Major U.S. Estuaries*

3.4.1.3 Shallow Marine and Oceanic Areas

The shallow marine habitat type encompasses all areas less than 200 m (656 ft) in depth between the shoreline and the outer boundary of the U.S. EEZ. These areas are typically separated from deeper waters by underwater topographic features such as shelf breaks or reef walls. The oceanic habitat type encompasses all areas 200 m (656 ft) or greater in depth between the shallow marine habitat areas and the outer boundary of the U.S. EEZ. As a whole, shallow marine and oceanic areas have higher water quality, lower turbidity, less disturbed bottom substrate, lower concentrations of contaminants, and provide more habitat value to dependent species than freshwater areas within the action area (NMFS, 2015a); the National Coastal Condition Report (NCCR) IV rated the overall condition of national coastal waters as 'fair' and fresh waters as 'poor to fair' (EPA, 2012). Regional water condition ratings from the NCCR IV are depicted in **Figure 3.4-6**.



Source: EPA, 2012

Figure 3.4-6. Shallow Marine Habitat Condition by Location

The West Coast, Southeastern Alaska, and Pacific Islands regions contain the best marine and oceanic water quality of all regions in the EEZ, whereas the water quality of the Northeast Coast, Southeast Coast, and Gulf Coast in the Greater Atlantic and Southeast regions are considered only 'fair' (EPA, 2012).

3.4.1.4 Terrestrial Areas

Coastal terrestrial areas are found above the spring high tide limit within coastal areas and are characterized by their proximity to the sea for the purposes of this analysis. Coastal terrestrial habitat features include coastal wetlands, deltas, beaches, bluffs, cliffs, and dunes (**Figure 3.4-1)** that provide valuable ecosystem services such as food, shoreline stabilization, and nesting and breeding grounds for many species, including sensitive ESA-listed sea turtles (Section 3.6) and birds (Section 3.10). Coastal wetlands are particularly important to marine and terrestrial taxa and are explicitly discussed in Section 3.4.1.5.

Rising sea levels and extreme weather events are constantly eroding coastlines throughout the action area, reducing the amount of coastal terrestrial habitat available for dependent species. Erosion rates vary considerably from location to location and year to year, but average 0.6-0.9 m (2-3 ft) annually along the Atlantic coast and over 1.8 m (6 ft) annually in areas bordering the Gulf of Mexico (Heinz Center, 2000). Pacific coastlines tend to erode less than 0.3 m (1 ft) a year, but this lower rate is primarily a result of averaging episodic cliff erosion events, which can erode over 30 m (100 ft) of coastline at one time, over many years (Heinz Center, 2000).

3.4.1.5 Coastal Wetlands

Coastal wetlands include salt water, brackish (mixed salt water and fresh water), and freshwater wetlands located within coastal watersheds that drain into the Atlantic Ocean, Pacific Ocean (including areas surrounding Alaska and the Pacific Islands), Bering Sea, Arctic Ocean, or the Gulf of Mexico. These wetlands can be tidal or non-tidal, fresh water or salt water, and occur in close proximity to fresh water, estuarine, and shallow marine areas, typically at the interface between terrestrial and aquatic habitat types. This broad category includes a wide variety of habitat features, such as marshes, swamps, and mangrove forests as described in **Figure 3.4-1.**

Coastal wetlands compose roughly one third of all wetlands in the U.S. Within the EEZ, the Alaska region has the highest quality coastal wetlands, whereas coastal wetlands in the West Coast region and in the Gulf of Mexico are rated as 'poor' overall (EPA, 2012). As awareness of their ecological and economic importance has increased and a regulatory apparatus has developed to protect them, wetland loss has decreased. Wetland loss is now at a level that is 3 percent of the rate that it was prior to the mid-1970s, but coastal wetlands have experienced a net increase in the wetland loss rate during the period 1998 to 2009. **Table 3.4-2** summarizes coastal wetland losses in the U.S.

Table 3.4-2. Coastal Wetland Losses

Coastal Wetland Type	Timeframe/ Quantity Lost (ac)	Notes
All Coastal Watershed Wetlands	2004-2009/360,000	36 percent increase in average annual loss rate over preceding six-year period
Marine and Estuarine Intertidal Wetlands	2004-2009/95,000	Includes small gains in unvegetated wetlands and scrub/shrub wetlands
Salt Marsh	2004-2009/128,200	Threefold increase in loss rate over preceding six-year period

Coastal Wetland Type	Timeframe/ Quantity Lost (ac)	Notes
Louisiana Wetlands Lost to Open Water	1932-2010/1,206,000	Contributing factors include coastal development, sea level rise, coastal subsidence, storms, and interference with normal erosional and depositional processes within the Mississippi River Delta
Mangroves and Seagrasses	Declining in many areas	Declining due to an excess of suspended sediment associated with poor land-use practices, as well as algal blooms stimulated by excess nutrients
Fresh water	2004-2009/56,000	Human activity, particularly development and some activities related to silviculture, is the leading cause of freshwater wetland loss

Source: NMFS, 2015a

3.4.2 Environmental Consequences for Habitats

The following sections identify and evaluate potential impacts to the five habitat types occurring in the action area under Alternatives A, B, and C. The analysis specifically considers impacts to the following habitat characteristics:

- Space for individual and population growth and for normal behavior;
- Food, water, air, light, minerals, and other nutritional or physiological requirements;
- Cover or shelter; and
- Sites for breeding, reproduction, or rearing and development of offspring.

Activities described in Sections 2.4.1 through 2.4.13 that occur during NOS projects and could be expected to have impacts on habitat characteristics in the action area include crewed vessel operations; anchoring; remotely operated vehicles (ROVs) and autonomous vehicles operations; use of echo sounders, Acoustic Doppler Current Profilers (ADCPs), acoustic communication systems, sound speed data collection equipment, and drop/towed video camera systems; collection of bottom grab samples; installation, maintenance, and removal of tide gauges/buoys and Global Positioning System (GPS) reference stations; and Self-contained Underwater Breathing Apparatus (SCUBA) operations.

3.4.2.1 Methodology

NOS activities could impact habitat characteristics in the action area through: (1) physical impacts to bottom substrate (e.g., from anchoring, collection of bottom grab samples, tide gauge or GPS reference station installation, and SCUBA operations); (2) increase in sedimentation, turbidity, and/or chemical contaminants (e.g., from crewed vessel operations, ROV and autonomous vehicle operations, anchoring, collection of bottom grab samples, installation of tide gauges and GPS reference stations, and SCUBA operations); (3) increased ambient sound levels (e.g., from crewed vessel operations, ROV and autonomous vehicles, use of echo sounders, ADCPs, and acoustic communication systems); (4) facilitated dispersal of invasive species (e.g., from ballast water discharged during crewed vessel operation or organisms attached to hulls, equipment, and anchors); (5) impacts to water column (e.g., from crewed vessel operations, ROVs, and autonomous vehicles, anchoring, use of sound speed data collection equipment and bottom grab samplers, operation of drop/towed cameras and video systems, and SCUBA operations); and (6) terrestrial impacts (e.g., from ground disturbance during installation or removal of tide gauges).

As discussed in Section 3.2.2, significance criteria have been developed for each resource to provide a systematic and consistent approach to identifying and assessing the impacts of the alternatives. The significance criteria for habitats are presented in **Table 3.4-3.**

Table 3.4-3. Impact Significance Criteria for the Analysis of Impacts to Habitats

Impact Descriptor	Context and Intensity	Significance Conclusion
Negligible	Impacts on habitat would be limited to temporary (lasting up to several hours) changes to habitat characteristics of space; nutritional or physiological requirements; cover or shelter; or sites for breeding, reproduction, or rearing (or development) of offspring found within the project area. Impacts on habitat would not cause lasting damage or alteration.	Insignificant
Minor	Impacts would be temporary or short-term (lasting several days to several weeks) changes that would not be outside the natural range of variability to habitat characteristics of space; nutritional or physiological requirements; cover or shelter; or sites for breeding, reproduction, or rearing (or development) of offspring found within the project area. Impacts on habitat would be easily recoverable with no long-term or permanent damage or alteration.	
Moderate	Impacts would be short-term or long-term (lasting several months or longer) changes that would be outside the natural range of variability to habitat characteristics of space; nutritional or physiological requirements; cover or shelter; or sites for breeding, reproduction, or rearing (or development) of offspring found within the project area. Habitat would be damaged or altered potentially over the long term but would continue to support the species dependent on it.	
Major	Short-term or long-term changes well outside the limits of natural variability to habitat characteristics of space; nutritional or physiological requirements; cover or shelter; or sites for breeding, reproduction, or rearing (or development) of offspring found within the project area. Habitat would be degraded over the long term or permanently such that it would no longer possess sustainable habitat requirements.	Significant

3.4.2.2 Alternative A: No Action - Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

Under Alternative A, NOS survey effort would continue to cover a total of 2,647,958nm (4,904,017 km) across all five regions over the five-year period. Although the survey effort under Alternative A would vary by year, approximately 47 percent of the total linear nautical miles surveyed over the five-year period would continue to be in the Southeast Region. The survey effort in each of the other four regions would continue to be approximately 10 percent of the total survey effort and slightly greater in the Alaska Region, which contains approximately 18 percent of the total survey effort. Survey effort in the Great Lakes would compose less than one percent of total survey effort and would continue to average only

2,917nm (5,402km) annually. Major navigable rivers would continue to host an even smaller proportion of activities than the Great Lakes. **Table 3.4-4** presents the expected survey effort under Alternative A for each year by region.

Table 3.4-4. Survey Effort under Alternative A, by Geographic Region by Year

Region	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Survey Effort (in nautical miles)						
Greater Atlantic Region*	64,205	108,557	53,771	49,712	49,712	325,958
Great Lakes	3,383	2,800	2,800	2,800	2,800	14,583
Southeast Region	220,336	210,185	262,450	281,733	281,733	1,256,437
West Coast Region	59,558	57,909	55,973	58,204	58,204	289,848
Alaska Region	93,871	119,974	174,445	41,350	41,327	470,967
Pacific Islands Region	70,210	54,900	69,742	54,948	54,948	304,748

* Survey effort within the Great Lakes is included as part of the total GAR survey effort as well as presented separately.

In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of projects, that add nuance to this trend. More than 71 percent of NOS survey effort would occur within shallow marine habitat areas (a depth range of less than 200 m [656 ft]), and approximately 24 percent of NOS survey effort would occur within oceanic habitat areas (a depth range greater than 200 m [656 ft]). The remaining survey work would occur within estuarine habitat areas and freshwater habitat areas. These areas would likely experience relatively lower impacts than shallow marine and oceanic habitat areas. Terrestrial habitat areas would experience the lowest impacts under Alternative A, as terrestrial areas would only be impacted by occasional shore visits in support of the installation, maintenance, and removal of shore-based instrument stations.

3.4.2.2.1 Physical Impacts to Bottom Substrate

Anchoring, collection of bottom grab samples, installation of tide gauges and remote GPS reference systems, dropped/towed camera systems, and SCUBA operations could physically impact bottom substrate in marine, freshwater, and estuarine areas, potentially degrading their habitat value to dependent species.

Anchoring of vessels and dropped or towed camera systems could potentially cause damage to bottom substrate in all aquatic habitat areas, potentially reducing available structure, cover, and nutrient/food availability for dependent species. Anchors, cameras, or their attached chains/lines could drag across or create holes and divots in the bottom substrates of aquatic areas, potentially damaging or destroying underwater vegetation or sea floor structure (note that the term “sea floor” includes lake and river bottoms where NOS activities could occur). This alteration of underwater structure would reduce the availability of shelter and cover necessary for the survival or offspring development of many aquatic taxa. This would particularly affect those organisms at lower levels of the aquatic food chain and could potentially reduce the overall aquatic biodiversity of the area through cascading trophic impacts (i.e., reduced prey availability reduces the abundance of higher-level predators).

Anchoring of vessels used by NOS, however, would not be a common practice. Only large vessels would typically anchor within or near project areas, while the small boats and launches used during NOS projects typically return to port or to the ship each day. Most vessels used by NOS would not anchor except in case of emergency, such as to avoid adverse weather conditions or in the event of an engine malfunction. Vessels would not anchor on coral reefs, and would avoid anchoring on hard bottom areas and in seagrass and abalone areas whenever possible; thus, these sensitive and critical habitat areas[5] and their dependent species would be minimally impacted, if at all. Additionally, NOS would not drag anchor chains and would ensure that anchors are properly secured so as to minimize bottom disturbance. However, it is possible that when a vessel is not collecting data, it may anchor either within the project area or nearby.

Installation of equipment on the sea floor, such as the installation of new moorings for tide buoys or GPS reference stations, would cause relatively small amounts of bottom substrate disturbance. The disturbance could potentially create holes in the bottom sediment and damage or destruction of submerged vegetation/macroalgae and bottom structure. This reduction of underwater structure would reduce the availability of shelter and cover necessary for the survival or offspring development of many aquatic taxa. This would particularly affect those organisms at lower levels of the aquatic food chain and could potentially reduce the overall aquatic biodiversity of the area through cascading trophic impacts (i.e., reduced prey availability reduces the abundance of higher-level predators). NOS would ensure that all instruments placed in contact with the sea floor (including anchors or moorings) are properly secured to avoid the dragging of moorings or lines across the bottom. NOS would also ensure that any buoys attached to the sea floor use the best available mooring systems: 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. 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. When possible, field crews would use retrievable equipment to avoid abandoning material on the sea floor. Furthermore, the frequency of bottom disturbance is expected to be low since NOS would use existing moorings to anchor installations wherever possible. Only a very small portion of the approximately 32 NOS projects performed annually that include tide gauge installations would involve installation of new moorings. Given the low number of equipment installations, the relatively small area of bottom substrate disturbance, the large geographic separation between installations, and the implementation of vessel operating procedures that avoid physical contact with sensitive substrates (e.g., coral, vegetated bottom, and hard-bottom), the physical impact on bottom habitat from equipment installation is expected to be small and not outside the range of natural variability.

Bottom grab sampling involves the targeted removal of sediment cores in approximately 54 projects annually in shallow marine and oceanic areas throughout the entire action area. Bottom grab samples inherently damage bottom substrate and could potentially reduce or damage existing underwater structure. This could result in reducing the availability of cover and shelter necessary for prey species or immature marine organisms to avoid predation. NOS sediment sampling activities would avoid sampling sensitive bottom substrates such as coral reefs, seagrass beds, and hard bottom areas. Given the low frequency, geographic separation, relatively small area of bottom substrate sampled (e.g., 6x6 inch area and two inches deep), and avoidance of sensitive habitat areas, the physical disturbance of bottom substrate within aquatic habitat areas associated with bottom grab sampling is expected to be very small and not outside the range of natural variability. Additionally, equipment such as AUVs would be programmed and operated to avoid sea floor disturbance, and stiffer line materials would be used for

[5] NMFS issued a final rule to remove Johnson's seagrass (*Halophila johnsonii*) from the federal list of threatened and endangered species on April 14, 2022. To correspond with this action, the critical habitat designation for Johnson's seagrass was also removed.

instrument deployment and kept taut during operations to reduce the potential for entanglement in bottom features such as coral habitats. NOS also operates dropped and towed cameras approximately 1 m (3 ft) above the sea floor, avoiding contact with bottom substrate to the extent possible.

Operations involving SCUBA divers may inadvertently cause disturbance to shallow marine bottom substrates. NOS SCUBA operations would include approximately 248 benthic and fish monitoring projects conducted on hard bottom and coral reef habitats annually; these areas contain shallow marine habitat characteristics necessary for many marine invertebrate and vertebrate species and are particularly sensitive to disturbances. Although just a very small component of NOS projects and mainly related to tide gauge installation/maintenance/removal projects (see Chapter 2), SCUBA divers in these areas could potentially reduce or damage existing underwater structure, reducing the availability of cover and shelter necessary for prey species or immature marine organisms to avoid predation, and potentially inducing cascading impacts throughout the food chain. NOS divers are trained to hover over the sea floor to avoid inadvertent disturbance of sediments and to place or handle equipment such that impacts to bottom habitat are avoided. Divers would not stand or rest on live corals or coral reefs, and bottom contact would only occur in unconsolidated areas or non-living hardbottom. Given the low risk of contact with the sea floor during diver operations and large geographic separation of diving projects throughout the action area, physical disturbances to bottom substrate from SCUBA operations are expected to be minimal and well within the range of natural variation.

The impacts from anchoring, drop/towed camera systems, equipment installation, bottom sample collection, and SCUBA operations under Alternative A would infrequently disrupt small areas of bottom substrate in aquatic habitat areas. These physical disruptions would be short-term and would not reduce the space, shelter/cover, or food availability in aquatic habitat areas outside of the range of natural variability. As such, impacts to all aquatic habitat areas from activities involving physical disturbance to bottom substrate under Alternative A would continue to be **adverse** and **negligible** to **minor,** and therefore **insignificant**.

3.4.2.2.2 Increase in Sedimentation, Turbidity, and/or Chemical Contaminants

Activities such as crewed vessel operations, ROV and autonomous vehicle operations, anchoring, collection of bottom grab samples SCUBA operations, and the installation or maintenance/removal of tide gauges and GPS reference stations could potentially increase the sedimentation, turbidity, and/or chemical contamination of all aquatic habitat areas throughout the action area, degrading their value to dependent species.

Crewed vessel, ROV, and autonomous vehicle operations in conjunction with all activities which physically contact bottom substrate (See 3.4.2.2.1) would increase sedimentation and turbidity in disturbed areas from bottom sediments loosened through displaced water from transiting vessels or physical contact with bottom substrate. High levels of sedimentation and turbidity can potentially cause direct respiratory damage to aquatic species and block sunlight necessary for photosynthesis by aquatic plants, macroalgae, and phytoplankton. These impacts could potentially lower the overall nutrient availability of affected habitat areas and could reduce the cover and structure available to dependent species from submerged vegetation or macroalgae. Furthermore, increases in suspended sediments and turbidity reduce the depth to which sunlight can penetrate, which changes the wavelengths of light reaching fish and benthic species.

Photosynthetic marine species are dependent on sunlight and often have a narrow band of wavelengths of light that they are able to use. Increased sedimentation and turbidity could inhibit photosynthesis in oceanic habitat areas, thus reducing nutrient cycling by marine phytoplankton and reducing shelter and cover provided by submerged plants and macroalgae. Suspended material may also react with dissolved oxygen (DO) in the water and result in temporary or short-term oxygen depletion to aquatic resources (e.g., vegetation and aquatic macroinvertebrates) and could further exacerbate impacts to habitat areas from reduced nutrient and cover availability. NOS crewed vessels, ROVs, and autonomous vehicle operations would be routed to avoid stirring up bottom sediments whenever possible and their impact on sedimentation and turbidity is expected to be minimal. Furthermore, given the low frequency, large degree of geographic separation, and small affected area of activities physically impacting bottom substrate, the resulting increases in sedimentation/turbidity would be very small and would likely settle back to the sea floor or dissipate with prevailing currents and winds relatively quickly (within seconds or minutes).

Crewed vessel, ROV, and autonomous vehicle operations may result in the discharge (mostly unintentional) of harmful substances including bilge water, debris, fuel, oil, and miscellaneous chemicals. The majority of contaminants, including oil and fuel, entering the aquatic environment are less dense than water and float on the surface until they evaporate, typically within several days (Neff et al., 2000). Floating contaminants typically would not affect habitat characteristics below the surface of the water, however contaminants introduced to shallow marine habitat areas could potentially harm seagrass ecosystems close to the water surface and could cause extensive mortality of the seabed (Zieman et al., 1984). Seagrass mortality would reduce the available cover and shelter that many marine species require to avoid predation, reproduce, and rear or develop offspring in addition to reducing food availability for seagrass foragers, including echinoderms, fish, manatees, and sea turtles.

Denser contaminants could also sink below the surface of the water and negatively impact coral colonies in shallow marine habitat areas through mortality, tissue death, reduced growth, impaired reproduction, bleaching, and reduced photosynthetic rates (Cook and Knap, 1983; Burns and Knap, 1989; Ballou et al., 1987). Reduction of corals would reduce the food, structure, and shelter necessary for prey species and would likely reduce the overall biodiversity of the area through cascading impacts throughout the food chain. Chemical contaminants could also cling or adhere to submerged structural features in all aquatic habitat areas, which could serve as an additional exposure vector to fish and aquatic macroinvertebrates and result in changes in growth rates or behavior, injuries, and death of exposed individuals. Bioaccumulation of some toxic chemicals could disproportionately impact higher-level predators which consume contaminated prey items, which could ultimately reduce top-down ecosystem regulation and degrade the nutrient availability of affected habitat areas.

The context and intensity of these impacts are contingent on the size, location, and chemical composition of the source discharge or spill. Small spills rarely occur during NOS activities, and large spills are unlikely given the size of vessels used during NOS projects. Given that operators of vessels used by NOS would strictly adhere to all applicable laws and regulations pursuant to the International Convention for the Prevention of Pollution from Ships (Marine Pollution [MARPOL] 73/78) (restricts onboard hazardous material use and the discharge of contaminants into the marine environment), and the low probability of accidental fuel spills, the likelihood of chemical contamination from vessels used by NOS, ROV, and autonomous vehicle operations would be relatively small. Impacts would be minimal especially when compared to similar disturbance and discharges from the much greater numbers of all other vessels occurring in the EEZ, lakes, and rivers.

Installation and removal of tide gauges or GPS reference stations on land along the shoreline could also increase the turbidity, sedimentation, and chemical contamination of the water column through run-off of disturbed soil. Increased sedimentation and turbidity could potentially lower the overall nutrient availability of affected coastal wetland and shallow marine habitat areas due to reduced photosynthesis by phytoplankton. Photosynthetic inhibition in these areas could also reduce the availability of cover and shelter created by submerged vegetation and macroalgae necessary for many species to avoid predation and develop offspring. Soil runoff also often includes chemical contaminants such as fertilizers or detergents with high levels of nitrates and phosphates. Influxes of nutrients or chemicals in shallow marine, estuarine, and coastal wetland habitat areas could potentially trigger algal blooms. Algal blooms are toxic for many marine species and they reduce DO concentrations, thus reducing the overall habitat quality of the affected area. NOS would only undertake approximately 32 projects that include tide gauge installations annually, and 30 projects that include tide gauge removal annually. Given the low frequency, large degree of geographic separation, relatively small affected area, and application of runoff control procedures during the installation and removal of tide gauges, the resulting increases in turbidity, sedimentation, and chemical contamination from these activities are expected to be minimal and temporary.

Overall, increased sedimentation, turbidity, and chemical contamination from all activities which physically contact bottom substrate under Alternative A would rarely occur and would largely be dissipated by prevailing currents or winds in seconds to minutes. These temporary reductions in water quality are not expected to substantially reduce the availability of space, shelter/cover, nutrients, or breeding/rearing grounds in any of the habitat types found throughout the action area outside the range of natural variability. Larger impacts could occur in the extremely unlikely event of a large spill; however, large spills are not expected to occur given the small size of vessels used in NOS projects and their adherence to hazardous material discharge regulations. As such, impacts to all aquatic habitat areas from increased sedimentation, turbidity, and/or chemical contaminants under Alternative A would continue to be **adverse** and **negligible** to **minor**, and therefore **insignificant**.

3.4.2.2.3 Increased Ambient Sound

Activities such as crewed vessel operations, ROV, and autonomous vehicle operations, and use of underwater acoustic equipment including echo sounders, ADCPs, and acoustic communication systems would increase the ambient sound level of affected aquatic habitats through the production of underwater sound. Increasing the ambient sound level could potentially degrade the habitat value of affected areas which would be manifested through impacts, such as behavioral disruption or injury to biological resources. Underwater sound adversely affects aquatic taxa variably, with effects differing considerably based on the frequency and intensity of the sound and the hearing sensitivity of the affected organism. Increased ambient sound levels are analyzed in this section for their potential impact on the various roles which biological resources have in their habitat, such as predator/prey interactions, as opposed to analyzing the impact on individual species. See Sections 3.5 to 3.10 for detailed discussions of the hearing capability of aquatic taxa present in the action area and the potential impacts on these species from vessel sound and underwater acoustic sources.

Crewed vessel, ROV, and autonomous vehicle operations would generate underwater sound and vibrations at low- to mid-frequencies that overlap with the hearing ranges of many aquatic prey species. Increases in the ambient sound level of aquatic habitat areas transited by vessels could potentially reduce the habitat quality of preferred feeding or breeding grounds and displace disturbed animals from these areas (Slabbekoorn et al., 2010). Increased ambient noise can also mask biologically important sounds which elicit predator-avoidance or mating behaviors, cause hearing loss, and/or generally have an adverse effect on an organism's stress levels and immune system (NOAA, 2016; Simpson et al., 2016). Reduction of prey species would reduce food and nutrient availability for top-level predators in aquatic habitat areas and could potentially result in cascading impacts throughout the local aquatic food chain and reduce biodiversity.

NOS crewed vessel transits would be infrequent in any given area and the exposure of prey species to vessel sound would be limited to the immediate vicinity of vessels. Exposure to vessel sounds would only persist for the duration of vessel transit through the habitat area. As such, prey species would only be temporarily exposed to vessel sound and likely would not change their behavior or habitat occupancy in the long-term. Furthermore, NOS vessel operations would represent a very small proportion of vessel traffic in the action area; therefore, the potential effects of sounds from vessels used by NOS would be minimal as compared to the aggregate effects from sound generated by all other ship traffic in the action area. The overall contribution to background sound in the ocean from vessels used by NOS would be very small. It would be unlikely that the exposure of prey species to these sounds would exceed the levels and lengths of time that would result in more than minimal adverse effects.

Use of active underwater acoustic sources would involve relatively high frequency, directional, and short duration, repeated signals which could increase the ambient sound environment of aquatic habitat areas. These instruments produce acoustic signals perceptible to several marine prey species; exposure of these marine prey species to this sound could result in the same adverse impacts to shallow marine and oceanic habitat areas as those discussed in the preceding paragraph. However, active acoustic underwater sources are typically only operated while a ship is in motion, thus habitat areas would only be exposed to emitted acoustic energy for a very short duration. Furthermore, these sources are highly directional in nature and the energy of their emitted acoustic signals would drop off rapidly with distance from the source. Therefore, impacts on marine prey species, if any, would be predominantly limited to temporary behavioral and stress-startle response, and likely would not substantially impact the overall habitat quality of any given area.

Sound from vessel operations, which would generate sounds in the mid- and low-level frequencies, are within the hearing range of most prey species, but would be infrequent, geographically widely distributed, and likely to elicit a minimal or temporary response. A majority of the sounds generated by underwater acoustic sources are well above the hearing frequencies of most prey species, thus, unlikely to cause behavioral disturbance and hearing impairment. Thus, activities under Alternative A that create underwater sound would continue to have **adverse** and **negligible** to **minor**, and therefore **insignificant** impacts on habitat.

3.4.2.2.4 Facilitated Dispersal of Invasive Species

Activities such as crewed vessel, ROV, and autonomous vehicle operations and the use of echosounders, sub-bottom profilers, ADCPs, acoustic communication systems, and sound speed data collection equipment entail the use of the same physical equipment and instruments in geographically disparate regions and could potentially facilitate the dispersal and establishment of invasive species in novel areas. This would degrade habitat value for native marine or terrestrial species.

NOS projects occur in all freshwater and marine regions of the action area and can potentially involve transit and surveying across large swaths of the action area using the same physical equipment and instrumentation. These longer voyages or projects could potentially inadvertently transport invasive macroinvertebrate larvae, vertebrate eggs or animals, plant seeds, or algae propagules in ballast water or on equipment surfaces to novel areas, thereby facilitating their dispersal and establishment (Gregory, 2009). Invasive species such as the lionfish (*Petrois spp.*), zebra mussel (*Dreissena polymorpha*), or Japanese wireweed (*Sargassum muticum*) have large numbers of offspring and limited or no natural threats or predators outside of their native habitat, allowing them to outcompete locally endemic species for space and nutrients (TISI, 2014).

Over time, the propagation of invasive species can result in cascading impacts to the local food chain through the extirpation of local predators and prey due to reduced nutrient cycling and availability. These impacts typically reduce the habitat value of affected areas in the long-term or permanently after the establishment of invasive species. These species and their resulting impacts persist until all invasive organisms are removed from a given area through aggressive trapping, harvesting, or use of pesticides such as glyphosate. All NOS projects would implement mandatory invasive species prevention procedures including, but not limited to, vessel and equipment washdown, cleaning, and de-ballasting (exchange of ballast water in open ocean waters for those vessels used by NOS that have ballast tanks). Proper implementation of these procedures would prevent most NOS equipment from serving as exchange vectors for invasive species; however, the possibility for the transmission of some invasive species would likely still exist. The majority of NOS projects would not transit to multiple areas consecutively, and NOS project crews would implement mandatory invasive species control procedures to limit or avoid hull fouling, use anti-fouling coatings, and clean hulls regularly to remove aquatic nuisance species, thus limiting the potential impact to habitat in the action area. Additionally, vessels used by NOS, however, compose only a very small proportion of vessel traffic in the action area and would likely contribute marginally to the overall transmission of invasive species.

NOS equipment and instruments used in consecutive projects in disparate geographically regions could potentially serve as transmission vectors for invasive species which could reduce the habitat value of their area of introduction by outcompeting endemic plants, animals, and algae. These impacts could potentially persist until invasive species are removed from these areas via aggressive management techniques and procedures. However, the vast majority of NOS projects would not transit to multiple areas consecutively and NOS project crews would implement mandatory invasive species control procedures, limiting the potential impact to habitat areas in the action area. Given its relatively low likelihood of occurrence, the **adverse** impact of invasive species dispersal facilitated by activities under Alternative A would likely continue to be **minor** and therefore **insignificant**.

3.4.2.2.5 Impacts to the Water Column

Activities such as crewed vessels, ROVs, and autonomous vehicles use of sound speed data collection equipment and bottom grab samplers, operation of drop/towed cameras and video systems, and SCUBA operations could potentially impact or disturb the water column of habitat areas during the movement of vessels, equipment or personnel.

Wakes from crewed vessels, ROVs, and autonomous vehicles would create turbulence and generate wave and surge effects in the water column. This displacement of water could temporarily disrupt important environmental gradients, including temperature, salinity, DO, turbidity, and nutrient supply. Propellers from vessels could also cause water column destratification and elevated water temperatures. Vessel movement through the water column may disrupt benthic communities in shallow areas and other prey species and cause mortality to floating eggs and larvae by physically damaging them with the hull or other ship parts, including the propulsion system. These disruptions would likely reduce the availability of space, shelter, and nutrients for dependent species within oceanic and shallow marine habitat areas. Disruptions could also potentially affect food chains and ultimately reduce the overall biodiversity of affected areas. However, the vast majority of impacts to habitat areas would be temporary as disturbance would be limited to the immediate vicinity of vessels and would only persist for the duration of transits or projects within the affected area.

Instruments, gear, and personnel that interact with the water column, including sound speed data collection equipment, bottom grab samplers, drop/towed cameras, anchors and chains, and SCUBA divers could temporarily cause turbulence and disturb or displace nearby benthic communities and other prey species. Reduction of prey species would reduce food and nutrient availability for top-level predators in aquatic habitat areas. This could potentially result in cascading impacts throughout the local aquatic food chain and reduce biodiversity. Lines connecting equipment to a vessel could also become entangled with, damage, or kill underwater structural habitat features such as seagrass or corals. Reduction of underwater structure would likely reduce the space, shelter, and cover necessary for the avoidance of predators by prey species and the rearing or development of offspring. Additionally, divers in SCUBA operations that would be conducted as part of various projects would move through the water column, this could temporarily disturb prey species and reduce their availability for higher-level predators. The vast majority of impacts to habitat areas would be temporary as disturbance would be limited to the immediate vicinity of instruments, gear, or personnel and would only persist for the duration of the activity. Mobile species would likely only be minimally displaced from project areas and would not experience long-term changes in the availability of space, structure, shelter, or nutrients outside the range of natural variability.

Vessels, equipment, and personnel used in activities conducted under Alternative A would disrupt the water column in project areas, potentially impacting their habitat quality by disturbing important environmental gradients, structure, and prey availability. However, the vast majority of these impacts would be limited to the immediate vicinity of vessels and would not persist beyond the duration of activities within the area. These temporary disruptions would not likely change the availability of space, shelter, cover, or nutrients necessary for dependent species outside of the range of natural variability. As such, impacts to habitat areas from water column disruptions under Alternative A would continue to be **adverse**, **negligible** and therefore **insignificant.**

3.4.2.2.6 Terrestrial Impacts from Tide Gauge Installation, Maintenance, or Removal

NOS onshore activities, such as the installation, maintenance, and removal of shore-based GPS reference stations and tide gauges, could potentially impact terrestrial habitat areas through disturbance of animals and the disturbance of onshore vegetation or topographical structure.

Sound and activity from both the access of remote locations and on-shore installation of tide gauges and GPS reference stations could cause temporary disturbance and behavioral changes in nearby animals, including terrestrial prey species. Repeated disturbances could result in long-term changes in terrestrial prey distributions and could ultimately reduce the overall biodiversity of habitat areas due to reduced nutrient cycling and availability. However, all disturbances would be limited to the immediate vicinity of the project area and would not persist beyond the conclusion of activity in the area. These responses would be well within the normal range of prey behavior; thus, onshore activities are not expected to contribute to any long-term changes in habitat occupancy, avoidance behavior, or energy expenditure in terrestrial prey.

The installation of semi-permanent monitoring equipment such as GPS reference systems and tide gauges could potentially reduce the quantity and quality of coastal terrestrial habitat. Many species of marine and terrestrial animals, including all ESA-listed bird species described in Sections 3.10.1.3.1 and 3.10.1.3.2 and ESA-listed sea turtles, breed and nest along the coast. During onshore activities, vegetation in and adjacent to the project area could be trampled by foot traffic, damaged, or cleared, thereby reducing cover and shelter necessary for terrestrial or marine animals to avoid predation, breed, and nurture offspring. However, the majority of onshore installations would only occupy very small portions of terrestrial habitat and any affected structural components would likely recover post-installation. Onshore installations are not expected to reduce the availability of space, shelter, cover, or nutrients necessary for dependent species in the long term.

Onshore activity would likely only displace terrestrial prey within the immediate vicinity of the project area and would not cause any mortality or direct injury. Onshore installations would only occupy very small portions of coastal terrestrial habitat areas and would not likely induce long-term changes in the availability of space, shelter, cover, or nutrients outside of the natural range of variation. Given the relatively low level of onshore activity anticipated, along with the short duration of exposure to sound and visual disturbance, the impact to terrestrial habitat areas, from NOS onshore activities under Alternative A would continue to be **adverse**, **negligible** to **minor**, and therefore **insignificant**.

3.4.2.2.7 Conclusion

Under Alternative A, NOS would continue to operate a variety of equipment and technologies to gather data on the marine and coastal environments at the level of effort reflecting current NOS funding levels. Since the effects of impact causing factors on habitat areas throughout the action area range from negligible to minor, the overall impact of Alternative A on habitat areas would continue to be **adverse, minor**, and therefore **insignificant**.

3.4.2.3 Alternative B: Conduct Surveying and Mapping Projects for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations

Projects under Alternative B would take place in the same geographic areas and timeframes as under Alternative A; however, Alternative B would include more projects, activities, and more nautical miles traveled, than Alternative A. Under Alternative B, NOS survey effort would cover a total of 2,912,753 nm (5,394,419 km) across all five regions over the five-year period. Overall, survey effort would cover an additional 264,796 nm (490,402 km) under Alternative B, an approximately 10 percent increase over Alternative A (2,647,958 nm [4,904,017 km] total) across all regions over the five-year period. The types and mechanisms of impacts would remain the same in Alternative B as discussed for Alternative A. Therefore, the difference between the two alternatives is primarily a matter of scale with increased activity levels distributed unevenly among the different types of activities. As such, effects under Alternative B would incrementally increase from those of Alternative A but would not differ fundamentally in type. **Table 3.4-5** presents the expected survey effort under Alternative B for each year by region.

Table 3.4-5. Survey Effort under Alternative B, by Geographic Region by Year

Region	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Survey Effort (in nautical miles)						
Greater Atlantic Region*	70,625	119,413	59,148	54,683	54,683	358,554
Great Lakes	3,722	3,080	3,080	3,080	3,080	16,042
Southeast Region	242,369	231,204	288,695	309,906	309,906	1,382,080
West Coast Region	65,514	63,700	61,571	64,024	64,024	318,833
Alaska Region	103,258	131,971	191,890	45,485	45,460	518,064
Pacific Islands Region	77,231	60,390	76,716	60,443	60,443	335,223

* Survey effort within the Great Lakes is included as part of the total GAR survey effort as well as presented separately.

Under Alternative B there would be crewed vessel operations covering 577,000 nm (1,070,000 km), as compared to 518,000 nm (959,000 km) under Alternative A. Vessel operations are amongst the most disruptive NOS activities to all habitat areas and could contribute to impacts through physical contact with bottom substrate, underwater vessel sound, vessel wake and underwater turbulence, and accidental spills of oil, fuel, or chemical contaminants. Although the amount of crewed vessel operations would be greater under Alternative B than under Alternative A, the additional 59,000 nm (109,000 km) would be distributed across the five regions of the EEZ. While these additional operations would result in greater impacts overall, the associated impact-causing factors would not be concentrated enough in any given area or habitat type to substantially increase the context and intensity of impacts (e.g., from negligible to minor). This relationship is consistent for all other impact causing factors from proposed activities, such as bottom substrate or onshore disturbance from the installation, maintenance, and removal of tide gauges and installation GPS reference stations (a combined 367 projects under Alternative A and 377 projects under Alternative B); and bottom substrate disturbance from anchoring, bottom sample collection, and trailing video equipment (a combined 140 projects under Alternative A and 156 projects under Alternative B).

Impacts of Alternative B on habitat areas throughout the action area would be the same or slightly, but not appreciably, larger than those discussed above under Alternative A for each impact causing factor given that impacts do not scale proportionally with survey effort. Impacts to habitat areas resulting from Alternative A would not cause long-term changes in the availability of space, shelter, cover, or nutrients necessary for dependent species and would not substantially increase in intensity with the increased level of effort of Alternative B. Overall, impacts on habitat areas under Alternative B would be **adverse**, **minor**, and therefore **insignificant**.

3.4.2.4 Alternative C: Upgrades and Improvements with Greater Funding Support

Projects under Alternative C would take place in the same geographic areas and timeframes as under Alternatives A and B; however, Alternative C would include more projects, activities, and more nautical miles traveled, than Alternatives A and B. Under Alternative C, NOS survey effort would cover a total of 3,177,549 nm (5,884,821 km) across all five regions over the five-year period. Overall, NOS survey effort would cover an additional 264,796 nm (490,402 km) under Alternative C, an approximately nine percent increase over Alternative B (2,912,753 nm [5,394,419 km] total) and 20 percent increase over Alternative A (2,647,958 nm [4,904,017 km] total) across all regions over the five-year period. The types and mechanisms of impacts would remain the same in Alternative C as discussed for Alternatives A and B. Therefore, the difference between the three alternatives is primarily a matter of scale with increased activity levels distributed unevenly among the different types of activities. As such, effects under Alternative C would incrementally increase from those of Alternative B, but would not differ fundamentally in type. **Table 3.4-6** presents the expected survey effort under Alternative C for each year by region.

Table 3.4-6. Survey Effort under Alternative C, by Geographic Region by Year

Region	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Survey Effort (in nautical miles)						
Greater Atlantic Region*	77,046	130,269	64,526	59,655	59,655	391,149
Great Lakes	4,060	3,360	3,360	3,360	3,360	17,500
Southeast Region	264,403	252,222	314,940	338,080	338,080	1,507,724
West Coast Region	71,470	69,491	67,168	69,845	69,845	347,818
Alaska Region	112,645	143,968	209,334	49,620	49,592	565,160

Region	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Survey Effort (in nautical miles)						
Pacific Islands Region	84,252	65,880	83,690	65,938	65,938	365,698

* Survey effort within the Great Lakes is included as part of the total GAR survey effort as well as presented separately.

Under Alternative C there would be annual crewed vessel operations covering 637,000 nm (1,180,000 km), as compared to 577,000 nm (1,070,000 km) under Alternative B and 518,000 nm (959,000 km) under Alternative A. Vessel operations are amongst the most disruptive NOS activities to all habitat areas and could contribute to impacts on through physical contact with bottom substrate, underwater vessel sound, vessel wake and underwater turbulence, and accidental spills of oil, fuel, or chemical contaminants. Although the amount of crewed vessel operations would be greater under Alternative C than under Alternative B, the additional 60,000 nm (111,000 km) would be distributed across the five regions of the EEZ.

While these additional operations would result in greater impacts overall, the associated impact-causing factors would not be concentrated enough in any given area or habitat type to substantially increase the context and intensity of impact (e.g., from negligible to minor). This relationship is consistent for all other proposed activities contributing potential impacts, such as bottom substrate or onshore disturbance from the installation, maintenance, and removal of tide gauges and installation GPS reference stations (a combined 377 projects under Alternative B and 383 projects under Alternative C); and bottom substrate disturbance from anchoring, bottom sample collection, and trailing video equipment (a combined 156 projects under Alternative B and 173 projects under Alternative C).

Impacts of Alternative C on habitat areas throughout the action area would be the same or slightly, but not appreciably, larger than those discussed above under Alternatives A and B for each impact causing factor. Impacts to habitat areas resulting from Alternatives A and B would not cause long-term decreases in the availability of space, shelter, cover, or nutrients necessary for dependent species and would not substantially increase in intensity with the increased level of effort of Alternative C. Overall, impacts on habitat areas under Alternative C would be **adverse**, **minor**, and therefore **insignificant**.

3.5 Marine Mammals

There are 70 species of marine mammals located throughout U.S. coastal and marine waters extending seaward to the limits of the U.S. EEZ (ECOS, No Date-a; NMFS, No Date-a). These species represent four classifications of marine mammals: Cetaceans (52 species of whales, dolphins, and porpoises), Pinnipeds (15 species of seals, sea lions, and walrus), Sirenians (one species of manatee), and Fissipeds (two species: sea otters and polar bears). Listings of species, including current status and region of occurrence, are provided in **Tables 3.5-1, 3.5-2, 3.5-3,** and **3.5-4**.

All marine mammals in U.S. waters are protected under the MMPA of 1972. The MMPA allows for agencies to organize marine mammals into separate stocks for management purposes. A stock is defined by the MMPA as a group of marine mammals of the same species or smaller taxa in a common spatial arrangement that interbreed when mature. Some species are further protected under the ESA of 1973. Under the ESA, a species is considered endangered if it is "in danger of extinction throughout all or a significant portion of its range." A species is considered threatened if it "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Under the MMPA, species or populations are considered depleted if they are below their optimum sustainable population level, or are listed as endangered or threatened under the ESA.

3.5.1 Affected Environment

The following sections provide discussions of marine mammal species or species group (where appropriate), including sound production and hearing, regional distribution, and descriptions of ESA-listed species. Due to the number of individual species that are present in the action area, this section provides detailed descriptions only of individual ESA-listed species in order to support interagency consultation. All USFWS MMPA species are also ESA-listed. Descriptions of all species in the action area that are not ESA-listed, as shown in **Tables 3.5-1**, **3.5-2**, **3.5-3**, and **3.5-4**, can be found on the NMFS web page at https://www.fisheries.noaa.gov/find-species (NMFS, No Date-a) and are incorporated here by reference.

3.5.1.1 Cetaceans (Baleen Whales and Toothed Whales)

Cetaceans are completely aquatic marine mammals; they feed, mate, calve, and suckle their young in the water. They are the most specialized mammalian swimmers. Some are capable of maintaining speeds up to 40 km (25 mi) per hour, diving to depths of at least 3,000 m (10,000 ft), and remaining submerged for up to 2 hours. The body is streamlined (limbs are tapered or lacking), and the tail is developed into horizontal flukes for propulsion. Cetaceans breathe through blowholes on top of the head (Sea Grant, 2015).

Cetaceans are grouped into two taxonomic suborders: the baleen whales (Mysticeti) and the toothed whales (Odontoceti). Mysticetes have two blowholes (**Figure 3.5-1**) and baleen plates (**Figure 3.5-2**) instead of teeth. They are filter feeders that forage for zooplankton and small fish by skimming or gulping huge amounts of prey and water; the water is then forced back out of the mouth past hundreds of baleen plates that act as sieves to trap the prey, which is then swallowed. Baleen whales are generally found in small groups (e.g., mother-calf pairs) or in loose associations, not in large groups, except during migration when they may be found in small groups of several individuals; large numbers of baleen whales may also congregate in feeding or calving areas. Odontocetes have teeth and one opening at their blowhole. Toothed whales tend to be social and live in groups. They use echolocation to detect objects in their environment, including their prey.

Figure 3.5-1. Humpback Whale with Two Blowholes

Photo credit: NOAA Photo Library

Figure 3.5-2. Humpback Whale Feeding (note Baleen Strainers)

Photo credit: NOAA Photo Library

All cetaceans are protected by the MMPA throughout their ranges, and some are designated as depleted. Many species are also federally listed under the ESA either throughout their ranges or for distinct population segments (DPS). Additionally, some species have critical habitat designated under the ESA. **Table 3.5-1** lists the 52 species of cetaceans (59 distinct species, subspecies, or DPS total) occurring throughout the action area; 15 mysticetes, 10 of which are ESA-listed as endangered, one listed as threatened, and three with designated critical habitat; and 44 odontocetes, four of which are ESA-listed as endangered, and three with designated critical habitat.

Table 3.5-1. Cetaceans Occurring in the Action Area

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Habitat
Baleen Whales - Mysticetes							
Bowhead whale	*Balaena mysticetus*	Yes: throughout its range	Endangered	NMFS	AR	No	Seasonal sea ice
Minke whale	*Balaenoptera acutorostrata*	No	--	NMFS	All	--	Shallow to deep waters, often coastal
Sei whale	*Balaenoptera borealis*	Yes: throughout its range	Endangered	NMFS	All	No	Primarily offshore pelagic deep and intermediate waters
Bryde's whale	*Balaenoptera edeni*	No	--	NMFS	GAR, SER, WCR, PIR	--	Shallow to deep waters
Rice's whale**	*Balaenoptera ricei*	Yes	Endangered	NMFS	SER	No	Shallow to deep waters
Blue whale	*Balaenoptera musculus*	Yes: throughout its range	Endangered	NMFS	All	No	Coastal and pelagic shallow, intermediate, and deep waters
Fin whale	*Balaenoptera physalus*	Yes: throughout its range	Endangered	NMFS	All	No	Mostly pelagic, continental slope intermediate and deep waters
Gray whale (Eastern North Pacific DPS)	*Eschrichtius robustus*	No	--	NMFS	WCR, AR	--	Inshore or shallow offshore continental shelf waters
Gray whale (Western North Pacific DPS)	*Eschrichtius robustus*	Yes	Endangered	NMFS	WCR, AR	No	Inshore or shallow offshore continental shelf waters
North Atlantic right whale	*Eubalaena glacialis*	Yes: throughout its range	Endangered	NMFS	GAR, SER	Yes	Coastal, shallow shelf waters, occasionally

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Habitat
							offshore intermediate and deep waters
North Pacific right whale	*Eubalaena japonica*	Yes: throughout its range	Endangered	NMFS	WCR, AR	Yes	Coastal, shallow shelf waters, occasionally offshore intermediate and deep waters
Humpback whale	*Megaptera novaeangliae*	Refer to discussion in Section 3.5.1.1.3.9	--	NMFS	All	--	Shallow to deep waters
Humpback whale (Mexico DPS)	*Megaptera novaeangliae*	Refer to discussion in Section 3.5.1.1.3.9	Threatened	NMFS	WCR, AR	Yes	Shallow to deep waters
Humpback whale (Central America DPS)	*Megaptera novaeangliae*	Refer to discussion in Section 3.5.1.1.3.9	Endangered	NMFS	WCR	Yes	Shallow to deep waters
Humpback whale (Western North Pacific DPS)	*Megaptera novaeangliae*	Refer to discussion in Section 3.5.1.1.3.9	Endangered	NMFS	AR, PIR	Yes	Shallow to deep waters
Toothed Whales – Odontocetes							
Baird's beaked whale	*Berardius bairdii*	No	--	NMFS	WCR, AR	--	Cold, deep, oceanic waters, occasionally near shore along narrow continental shelves
Beluga whale	*Delphinapterus leucas*	No	--	NMFS	AR	--	Shallow coastal waters, deep water, estuaries, and large river deltas

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Habitat
Beluga whale (Cook Inlet DPS)	*Delphinapterus leucas*	Yes: Cook Inlet stock	Endangered	NMFS	AR	Yes	Shallow coastal waters, deep water, estuaries, and large river deltas
Long-beaked common dolphin	*Delphinus capensis*	No	--	NMFS	WCR	--	Shallow, tropical, subtropical, and warmer temperate waters closer to the coast and on the continental shelf
Short-beaked common dolphin	*Delphinus delphis*	No	--	NMFS	GAR, SER, WCR, PIR	--	Oceanic and offshore, underwater ridges, seamounts, and continental shelf
Pygmy killer whale	*Feresa attenuata*	No	--	NMFS	GAR, SER, PIR	--	Deep water
Long-finned pilot whale	*Globicephala melas*	No	--	NMFS	GAR, SER	--	Pelagic
Short-finned pilot whale	*Globicephala macrorhynchus*	No	--	NMFS	All	--	Pelagic
Risso’s dolphin	*Grampus griseus*	No	--	NMFS	All	--	Pelagic over steep slopes, seamounts, and escarpments
Northern bottlenose whale	*Hyperoodon ampullatus*	No	--	NMFS	GAR	--	Pelagic deep water; known to forage in submarine canyons
Longman's beaked Whale	*Indopacetus pacificus*	No	--	NMFS	PIR	--	Warm, deep pelagic waters
Pygmy sperm whale	*Kogia breviceps*	No	--	NMFS	GAR, SER, WCR, PIR	--	Continental shelf edge, deep water

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Habitat
Dwarf sperm whale	*Kogia sima*	No	--	NMFS	GAR, SER, WCR, PIR	--	Continental shelf edge, deep water
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	No	--	NMFS	GAR, SER	--	Continental shelf, slope, and canyons
White-beaked dolphin	*Lagenorhynchus albirostris*	No	--	NMFS	GAR	--	Continental shelf waters, especially along shelf edge
Fraser's dolphin	*Lagenodelphis hosei*	No	--	NMFS	SER, PIR	--	Waters over 1,000 m (3,280 ft) deep
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	No	--	NMFS	AR, WCR	--	Continental margins, occasionally enter inshore passages
Northern right whale dolphin	*Lissodelphis borealis*	No	--	NMFS	WCR	--	Shelf and slope waters up to and >2,000m
Sowerby's beaked whale	*Mesoplodon bidens*	No	--	NMFS	GAR	--	Pelagic deep water of continental shelf edge and slopes
Hubbs' beaked whale	*Mesoplodon carlhubbsi*	No	--	NMFS	WCR	--	Pelagic deep water
Blainville's beaked whale	*Mesoplodon densirostris*	No	--	NMFS	GAR, SER, WCR, PIR	--	Pelagic deep water
Gervais' beaked whale	*Mesoplodon europaeus*	No	--	NMFS	GAR, SER	--	Pelagic deep water
Ginkgo-toothed beaked whale	*Mesoplodon gingkodens*	No	--	NMFS	WCR	--	Pelagic deep water
True's beaked whale	*Mesoplodon mirus*	No	--	NMFS	GAR, SER	--	Pelagic deep water, occasionally coastal

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Habitat
Perrin's beaked whale	*Mesoplodon perrini*	No	--	NMFS	WCR	--	Pelagic deep water
Lesser beaked whale	*Mesoplodon peruvianus*	No	--	NMFS	WCR	--	Pelagic deep water
Stejneger's beaked whale	*Mesoplodon stejnegeri*	No	--	NMFS	WCR, AR	--	Deep cold, temperate, and subarctic waters
Narwhal	*Monodon monoceros*	No	--	NMFS	AR	--	Deep-water beneath ice pack in winter, shallow water in summer
Killer whale	*Orcinus orca*	Yes: AT1 Transient Stock	--	NMFS	All	--	Open ocean waters to estuaries and fjords
Killer whale (Southern Resident DPS)	*Orcinus orca*	Yes	Endangered	NMFS	WCR	Yes	Open ocean waters to estuaries and fjords
Melon-headed whale	*Peponocephala electra*	No	--	NMFS	GAR, SER, WCR, PIR	--	Pelagic or around oceanic islands
Harbor porpoise	*Phocoena phocoena*	No	--	NMFS	GAR, SER, WCR, AR	--	Shallow coastal and shelf waters
Dall's porpoise	*Phocoenoides dalli*	No	--	NMFS	WCR, AR	--	Inshore to deep oceanic waters
Sperm whale	*Physeter macrocephalus*	Yes: throughout its range	Endangered	NMFS	All	No	Deep water, along continental slope
False killer whale	*Pseudorca crassidens*	No	--	NMFS	AR, SER, WCR, PIR	--	Deep offshore waters
False killer whale (Main Hawaiian Islands Insular DPS)	*Pseudorca crassidens*	Yes: Main Hawaiian Islands Insular stock	Endangered	NMFS	PIR	Yes	Deep offshore waters

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Habitat
Pantropical spotted dolphin	*Stenella attenuata*	No	--	NMFS	GAR, SER, PIR	--	Deeper waters
Clymene dolphin	*Stenella clymene*	No	--	NMFS	GAR, SER	--	Deep tropical, subtropical, and temperate waters throughout the Atlantic Ocean
Striped dolphin	*Stenella coeruleoalba*	No	--	NMFS	GAR, SER, WCR, PIR	--	Pelagic edge of continental shelf, occasionally coastal
Atlantic spotted dolphin	*Stenella frontalis*	No	--	NMFS	GAR, SER	--	Continental shelf waters <250 m (820 ft) deep
Spinner dolphin	*Stenella longirostris*	No	--	NMFS	GAR, SER, PIR	--	Pelagic and near oceanic islands
Rough-toothed dolphin	*Steno bredanensis*	No	--	NMFS	GAR, SER, WCR, PIR	--	Deep offshore waters
Bottlenose dolphin	*Tursiops truncatus*	Yes: Western North Atlantic Central Florida Coastal stock, Western North Atlantic Northern Florida Coastal stock, Western North Atlantic Northern Migratory Coastal stock, Western North Atlantic South Carolina-Georgia Coastal	--	NMFS	GAR, SER, WCR, PIR	--	Harbors, bays, gulfs, estuaries, nearshore coastal waters, deeper waters over the continental shelf, and far offshore pelagic

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Habitat
		stock, and Western North Atlantic Southern Migratory Coastal stock					
Cuvier's beaked whale	*Ziphius cavirostris*	No	--	NMFS	All	--	Pelagic deep water

Source: ECOS, No Date-a; NMFS, No Date-a

* GAR = Greater Atlantic Region (includes the U.S. portions of the Great Lakes, New England, and the mid-Atlantic); SER = Southeast Region (includes the southern portion of the U.S. Eastern Seaboard, the U.S. Caribbean Islands [Puerto Rico and the U.S. Virgin Islands], and the Gulf of Mexico); AR = Alaska Region (includes Alaskan waters and the Arctic); WCR = West Coast Region (includes coastal California, Oregon and Washington); PIR = Pacific Islands Region (includes Hawai'i and territories of the U.S.)

**Rice's whale was referred to as Bryde's whale in the Draft PEIS.

3.5.1.1.1 Cetacean Sound Production and Hearing

Cetaceans can vocalize and hear in a variety of frequency ranges underwater, but not all species have equal hearing capabilities in terms of absolute hearing sensitivity and the frequency band of hearing (Richardson et al., 1995; Southall et al., 2007; Au and Hastings, 2008). Odontocetes have a melon (mysticetes do not), which is a globular fatty organ that gives shape to the domed forehead, focuses and modulates the animal's vocalizations, and acts as a sound lens (Cranford et al., 1996); it is a key organ involved in communication and echolocation. While hearing measurements are available for a small number of species based on captive animal studies, direct hearing measurements of many odontocetes and all mysticetes do not exist. As a result, hearing ranges for many odontocetes are grouped with similar species, and predictions for mysticetes are based on other methods. In 2007, Southall et al. proposed that marine mammals be divided into hearing groups based on characteristics such as audible frequency range, auditory sensitivity, ear anatomy, and acoustic ecology (i.e., how they use sound). This division was updated by NMFS (2018a) using more recent best available science.

The low-frequency (LF) cetacean group contains all of the mysticetes. Although there have been no direct measurements of hearing sensitivity in any mysticete, an audible frequency range of approximately 10 Hz to 30 kHz has been inferred from observed vocalization frequencies, observed reactions to playback of sounds, and anatomical analyses of the auditory system (Finneran et al., 2017). Functional hearing for mysticetes as a group extends from approximately 7 Hz to 35 kHz, though the hearing range of individual species may not be as wide (Southall et al., 2007, 2019; NMFS, 2018a). A natural division may exist within the mysticetes, with some species (e.g., blue, fin) having better low-frequency sensitivity and others (e.g., humpback, minke) having better sensitivity to higher frequencies; however, at present there is insufficient knowledge to justify separating species into multiple groups (Southall et al., 2019). Therefore, a single species group is used for all mysticetes. Sound production for mysticetes can range between 0.2 kHz and 24 kHz (Southall et al., 2019). As an example, Girola et al. (2019) found source levels varied in humpback whales from 138 to 187 dB re 1 µPa m (root mean squared).

Mid- and high-frequency (HF) cetaceans are all odontocetes. Unlike the mysticetes, all odontocete cetaceans appear to have highly advanced echolocation systems that use intermediate to very high frequencies (tens of kHz to 100+ kHz). Most of them are also proven to produce social sounds in a lower-frequency band, including generally low to intermediate frequencies (1 kHz to tens of kHz) (Southall et al., 2007). Consequently, their functional hearing would be expected to cover a wider absolute frequency range than is assumed for mysticetes; however, their best hearing sensitivity typically occurs at or near the frequency where echolocation signals are strongest (Southall et al., 2007).

The mid-frequency (MF) cetacean group comprises dolphins and beaked whales (NMFS, 2018a). Hearing sensitivity has been directly measured for a number of species within this group using behavioral or auditory evoked potential measurements (Finneran et al., 2017). MF species are estimated to have lower and upper frequency limits of nominal hearing at approximately 150 Hz and 160 kHz (Southall et al., 2007, 2019; NMFS, 2018a). Sound production for MF cetaceans can range between 0.1 kHz and 148 kHz (Southall et al., 2019). As an example, Møhl et al. (2003) found source levels in sperm whales to be up to 236 dB re 1 µPa m (root mean squared).

The HF cetacean group comprises true porpoises, *Kogia*, river dolphins, *Cephalorhynchus*, *Lagenorhynchus cruciger* and *L. australis*. HF cetaceans generally possess a higher upper-frequency limit and better sensitivity at high frequencies compared to the MF cetacean species (Finneran et al., 2017). Functional hearing in this group was estimated to occur between 275 Hz and 160 kHz (Southall et al., 2007, 2019;

NMFS, 2018a). Sound production for HF cetaceans can range between 0.2 kHz and 200 kHz (Southall et al., 2019). As an example, Kyhn et al. (2013) found source levels varied in Dall's and harbor porpoises from 178 to 189 dB re 1 µPa m (root mean squared).

3.5.1.1.2 Regional Distribution of Cetaceans

Cetaceans are known to make wide-ranging movements and may not be present in a specific region year-round; however, some species do not migrate but may still exhibit seasonal movement patterns. The distribution of cetaceans is influenced by many factors, including ecological conditions, prey availability, anthropogenic activities, and physical features such as oceanic shelf edge or canyons; movements are most often associated with feeding or breeding.

Mysticetes are widely distributed throughout all major oceans. They are highly mobile and often move seasonally for food and breeding. Nearly all baleen whales undertake significant seasonal migrations. Many stocks return to the same breeding and/or feeding areas each year including humpback, gray, and the North Atlantic and North Pacific right whales (Reeves et al., 2002). Mysticetes often feed at high latitudes in summer, exploiting biologically productive areas, and move to lower latitudes during the winter to mate and calve. Exceptions include the Bryde's whale, which remains year-round in tropical and subtropical areas, and the pygmy right whale, which appears to remain in southern temperate and sub-polar waters (Reeves et al., 2002). Most baleen whale species calve in offshore areas. A few exceptions are some populations of humpback and right whales that inhabit shallow coastal, reef, or lagoon areas during the calving season.

Odontocetes are also widely distributed and occur in all major oceans. They are highly mobile and often move seasonally for food and breeding (Reeves et al., 2002). Many species remain year-round in tropical and subtropical areas, including the Fraser's dolphin and pygmy killer whale. Some are year-round residents in colder waters, with relatively small seasonal migrations (e.g., harbor porpoise). Others are more widespread, including the killer whale, sperm whale, and Cuvier's beaked whale. Some odontocetes undertake extensive seasonal migrations. For example, adult male sperm whales travel to high latitudes for summer feeding and back toward the equator for winter breeding (Reeves et al., 2002). Numerous odontocetes, such as the Atlantic white-sided dolphin and Pacific white-sided dolphin feed at high latitudes in summer, exploiting biologically productive areas. Calving and/or breeding can occur year-round throughout the range of some odontocetes. Others exhibit specific breeding/calving periods and/or locations. In general, species that occur in colder waters tend to calve in warmer months while those in tropical waters year-round show less seasonality.

Biologically important areas (BIAs) are spatially defined areas where aggregations of individual cetaceans display biologically important behaviors which are region-, species-, and time-specific. Identification of BIAs relates to understanding activities in which cetaceans are likely to be engaged at a certain time and place. For cetacean species with distinct migrations that separate feeding and breeding areas, three types of BIAs have been identified (Ferguson et al., 2015):

- Reproductive Areas: areas and months within which a particular species or population selectively mates, gives birth, or is found with neonates or other sensitive age classes;
- Feeding Areas: areas and months within which a particular species or population selectively feeds. These may either be found consistently in space and time, or may be associated with ephemeral features that are less predictable but can be delineated and are generally located within a larger identifiable area; and

- Migratory Corridors: areas and months within which a substantial portion of a species or population is known to migrate; the corridor is typically delimited on one or both sides by land or ice.

A fourth type of BIA has also been identified:

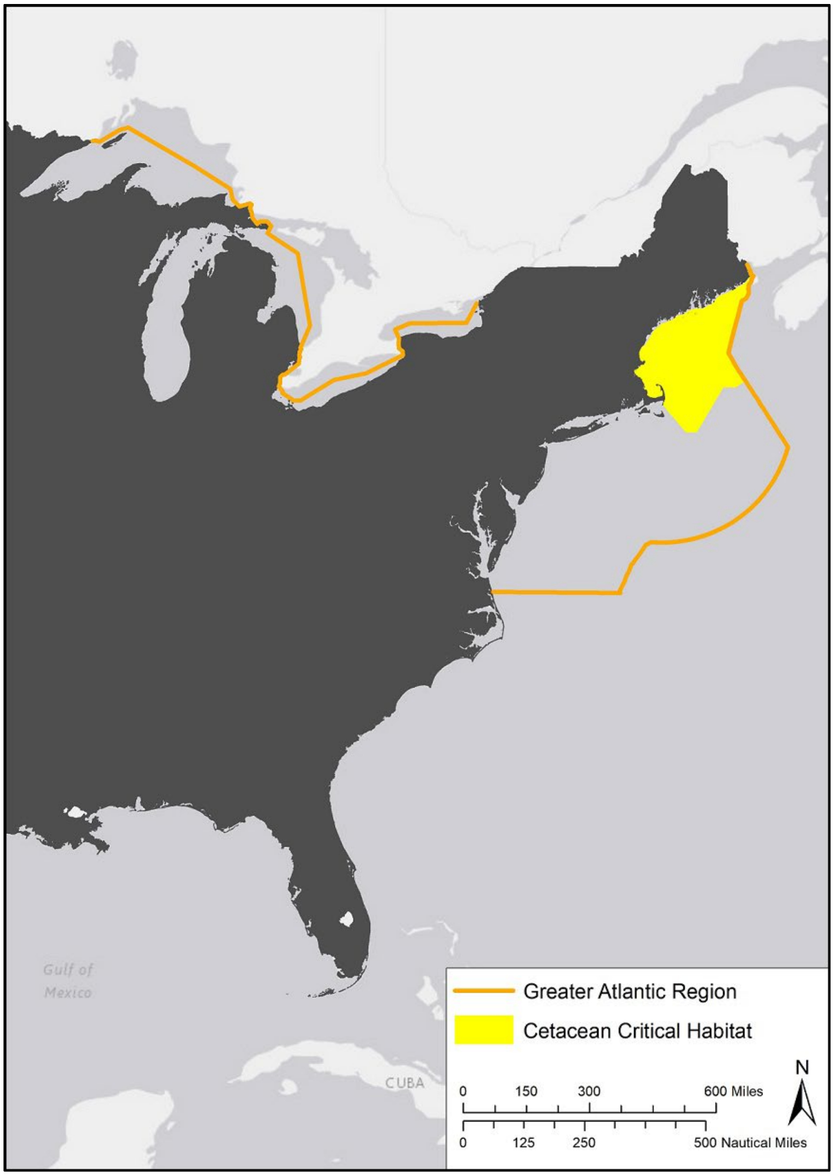
- Small and Resident Population: areas and months within which small and resident populations occupying a limited geographic extent exist.

Recognition of an area as biologically important for some species activity does not cause the area to rise to designation of critical habitat under the ESA. BIAs were created to help NOAA, other federal agencies, and the public in the analyses and planning used to characterize and minimize the impacts of anthropogenic activities on cetaceans and to achieve conservation and protection goals (Ferguson et al., 2015). BIAs occur in every region throughout the NOS action area, but they do not present the totality of important habitat throughout the marine mammals' full range. The stated intention is for the BIAs to serve as a resource management tool and for their currently identified boundaries to be considered dynamic and subject to change based on any new information.

Distribution of cetaceans in the geographic regions that comprise the NOS action area is described below.

3.5.1.1.2.1 Greater Atlantic Region

Thirty-three cetaceans (seven mysticetes and 26 odontocetes) occur in the Greater Atlantic Region, as indicated in **Table 3.5-1**. Four of the mysticetes are ESA-listed: the sei, blue, fin, and North Atlantic right whales. The North Atlantic right whale also has designated critical habitat in the region as shown in **Figure 3.5-3**. One of the odontocetes is ESA-listed: the sperm whale.

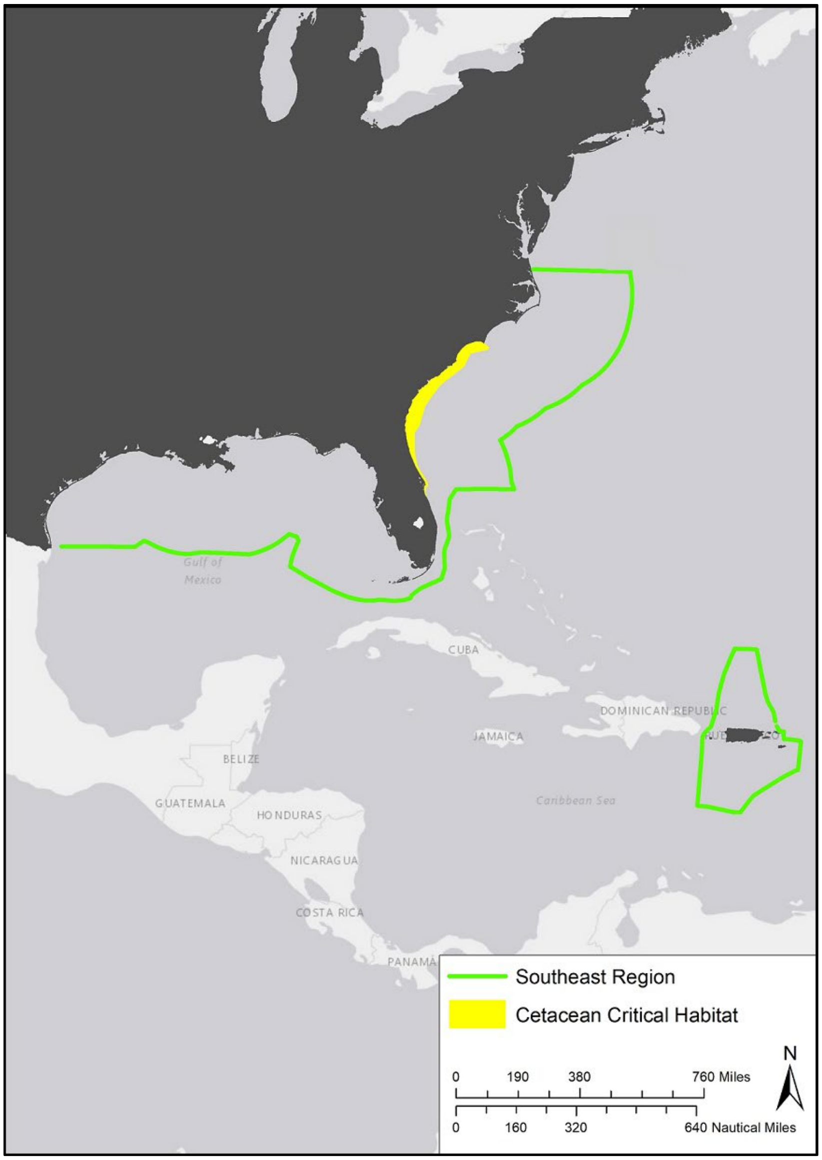


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.5-3. Cetacean Designated Critical Habitat in the Greater Atlantic Region

3.5.1.1.2.2 Southeast Region

Thirty-three cetaceans (eight mysticetes and 25 odontocetes) occur in the Southeast Region, as indicated in **Table 3.5-1**. Five of the mysticetes are ESA-listed: the sei, blue, fin, Rice’s whale, and North Atlantic right whales. The North Atlantic right whale also has designated critical habitat in the region as shown in **Figure 3.5-4**. One of the odontocetes is ESA-listed: the sperm whale.

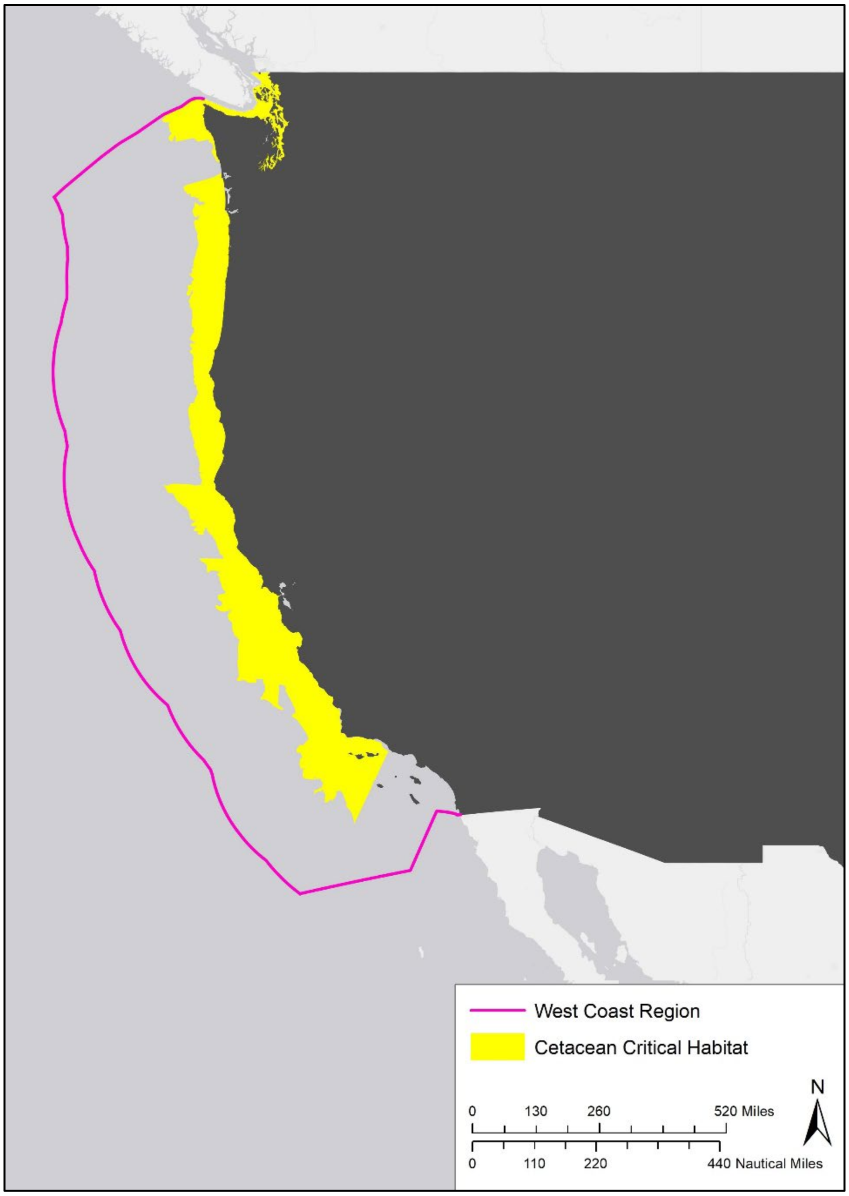


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.5-4. Cetacean Designated Critical Habitat in the Southeast Region

3.5.1.1.2.3 West Coast Region

Thirty-seven cetaceans (11 mysticetes and 26 odontocetes) occur in the West Coast Region, as indicated in **Table 3.5-1**. Seven of the mysticetes are ESA-listed: the sei, blue, fin, gray (Western North Pacific DPS), North Pacific right, humpback (Mexico DPS), and humpback (Central America DPS) whales. Two of the odontocetes are ESA-listed: the sperm and killer (Southern resident DPS) whales. The North Pacific right whale, humpback whale, and killer whale also have designated critical habitat in the region as shown in **Figure 3.5-5**.

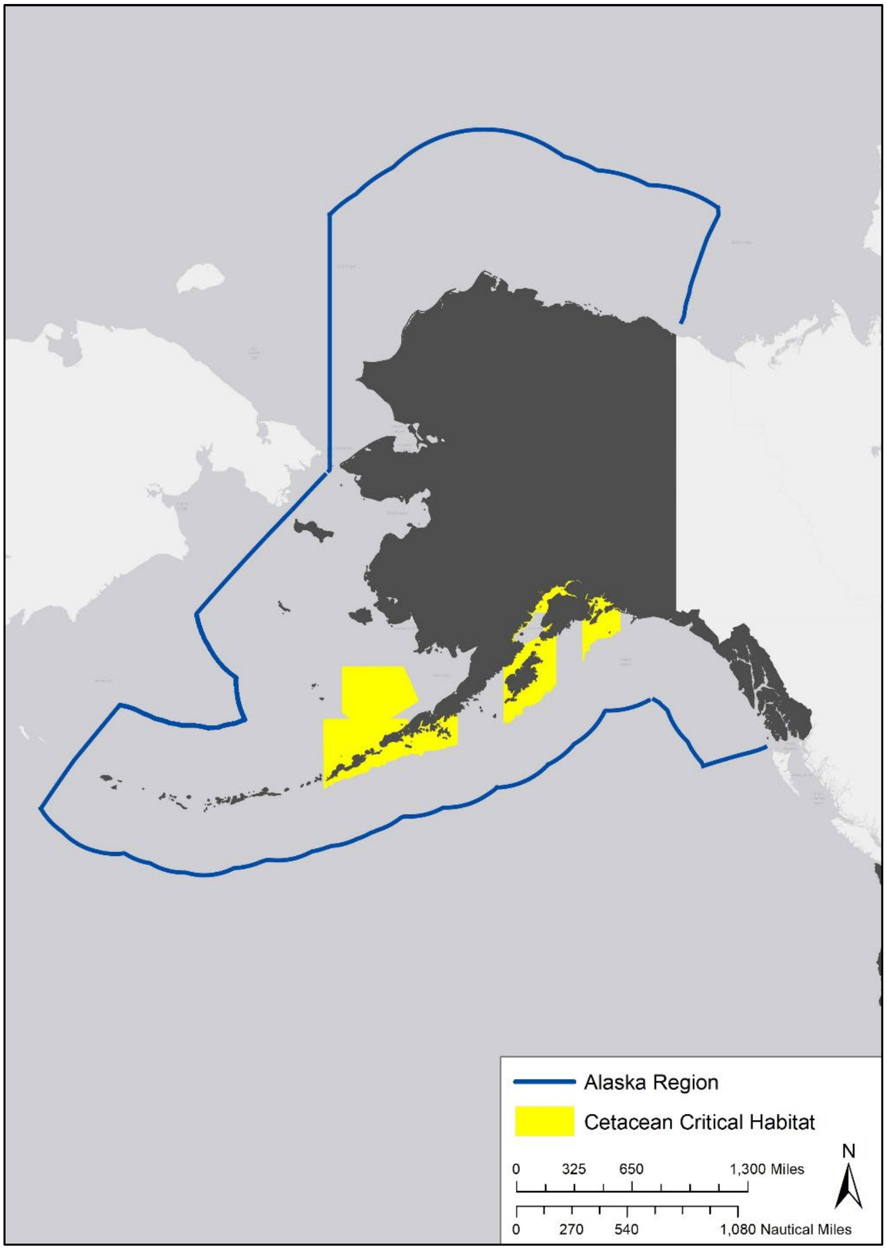


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.5-5. Cetacean Designated Critical Habitat in the West Coast Region

3.5.1.1.2.4 Alaska Region

Twenty-five cetaceans (11 mysticetes and 14 odontocetes) occur in the Alaska Region, as indicated in **Table 3.5-1**. Eight of the mysticetes are ESA-listed: the bowhead, sei, blue, fin, gray (Western North Pacific DPS), North Pacific right, humpback (Mexico DPS), and humpback (Western North Pacific DPS) whales. Two of the odontocetes are ESA-listed: the beluga (Cook Inlet DPS) and sperm whales. The North Pacific right whale, humpback whale, and beluga whale also have designated critical habitat in the region as shown in **Figure 3.5-6**.

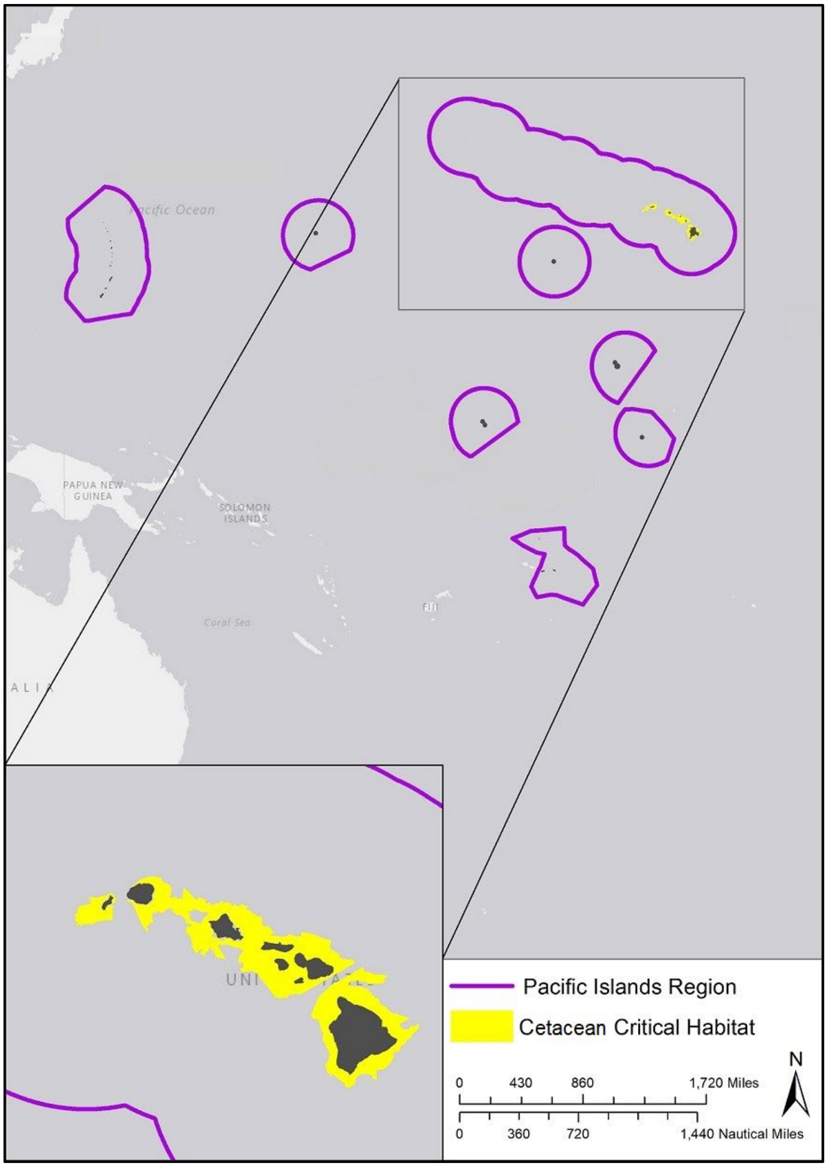


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.5-6. Cetacean Designated Critical Habitat in the Alaska Region

3.5.1.1.2.5 Pacific Islands Region

Twenty-seven cetaceans (seven mysticetes and 20 odontocetes) occur in the Pacific Islands Region, as indicated in **Table 3.5-1**. Four of the mysticetes are ESA-listed: the sei, blue, fin, and humpback (Western North Pacific DPS) whales. Two of the odontocetes are ESA-listed: sperm and false killer (Main Hawaiian Islands Insular DPS) whales. The false killer whale also has critical habitat in this region as shown in **Figure 3.5-7**.



Note: The critical habitat polygons shown in this map were digitized by hand and may contain manual errors. Care has been taken to align the polygons, to the extent practicable, with the *Main Hawaiian Islands Insular False Killer Whale Critical Habitat Designation Map* found at https://www.fisheries.noaa.gov/resource/map/main-hawaiian-islands-insular-false-killer-whale-critical-habitat-designation-map.

Figure 3.5-7. Cetacean Designated Critical Habitat in the Pacific Islands Region

3.5.1.1.3 Threatened and Endangered Cetaceans

Fifteen distinct populations of cetaceans are ESA-listed in the action area; eleven are mysticetes and four are odontocetes. Two listed mysticetes and three listed odontocetes also have designated critical habitat. These species are shown in **Table 3.5-1** and described in detail below. In some of the species descriptions below, species abundance is given as a best estimate of population size (due to sampling uncertainty), but also as a minimum population size, which is the lowest number of animals calculated to currently occur.

3.5.1.1.3.1 Bowhead Whale

Bowhead whales (**Figure 3.5-8**) are one of the few whale species that reside almost exclusively in Arctic and subarctic waters experiencing seasonal sea ice coverage, primarily between 60° and 75° north latitude (NMFS, No Date-a). Commercial whaling severely reduced bowhead whale numbers from historical levels. The economic value of the bowheads' oil and baleen, combined with their slow swimming speeds and tendency to float when killed, made them a prime target for whalers. By the time commercial whaling of bowheads effectively ended in 1921, the worldwide bowhead abundance had declined to less than 3,000 whales. Today, bowhead whales may be still threatened by loss of food sources, climate change, vessel strikes, entanglement in fishing gear, ocean noise, sound and activity from offshore oil and gas development, and chemical pollution.

The worldwide number of bowheads prior to commercial exploitation is estimated at a minimum of 50,000, including an estimated 10,400 to 23,000 whales in the Western Arctic stock, the stock found in U.S. waters (NMFS, No Date-a). The bowhead whale was listed as endangered under the ESA in 1973. Bowhead whales are also listed as depleted under the MMPA (i.e., they have fallen below their optimum sustainable population levels). Western Arctic bowheads have shown considerable recovery since the end of commercial whaling, and they now comprise the largest population of bowheads in the world. The most recent stock assessment reports abundance data for the Western Arctic bowhead stock, collected during spring 2011, indicating that there are over 16,000 Western Arctic bowheads (Muto et al., 2020).

Figure 3.5-8. Bowhead Whale and Calf

Photo Credit: NOAA National Ocean Service

Bowhead whales inhabit the Bering, Chukchi, and Beaufort seas, Hudson Bay and Foxe Basin, Baffin Bay and Davis Strait, the Sea of Okhotsk, and waters from eastern Greenland and Spitsbergen to eastern Siberia. They spend the winter near the southern limit of the pack ice and move north as the sea ice breaks up and recedes during spring. The bowhead whale's migration begins in the winter months from November to March. They travel from winter breeding grounds in the northern Bering Sea to the Chukchi Sea in the spring between March and June when most calving occurs. Between May and September they travel to the Canadian Beaufort Sea and spend the remainder of the summer in these waters. From September through December they return back to the Bering Sea to overwinter (Muto et al., 2020).

Bowhead whales live in areas often covered in thick ice and are capable of breaking through ice up to 60 centimeters (cm) (23 inches [in]) thick to manufacture breathing holes. They feed throughout the water column at the surface and on the bottom; the most prevalent prey are copepods, euphausiids, mysids, and gammarid amphipods. They may stay submerged for over an hour (Rugh and Shelden, 2009). Bowheads likely mate in late winter or early spring, although mating behavior has been observed at other times of the year. Calves are usually born between April and June, during the spring migration. The calving interval is about three to four years. Bowheads are exceedingly long-lived and may live to greater than 100-150 years of age (George et al., 1999).

3.5.1.1.3.2 Sei Whale

Sei whales occur in subtropical, temperate, and subpolar waters around the world, but they are most common in mid-latitude temperate zones. During the 19th and 20th centuries, sei whales were targeted and greatly depleted by commercial hunting and whaling, with an estimated 300,000 animals killed for their meat and oil (NMFS, No Date-a). Commercial whaling ended for this species in 1980. Although whaling is no longer a major threat, some scientific whaling continues today by Iceland and Japan. Vessel strikes, ocean noise, and entanglement with fishing gear pose the biggest threats to sei whales today. The sei whale was listed as endangered under the ESA in 1970, and it is listed as depleted under the MMPA.

Sei whales are usually observed alone or in small groups of two to five animals. They are fast swimmers that can reach speeds of over 55 km (34 mi) per hour. Sei whales dive differently than most whales as they do not arch their backs or show their flukes before diving; they simply sink below the surface. They can dive for five to 20 minutes to feed on plankton (including copepods and krill), small schooling fish, and cephalopods (including squid). They prefer to feed at dawn and may exhibit unpredictable behavior while foraging and feeding on prey (NMFS, No Date-a).

Sei whales prefer temperate waters in the mid-latitudes and can be found in the Atlantic, Indian, and Pacific Oceans. Sei whales have an unpredictable distribution. Many whales may be found in one area for a period and then not return for years or decades. This behavior is unusual for large whales, which generally have a predictable distribution. Sei whales are distributed far out to sea, most often over the continental slope, and do not often appear to be associated with coastal features (Carretta et al., 2020). At times, this general offshore pattern of sei whale distribution can be disrupted during episodic incursions into shallower, more inshore waters.

Sei whales within the Pacific U.S. EEZ are divided into three discrete, non-contiguous areas: 1) waters around Hawai'i; 2) California, Oregon, and Washington waters; and 3) Alaskan waters. Sei whales migrate to lower latitudes for breeding and calving in the winter and to higher latitudes in summer for feeding, including in the Gulf of Alaska and along the Aleutian Islands and the southern Bering Sea. The abundance of the eastern North Pacific stock is estimated at 519 animals with a minimum of 374 whales. The abundance of the Hawai'i stock is estimated at 391 with a minimum of 204 (Carretta et al., 2020).

There are two classified sei whale stocks within the Atlantic, the Nova Scotia stock and the Labrador Sea stock. The range of the Nova Scotia stock includes the continental shelf waters of the northeastern U.S. and extends northeastward to the south of Newfoundland. Sei whales are commonly sighted off Nova Scotia, the Gulf of Maine, and Georges Bank in spring and summer. The Nova Scotia stock size is estimated at 6,292 individuals with a minimum population of 3,098 (Hayes et al., 2020).

3.5.1.1.3.3 Rice's Whale

In 2019, NMFS listed the Gulf of Mexico Bryde's whale as an endangered subspecies under the ESA. It is also protected under the MMPA and designated as strategic and depleted. In 2021, NMFS revised the common and scientific name of the listed entity to Rice's whale and classification to species to reflect the new scientifically accepted taxonomy and nomenclature of the species. Thus, the previous Gulf of Mexico subspecies of Bryde's whale is now officially named Rice's whale. There is currently no designated critical habitat for this species; however, **Figure 3.5-9** shows the Rice's whale Core Distribution Area (CDA) and the 100 – 400 m (325 – 1,300 ft) isobath (i.e., depth contour) that the species occupies along the northwestern Gulf of Mexico shelf break (NMFS, No Date-a; Roberts et al., 2015a; 2016a; Soldevilla et al., 2022).

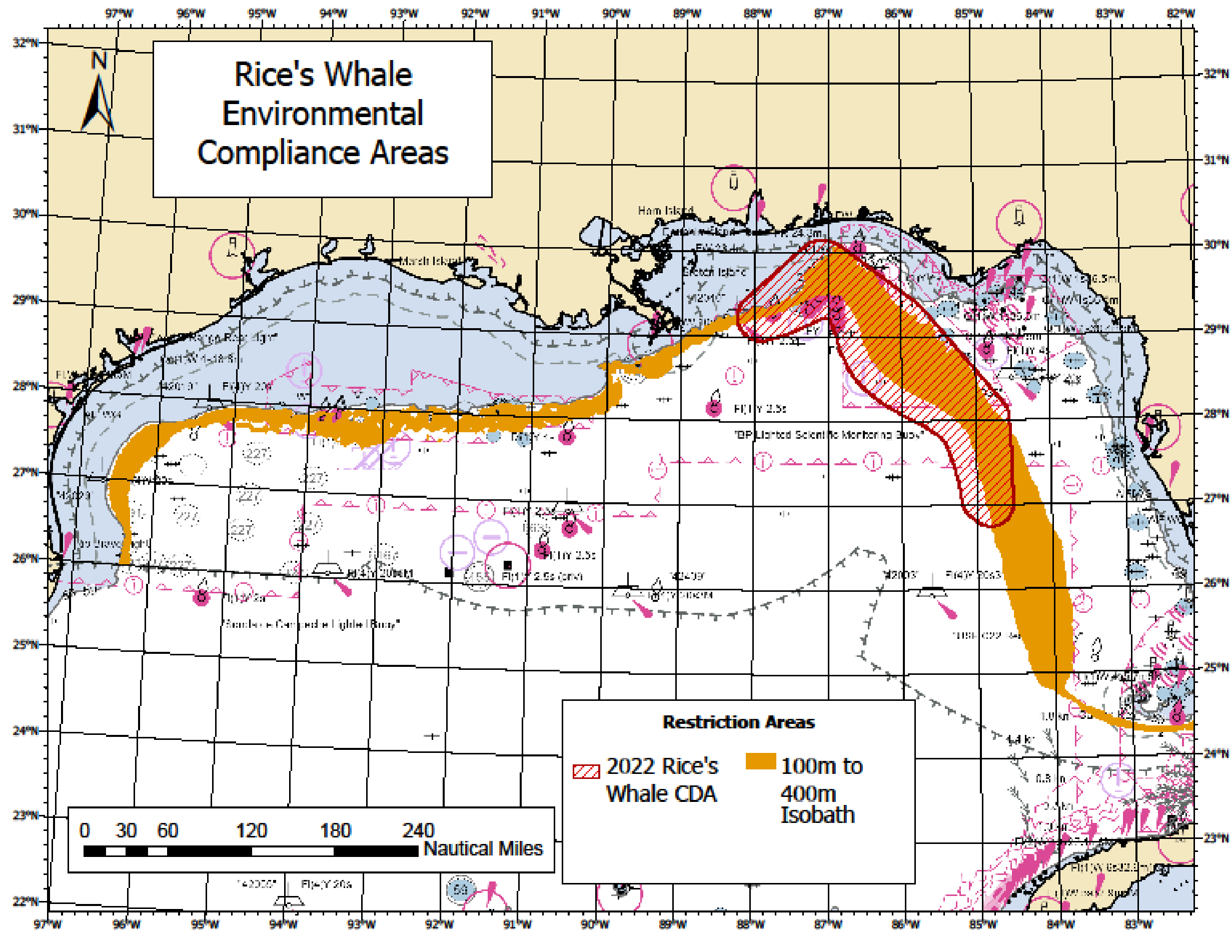


Figure 3.5-9. Core Distribution Area for the Rice's Whale in the Gulf of Mexico

Rice's whale is the only resident baleen whale in the Gulf of Mexico and is most closely related to Bryde's whales. In 2021 scientists determined that the Rice's whale was a unique species, genetically and morphologically distinct from Bryde's whales (NMFS, No Date-a). The Rice's whale's very small population size and limited distribution increase its vulnerability to threats. The most significant threats they face are energy exploration and development, oil spills and spill response, vessel strikes, ocean noise, ocean debris, aquaculture, and entanglement in fishing gear (NMFS, No Date-a). With such a small population size, the death of a single whale due to any of these stressors could have devastating consequences for the population's recovery.

The historical distribution of Rice's whales may have once encompassed the northern and southern Gulf of Mexico (NMFS, No Date-a). For the past 25 years, Rice's whale has been consistently located in the northeastern Gulf of Mexico, along the continental shelf break between 100 and about 400 m (325 to 1,300 ft) depth. A single Rice's whale was observed in the western Gulf of Mexico off the coast of Texas, suggesting that their distribution may occasionally include waters elsewhere in the Gulf of Mexico. Research is currently being conducted to better understand Rice's whales' distribution (e.g., if they use the western Gulf of Mexico and Mexican waters of the southern Gulf of Mexico, and how frequently they may occur in these other areas). Rice's whale is one of the few types of baleen whales to prefer warmer, tropical waters and that does not make long-distance migrations. Rice's whale is one of the few types of baleen whales that does not migrate; they remain in the Gulf of Mexico year-round.

Rice's whales are usually seen alone or in pairs, but may form larger, loose groups associated with feeding (NMFS, No Date-a). Limited data suggest that Rice's whales spend the daytime diving near the sea floor bottom and the majority of their time at night near the water's surface. Little is known about their foraging ecology and diet. However, data from two Rice's whales suggest they may mostly forage at or near the sea floor. This is in contrast to Bryde's whales that have been observed feeding in the water column and near the surface on small crustaceans and schooling fish such as anchovy, sardine, mackerel, and herring.

When the ESA status review was completed in 2016, the team of scientists conducting the review concluded that there were likely fewer than 100 individual Rice's whales throughout the Gulf of Mexico, with 50 or fewer being mature individuals (NMFS, No Date-a). The most recent abundance estimate from 2017–2018 surveys in the northeastern Gulf of Mexico is approximately 51 individual Rice's whales. With the minimum population estimate for the northern Gulf of Mexico at 34 animals (Hayes et al., 2022), Rice's whales are one of the most endangered whales in the world. Recovery of the species depends upon the protection of each remaining whale.

3.5.1.1.3.4 Blue Whale

Blue whales are found in all oceans except the Arctic Ocean. They are the largest cetacean, and they feed almost exclusively on krill. Fish and copepods may also occasionally be part of the blue whale's diet. The number of blue whales in the world's oceans is only a small fraction of what it was before modern commercial whaling significantly reduced their numbers during the early 1900s, but populations are increasing globally (NMFS, No Date-a). The northern hemisphere subspecies of blue whale was listed as endangered under the ESA in 1970, and they are listed as depleted under the MMPA. The primary threats currently facing blue whales are vessel strikes and entanglements in fishing gear.

There are five currently recognized subspecies of blue whales; the subspecies *Balaenoptera musculus* is present in the U.S. EEZ. On the west coast, there are two populations of North Pacific blue whales with some degree of geographic overlap – the Eastern North Pacific stock and the Central North Pacific stock (Carretta et al., 2020). The regional occurrence patterns suggest that blue whales from the Eastern North Pacific stock winter off Mexico, Central America, and as far south as 8° south, and feed during summer off the U.S. West Coast and to a lesser extent in the Gulf of Alaska. Blue whales belonging to the Central Pacific stock appear to feed in summer southwest of the Kamchatka Peninsula, in the Russian Far East, south of the Aleutians, and in the Gulf of Alaska, and in winter migrate to lower latitudes in the western and central Pacific, including Hawai'i. Both populations occur in lower latitudes in the central North Pacific, but differ in their seasonal patterns.

The best population estimate for blue whales in the Eastern North Pacific stock is 1,898 animals, with a minimum estimate of 1,767 animals (Carretta et al., 2022). Because whales in this stock spend approximately three quarters of their time outside the U.S. EEZ, the potential biological removal level allocation for U.S. waters is one-quarter of this total. The best population estimate for blue whales in the Central North Pacific stock is 133 animals, with a minimum estimate of 63 animals; this is based on a summer/fall abundance estimate, but the majority of blue whales would be expected to be at higher latitudes feeding grounds at this time of year (Carretta et al., 2020).

Blue whales sometimes swim in small groups but are mostly found alone or in pairs. Blue whales generally migrate seasonally between summer feeding grounds in polar waters and winter breeding grounds towards the equator, but some evidence suggests that individuals remain in certain areas year-round (NMFS, No Date-a). Information about distribution and movement varies with location, and migratory routes are not well-known. In general, distribution is driven largely by food requirements as they occur in waters where krill is concentrated. In the North Atlantic Ocean, their range extends from the subtropics to the Greenland Sea. Blue whales have been sighted in the waters off eastern Canada, in the shelf waters off the eastern U.S., and infrequently in the Gulf of Mexico and the Caribbean. Along the west coast of the U.S., eastern North Pacific blue whales are believed to spend winters off of Mexico and Central America. They likely feed during summer off the U.S. west coast and, to a lesser extent, in the Gulf of Alaska and central North Pacific waters. Blue whales with young calves have been observed often in the Gulf of California (Sea of Cortez) from December through March. Thus, at least some calves may be born in or near the Gulf of California; this area is probably an important calving and nursing area for the species.

The blue whale is an occasional visitor in U.S. Atlantic EEZ waters, which may represent the current southern limit of its feeding range in the Atlantic. In the western North Atlantic Ocean, the blue whale's range extends from the Arctic to Cape Cod, Massachusetts, and it is frequently sighted off eastern Canada (e.g., Newfoundland). Blue whales have been identified as far south as Bermuda. Blue whales show a strong preference for shelf breaks, sea mounts, or other areas where food resources are known to occur, even during summer months. Blue whales do not have specific breeding or calving areas.

3.5.1.1.3.5 Fin Whale

The fin whale is the second-largest species of cetacean. It is found throughout the world's oceans. During the summer, fin whales feed on krill, small schooling fish (including herring, capelin, and sand lance), and squid. Fin whales fast in the winter while they migrate to warmer waters. Like all large whales, fin whales were hunted by commercial whalers, which greatly lowered their population. Whaling is no longer a major threat for this species as commercial whaling ended in the 1970s and 1980s, though some hunting continues today in Greenland through subsistence whaling allowances (NMFS, No Date-a). The biggest threat to fin whales comes from vessel strikes; entanglement in fishing gear, lack of prey due to overfishing, and ocean noise also threaten this species. The fin whale was listed as endangered under the ESA in 1970, and it is listed as depleted under the MMPA.

Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes. They are less common in the tropics. They occur year-round in a wide range of locations, but the density of individuals in any one area changes seasonally. Most migrate from the Arctic and Antarctic feeding areas in the summer to tropical breeding and calving areas in the winter. The overall migration pattern is complex and specific routes have not been documented (NMFS, No Date-a).

The location of winter breeding grounds is not known. Surveys indicate a southward flow pattern in the fall from the Labrador-Newfoundland region, past Bermuda, and into the West Indies. The fin whale is the most common whale sighted in northwest Atlantic waters from Cape Hatteras, North Carolina to Maine; New England waters represent a major feeding ground (Hayes et al., 2020). Within the U.S. waters in the Pacific Ocean, fin whales are found seasonally off the coast of North America and in the Bering Sea during the summer (Muto et al., 2020). Some fin whales feed in the Gulf of Alaska, including near the entrance to Cook Inlet, and during the months of July and August they are concentrated in the Bering Sea and eastern Aleutian Island area. From September to October, most fin whales are in the Bering Sea, Gulf of Alaska, and along the U.S. coast as far south as Baja, California. There may be resident groups of fin whales in some areas, such as the Gulf of California. Fin whales have been considered rare in Hawaiian waters and are absent to rare in eastern tropical Pacific waters (Carretta et al., 2020). Fin whales travel in the open seas, away from the coast, so they are difficult to track.

For management purposes, fin whales in U.S. waters are divided into four stocks: Hawai'i, California/ Oregon/Washington, Alaska (Northeast Pacific), and Western North Atlantic. Reliable, recent population estimates are available for much of the North Atlantic Ocean, but not for most of the North Pacific or the South Pacific. Population estimates are 6,802 fin whales in the Western North Atlantic stock with a minimum estimate of 5,573 animals; 3,168 individuals in the Northeast Pacific stock with a minimum estimate of 2,554 animals with a minimum estimate of 2,554 animals; 11,065 in the waters off of California, Oregon, and Washington with a minimum estimate of 7,970 animals; and 203 for the Hawai'i stock with a minimum estimate of 101 animals (Carretta et al., 2022; Muto et al., 2022; Hayes et al., 2022). The estimate for the entire North Pacific is between 14,000 and 18,000. The number of fin whales in the southern hemisphere is around 82,000 (NMFS, No Date-a).

3.5.1.1.3.6 Gray Whale (Western North Pacific Distinct Population Segment)

Once common throughout the Northern Hemisphere, gray whales are now mainly found in the shallow coastal waters in the North Pacific Ocean. Commercial whaling brought both Pacific populations to near extinction. Conservation measures were enacted in the 1930s and 1940s to protect whales from over exploitation, and in the mid-1980s, the International Whaling Commission instituted a moratorium on commercial whaling (NMFS, No Date-a). Gray whales are known for their curiosity toward boats and are the focus of whale watching; thus, they face threats from vessel strikes and disturbance on their migration route. The eastern population of gray whales which occurs in the action area was once listed as endangered under the ESA but successfully recovered and delisted in 1994. The species is protected under the MMPA throughout its range, but the eastern population is non-strategic and is not considered depleted (Carretta et al., 2020). The western population remains very low and is listed as endangered under the ESA and depleted under the MMPA.

There are two geographic distributions of gray whales in the North Pacific: the Eastern North Pacific stock, found along the west coast of North America, and the Western North Pacific stock, found along the coast of eastern Asia. Most eastern North Pacific gray whales spend the summer in the shallow waters of the northern and western Bering Sea and in the adjacent waters of the Arctic Ocean; however, some remain throughout the summer and fall along the Pacific coast as far south as southern California (NMFS, No Date-a). In the fall, gray whales migrate from their summer feeding grounds, heading south along the coast of North America to spend the winter in their wintering and calving areas in sheltered waters off the coast of Baja California, Mexico. From mid-February to May, eastern North Pacific gray whales can be seen migrating northward along the U.S. west coast. Gray whales are by far the most coastal of all the great whales and inhabit primarily inshore or shallow, offshore continental shelf waters of the North Pacific. They tend to be nomadic, highly migratory, and tolerant of climate extremes (Caretta et al., 2020).

The presence of individuals from the Western North Pacific stock of gray whales in the action area is considered extralimital. During summer and fall, the Western North Pacific stock feeds in the Okhotsk Sea, Russia. Historically, wintering areas included waters off Korea, Japan, and China. Recent tagging, photo-identification, and genetics studies revealed that some gray whales from this stock migrate to the eastern North Pacific in winter, including waters off Canada, the U.S., and Mexico (Caretta et al., 2020).

The population size of the Eastern North Pacific stock has increased over several decades and is stable or still increasing (Carretta et al, 2020). Monitoring over the last 30 years has provided data that have indicated the Eastern North Pacific population and stock is within range of its optimum sustainable population, which is consistent with a population approaching the carrying capacity of the environment. The current estimated abundance for the Eastern North Pacific stock is 26,960 whales, with a minimum population estimate of 25,849 (Carretta et al., 2020). The Western North Pacific stock of gray whales was once considered extinct, but now small numbers are known to exist (Carretta et al., 2020). Based on photo-identification studies off Sakhalin Island, Russia, estimated abundance of the Western North Pacific stock is 290, with a minimum estimate of 271 gray whales off Sakhalin (Carretta et al., 2020).

3.5.1.1.3.7 North Atlantic Right Whale

The North Atlantic right whale (**Figure 3.5-10**) is one of the world's most endangered large whale species. By the early 1890s, commercial whalers had hunted right whales in the Atlantic to the brink of extinction. Whaling is no longer a threat, but human interactions still present the greatest danger to this species (NMFS, No Date-a). The leading causes of known mortality for North Atlantic right whales are entanglement in fishing gear and vessel strikes; for the period 2011 through 2015, the minimum rate of annual human-caused mortality and serious injury to right whales averaged 5.36 per year (Hayes et al., 2020). Other threats include ocean noise, climate change, disturbance from whale watching activities, and lack of food.

Figure 3.5-10. North Atlantic Right Whale

Photo credit: NOAA Photo Library

North Atlantic right whales were listed as endangered under the ESA in 1970, and they are listed as depleted under the MMPA. North Atlantic right whales represent one of the most intensely studied populations of cetaceans in the world, supported by a rigorously maintained individual sightings database and considerable surveys throughout their range. The current estimated abundance for this species is 368 whales, with a minimum population estimate of 364 animals (Hayes et al., 2022).

North Atlantic right whales primarily occur in Atlantic coastal waters or close to the continental shelf, although movements over deep waters are known (NMFS, No Date-a). New England waters are important feeding habitats for right whales, where they feed primarily on copepods. Right whales feed anywhere from the water's surface to the bottom of the water column.

Right whales migrate seasonally and may travel alone or in small groups. In the spring, summer, and fall they are found in their northern habitats, where they feed and mate. Each fall, some right whales travel more than 1,600 km (1,000 mi) from their feeding grounds off the Canadian Maritimes and New England to the warm coastal waters off South Carolina, Georgia, and northeastern Florida. During winter, pregnant females give birth in the only known North Atlantic right whale calving area off the southeastern U.S. in shallow, coastal waters. However, the location of much of the population is unknown during the winter.

Surveys have demonstrated the existence of seven areas where western North Atlantic right whales aggregate seasonally: the coastal waters of the southeastern U.S.; the Great South Channel (south of the Gulf of Maine); Jordan Basin (within the Gulf of Maine); Georges Basin along the northeastern edge of Georges Bank; Cape Cod and Massachusetts Bays; the Bay of Fundy; and the Roseway Basin on the Scotian Shelf (Hayes et al., 2020). They are present year-round in the Gulf of Maine. Movements within and between habitats are extensive, and the area off the mid-Atlantic states is an important migratory corridor.

There are two designated critical habitat areas determined to provide important feeding, nursery, and calving habitat for the North Atlantic population of right whales. One is a foraging area off the coast of New England; the other is a calving area off the southeast U.S. coast from Cape Fear, North Carolina to below Cape Canaveral, Florida (NMFS, No Date-a).

3.5.1.1.3.8 North Pacific Right Whale

North Pacific right whales are the rarest of all large whale species and among the rarest of all marine mammal species. In past years, commercial whaling greatly reduced right whale populations in the Pacific Ocean. Whaling is no longer a threat, but human activity such as entanglement in fishing gear and marine debris, vessel strikes, impacts from climate change, and ocean noise continue to endanger this species (NMFS, No Date-a). Subsistence hunters in Alaska and Russia do not hunt animals from the Eastern North Pacific right whale stock (Muto et al., 2020).

North Pacific right whales have been listed as endangered under the ESA since 1970, and they are designated as depleted under the MMPA. In 2008, NMFS relisted the North Pacific right whale as endangered as a separate species (*Eubalaena japonica*) from the North Atlantic species (*E. glacialis*). The principal habitat requirements for right whales are dense concentrations of prey, so on this basis, two areas of critical habitat were proposed: one in the southeastern Bering Sea and another south of Kodiak Island. (The primary prey for right whales on the Bering Sea shelf is the copepod *Calanus marshallae* [Muto et al., 2020]). In 2006, NMFS issued a final rule designating these two areas as northern right whale critical habitat. In 2008, the same two areas were redesignated as Eastern North Pacific right whale critical habitat under the newly recognized species name, *E. japonica*.

The North Pacific right whale population is very small, and most sightings have been of single whales, though small groups have been sighted (Muto et al., 2018; NMFS, No Date-a). From 1962 to 1999, there were only 82 published sightings of right whales in the entire eastern North Pacific, with the majority of these occurring in the Bering Sea and adjacent areas of the Aleutian Islands; this surprising lack of sightings ultimately led to the discovery that right whales had been subject to large illegal catches by the former U.S.S.R. (Muto et al., 2020). The current estimated abundance for the Eastern North Pacific stock is 31 whales, with a minimum population estimate of 26 individuals (Muto et al., 2020).

North Pacific right whales have occurred historically in all the world's oceans from temperate to subpolar latitudes. Most right whale sightings since 1996 have occurred in the southeastern Bering Sea, with a few records in the Gulf of Alaska near Kodiak Island, Alaska (Muto et al., 2020). Since 1996, right whales have been observed repeatedly in their critical habitat in the southeastern Bering Sea during the summer months. Migration patterns of the North Pacific right whale are unknown, although it is thought that the whales spend the summer in far northern feeding grounds and migrate south to warmer waters, such as southern California, during the winter. Right whales calve in coastal waters during the winter months, but calving grounds have not been identified in the eastern North Pacific. Worldwide, most known right whale nursery areas are in shallow, coastal waters (Muto et al., 2020; NMFS, No Date-a).

3.5.1.1.3.9 Humpback Whale (Mexico DPS, Central America DPS, and Western North Pacific DPS)

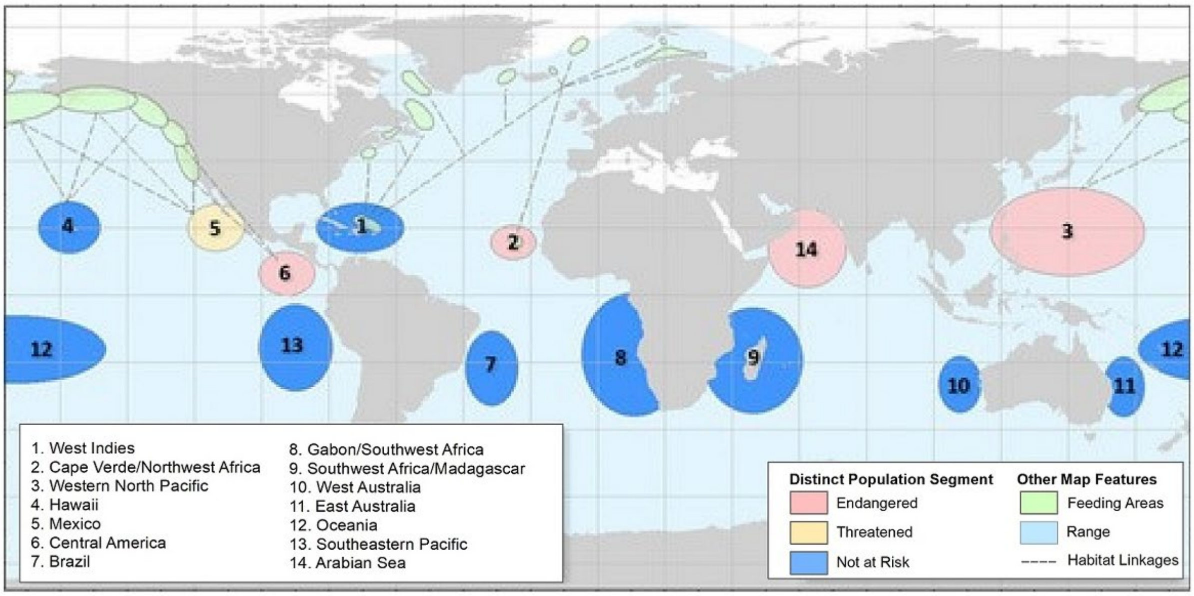
Humpback whales live in oceans around the world. They travel extensive distances every year and have one of the longest migrations of any mammal. Some populations swim 8,000 km (5,000 mi) from tropical breeding grounds in winter to high-latitude feeding grounds in summer. Humpback whales feed on shrimp-like krill and small fish. They are generally found close to shore and are commonly active on the surface, including breaching (leaping above the water) or slapping the surface with their pectoral fins and tails (NMFS, No Date-a). Commercial whaling severely reduced humpback whale numbers from historical levels. Before a moratorium on commercial whaling in 1985, all populations of humpback whales were greatly reduced, some by more than 95 percent. The species is increasing in abundance in much of its range but still faces threats from entanglement in fishing gear, vessel strikes, vessel-based harassment, underwater noise, and habitat impacts.

All humpback whales were listed as endangered under the Endangered Species Conservation Act in 1970, and then again under the ESA in 1973. NMFS has conducted a global status review of humpback whales, and in 2016 revised the ESA listing of the species. Currently, four out of the 14 DPS (**Figure 3.5-11**) are still protected as endangered (including two occurring in the action area: the Western North Pacific DPS and Central American DPS), and one is listed as threatened (the Mexico DPS, which occurs in the action area). Critical habitat for the endangered Western North Pacific distinct population segment (DPS), the endangered Central America DPS, and the threatened Mexico DPS of humpback whales (Megaptera novaeangliae) was designated in 2021 (86 FR 20632, April 21, 2021. Specific areas designated as critical habitat for the Western North Pacific DPS of humpback whales contain approximately 59,411 square nautical miles (nm^2) of marine habitat in the North Pacific Ocean, including areas within the eastern Bering Sea and Gulf of Alaska. Specific areas designated as critical habitat for the Central America DPS of humpback whales contain approximately 48,521 nm^2 of marine habitat in the North Pacific Ocean within the portions of the California Current Ecosystem off the coasts of Washington, Oregon, and California. Specific areas designated as critical habitat for the Mexico DPS of humpback whales contain approximately 116,098 nm^2 of marine habitat in the North Pacific Ocean, including areas within portions of the eastern Bering Sea, Gulf of Alaska, and California Current Ecosystem.

The stock structure of humpback whales is defined by NMFS based on the stock's fidelity to feeding grounds (Muto et al., 2020). As a result, the stock designations are inconsistent with the DPS designations.

Of the stocks occurring in the action area, the Western North Pacific stock, the Central North Pacific stock, the California/Oregon/Washington stock, and the American Samoa stock are designated as strategic and depleted under the MMPA; the Gulf of Maine stock is non-strategic.

Mexico DPS whales breed along the Pacific coast of Mexico, the Baja California Peninsula, and the Revillagigedos Islands, and feed across a broad range from California to the Aleutian Islands (Alaska). The Central America DPS breeds along the Pacific coast of Costa Rica, Panama, Guatemala, El Salvador, Honduras, and Nicaragua and feeds almost exclusively off California and Oregon. The Western North Pacific DPS breeds in the areas of Okinawa, Japan, and the Philippines, and feeds in the northern Pacific, primarily off the Russian coast, but also in the Bering Sea and Aleutian Islands of Alaska (NMFS, No Date; Muto et al., 2020).



Source: NMFS, No Date-a

Figure 3.5-11. Locations of the 14 Distinct Population Segments of Humpback Whales Worldwide

While calving, humpback whales prefer shallow, warm waters commonly near offshore reef systems or shores. Humpback whale feeding grounds are generally in cold, productive waters (NMFS, No Date). Along the U.S. west coast, three relatively distinct stocks migrate between their summer/fall feeding areas and winter/spring calving and mating areas: 1) the California/Oregon/Washington stock, consisting of winter/spring populations in coastal Central America and coastal Mexico which migrate to the coast of California to southern British Columbia in summer/fall; 2) the Central North Pacific stock, consisting of winter/spring populations of the Hawaiian Islands which migrate primarily to northern British Columbia/Southeast Alaska, the Gulf of Alaska, and the Bering Sea/Aleutian Islands; and 3) the Western North Pacific stock, consisting of winter/spring populations off Asia which migrate primarily to Russia and the Bering Sea/Aleutian Islands (Caretta et al., 2020). Humpback whales from the Western and Central North Pacific stocks mix to a limited extent on summer feeding grounds ranging from British Columbia through the central Gulf of Alaska and up to the Bering Sea.

Most North Atlantic humpback whales, including the Gulf of Maine stock, migrate to the West Indies during the winter to mate and calve. Not all migrate south, however, as significant numbers occur in mid- and high-latitude regions in winter. Humpback whales in the western North Atlantic feed during spring, summer, and fall over a range which encompasses the eastern coast of the U.S., the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland (Hayes et al., 2020). Additional feeding areas are off Iceland and northern Norway. These areas represent six relatively discrete subpopulations. Based on genetic analyses, the Gulf of Maine feeding stock is treated as a separate management stock.

The American Samoa stock comes from the Oceania subpopulation of humpback whales which ranges throughout the South Pacific, except the west coast of South America, and from the equator to the edges of the Antarctic ice (Caretta et al., 2020).

North Pacific humpback whales (*M. novaeangliae kuzira*) comprise a distinct subspecies based on DNA relationships and distribution compared to North Atlantic humpback whales (*M. n. novaeangliae*) and those in the Southern Hemisphere (Carretta et al., 2020). Humpback whales occur throughout the North Pacific, with multiple populations currently recognized based on low-latitude winter breeding areas. Exchange of animals between breeding areas rarely occurs, based on photo-identification data of individual whales; photo-identification evidence also suggests strong site fidelity to feeding areas (Carretta et al., 2020).

The current population estimate for the Western North Pacific stock is 1,107 animals, with a minimum population estimate of 865 (Muto et al., 2020). The current population estimate for the Central North Pacific stock is 10,103 animals, with a minimum population estimate of 7,891 (Muto et al., 2020). The current population estimate for the California/Oregon/Washington stock is 4,973 animals, with a minimum population estimate of 4,776 (Carretta et al., 2022).

Recent abundance estimates indicate continued population growth, but the size of the humpback whale Gulf of Maine stock off the U.S. east coast may still be below its optimum sustainable population. The current estimated abundance for the Gulf of Maine stock is 1,396 whales, with a minimum population estimate of 1,380 individuals (Hayes et al., 2020).

The status of humpback whales in American Samoan EEZ waters is unknown, and there are insufficient data to estimate trends in abundance. However, the minimum population estimate for the American Samoa stock is 150 whales, which is the number of unique humpbacks identified in the waters around American Samoa via photo identification (Caretta et al., 2020).

3.5.1.1.3.10 Beluga Whale (Cook Inlet DPS)

Beluga whales are known for their white color and range of vocal sounds. They are very social animals, forming groups to hunt, migrate, and interact with each other. Beluga whales are found in the U.S. in Alaska and globally throughout the Arctic Ocean. They are also at home in large rivers and can move between salt and fresh water. Beluga whales are vulnerable to many stressors and threats, including pollution, habitat degradation, harassment, interactions with commercial and recreational fisheries, sound and activity from oil and gas exploration, disease, and other types of human disturbance such as underwater noise (NMFS, No Date-a).

There are five management stocks in Alaska based on distributional separation, distinct population trends between regions occupied in summer, and genetic differences. These five stocks of beluga whales in Alaskan waters are: the Beaufort Sea, Bristol Bay, Cook Inlet, eastern Bering Sea, and eastern Chukchi Sea stocks. Each stock is unique, isolated from one another genetically and/or physically by migration routes and preferred habitats. Worldwide, belugas may number in the hundreds of thousands; however, some stocks are small, numbering in the low hundreds.

The endangered Cook Inlet beluga whale population has declined by nearly 75 percent since 1979, from about 1,300 whales to an estimated 328 whales in 2016 (NMFS, No Date-a). The current population estimate for the Cook Inlet stock is 279 animals, with a minimum population estimate of 267 individuals (Muto et al., 2022).

Commercial and sport hunting once threatened beluga whale populations. These activities are now banned, though Alaska Natives still hunt beluga whales for subsistence. Beluga subsistence harvest in the Cook Inlet of south-central Alaska is now regulated because of the lack of recovery in the area (NMFS, No

Date-a). Alaska Natives last hunted Cook Inlet beluga whales in 2005. All beluga whale populations are protected under the MMPA. NMFS has designated the Cook Inlet beluga whale population in Alaska and the Sakhalin Bay-Nikolaya Bay-Amur River stock off the coast of Russia as depleted under the MMPA. In addition, the Cook Inlet DPS was listed as endangered under the ESA in 2011.

Beluga whales inhabit cold waters of the Arctic and subarctic. The northernmost extent is off Alaska, northwest Canada, and off Ellesmere Island, West Greenland, and Svalbard (>80° north); the southern limit of distribution is in the St. Lawrence River in eastern Canada (47° – 49° north). Depending on season and region, beluga whales can occur in both offshore and coastal waters. During the winter, beluga whales generally occur in offshore waters associated with the ice pack; in the spring, many migrate to warmer coastal estuaries, bays, and rivers for molting and calving. Breeding occurs in March and April, with calves born the following May through July, usually when pods are at or near summer concentration areas (**Figure 3.5-12**). The Cook Inlet DPS occurs near river mouths in the northern Cook Inlet during the spring and summer months and in mid-Inlet waters in the winter. The stock remains in Cook Inlet throughout the year (Muto et al., 2022).

Figure 3.5-12. Pod of Beluga Whales

Photo Credit: LCDR Gary Barone, NOAA

NMFS has designated 7,800 km^2 (3,013 mi^2) of critical habitat for the Cook Inlet DPS (76 Federal Register [FR] 20180, April 11, 2011). Critical Habitat Area 1 occurs in the upper portion of Cook Inlet that contains a number of shallow tidal flats, river mouths, and estuarine areas important for foraging, calving, molting, and escaping predators. This area contains the highest concentration of beluga whales from spring through fall. Critical Habitat Area 2, which includes near and offshore areas of the mid- and upper Inlet and nearshore areas of the lower Inlet, is used less during spring and summer, but it is used in fall and winter. Dispersed fall and winter feeding and transit areas occur in Critical Habitat Area 2.

3.5.1.1.3.11 Killer Whale (Southern Resident DPS)

The killer whale (**Figure 3.5-13**), also known as the orca, is one of the top marine predators. They are found in every ocean in the world, with the highest densities found in coastal temperate waters, and are the most widely distributed of all whales and dolphins. Killer whales can adapt to almost any condition, and are found in both open seas and coastal waters. Killer whales are highly social, and most live in social groups called pods. Pod members communicate with each other through clicks, whistles, and pulsed calls. Each pod in the eastern North Pacific possesses a unique set of calls that are learned and culturally transmitted among individuals. These calls maintain group cohesion and serve as family badges. Taken as a whole, the species has the most varied diet of all cetaceans, but different populations are usually specialized in their foraging behavior and diet. Resident killer whales exclusively eat fish, while Transient killer whales primarily eat marine mammals and squid (NMFS, No Date-a).

Figure 3.5-13. Killer Whale Breaching

Photo Credit: NOAA Central Library Historical Image

Hunters and fishermen once targeted killer whales. As a result, historical threats to killer whales included commercial hunting, and culling to protect fisheries from killer whales. In addition, although live capture of killer whales for aquarium display and marine parks no longer occurs in the U.S., it remains a threat globally. Today, some killer whale populations face many other threats, including food limitations, chemical contaminants, and disturbances from vessel traffic and sound (NMFS, No Date-a).

All killer whale populations are protected under the MMPA. Additionally, the Southern Resident population was listed as endangered under the ESA in 2006, and, along with the AT1 Transient population, is listed as depleted under the MMPA. AT1 Transients, a subgroup of transient killer whales in the eastern North Pacific, has been reduced from 22 to seven whales since the 1989 *Exxon Valdez* oil spill (NMFS, No Date-a). The minimum historical population size of Southern Residents in the eastern North Pacific was about 140 animals. Following a live-capture fishery in the 1960s for use in marine mammal parks, 71 animals remained in 1974. Although there was some growth in the population in the 1970s and 1980s, the population experienced a decline of almost 20 percent in the late 1990s (NMFS, No Date-a). The population increased to 99 whales in 1995, then declined to 79 whales in 2001, and 83 whales in 2016 (Carretta et al., 2018). The current population estimate for the Eastern North Pacific Southern Resident stock is 72 animals, with a minimum population estimate of 72 individuals (Caretta et al., 2021).

The Southern Resident stock is a trans-boundary stock including killer whales in inland Washington and southern British Columbia waters. Southern Resident killer whales range from central California to southeast Alaska. Most sightings have occurred in the summer in inland waters of Washington and southern British Columbia. However, pods belonging to this stock have also been sighted in coastal waters off southern Vancouver Island and Washington. The complete winter range of this stock is uncertain. Of the three pods comprising this stock, one is commonly sighted in inshore waters in winter, while the other two apparently spend more time offshore. These latter two pods have been sighted as far south as Monterey Bay and central California in recent years. They sometimes have also been seen entering the inland waters of Vancouver Island through Johnstone Strait in the spring (Carretta et al., 2020).

The Southern Residents spend large amounts of time in core inland marine waters coinciding with congregations of migratory salmon returning from the Pacific Ocean to spawn in U.S. and Canadian rivers. The topographic and oceanographic features in these core areas include channels and shorelines used to assist with foraging. In November 2006, a final rule was issued designating approximately 6,630 km^2 (2,560 mi^2) of inland waters of Washington State as critical habitat for the Southern Resident killer whale DPS. In 2014, NMFS accepted a petition requesting that critical habitat be revised to include Pacific Ocean marine waters along the west coast of the U.S. that constitute essential foraging and wintering areas for Southern Resident killer whales. Additionally, the petition requests that a primary constituent element (PCE) (i.e., the physical and biological features of a habitat that a species needs to survive and reproduce) for protective in-water sound levels be adopted for both currently designated critical habitat and the proposed revised critical habitat (NMFS, 2018b). In 2019, NMFS proposed to revise this critical habitat designation by expanding it to include six new areas along the U.S. west coast, while maintaining the currently designated critical habitat in inland waters of Washington. Specific new areas included 40,471 km^2 (15,626 mi^2) of marine waters between the 6.1-m (20-ft) depth contour and the 200-m (656-ft) depth contour from the U.S. international border with Canada south to Point Sur, California (NMFS, 2018b). The final rule for this revised critical habitat designation came out in 2021 (86 FR 41668, August 2, 2021).

3.5.1.1.3.12 Sperm Whale

Sperm whales are the largest of the toothed whales and have one of the widest global distributions of any marine mammal species. They are found in all deep oceans, from the equator to the edge of the pack ice in the Arctic and Antarctic. They are named after the waxy substance, spermaceti, found in their heads. Spermaceti was used in oil lamps, lubricants, and candles. Sperm whales were a prime target of the commercial whaling industry from 1800 to 1987. Whaling greatly reduced the sperm whale population. Whaling is no longer a major threat and its population is still recovering. Current threats include vessel strikes, entanglement in fishing gear, ocean noise, marine debris, climate change, and oil spills and contaminants (NMFS, No Date-a).

The sperm whale was listed as endangered under the Endangered Species Conservation Act in 1970. When the ESA was passed in 1973, the sperm whale was listed as endangered throughout its range. It is also listed as depleted under the MMPA. Currently, there is no exact accounting of the total number of sperm whales worldwide. The best estimate of worldwide sperm whale population is between 300,000 and 450,000 individuals (NMFS, No Date-a). Sperm whales within the Pacific U.S. EEZ are divided into three discrete, non-contiguous areas: 1) California, Oregon and Washington waters, 2) waters around Hawai'i, and 3) Alaska waters. In the Atlantic U.S. EEZ, they are divided into the North Atlantic stock and the Gulf of Mexico stock.

The current population estimate for the North Pacific stock in Alaska is 345 animals, with a minimum population estimate of 244 individuals (Muto et al., 2020). However, current and historical abundance estimates of sperm whales in the North Pacific are based on limited data and are considered unreliable. Further, sperm whales are far-ranging and exhibit sex segregation and stock overlap that together make population size estimation difficult. The existing estimates are caveated and do not cover consistent areas.

The current population estimate for the California/Oregon/Washington stock is 1,997 animals, with a minimum population estimate of 1,270 individuals (Caretta et al., 2020). Sperm whales in the California Current have been identified as demographically independent from animals in Hawai'i and the Eastern Tropical Pacific, based on genetic analyses.

The current population estimate for the Hawai'i stock is 5,707 animals, with a minimum population estimate of 4,486 individuals (Caretta et al., 2021). In the eastern tropical Pacific, the abundance of sperm whales has been estimated as 22,700 whales; however, it is not known whether any or all of these animals routinely enter the U.S. EEZ of the Hawaiian Islands.

Several estimates from selected regions of sperm whale habitat exist for select time periods, however, at present there is no reliable estimate of total sperm whale abundance for the entire North Atlantic (Hayes et al., 2020). Sightings have been almost exclusively in the continental shelf edge and continental slope areas; however, there has been little or no survey effort beyond the slope. The current population estimate for the North Atlantic stock is 4,349 animals, with a minimum population estimate of 3,451 individuals (Hayes et al., 2020).

Sperm whales hunt for food during deep dives that routinely reach depths of 600 m (2,000 ft) and can last for 45 minutes. They are capable of diving to depths of over 3,000 m (10,000 ft) for over 60 minutes. After long, deep dives, individuals come to the surface to breathe and recover for approximately nine minutes. Because sperm whales spend most of their time in deep waters, their diet consists of many larger species that also occupy deep ocean waters. This includes squid, sharks, skates, and fish (NMFS, No Date-a).

Sperm whales inhabit all of the world's oceans. Their distribution is dependent on their food source and suitable conditions for breeding, and varies with the sex and age composition of the group. Sperm whale migrations are not as predictable or well understood as migrations of most baleen whales. In some mid-latitudes, sperm whales seem to generally migrate north and south depending on the seasons, moving toward the poles in the summer. However, in tropical and temperate areas, there appears to be no obvious seasonal migration.

Sperm whales are distributed across the entire North Pacific and into the southern Bering Sea in summer, but the majority are thought to be south of 40^o north in winter. Historically they concentrated seasonally along oceanic frontal zones, for example, in the subtropical frontal zone (ca. 28-34° north) and the subarctic frontal zones (ca. 40-43° north) (Muto et al., 2020). In Alaska, their northernmost boundary extends from Cape Navarin (62° north) to the Pribilof Islands, with whales most commonly found in the Gulf of Alaska and along the Aleutian Islands (Muto et al., 2020). The shallow continental shelf may prevent their movement into the northeastern Bering Sea and the Arctic Ocean. They are found year-round in the Gulf of Alaska, although they appear to be approximately twice as common in summer than in winter. This seasonality of detections is consistent with the hypothesis that sperm whales generally move to higher latitudes in summer and to lower latitudes in winter. Sperm whales are found year-round in California waters, but they reach peak abundance from April through mid-June and from the end of August through mid-November (Carretta et al., 2020). They are seen off Washington and Oregon in every season except winter. Sperm whales are widely distributed in the tropics and have been sighted throughout the Hawaiian EEZ, including nearshore waters of the main and Northwestern Hawaiian Islands (Carretta et al., 2020). Sperm whales summer in the Mid-Atlantic Bight off the eastern U.S. coast from Virginia to Massachusetts (Hayes et al., 2018). In winter, sperm whales concentrate east and northeast of Cape Hatteras, North Carolina. Female/juvenile groups inhabit temperate and tropical waters and rarely move as far north as the Canadian EEZ. Males have a wider range, including the Hudson Strait in Canada. Sperm whales occur year-round in the northern Gulf of Mexico along the continental slope and in oceanic waters; information is limited for the southern Gulf of Mexico (Hayes et al., 2020). Satellite-tagging studies showed no discernible seasonal migrations except for Gulf-wide movements particularly along the northern Gulf slope.

3.5.1.1.3.13 False Killer Whale (Main Hawaiian Islands Insular DPS)

False killer whales are social animals found globally in all tropical and subtropical oceans and generally in deep offshore waters. They are often found in relatively small subgroups of a single to a few individuals that are associated with a larger aggregation that may spread over tens of kilometers (NMFS, No Date-a). These strong social bonds between groups and dispersion into small subgroups likely help them find prey. False killer whales are top predators that primarily hunt fish and squid. Fishery interaction is one of the main threats facing this species. False killer whales are known to take fish and bait off of fishing lines, which can lead to hooking and/or entanglement. This is especially a concern for false killer whales that interact with the Hawai'i longline fishery (NMFS, No Date-a).

Three populations or stocks of false killer whales occur in Hawai'i: the Northwestern Hawaiian Islands population, the pelagic population, and the endangered main Hawaiian Islands Insular population. The main Hawaiian Islands insular false killer whale population is estimated at 167 animals, with a minimum population estimate of 149 individuals (Carretta et al., 2022). Due to the very small population size and population decline in recent decades of the main Hawaiian Islands Insular false killer whale DPS, it was listed as endangered under the ESA in 2012. It is the only false killer whale population protected under the ESA. This stock is also listed as depleted under the MMPA.

Although the range of the main Hawaiian Islands Insular false killer whale DPS partially overlaps with the ranges of the Hawai'i pelagic and Northwestern Hawaiian Islands populations, genetic analyses, photo-identification, and social network analyses indicate that the main Hawaiian Islands Insular DPS consists of a tight social network that is socially unconnected with the other two Hawai'i-based populations (NMFS, No Date-a; Carretta et al., 2020).

False killer whales generally prefer offshore tropical to subtropical waters that are deeper than 1,000 m (3,300 ft). Both main Hawaiian Islands Insular false killer whales and Northwestern Hawaiian Islands false killer whales maintain a more island-associated habitat, preferring to remain close to the Hawaiian Islands. This is likely due to the islands' unique oceanographic setting, which concentrates and aggregates prey. The range of the main Hawaiian Islands Insular false killer whale is a modified 70-km (44-mi) radius (approximately 39 nm) around the main Hawaiian Islands. The waters farther than 70 km (44 mi) from shore, from the Island of Oahu to Hawai'i Island out to the main Hawaiian Islands Insular stock boundary, are an overlap zone between the insular and pelagic stocks. The greatest offshore movements occur on the leeward (western) sides of the islands, where individuals tend to spread out over much larger areas, both near and far from shore. When on the windward (eastern) sides, individuals concentrate closer to shore. Movements between islands may occur over the course of a few days, moving from the windward to leeward side and back within a day (NMFS, No Date-a).

Critical habitat for the main Hawaiian Islands Insular false killer whale DPS was designated in 2018 for waters from the 45-m (150-ft) depth contour to the 3,200-m (10,500-ft) depth contour around the main Hawaiian Islands from Ni'ihau east to Hawai'i (83 FR 35062, July 24, 2018). The physical or biological features essential to the conservation of this DPS are: (1) island-associated marine habitat; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; (3) waters free of pollutants of a type and amount harmful to the species, and (4) habitat free of anthropogenic sound that would significantly impair the value of the habitat for false killer whale use or occupancy.

3.5.1.2 Pinnipeds (Seals, Sea Lions, and Walrus)

Pinnipeds are the marine mammals that include the true seals, eared seals, and walruses. Phocids are the earless seals or true seals and can be identified by their lack of external ear flaps. They have ear holes and small front flippers used to move on land by flopping along on their bellies, as well as rear flippers; their front flippers are functionally different to those of otariids. At sea, true seals move their rear flippers left and right to propel themselves through the water. Otariids are the eared seals. This family includes sea lions and fur seals. Unlike true seals, otariids have external ear flaps. Their front flippers are large, and on land they are able to bring all four flippers underneath their bodies and walk on them. In the water, they swim using their front flippers like oars. The odobenids are the walruses. Both males and females have tusks and vacuum-like mouths for sucking up shellfish from the sea floor.

Pinnipeds are amphibious animals, i.e., they venture onto land for extended periods of time, called “hauling-out”. They forage at sea but most come ashore or onto ice at some point during the year to mate, give birth, suckle their young, or to molt (Sea Grant, 2015). Many of their anatomical features reflect compromises needed to succeed in both marine and terrestrial environments. Pinnipeds have four webbed flippers in the front and rear used to propel their spindle-shaped bodies. Their sensory organs are adapted to function in both air and water; large eyes and well-developed whiskers allow feeding in dimly lit water; tail and external ears are small, limiting drag. Pinnipeds have retained canine teeth, but molars are modified for consuming prey whole. All pinnipeds have fur, which is shed or molted annually, but they are insulated primarily by blubber.

Pinnipeds are present in habitats ranging from ice to tropics, coastal to pelagic waters, and may live a migratory or sedentary existence. They are opportunistic feeders and consume their varied prey whole or in chunks. Many pinnipeds are capable of long, deep, repetitive dives (up to 1,370-m [4,500-ft] depths and two hours). This diving ability is possible because of several physiological traits similar to cetaceans, such as high blood volume and reduced heart rate (Schytte Blix, 2018).

All pinnipeds are protected by the MMPA throughout their ranges. Some species are also federally listed under the ESA either throughout their ranges or for certain DPSs. Additionally, some species have designated critical habitat. **Table 3.5-2** lists the 15 species of pinnipeds (16 distinct species, subspecies, or DPS total) occurring throughout the action area, consisting of one odobenid; five otariids, one of which is ESA-listed as endangered with designated critical habitat, and one listed as threatened; and 10 phocids, one of which is ESA-listed as endangered with designated critical habitat, and two listed as threatened, both with designated critical habitat.

Table 3.5-2. Pinnipeds Occurring in the Action Area

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Ecology
Walruses-Odobenids							
Pacific walrus	*Odobenus rosmarus*	No	--	USFWS	AR	--	Coastal, loose pack ice
Eared Seals-Otariids							
Guadalupe fur seal	*Arctocephalus townsendi*	Yes: throughout its range	Threatened	NMFS	WCR	No	Coastal, shelf, pelagic during foraging
Northern fur seal	*Callorhinus ursinus*	Yes: Pribilof Island/ Eastern Pacific stock	--	NMFS	AR, WCR	--	Pelagic, coastal
Steller sea lion (Western DPS)	*Eumetopias jubatus*	Yes: Western DPS	Endangered	NMFS	AR	Yes	Coastal, shelf, sea ice
Steller sea lion (Eastern DPS)	*Eumetopias jubatus*	No	--	NMFS	WCR, AR	Yes	Coastal, shelf, sea ice
California sea lion	*Zalophus californianus*	No	--	NMFS	WCR	--	Coastal, shelf
Earless Seals-Phocids							
Hooded seal	*Cystophora cristata*	No	--	NMFS	GAR	--	Pack ice and pelagic
Bearded seal (Beringia DPS)	*Erignathus barbatus nauticus*	Yes: Beringia DPS	Threatened	NMFS	AR	Yes	Sea ice, shelf areas
Gray seal	*Halichoerus grypus*	No	--	NMFS	GAR	--	Coastal, coastal waters
Ribbon seal	*Histriophoca fasciata*	No	--	NMFS	AR	--	Pack ice and pelagic
Northern elephant seal	*Mirounga angustirostris*	No	--	NMFS	WCR, AR	--	Coastal to pelagic during foraging and migrating
Hawaiian monk seal	*Neomonachus schauinslandi*	Yes: throughout its range	Endangered	NMFS	PIR	Yes	Coastal, reefs, submerged banks, deepwater coral beds, pelagic

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Ecology
Harp seal	*Pagophilus groenlandicus*	No	--	NMFS	GAR	--	Pack ice and pelagic
Ringed seal (Arctic subspecies)	*Phoca hispida*	Yes: Arctic subspecies	Threatened	NMFS	AR	Yes	Pack ice
Spotted seal (Bering Sea DPS)	*Phoca largha*	No	--	NMFS	AR	--	Seasonal sea ice, coastal, pelagic
Harbor seal	*Phoca vitulina*	No	--	NMFS	GAR, WCR, AR	--	Coastal waters

Source: ECOS, No Date-a; NMFS, No Date-a

*GAR = Greater Atlantic Region (includes the U.S. portions of the Great Lakes, New England, and the mid-Atlantic); SER = Southeast Region (includes the southern portion of the U.S. Eastern Seaboard, the U.S. Caribbean Islands [Puerto Rico and the U.S. Virgin Islands], and the Gulf of Mexico); AR = Alaska Region (includes Alaskan waters and the Arctic); WCR = West Coast Region (includes coastal California, Oregon, and Washington); PIR = Pacific Islands Region (includes Hawai'i and territories of the U.S.)

3.5.1.2.1 Pinniped Sound Production and Hearing

Pinnipeds produce a wide range of vocalizations, most occurring at relatively low frequencies (Southall et al., 2007). They communicate acoustically in air and water and have different hearing capabilities in the two media. The main function of pinniped vocalizations appears to be to elicit the attention of recipients (Schusterman et al., 2001). In-air vocalizations are used to defend territories, attract females, and maintain the mother-pup bond, while underwater calls are mainly used to establish dominance.

Southall et al. (2007) considered pinnipeds as a single functional hearing group; more recently, however, pinnipeds were placed in two separate hearing groups, with phocids in one group and otariids and odobenids in another (NMFS, 2018a; Southall et al., 2019). Phocid species have consistently demonstrated an extended frequency range of hearing compared to otariids, especially in the higher frequency range. Phocid ears are anatomically distinct from otariid ears so that phocids are hypothetically more adapted for underwater hearing (NMFS, 2018a). Walrus have ears that are somewhat intermediate to a freely mobile ear and the ear type characteristic of phocids. Few data are available regarding acoustic sensitivity in walruses, so more research on walrus auditory anatomy would support further evaluation of their characterization within the marine carnivores group both in air and water (Southall et al., 2019; NMFS, 2018a) either within phocid or non-phocid hearing groups or, potentially, as a distinct hearing group.

As pinnipeds are amphibious mammals, their hearing differs in air and in water; thus, separate sound exposure criteria are required for each medium. Pinnipeds are sensitive to a broader range of sound frequencies in water than in air, and there are differences in the functional hearing range among otariids, phocids, and odobenids, especially under water, as well as differences in hearing sensitivity: phocids are more sensitive in air and underwater with especially good sensitivity at low frequencies. Southall et al. (2007, 2019) categorized pinnipeds as having functional underwater hearing between 75 Hz and 75 kHz and functional aerial hearing between 75 Hz and 30 kHz. NMFS (2018d) classified phocids as having functional underwater hearing between 50 Hz to 86 kHz and otariids as 60 Hz to 39 kHz. The audible range of hearing for walrus extends from 60 Hz to 23 kHz in air; the hearing range in water is expected to be similar or broader at high frequencies (Reichmuth et al., 2020). Although the upper hearing range for walrus in water is not precisely known, using the ratio of the in-water to in-air corner frequency from Southall et al. (2019) to scale up the walrus hearing range measured in air provides a good estimate for their high frequency cutoff in water: 34 kHz (JASCO, 2022)[6].

3.5.1.2.2 Regional Distribution of Pinnipeds

Pinnipeds are widely distributed throughout all major oceans. Many pinnipeds undertake seasonal migrations between breeding/pupping grounds and feeding areas, which are often at higher latitudes. Walruses and some phocids migrate with the seasonally-changing location of pack ice. However, some pinniped species remain year-round in a general region. Ice-breeding phocids tend to be solitary or form dispersed breeding aggregations. In contrast, other phocids, many otariids, and walruses aggregate in large groups to breed, pup, or molt (e.g., the elephant seals and sea lions). Most pinnipeds have a coastal distribution, but some occur further offshore, including foraging northern fur seals and Steller sea lions. Elephant seals are one of the pinnipeds that are pelagic much of the year.

[6] For walrus, this calculation is 23 kHz * 12.8 kHz/8.66kHz = 34 kHz. The two latter numbers come from Table 3 of Southall et al. (2019).

3.5.1.2.2.1 Greater Atlantic Region

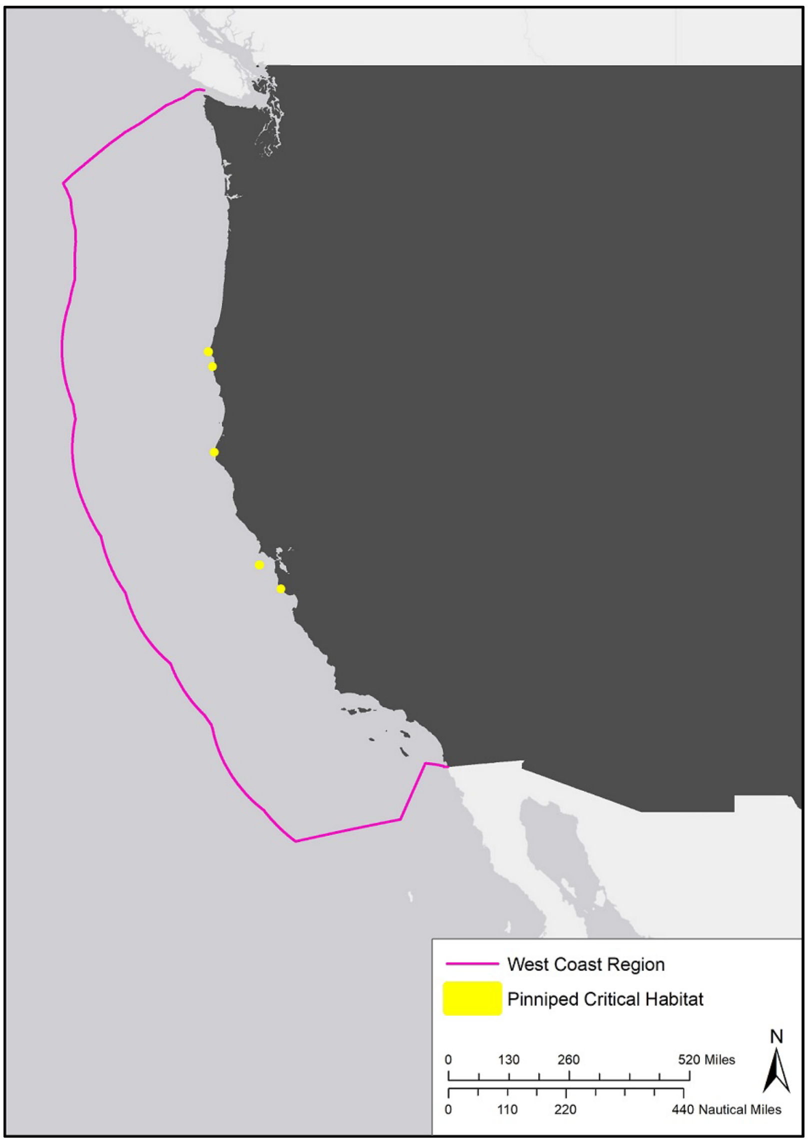
Four pinnipeds (hooded seal, gray seal, harp seal, and harbor seal) occur in the Greater Atlantic Region, as indicated in **Table 3.5-2**. None are ESA-listed. There is no designated critical habitat in the region.

3.5.1.2.2.2 Southeast Region

While harbor seals and gray seals can occur in the Southeast Region as vagrants, there are no known reliable occurrences. No other pinnipeds occur in this region.

3.5.1.2.2.3 West Coast Region

Six pinnipeds (Guadalupe fur seal, northern fur seal, Steller sea lion, California sea lion, northern elephant seal, and harbor seal) occur in the West Coast Region, as indicated in **Table 3.5-2**. The Guadalupe fur seal is ESA-listed. The Steller sea lion has designated critical habitat in the region as shown in **Figure 3.5-14**.

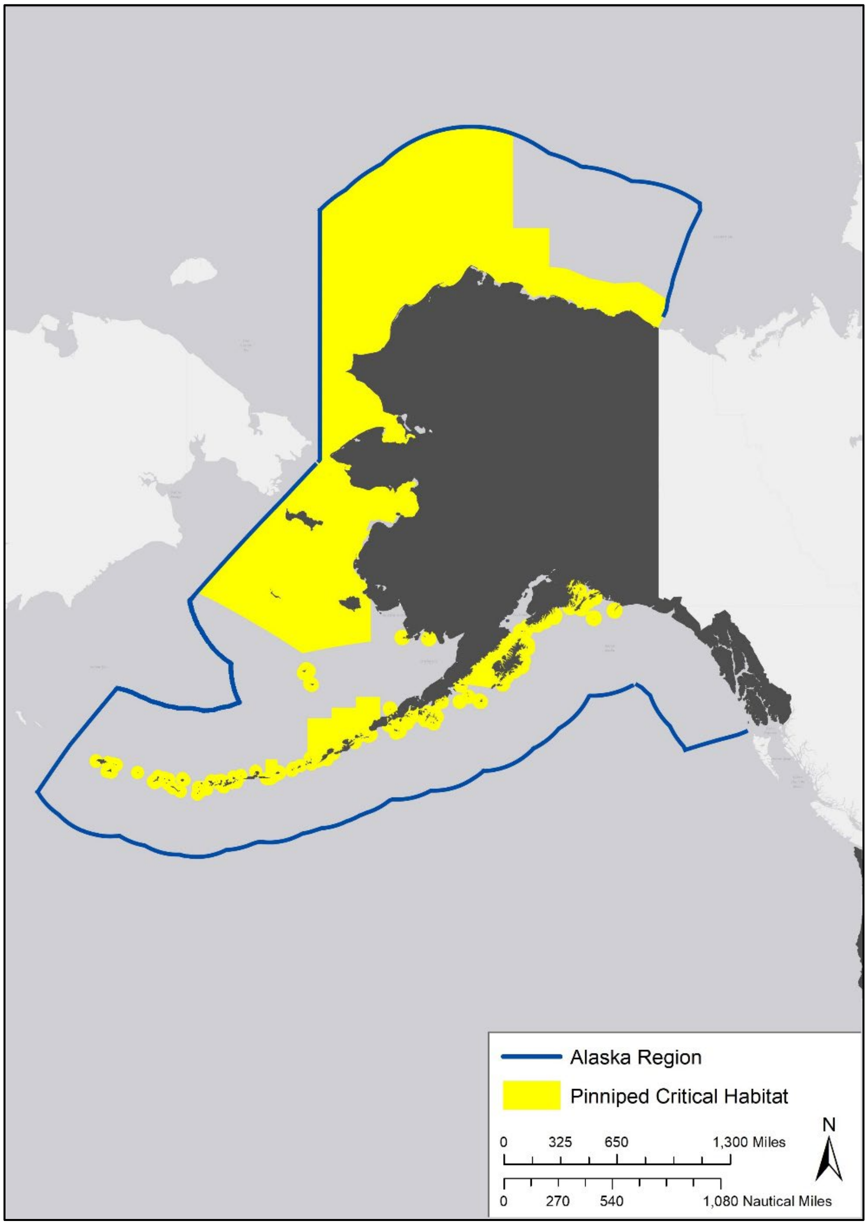


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.5-14. Pinniped Designated Critical Habitat in the West Coast Region

3.5.1.2.2.4 Alaska Region

Ten pinnipeds (one odobenid, three otariids, and six phocids) occur in the Alaska Region, as indicated in **Table 3.5-2**. One of the otariids is ESA-listed: the Steller sea lion (Western DPS), and two of the phocids are ESA-listed: the bearded seal (Beringia DPS) and ringed seal (Arctic subspecies). All of these species also have designated critical habitat in the region as shown in **Figure 3.5-15**.

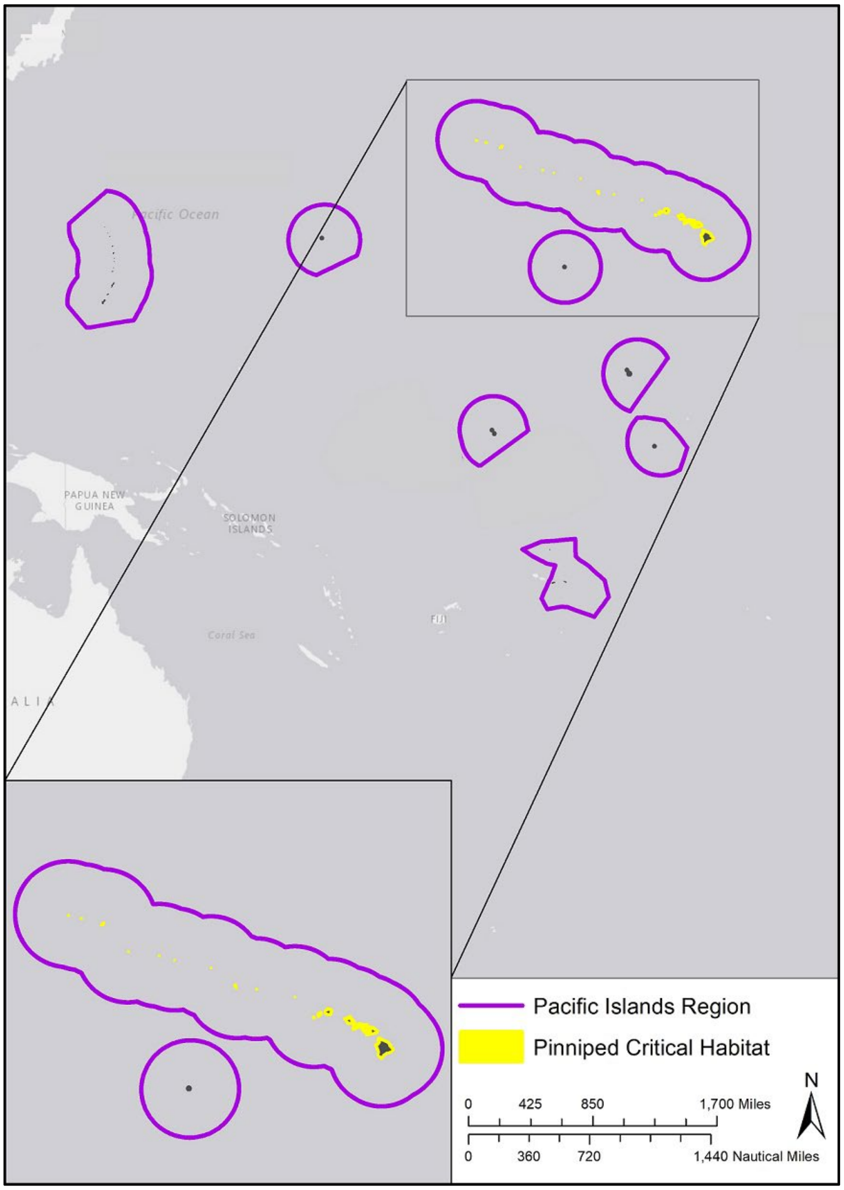


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.5-15. Pinniped Designated Critical Habitat in the Alaska Region

3.5.1.2.2.5 Pacific Islands Region

One pinniped (Hawaiian monk seal) occurs in the Pacific Islands Region, as indicated in **Table 3.5-2**. The Hawaiian monk seal is ESA-listed, and it also has designated critical habitat in the region as shown in **Figure 3.5-16**.



Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.5-16. Pinniped Designated Critical Habitat in the Pacific Islands Region

3.5.1.2.3 Threatened and Endangered Pinnipeds

Five distinct populations of pinnipeds are ESA-listed in the action area; two are otariids and three are phocids. One listed otariid and one listed phocid also have designated critical habitat. These pinnipeds are shown in **Table 3.5-2** and described in more detail below.

3.5.1.2.3.1 Guadalupe Fur Seal

Guadalupe fur seals are generally solitary and thought to be non-social animals when at sea. They primarily feed at night on coastal and pelagic squid, and small pelagic fish (e.g., mackerel, sardine, and lanternfish) by diving to average depths of 20 m (65 ft) with maximum depths of about 75 m (250 ft). Commercial sealers heavily hunted Guadalupe fur seals in the 1700s to the 1800s until they were thought to be extinct in the early 1900s (NMFS, No Date-a). They were rediscovered breeding in a cave on Guadalupe Island in 1954. The Guadalupe fur seal population has continued to increase from the small remnant group on Guadalupe Island due to protection by the Mexican Government. Current threats include entanglement in and incidental hooking on commercial and recreational fishing gear, oil spills, coastal development, and military activities (NMFS, No Date-a).

Guadalupe fur seals live in the waters off southern California and the Pacific coast of Mexico. Guadalupe fur seals generally do not migrate, although they have been documented traveling great distances from their breeding grounds. During the breeding season, they are found in coastal rocky habitats and caves. Their breeding grounds are almost entirely on Guadalupe Island, off the Pacific coast of Mexico, with recent re-colonization off Baja California on the San Benito Archipelago (NMFS, No Date-a). A small number of Guadalupe fur seals have also been reported on San Miguel Island in the Channel Islands off southern California. Little is known about their whereabouts during the non-breeding season. Guadalupe fur seals are not common along the West Coast of the U.S., although strandings occur almost annually in California waters, and animals are increasingly observed in Oregon and Washington waters (Carretta et al., 2017).

Guadalupe fur seals were listed as threatened under the ESA in 1985, and they are listed as depleted under the MMPA. Guadalupe fur seals within the U.S. Pacific EEZ are aggregated into a single management unit under the MMPA: the Mexico stock (Caretta et al., 2020). The most recent estimate of population size is based on pup count data collected in 2013 and a range of correction factors applied to pup counts to account for uncounted age classes and pre-census pup mortality (Carretta et al., 2020). Resulting estimates were 34,187 individuals but do not include animals at San Benito Island, where surveys counted a maximum of 3,710 animals and 1,494 animals in July of 2014 and 2015, respectively (Carretta et al., 2020). The San Benito Island rookery is represented almost exclusively by immature animals migrating from Guadalupe Island, and negligible numbers of pups are produced at San Benito. The minimum population estimate for Guadalupe fur seals is 31,019 animals.

3.5.1.2.3.2 Steller Sea Lion (Western DPS)

Steller sea lions (**Figure 3.5-17**) were first listed as threatened under the ESA in 1990. Due to genetic, morphological, ecological, and population trend data supporting the overall distinctiveness, two DPSs for the Steller sea lion were recognized in 1997 (NMFS, No Date-a):

- The Western DPS includes all Steller sea lions originating from rookeries west of Cape Suckling (144° west longitude). The Western DPS ESA listing status was changed to endangered when it was established, due to continued declines; it remains listed as endangered today.
- The Eastern DPS includes Steller sea lions originating from rookeries east of Cape Suckling. The Eastern DPS kept a status of threatened when it was established; by 2013, it had recovered enough to be delisted off the endangered species list.

All Steller sea lions are protected under the MMPA, and the Western DPS is also designated as strategic and depleted.

Figure 3.5-17. Steller Sea Lions

Photo Credit: Capt. Budd Christman, NOAA

Historically, Steller sea lions were highly abundant throughout many parts of the North Pacific. Indigenous peoples and other settlers hunted them for their meat, hides, oil, and other products. In addition, they were killed for predator control and commercial harvests, causing their numbers to decrease. Threats that continue today include the effects of fisheries on prey, climate change, predation, exposure to toxic substances, incidental take due to interactions with active fishing gear, illegal shooting, disturbance, disease and parasites, vessel strikes, entanglement, and illegal feeding (NMFS, No Date-a).

The western stock of Steller sea lions decreased from an estimated 220,000 to 265,000 animals in the late 1970s to less than 50,000 in 2000. While the western population has been increasing slowly overall since 2003, it is still declining quickly in large areas of its range. The current and minimum population estimates for the Western U.S. stock is approximately 52,932 animals (Muto et al., 2022).

Steller sea lions prefer the colder temperate to subarctic waters of the North Pacific Ocean. They need both terrestrial and aquatic habitats. Steller sea lions are opportunistic predators, foraging and feeding primarily at night on over a hundred species of fish. They forage near shore and in open waters. In the non-breeding season, some adult females may spend long periods of time foraging well off the continental shelf while others forage much nearer to terrestrial sites. During the breeding season, a female must forage close enough to her rookery to return often and nurse her young. Steller sea lions, especially males, can travel long distances in a season. Steller sea lions need undisturbed land habitat to rest, molt, socialize, mate, give birth, and nurse small pups during the breeding season (NMFS, No Date-a). They are highly social and may rest in large groups, overlapping their bodies. At sea, they are seen alone or in small groups, but may gather in large "rafts" at the surface, including areas near important seasonal prey resources. Haul-outs and rookeries usually consist of beaches, ledges, and rocky reefs. Rookeries are normally occupied from late May to early July. In the Bering Sea, sea lions may also haul out on sea ice. The locations of rookeries and haul outs change little from year to year.

Steller sea lions are distributed mainly around the coasts along the North Pacific Ocean rim from northern Hokkaido, Japan through the Kuril Islands and Okhotsk Sea, the Aleutian Islands and Bering Sea, the southern coast of Alaska, and south to central California (NMFS, No Date-a; Muto et al., 2018). The Western DPS includes Steller sea lions that originate from rookeries west of 144° west longitude (Cape Suckling): those in the Gulf of Alaska, the Aleutian Islands, the Bering Sea, and Asia. The Eastern DPS includes sea lions originating from rookeries in southeast Alaska, British Columbia, Washington, Oregon, and California. The foraging ranges of the two DPSs overlap, especially in the non-breeding season. In recent years, a "mixing zone" has also become established in northern southeast Alaska on at least two new rookeries partially established by Western DPS females.

Critical habitat for Steller sea lions was first designated in 1993 and includes 66 specific sites (26 rookeries and 40 haul outs) in Alaska. It also includes a 32-km (20-nm) buffer around all major haul outs and rookeries, as well as associated terrestrial, air, and aquatic zones. Special foraging areas in Alaska have also been designated critical habitat for Steller sea lions, including the Shelikof Strait area of the Gulf of Alaska, the Bogoslof area in the Bering Sea shelf, and the Seguam Pass area in the central Aleutian Islands (58 FR 45269, August 27, 1993).

3.5.1.2.3.3 Bearded Seal (Beringia DPS)

Bearded seals are the largest of the northern phocids. There are two currently recognized subspecies of the bearded seal: *E. b. barbatus*, often described as inhabiting the Atlantic sector, and *E. b. nauticus*, inhabiting the Pacific sector (NMFS, No Date-a; Muto et al., 2018). Although subsistence harvest of bearded seals occurs in some parts of the species' range, there is little or no evidence that these harvests currently pose or are likely to pose a significant threat. While the U.S. does not allow commercial harvest of marine mammals, such harvests are permitted in some other portions of the species' range; however, there is currently no significant commercial harvest of bearded seals and significant harvests seem unlikely in the foreseeable future. Current threats include climate change, increased shipping activity, sound and activity from oil and gas exploration, and development (NMFS, No Date-a).

The Okhotsk (foreign) and Beringia (U.S.) DPSs of the Pacific sector subspecies were listed as threatened under the ESA in 2013, and they are also designated as depleted under the MMPA. Critical habitat was designed in 2022 and comprises an area of marine habitat in the Bering, Chukchi, and Beaufort seas (87 FR 19180, April 1, 2022). Accurately assessing bearded seal abundance and trends is hindered by their broad distribution, sea-ice habitat, logistical challenges in data collection, and cross-political boundaries; thus, a reliable population estimate for the entire stock is not currently available. It is estimated that there are approximately 500,000 bearded seals worldwide (NMFS, No Date). The current population estimate for the Beringia stock is 301,836 animals, with a minimum population estimate of 273,676 individuals (Muto et al., 2020).

Bearded seals primarily feed on or near the sea bottom on a variety of invertebrates (e.g., shrimps, crabs, clams, and whelks) and some fish (e.g., cod and sculpin). While foraging, they typically dive to depths of less than 100 m (328 ft). They are not known to spend much time in deep water and seem prefer to forage in waters less than 200 m (650 ft) deep where they can reach the sea floor (NMFS, No Date-a).

Bearded seals inhabit Arctic and sub-Arctic waters that are relatively shallow (primarily less than about 490 m [1,600 ft] deep) and seasonally ice-covered. Typically, they occupy sea ice habitat that is broken and drifting with natural areas of open water. Sea ice provides some protection from predators, such as polar bears, during birthing and nursing. Sea ice also provides bearded seals a haul-out platform for molting and resting. Bearded seals are solitary and can be seen resting on ice floes with their heads facing downward into the water. This allows them to quickly escape into the sea if pursued by a predator. Bearded seals also have been seen sleeping vertically in open water with their heads on the water surface (NMFS, No Date-a).

Bearded seals are circumpolar in their distribution, extending from the Arctic Ocean (85° north) south to Hokkaido (45° north) in the western Pacific (NMFS, No Date-a). In U.S. waters, they are found off the coast of Alaska over the continental shelf in the Bering, Chukchi, and Beaufort Seas. Because bearded seals are closely associated with sea ice, particularly pack ice, their seasonal distribution and movements are linked to seasonal changes in ice conditions. The shallow shelf of the Bering and Chukchi Seas provides the largest continuous area of habitat for bearded seals. In late winter and early spring, bearded seals are widely but not uniformly distributed in the broken, drifting pack ice, where they tend to avoid the coasts and areas of fast ice. To remain associated with their preferred ice habitat, most adult seals in the Bering Sea are thought to move north through the Bering Strait in late spring and summer as the ice melts and retreats. They then spend the summer and early fall at the edge of the Chukchi and Beaufort Sea pack ice and at the fragmented edge of multi-year ice. Some bearded seals—mostly juveniles—remain near the coasts of the Bering and Chukchi Seas during summer and early fall, where they are often found in bays, estuaries, and river mouths. As the ice forms again in the fall and winter, most bearded seals are thought to move south with the advancing ice edge (NMFS, No Date-a).

3.5.1.2.3.4 Hawaiian Monk Seal

The Hawaiian monk seal (**Figure 3.5-18**) is one of the most endangered seal species in the world. The Hawaiian monk seal is the last surviving species in its genus, and is endemic to the 2,400-km (1,500-mi)-long Hawaiian Islands archipelago, from Hawai'i Island to Kure Atoll, occurring nowhere else in the world. The population overall has been declining for over six decades, and current numbers are only about one-third of historic population levels. Importantly, however, the prolonged decline has slowed over the last 10 years due to recovery efforts. The current threats that Hawaiian monk seals face include food limitations in the Northwestern Hawaiian Islands, especially for juveniles and sub-adults, entanglement in marine debris, and human interactions, especially in the main Hawaiian Islands. These human interactions include bycatch in fishing gear, mother-pup disturbance on beaches, and exposure to disease. Other threats to Hawaiian monk seals include loss of haul-out and pupping beaches due to erosion in the Northwestern Hawaiian Islands, disease outbreaks, shark predation, male aggression towards females, and low genetic diversity (NMFS, No Date-a).

Figure 3.5-18. Hawaiian Monk Seal

Photo Credit: NOAA/PIFSC/HMSRP

Hawaiian monk seals were listed as endangered under the ESA in 1976, and they are listed as depleted under the MMPA; they are also protected under State of Hawai'i law. Critical habitat for the Hawaiian monk seal was initially designated in 1986, and revised critical habitat was designated in 2015. Specific designated areas include sixteen occupied locations within the range of the species: ten areas in the

Northwestern Hawaiian Islands and six in the main Hawaiian Islands. These areas contain one or a combination of habitat types: preferred pupping and nursing areas, significant haul-out areas, and/or marine foraging areas that support conservation for the species. Specific critical habitat areas are described in detail in the final rule (76 FR 50926 to 50988, August 17, 2011).

Though Hawaiian monk seal subpopulations often exhibit variation in demographic parameters (such as abundance trends and survival rates), they are connected by animal movement throughout the species' range, and genetic analysis indicates the species is a single panmictic population (i.e., random mating within a breeding population); therefore, the Hawaiian monk seal is considered a single stock (Carretta et al., 2020). The population of Hawaiian monk seals is estimated to be 1,437 seals, with a minimum population estimate of 1,376 animals (Carretta et al., 2022).

The species is well below its optimum sustainable population and has not recovered from past declines that began in the late 1950s and continued until recently. Although this decline means that a full recovery of the species is a long way off, there have been some relatively recent, encouraging developments, including (NMFS, No Date): 1) apparent recolonization and significant growth of the main Hawaiian Islands monk seal subpopulation from low numbers to approximately 300 over the past two or more decades, and 2) overall species population growth of three percent each year between 2014 and 2016.

Hawaiian monk seals can hold their breath for up to 20 minutes and dive more than 550 m (1,800 ft); however, they usually dive an average of six minutes to depths of less than 60 m (200 ft) to forage at the sea floor. They are mostly solitary and do not live in colonies, but they do sometimes lie near each other in small groups. They usually sleep on beaches, sometimes for days at a time. They also occasionally sleep in small underwater caves. Monk seals do not migrate seasonally, but some seals have traveled hundreds of kilometers in the open ocean. Individual seals often frequent the same beaches over and over, but they do not defend territories (NMFS, No Date-a).

Hawaiian monk seals are found throughout the entire Hawaiian archipelago. The majority of Hawaiian monk seals live in the Northwestern Hawaiian Islands, and a smaller population lives in the main Hawaiian Islands. There have also been rare sightings of Hawaiian monk seals, as well as a single birth, at Johnston Atoll, the closest atoll southwest of the Hawaiian Islands (NMFS, No Date-a). Monk seals live in warm, subtropical waters and spend two-thirds of their time at sea. They occur in the waters surrounding atolls and islands and areas farther offshore on reefs and submerged banks; they also use deepwater coral beds as foraging habitat. When on land, monk seals haul-out to rest, breed, give birth, and molt on sand, corals, and volcanic rock shorelines. They prefer sandy, protected beaches surrounded by shallow waters for pupping.

3.5.1.2.3.5 Ringed Seal (Arctic subspecies)

Ringed seals are the smallest and most common Arctic seal. There are five currently recognized subspecies of the ringed seal: Arctic ringed seals in the Arctic Basin and adjacent seas, including the Bering and Labrador Seas; Okhotsk ringed seals in the Sea of Okhotsk; Baltic ringed seals in the Baltic Sea; Ladoga ringed seals in Lake Ladoga, Russia; and Saimaa ringed seals in Lake Saimaa, Finland (NMFS, No Date-a; Muto et al., 2018). These subspecies were all listed as endangered or threatened under the ESA in 2013, and they are also listed as depleted under the MMPA. Critical habitat was designed in 2022 and comprises an area of marine habitat in the Bering, Chukchi, and Beaufort seas (87 FR 19232, April 1, 2022). Loss of sea ice and snow cover on the ice poses the main threat to this species. Although subsistence harvest of Arctic ringed seals occurs in some parts of this subspecies' range, harvest levels appear to be sustainable. While the U.S. does not allow commercial harvest of marine mammals, such harvests are permitted in other portions of the species' range. This has caused population declines in some regions in the past but has generally been restricted since then. Other threats to the ringed seal include climate change, entanglement in fishing gear, increasing Arctic shipping activity, sound and activity from offshore oil and gas exploration, and development (NMFS, No Date-a).

The Arctic ringed seal is the most abundant of the five ringed seal subspecies. Although no accurate estimate exists, there are probably more than 2 million Arctic ringed seals worldwide. There is one recognized stock of (Arctic) ringed seals in U.S. waters: the Arctic stock. Although a reliable population estimate for the entire stock is not available, research programs have developed survey methods that have been used to determine abundance estimates for part of the range of the stock. The estimated population size for this stock is 171,418 animals, with a minimum population estimate of 158,507 individuals (Muto et al., 2020). However, the actual number of ringed seals in the U.S. portion of the Bering Sea is likely much higher, perhaps by a factor of two or more. Researchers expect to provide a population estimate, corrected for availability bias, for the entire Arctic stock of ringed seals once the final Bering Sea results are combined with the results from spring surveys of the Chukchi Sea (conducted in 2016) and Beaufort Sea (in 2020).

Ringed seals do not live in large groups and are usually found alone, but they may occur in large groups during the molting season. Ringed seals eat a wide variety of mostly small prey. Despite regional and seasonal variations in the diet of ringed seals, fishes of the cod family tend to dominate the diet in many areas from late fall through spring. Crustaceans appear to become more important in many areas during the open-water season and often dominate the diet of young seals. While foraging, ringed seals dive to depths of up to 45 m (150 ft) or more.

Ringed seals are circumpolar and are found in all seasonally ice-covered seas of the Northern Hemisphere and in certain freshwater lakes (NMFS, No Date-a). They range throughout the Arctic Basin and southward into adjacent seas, including the Bering and Labrador Seas. They are also found in the Sea of Okhotsk and Sea of Japan in the western North Pacific and the Baltic Sea in the North Atlantic. Landlocked subspecies inhabit Lakes Ladoga (Russia) and Saimaa (Finland). During winter and spring in the U.S., ringed seals are found throughout the Beaufort and Chukchi Seas; they occur in the Bering Sea as far south as Bristol Bay in years of extensive ice coverage. Most ringed seals that winter in the Bering and Chukchi Seas are thought to migrate northward in spring with the receding ice edge and spend summer in the pack ice of the northern Chukchi and Beaufort Seas.

Throughout their range, ringed seals have an affinity for ice-covered waters and are well-adapted to occupying heavily ice-covered areas throughout the fall, winter, and spring by using the stout claws on their fore flippers to maintain breathing holes in the ice. Ringed seals remain in contact with the ice most of the year and normally pup and nurse pups on the ice in snow-covered lairs (snow caves) in late winter through early spring. The ice and snow caves provide some protection from predators, though polar bears spend much of their time on sea ice hunting ringed seals, which are their primary prey. Snow caves also protect ringed seal pups from extreme cold. As the temperatures warm and the snow covering their lairs melts during spring, ringed seals transition from lair use to basking on the surface of the ice near breathing holes, lairs, or cracks in the ice as they undergo their annual molt (NMFS, No Date-a; Muto et al., 2018).

3.5.1.2.4 Pinnipeds Hunted for Subsistence

Species of pinnipeds hunted for subsistence by Alaska native communities that are not also listed as threatened or endangered under the ESA are described below. Subsistence practices and analysis of impacts of subsistence hunting are discussed in Section 3.17 Environmental Justice.

3.5.1.2.4.1 Northern Fur Seal

Northern fur seals primarily inhabit two types of habitats: open ocean and rocky or sandy beaches on islands for resting, reproduction, and molting. They seasonally breed on six islands in the eastern North Pacific Ocean and Bering Sea in the U.S.: St. Paul, Bogoslof, St. George, Sea Lion Rock, San Miguel, and South Farallon. The Pribilof Islands, the four-island archipelago off the coast of Alaska, support the largest aggregation of northern fur seals, about half of the world's northern fur seal population. In spring, most northern fur seals migrate north to breeding colonies in the Bering Sea. Territorial adult male northern fur seals leave their breeding colonies in August and are thought to spend most of their time in the Bering Sea and North Pacific Ocean along the Aleutian Islands. Pregnant adult females begin their winter migration in November and generally travel to either the central North Pacific Ocean or to offshore areas along the west coast of North America to feed. During summer and autumn, these seals intermittently fast while on land and feed at sea (NMFS, No Date-a). The Pribilof Islands/eastern Pacific stock is listed as depleted under the MMPA (NMFS, No Date-a).

3.5.1.2.4.2 Harbor Seal

Harbor seals are one of the most common marine mammals along both the west and east coasts of the U.S. On the east coast, harbor seals are found from the Canadian Arctic to New York and occasionally as far south as the Carolinas. On the west coast, they are found from California to the Bering Sea. They are typically non-migratory and stay within 24 to 50 km (15 to 31 mi) of their home. NMFS has identified five stocks of harbor seals in the U.S.: Alaska, California, Oregon-Washington coastal, Washington inland, and western North Atlantic. The harbor seal is protected under MMPA throughout its range (NMFS, No Date-a).

3.5.1.2.4.3 Ice Seals

Bearded, ringed, spotted, and ribbon seals are collectively called ice seals because of their association with sea ice for feeding, resting, and pupping. The geographic distribution of bearded and ringed seals and details of their status under ESA and MMPA are described above under Threatened and Endangered Species. Ribbon and spotted seals, which are not ESA-listed, are described here.

Ribbon seals commonly occur in the Sea of Okhotsk and Bering Sea. More specifically, in U.S. waters they are found in the Bering Sea and in the Chukchi and western Beaufort Seas. Ribbon seals spend most of their time in the open ocean and the remainder on pack ice during spring to give birth, nurse pups, and molt. During summer, only a small number of ribbon seals are hauled out on the ice since ice melts completely in the Sea of Okhotsk, and the Bering Sea ice recedes north. Most ribbon seals are only seen again when the sea ice reforms in winter. Ribbon seals protected under the MMPA and included in NMFS' Species of Concern list (NMFS, No Date-a).

Spotted seals are widely distributed on the continental shelf of the Beaufort, Chukchi, southeastern East Siberian, Bering, and Okhotsk seas; south through the Sea of Japan; and into the Yellow Sea. In U.S. waters, spotted seals migrate south from Chukchi Sea through the Bering Strait from October to November ahead of advancing sea ice. They spend the winter in the Bering Sea in the annual pack ice over the continental shelf. During spring, they migrate to coastal habitats after the sea ice retreats. The foreign DPS of spotted seals and the southern DPS are listed as threatened under ESA and depleted under MMPA (NMFS, No Date-a).

3.5.1.3 Sirenians (Manatees)

Sirenians are an order of fully aquatic, herbivorous mammals that inhabit swamps, rivers, estuaries, marine wetlands, and coastal marine waters. Sirenians currently comprise the families Dugongidae (the dugong) and Trichechidae (manatees) with a total of four species, only one of which occurs in the U.S., the West Indian manatee (**Figure 3.5-19**) with two distinct subspecies (**Table 3.5-3**). The remaining three sirenian species do not occur in the action area.

Figure 3.5-19. West Indian Manatee

Photo Credit: David A. Straz, Jr., Manatee Critical Care Center

3.5.1.3.1 Sirenian Sound Production and Hearing

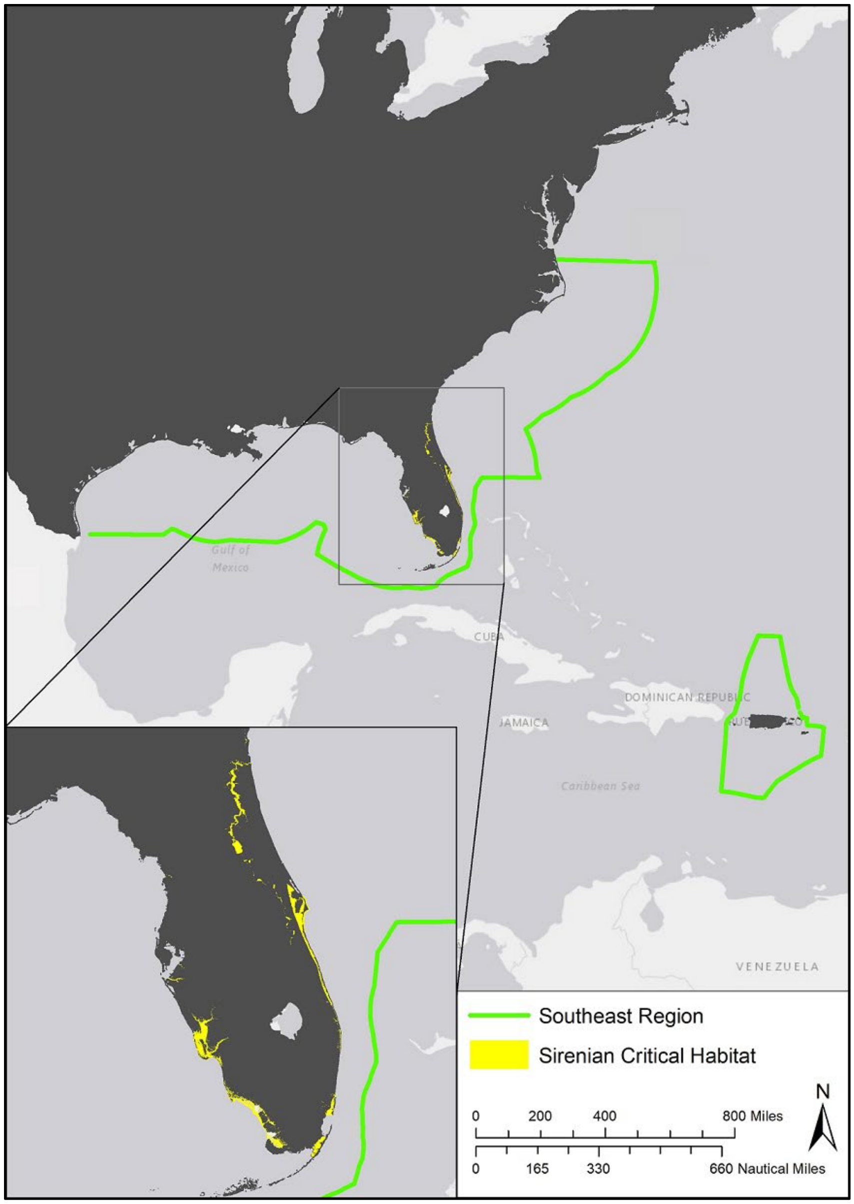
Manatees have a history of negative interaction with people. Due to their slow swimming speeds, tendency to linger near the water surface, and low profile at the surface, their main issue has been with vessel strikes, particularly by small watercraft. Vessel sound may also be a concern, but there is little other information available about manatee responses to other sound sources, including active sonar. Mysticetes, although distant relatives, are the most closely related group of marine mammals taxonomically and share important behavioral traits (e.g., grazing). Southall et al. (2019) indicates that sirenian hearing can extend from low frequencies (< 5 kHz) to above 60 kHz, and sound production for sirenians can range between 0.15 kHz and 22 kHz (Southall et al., 2019).

3.5.1.3.2 Regional Distribution of Sirenians

Manatees occur mainly in the Southeast Region of the action area, although they have been observed on occasion further north in the Greater Atlantic Region.

3.5.1.3.2.1 Southeast Region

Both subspecies of the West Indian manatee occur in the Southeast Region, as indicated in **Table 3.5-3**. Both subspecies are ESA-listed, but only the Florida subspecies has designated critical habitat as shown in **Figure 3.5-20**.



Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.5-20. Sirenian Designated Critical Habitat in the Southeast Region

Table 3.5-3. Sirenians Occurring in the Action Area

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Ecology
Manatees							
West Indian manatee (Antillean subspecies)	*Trichechus manatus manatus*	Yes: Antillean subspecies	Threatened	USFWS	SER	No	Submerged aquatic vegetation in shallow freshwater, brackish water, and marine waters
West Indian manatee (Florida subspecies)	*Trichechus manatus latirostris*	Yes: Florida subspecies	Threatened	USFWS	SER	Yes	Submerged aquatic vegetation in shallow freshwater, brackish water, and marine waters

Source: ECOS, No Date-a

*SER = Southeast Region (includes the southern portion of the U.S. Eastern Seaboard, the U.S. Caribbean Islands [Puerto Rico and the U.S. Virgin Islands], and the Gulf of Mexico)

3.5.1.3.3 Threatened and Endangered Sirenians

The West Indian manatee is ESA-listed in the action area, and one of the two manatee subspecies has designated critical habitat. These sirenians are shown in **Table 3.5-3** and described in more detail below.

3.5.1.3.3.1 West Indian Manatee (Antillean subspecies and Florida subspecies)

The West Indian manatee is found in the Southeast Region throughout the Caribbean basin and in the southeastern U.S. where it reaches the northern limit of its range. It is limited to the tropics and subtropics due to an extremely low metabolic rate and lack of a thick layer of insulating body fat, and prolonged exposure to water temperatures below 20° Celsius (C) (68° Fahrenheit [F]) can be lethal. Collisions with motorboats are the primary cause of human-related deaths; since manatees swim slowly just below or at the surface of the water, they are especially vulnerable to collisions with boats. Florida manatees are also threatened by loss of warm-water habitat, periodic die-offs due to red tides, and unusually cold weather events.

Two subspecies of West Indian manatee are recognized: the Antillean subspecies (*T. m. manatus*) and the Florida subspecies (*T. m. latirostris*). This subspeciation could reflect reproductive isolation brought on by the intemperate northern coast of the Gulf of Mexico and characteristically strong currents found in the Straits of Florida (USFWS, 2014a; USFWS, 2014b). Florida manatees are found throughout the southeastern U.S., and Antillean manatees are found in Puerto Rico in the U.S. EEZ, as well as in other parts of the Caribbean, Central America, and South America (82 FR 16668, April 5, 2017).

The West Indian manatee was listed as endangered under the ESA in 1967, and it was reclassified as threatened in 2017 (82 FR 16668, April 5, 2017). It is also a strategic stock under the MMPA. The Florida subspecies is also protected under the Florida Manatee Sanctuary Act. Florida manatees are managed jointly by both the USFWS and the Florida Fish and Wildlife Conservation Commission. The Antillean manatee population is managed jointly by the USFWS and the Puerto Rico Department of Natural and Environmental Resources. Critical habitat was designated for the Florida manatee 1976 and includes coastal areas, inland waterways, headwaters, bays, estuaries, and rivers as detailed in the final rule (41FR41914). No critical habitat has been designated outside of Florida. The most recent surveys to determine the population of the Florida manatee were conducted in 2015-16 (Hostetler et al., 2018). These surveys estimated that the number of manatees in Florida was 8,810 animals, of which 4,810 were on the west coast of Florida and 4,000 were on the east coast; the minimum population estimate is 7,520 manatees. Surveys from 2010 to 2014 estimated the average minimum island-wide population of the Antillean subspecies to be 386 manatees (Collazo et al., 2019) and found that manatees were more widespread than previously understood.

Manatees live in freshwater, brackish, and marine habitats in riverine and coastal areas. Sightings in the Atlantic Ocean and Gulf of Mexico are fairly common, especially near the coastlines. Satellite-tracked manatees have been documented moving along the coasts more than five miles offshore, and it is not uncommon for manatees to be seen near offshore oil platforms in the Gulf of Mexico more than 20 miles offshore. Preferred habitats feature submerged aquatic vegetation such as eelgrass and seagrass. The majority of the Atlantic population of the Florida manatee is located in eastern Florida, (USFWS, 2014b). As water temperatures rise in spring and summer, manatees in Florida disperse throughout the state and into neighboring states. Warm-season manatee use along the Atlantic coast north of Florida occurs frequently in Georgia, South Carolina, and North Carolina, and fairly frequently in Virginia, Delaware, and Maryland (82 FR 16668, April 5, 2017). The numbers of manatees using these areas is not known, but use in South Carolina is likely similar to use in Georgia. Use in North Carolina may be a little less, and use farther north is likely small but frequent. Because they have little tolerance for cold, manatees are generally restricted to the inland and coastal waters of peninsular Florida during the winter, where they shelter in or near sources of warm water (springs, industrial and power plant effluents, and other warm water sites).

The Antillean manatee is found in eastern Mexico and Central America, northern and eastern South America, and in the Greater Antilles (USFWS, 2014a). It inhabits riverine and coastal systems in the subtropical Western Atlantic Coastal Zone from the Caribbean islands to Brazil, including the Gulf of Mexico. Manatees found in the Bahamas are believed to be the Florida subspecies, not the Antillean. The distribution of the Antillean manatee extends eastward to Puerto Rico. In Puerto Rico, manatees favor habitats in coastal areas that are protected from severe wave action, harbor submerged aquatic vegetation, and have some source of fresh water. Manatees are consistently detected more on the eastern and southern coast than on the northern coast of the main island. Relatively higher concentrations of manatees are found in four areas: Ceiba on the east coast, Jobos Bay area between Guayama and Salinas on the southeast coast, Guayanilla and Guánica Bay area on the southwest coast, and between Cabo Rojo and Mayaguez (Guanajibo River mouth) in the west coast. Five offshore islands are significant biogeographic features in Puerto Rico: (west to east) Desecheo, Mona, Caja de Muertos, Culebra, and Vieques islands. Manatees do not use the western offshore islands of Mona and Desecheo as Mona Passage constitutes a migratory barrier to these islands since it is characterized by strong currents and high surf. There have been few sightings in Caja de Muertos and Culebra Island. In contrast, Vieques Island is within the range of the species, and manatees have been seen traveling to and from the east coast (USFWS, 2014a).

Manatees are herbivorous, feeding on a wide array of aquatic (freshwater and marine) plants such as water hyacinths and marine seagrasses. They generally prefer shallow seagrass beds, especially areas with access to deep channels. Preferred coastal and riverine habitats (e.g., near the mouths of coastal rivers) are also used for resting, mating, and calving.

3.5.1.4 Fissipeds (Sea Otters and Polar Bears)

Polar bears and sea otters are marine mammals that are neither pinniped nor cetacean. They are both fissipeds, or “split-footed” members of the taxonomic order Carnivora and are more closely related to terrestrial carnivores, like weasels (the sea otter, like its “cousin” the river otter, is in Mustelidae, the weasel family), than to seals or whales (Wynne, 2013). These species lack many of the physiologic adaptations to marine life seen in pinnipeds and cetaceans. Both species are considered marine mammals under U.S. laws because of the roles they play in the marine environment.

Polar bears, closely related to brown bears (*Ursus arctos*) in the bear family (Ursidae), spend most of their lives associated with marine ice and waters and are dependent on pack ice for much of their denning habitat and for hunting seals. Although competent swimmers, they are the marine mammal least adapted to aquatic existence. They rest, mate, give birth, and suckle their young on ice and terrestrial habitats (Wynne, 2013).

Sea otters, in the weasel family (Mustelidae), and much larger than river otters, live a primarily marine life: they rest, mate, give birth, and suckle their young in the water. Their hind limbs are webbed for swimming, but their front paws are padded with separate, clawed digits. They lack blubber but are insulated by air trapped in their thick fur, which is densest among all mammals (Wynne, 2013), and the reason for which they were heavily hunted historically, drastically reducing their populations.

All marine fissipeds are protected by the MMPA throughout their ranges. Polar bears and sea otters are also federally listed under the ESA either throughout their ranges or for certain subspecies and DPSs. Additionally, the northern sea otter (Southwest Alaska DPS) and the polar bear have designated critical habitat. **Table 3.5-4** lists the two species of fissipeds (four distinct species, subspecies, or DPS total) occurring throughout the action area.

3.5.1.4.1 Fissiped Sound Production and Hearing

Polar bears spend much of their time on land or ice and little time with their heads submerged below the surface when they are swimming or hunting. Sea otters live in shallow coastal areas and spend a great deal of time floating at the surface, or conducting short foraging dives. Finneran et al. (2017) placed fissipeds in the "Otariids and other non-phocid marine carnivores" functional hearing group (which contains all eared seals, walruses, sea otters, and polar bears) as limited data can be found specifically for polar bear or sea otter reactions to underwater sounds.

Polar bears are not known to communicate underwater. Nachtigall et al. (2007) measured the in-air hearing of polar bears and found that the best sensitivity was in the 11.2 to 22.5 kHz range. Behavioral testing of hearing indicates that polar bears can hear down to at least 14 Hz and up to 25 kHz. Testing by Owen and Bowles (2011) indicates that the greatest in-air hearing sensitivity occurs between 8-14 kHz. Polar bears generally hear in the less than 25 kHz range underwater (Owen and Bowles, 2011).

Ghoul and Reichmuth (2014) found that the aerial audiogram of the sea otter resembled that of sea lions; they can hear in the 125 Hz to 38 kHz in the air, with a best hearing sensitivity between 1.2 kHz and 27 kHz. Under water, hearing sensitivity was significantly reduced when compared to sea lions and other pinniped species, demonstrating that sea otter hearing is primarily adapted to receive airborne sounds. Underwater, sea otters hear in the less than 32 kHz range with best sensitivity between 2 kHz to 26 kHz underwater They are less efficient than other marine carnivores at extracting acoustic signals from background sound underwater, especially at frequencies below 2 kHz (Ghoul and Reichmuth, 2014).

3.5.1.4.2 Regional Distribution of Fissipeds

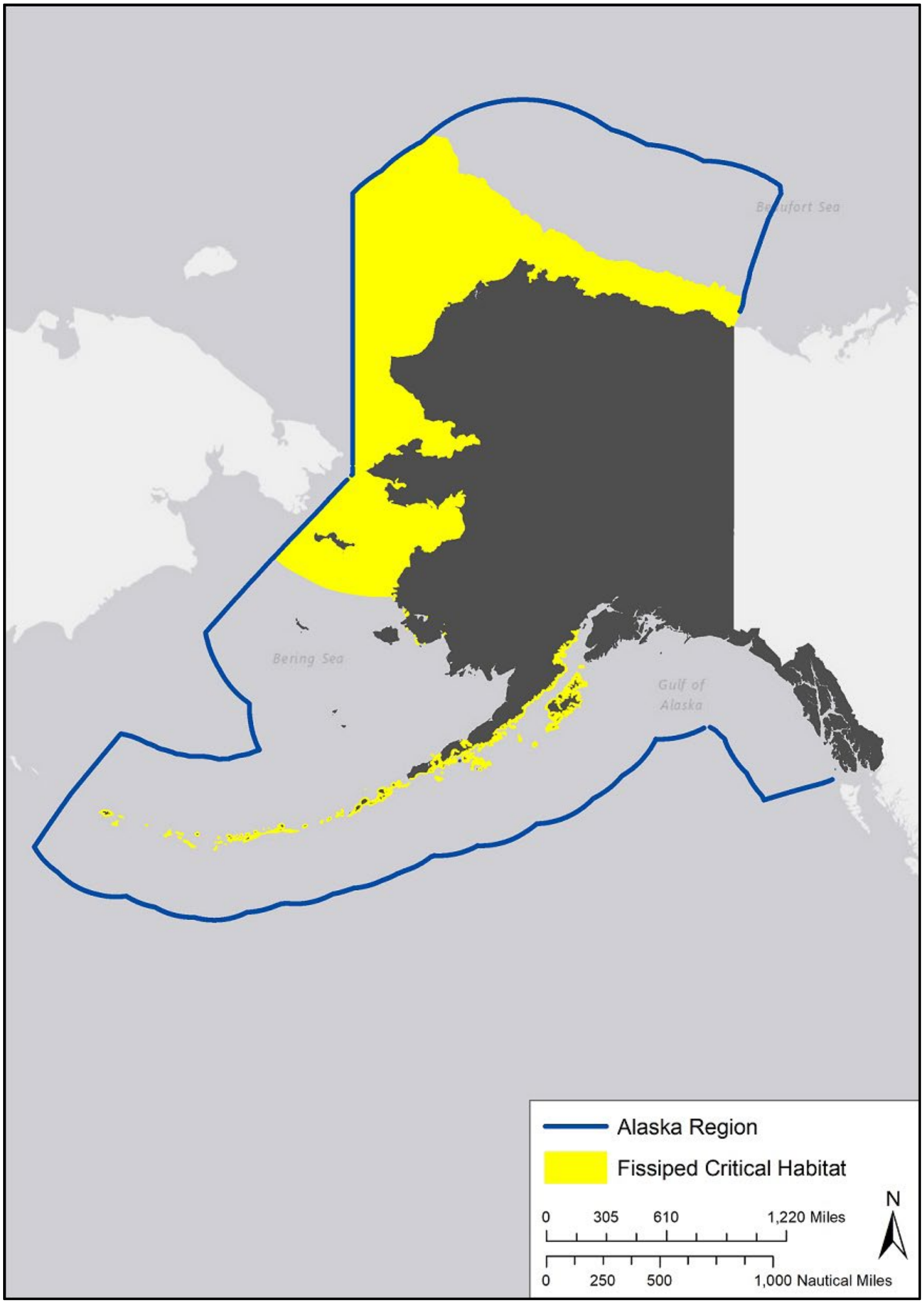
The polar bear and sea otter are distributed in two regions of the action area, described below.

3.5.1.4.2.1 West Coast Region

Two fissipeds occur in the West Coast Region, as indicated in **Table 3.5-4**: the northern sea otter and the southern sea otter, which is ESA-listed as threatened. There is no designated critical habitat in the region.

3.5.1.4.2.2 Alaska Region

Two fissipeds (northern sea otter, including the Southwest Alaska DPS, and polar bear) occur in the Alaska Region, as indicated in **Table 3.5-4.** The northern sea otter (Southwest Alaska DPS) and the polar bear are ESA-listed as threatened, and both have designated critical habitat in the region as shown in **Figure 3.5-21**.



Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.5-21. Fissiped Designated Critical Habitat in the Alaska Region

Table 3.5-4. Fissipeds Occurring in the Action Area

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Ecology
Mustelids							
Northern sea otter	*Enhydra lutris kenyoni*	No	--	USFWS	AR, WCR	--	Shallow, coastal, kelp forests
Northern sea otter (Southwest Alaska DPS)	*Enhydra lutris kenyoni*	Yes: Southwest Alaska DPS	Threatened	USFWS	AR	Yes	Shallow, coastal, kelp forests
Southern sea otter	*Enhydra lutris nereis*	Yes: throughout its range	Threatened	USFWS	WCR	No	Shallow, coastal, kelp forests
Ursids							
Polar bear	*Ursus maritimus*	Yes: throughout its range	Threatened	USFWS	AR	Yes	Sea ice

Source: ECOS, No Date-a; NMFS, No Date-a

* AR = Alaska Region (includes Alaskan waters and the Arctic); WCR = West Coast Region (includes coastal California, Oregon, and Washington)

3.5.1.4.3 Threatened and Endangered Fissipeds

Three distinct populations of fissipeds in the action area are ESA-listed under the ESA and managed by the USFWS; two species also have designated critical habitat. These fissipeds are shown on **Table 3.5-4** and described in detail below.

3.5.1.4.3.1 Southern Sea Otter and Northern Sea Otter

Historically, sea otters (**Figure 3.5-22**) occurred in nearshore marine waters around the North Pacific Rim from Hokkaido, Japan, through the Kuril Islands, the Kamchatka Peninsula, the Commander Islands, the Aleutian Islands, peninsular and south coastal Alaska, and south to Baja California, Mexico (USFWS, 2014c). In the early 1700s, the worldwide population was estimated to be between 150,000 and 300,000 individuals. Sea otters were hunted nearly to extinction during the 1700s and 1800s for the fur trade. Only small remnant groups of sea otters survived the fur hunting period. Prior to large-scale commercial exploitation, indigenous peoples of the North Pacific hunted sea otters. Although it appears that harvests may have periodically led to local reductions of sea otters, the species remained abundant throughout its range until the mid-1700s. When sea otters were afforded protection by the International Fur Seal Treaty in 1911, probably fewer than 2,000 animals remained in 13 remnant colonies. Population recovery began following legal protection. As part of efforts to re-establish sea otters in portions of their historical range, otters from Amchitka Island and Prince William Sound were translocated to other areas in the 1960s and 1970s. The primary threats to sea otters currently include entanglement in fishing gear and debris, oil spills, harvesting for pelts, conflicts with commercial fishing interests, and coastal development. Several thousand sea otters were killed in Alaska by the *Exxon Valdez* oil spill in Prince William Sound in 1989, and the detrimental effects of the spill may have persisted into the 1990s.

Figure 3.5-22. Sea Otter with Sea Urchins

Photo Credit: Neil Fisher

The USFWS recognizes five sea otter stocks in U.S. waters; these include single stocks in California and Washington and three in Alaska (Southeast, Southcentral, and Southwest). The California sea otter is the southern sea otter; all the rest comprise the northern sea otter. Sea otters are protected from hunting and harassment by the MMPA. The southern sea otter in California was listed as threatened under the ESA in 1977. The USFWS listed the Southwest Alaska DPS of northern sea otter as threatened under the ESA in 2005. The global population size is estimated at greater than 150,000 animals. The current and minimum population estimate for the southern sea otter in California is 3,272 animals (USFWS, 2021a). The minimum population estimate of the Washington sea otter population is 2,785 individuals (Jeffries et al., 2019). The estimated population size for the Southwest Alaska stock is 54,771 animals, with a minimum population estimate of 45,064 individuals (USFWS, 2014c). The estimated population size for the Southeast Alaska stock is 25,712 animals, with a minimum population estimate of 21,798 individuals (USFWS, 2014d). The estimated population size for the Southcentral Alaska stock is 18,297 animals, with a minimum population estimate of 14,661 individuals (USFWS, 2014e).

Critical habitat was designated for the northern sea otter Southwest Alaska DPS in 2009 (74 FR 51988, October 8, 2009). Five units were designated as critical habitat: the Western Aleutian Unit, the Eastern Aleutian Unit, the South Alaska Peninsula Unit, the Bristol Bay Unit, and the Kodiak, Kamishak, Alaska Peninsula Unit. The PCEs of critical habitats for the northern sea otter are:

1) Shallow, rocky areas where marine predators are less likely to forage, which are waters less than 2 m (6.6 ft) in depth;
2) Nearshore waters that may provide protection or escape from marine predators, which are those within 100 m (328.1 ft) from the mean high tide line;
3) Kelp forests that provide protection from marine predators, which occur in waters less than 20 m (65.6 ft) in depth; and
4) Prey resources within the areas identified by PCEs 1, 2, and 3 that are present in sufficient quantity and quality to support the energetic requirements of the species.

The sea otter differs from most marine mammals in that it lacks an insulating subcutaneous layer of fat. For protection against cold water, it depends on a layer of air trapped among its hair. The underfur is the densest mammalian fur. The species is most commonly observed within the 40-m (approximately 12.2-ft) depth contour because the animals require frequent access to benthic foraging habitat in subtidal and intertidal zones (USFWS, 2014c). In Washington they have also been documented in waters 58 km (36 mi) offshore in depths of 200 m (656 ft). Sea otters forage diurnally and nocturnally (Esslinger et al., 2014). During their typical midday rest period, sea otters often rest in kelp beds, where they also spend the night.

Sea otters are gregarious and may become concentrated in an area, sometimes resting in groups containing less than 10 to over 1,000 animals. Sea otters mate at all times of the year, and young may be born in any season. However, in Alaska most pups are born in late spring. The pupping period for Washington's sea otter stock occurs primarily from March to April, with peak numbers of dependent pups expected to be present from May to September (USFWS, 2018).

Sea otter movements are likely limited by geographic barriers, their high-energy requirements, and social behavior. Sea otters are not migratory and generally do not disperse over long distances, although movements of tens of kilometers are common. Due to their benthic foraging, sea otter distribution is largely limited by their ability to dive to the sea floor. The ranges of the Alaska stocks are defined as follows (USFWS, 2014c): 1) the Southeast Alaska stock extends from Dixon Entrance to Cape Yakataga; 2) the Southcentral Alaska stock extends from Cape Yakataga to Cook Inlet including Prince William Sound, the Kenai Peninsula coast, and Kachemak Bay; and 3) the Southwest Alaska stock includes the Alaska Peninsula and Bristol Bay coasts, and the Aleutian, Barren, Kodiak, and Pribilof Islands. The distribution of the majority of the Washington sea otter stock ranges from Pillar Point in the Strait of Juan de Fuca, west to Cape Flattery and as far south as Point Grenville on the outer Olympic Peninsula coast (USFWS, 2018). Otters can be present in Puget Sound as far south as Olympia and along the outer coast as far south as Cape Arago, Oregon. Southern sea otters occupy nearshore waters along the mainland coastline of California from San Mateo County to Santa Barbara County; a subpopulation of southern sea otters also exists at San Nicolas Island, Ventura County (USFWS, 2021a).

3.5.1.4.3.2 Polar Bear

Polar bears are distributed across ice-covered waters of the circumpolar Arctic. Sea ice (**Figure 3.5-23**) is their primary habitat upon which they depend for most life functions including hunting, feeding, breeding, travel, maternity denning areas, and resting (USFWS, 2016a). Two stocks of polar bears exist in Alaska, the Southern Beaufort Sea (SBS) stock and the Chukchi/Bering Seas (CBS) stock.

Warming-induced habitat degradation and loss are negatively affecting some polar bear stocks, and unabated global warming will ultimately reduce the worldwide polar bear population (USFWS, 2016a). Loss of sea ice habitat due to climate change is identified as the primary threat to polar bears. Patterns of increased temperatures, earlier spring thaw, later fall freeze-up, increased rain-on-snow events (which can cause dens to collapse), and potential reductions in snowfall are also occurring. As a result, there is fragmentation of sea ice, reduction in the extent and area of sea ice in all seasons, retraction of sea ice away from productive continental shelf areas throughout the polar basin, reduction of the amount of heavier and more stable multi-year ice, and declining thickness and quality of shore-fast ice. These climatic phenomena may also affect the abundance of seals, the polar bear's main food source.

Figure 3.5-23. Polar Bear on Sea Ice

Photo Credit: Collection of Dr. Pablo Clemente-Colon

Subpopulations of polar bears also face different combinations of human-induced threats. The largest human-caused loss of polar bears results from subsistence hunting of the species, but for most subpopulations where subsistence hunting of polar bears occurs, it is a regulated or monitored activity. Other threats include accumulation of persistent organic pollutants in polar bear tissue, tourism, human-bear conflict, and increased development in the Arctic (USFWS, 2016a).

Due to threats to its sea ice habitat, the polar bear was listed in 2008 as threatened (73 FR 28212, May 15, 2008) throughout its range under the ESA. Polar bears are also protected under the MMPA. Low population densities, inaccessible habitat, and budget constraints have made estimating abundance of polar bear populations difficult. The estimated population of polar bears is 20,000-25,000 individuals with 19 recognized management subpopulations or stocks worldwide (USFWS, 2016a). The estimated population size for the CBS stock is 2,937 animals (Regehr et al., 2018). The estimated population size for the SBS stock is 573 bears, with 95-percent credible interval from 232 to 1,140 animals (Atwood et al., 2020).

Polar bear critical habitat was designated in 2010 (75 FR 76086, December 7, 2010). The PCEs of critical habitats for the polar bear are (USFWS, 2016a):

1) Sea-ice habitat used for feeding, breeding, denning, and movements, which is sea ice over waters 300 m (984.2 ft) or less in depth that occurs over the continental shelf with adequate prey resources (primarily ringed and bearded seals) to support polar bears.
2) Terrestrial denning habitat, which includes topographic features, such as coastal bluffs and river banks, with suitable macrohabitat characteristics:
    a. Steep, stable slopes with heights ranging from 1.3 to 34 m (4.3 to 111.6 ft), and with water or relatively level ground below the slope and relatively flat terrain above the slope;
    b. Unobstructed, undisturbed access between den sites and the coast;
    c. Sea ice in proximity to terrestrial denning habitat prior to the onset of denning during the fall to provide access to terrestrial den sites; and
    d. The absence of disturbance from humans and human activities that might attract other polar bears.
3) Barrier island habitat used for denning, refuge from human disturbance, and movements along the coast to access maternal den and optimal feeding habitat, which includes all barrier islands along the Alaska coast and their associated spits, within the range of the polar bear in the U.S., and the water, ice, and terrestrial habitat within 1.6 km (1 mi) of these islands (no-disturbance zone).

Ringed seals are the polar bear's primary food source, and the most productive hunting grounds are areas near ice edges where ocean depth is minimal (BOEM, 2015a). While polar bears primarily hunt seals, they occasionally also consume other marine mammals. Most polar bears use terrestrial habitat partially or exclusively for maternity denning; therefore, females must adjust their movements to access land at the appropriate time. Most pregnant female polar bears excavate snow dens in the fall to early winter and give birth in the dens during midwinter. Family groups emerge from dens in March and April when cubs are approximately three months old.

The SBS population ranges from approximately Tuktoyaktuk, Canada and west to Icy Cape, Alaska. Approximately 60 percent of the SBS population spends the summer on pack ice with the remaining bears using land during late summer and fall (Atwood et al., 2020). The CBS population is widely distributed on the pack ice in the Chukchi Sea and northern Bering Sea and adjacent coastal areas in Alaska and Russia. Individuals of the CBS stock range widely on pack ice primarily from Kivalina, Alaska west to the eastern Siberian Sea, but could also occur as far east as the Colville River delta. The stock's southern boundary in the Bering Sea is determined by the annual extent of the pack ice. These two stocks have an extensive area of overlap between Icy Cape and Point Barrow, Alaska, centered near Wainwright (Scharf et al., 2019).

Polar bear movements are extensive, individual activity areas are enormous, and bears are not dispersed evenly throughout their range. To access ringed and bearded seals, polar bears in the SBS concentrate in shallow waters less than 300 m (984 ft) deep over the continental shelf and in areas with greater than 50 percent ice cover. In response to changes in the sea ice characteristics and declines in sea ice habitat over the continental shelf during the summer and late fall, some polar bears have changed distribution to search for seals and to access the remains of subsistence harvested bowhead whales.

3.5.2 Environmental Consequences for Marine Mammals

This section discusses potential impacts of proposed activities associated with Alternatives A, B, and C on marine mammals. ESA-listed endangered and threatened species are included as part of the discussion with non-listed species because the potential impact mechanisms are the same. Effects determinations as required under Section 7 of the Endangered Species Act for ESA-listed species are presented at the end of this section after the analysis of impacts. Activities that are part of the Proposed Action and that could be expected to impact marine mammals include operation of crewed sea-going surface vessels; operation of remotely operated or autonomous vehicles; use of echo sounders, ADCPs, acoustic communication systems, and sound speed data collection equipment; anchoring; operation of drop/towed cameras and video systems; installation, maintenance, and removal of tide gauges and GPS reference stations; and SCUBA operations.

3.5.2.1 Methodology

Project activities may impact marine mammals in a variety of manners in the action area, including (1) sound from active underwater acoustic sources (i.e., from echo sounders, ADCPs, and acoustic communication systems); (2) vessel operation and equipment sound - underwater and airborne (i.e., from crewed surface vessels; remotely operated and autonomous vehicles; tide gauge installation; and GPS reference station installation); (3) vessel presence and movement, including equipment in the water (i.e., visual and physical disturbance of and risk of collisions with marine mammals); (4) human presence and activity (i.e., onboard vessels, on land during tide gauge and GPS reference station installation, and underwater during SCUBA operations); (5) accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters (i.e., from vessel operations); (6) trash and debris (i.e., potential for entanglement and ingestion); and (7) air emissions (i.e., from smokestacks and outboard motors). These potential impact causing factors and their associated effects on marine mammals are discussed below after an overview of the general effects of underwater sound on marine mammals.

As discussed in Section 3.2.2, significance criteria were developed for each resource to provide a structured framework for assessing impacts from the alternatives and the significance of the impacts. The significance criteria for marine mammals are shown in **Table 3.5-5**. Potential impacts resulting from the Proposed Action are calculated or discussed on an individual animal basis (i.e., the estimate of total exposures to sound levels above specified thresholds). However, the focus of the significance analysis is to determine the consequences that those individual exposures may have on a species' population. In situations where the consequence of individual exposures has a potential for injury or behavioral disturbance (e.g., not direct mortality), it is difficult to quantitatively calculate population-level impacts from individual exposures. The significance criteria at the population level, while informed by the exposure estimates, are necessarily qualitative in considering the potential for injury or behavioral disturbance at the population level. The significance criteria also consider the status of the population, such as whether the individuals are part of an ESA-listed population. Finally, the significance criteria consider not only the number of individuals exposed, but also the spatial extent of exposures and whether the exposures are expected to occur in designated critical habitat or other biologically important areas such as preferred breeding, feeding, and nursery grounds or migratory routes.

Table 3.5-5. Significance Criteria for the Analysis of Impacts to Marine Mammals

Impact Descriptor	Context and Intensity	Significance Conclusion
Negligible	Impacts would be temporary (lasting up to several hours) and would not be outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disturbances to communication and/or echolocation and behaviors of individuals without interference to feeding, reproduction, or other biologically important functions affecting population levels. No mortality or debilitating injury to any individual marine mammal would occur. There would be no displacement of marine mammals from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat.	Insignificant
Minor	Impacts would be temporary or short-term (lasting several days to several weeks) but would not be outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include non-life-threatening injury to individual marine mammals and disruptions of behavioral patterns, including occasional disruption of communication and/or echolocation, behavioral disturbance of individuals or groups of marine mammals, and displacement of individuals or groups without interference to feeding, reproduction, or other biological important functions affecting population levels. Displacement of marine mammals from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat would be limited to the project area or its immediate surroundings.	
Moderate	Impacts would be short-term or long-term (lasting several months or longer) and outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include injury (up to and including mortal injury) and repeated disruptions of communication and/or echolocation and time-sensitive behaviors such as feeding and breeding, but in low enough numbers such that the continued viability of the population is not threatened. Behavioral responses to disturbance by individuals or groups could be expected in the project area, its immediate surroundings, or beyond, including extended displacement of individuals from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat.	
Major	Impacts would be short-term or long-term and well outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include extensive (i.e., affecting a large proportion of the local population), life-threatening, or debilitating injury and mortality and substantial	Significant

Impact Descriptor	Context and Intensity	Significance Conclusion
	disruption of communication and/or echolocation and time-sensitive behaviors such as breeding so that the continued viability of the local population is seriously threatened. Displacement from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat would be short- or long-term within and well beyond the project area. Full recovery of a population would not be expected to occur in a reasonable time.	

The following terms are used in the analysis below and are defined here:

- Continuous Sound – a sound that is present at all times in a relevant time window.
- Intermittent Sound – a sound that is periodically present.
- Pulse – a single segment of a periodic signal that consists of (potentially) repeating segments with defined beginning and end points and is, typically, short in duration (pulses are not necessarily impulsive).
- Impulsive Sound – sounds that are typically transient, brief (less than 1 second), broadband, and consist of high peak sound pressure (i.e., the decibel level of the maximum instantaneous acoustic pressure in a stated frequency band) with rapid rise time and rapid decay.
- Non-impulsive Sound – sounds that can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do.
- Duty Cycle – the percentage of time a signal is on in a relevant time window.

3.5.2.2 Potential Effects of Sound on Marine Mammals

The sounds that marine mammals hear and generate vary in characteristics such as dominant frequency, bandwidth, energy, temporal pattern, and directivity. The environment often contains multiple co-occurring sounds and, like all animals, marine mammals must be able to discriminate signals (meaningful sounds) from background sounds.

Where there is an overlap between sound sources and the frequencies of sound heard and used by marine mammals, there is the potential for sound to interfere with important biological functions. Responses of marine mammals exposed to underwater anthropogenic sounds are variable and range from subtle response to injury. The magnitude of the effect appears to depend on a combination of various factors, such as spatial relationships between a sound source and the animal, hearing sensitivity of the animal, overlaps in sound frequency, received sound exposure, duration of exposure, duty cycle, and ambient sound level. Responses to sounds are context dependent; among other ecological factors, the animal's activity at time of exposure and its history of exposure and familiarity with the sound signal are important influences (Ellison et al., 2012). Marine mammal hearing and sensitivity is discussed in Section 3.5.1 for each type of marine mammal. More information on acoustic properties and propagation of sound sources can be found in Appendix E, Technical Acoustic Analysis of Oceanographic Surveys.

The range of potential effects from sound includes death; non-auditory physiological effects; auditory effects (temporary or permanent hearing threshold shift); masking; physiological stress; and behavioral responses. All of these effects can have potential population consequences depending on the number of affected individuals and whether the effects exclude marine mammals from a habitat critical for their survival.

Underwater sound sources from the Proposed Action include active acoustic equipment and vessel sounds. For regulatory purposes, sound sources are categorized as impulsive or non-impulsive. Continuous-type sounds such as vessels and many sonar signals are considered non-impulsive. Impulsive sounds consist of relatively short duration on/off pulses and include sources such as pile driving and airguns (although these are not a part of the NOS Proposed Action), as well as some sonar. Following guidance from NMFS, high-resolution geophysical sources can be either impulsive or non-impulsive. NMFS has performed qualitative classification of the impulsiveness of these sources. NMFS has determined that sparkers and boomers are classified as impulsive sources, while sub-bottom profilers and multi-beam echo sounders are non-impulsive. This classification is based on NMFS' qualitative assessment of the generated waveforms. The acoustic analysis is based on thresholds for non-impulsive sounds (see Section 3.5.2.3.1.1 below and Appendix E).

The following sections address this range of potential effects of underwater anthropogenic sound on marine mammals.

3.5.2.2.1 Death and Non-Auditory Physiological Effects

Direct physical injury, which may result in death, may occur from exposure to high levels of impulsive sound such as shock waves associated with in-water explosions. These pulses are typically short, with peak pressures that may damage internal organs or air-filled body cavities (i.e., lungs). Marine mammals can be susceptible to direct physical injury following intense exposure (e.g., close proximity to explosives; Ketten et al., 1993), such as the initial compression of a body exposed to a blast wave, or barotrauma, in which injuries are caused when large pressure changes occur across tissue interfaces such as the lungs. However, the operation of NOS acoustic equipment is not likely to elicit direct physical injury resulting in death because these sources do not emit high level impulsive sound or produce intense exposures.

Potential non-auditory effects from sound sources such as sonar are unlikely due to relatively lower peak pressures (i.e., the maximum instantaneous sound pressure during a measurement period or sound event) and slower rise times (i.e., the propagation of the wave between the source and the sensor) than potentially injurious impulsive sources such as explosives. Therefore, blast injury and barotrauma would not occur. The sound sources used by NOS are not expected to result in non-auditory physiological effects, other than stress as discussed below in Section 3.5.2.2.4.

Exposure to non-impulsive acoustic energy has also been considered a potential indirect cause of the death of marine mammals. In some cases, while the sound itself may not have directly caused death or injury, it is assumed to be a causal factor in behavior (i.e., in such cases as strandings) that led to deaths (Marine Mammal Commission, 2006; ICES, 2005). Sonar use during exercises involving the U.S. Navy has been identified as a contributing cause or factor in five specific mass stranding events: Greece in 1996; the Bahamas in March 2000; Madeira Island, Portugal in 2000; the Canary Islands in 2002, and Spain in 2006 (Cox et al., 2006; Fernandez, 2006; Navy, 2017a). These five mass strandings have resulted in about 40 known cetacean deaths consisting mostly of beaked whales and with close linkages to mid-frequency active sonar activity. In these circumstances, exposure to non-impulsive acoustic energy was considered a potential indirect cause of death of the marine mammals (Cox et al., 2006).

In another example, analysis of potential causes of a mass stranding of 100 melon-headed whales (*Peponocephala electra*) in Madagascar in 2008 implicated a mapping survey using a high-power 12 kHz multi-beam echo sounder (similar to that used in the Proposed Action) as a likely trigger for this event. Although the cause is equivocal and other environmental, social, or anthropogenic factors may have facilitated the strandings and contributed to the mortalities, the authors determined the echo sounder as the most plausible factor initiating the stranding response, suggesting that avoidance behavior may have led the pelagic whales into shallow, unfamiliar waters (Southall et al., 2013). This was the first time that a relatively high-frequency mapping sonar system had been associated with a stranding event (Southall et al., 2013). However, the exact same sound source had been used a few weeks prior in the same general area off Madagascar without incident. These types of systems are used extensively for ocean bottom mapping, fish finding, and other common surveys without any documented links to stranding events. Impacts can be situation-specific; in this case, the operation of the survey (north to south) parallel to shore may have trapped the animals between the ship (where the sound source was located) and the shore, and the animals continued to turn inland until they entered the lagoon and became entrapped. Although high-resolution acoustic surveys are routinely conducted by NOS, but there has only been one documented incident due to the use of high-resolution acoustic survey sources (as discussed above in Madagascar), stranding events are not expected to result from the Proposed Action.

3.5.2.2.2 Auditory Injuries – Hearing Threshold Shift

The hearing threshold is the minimum sound level (measured in decibels, or dB) an animal can hear within a specified frequency band. Sounds that are loud, well above the hearing threshold, and long-duration may result in an elevation of the hearing threshold (BOEM, 2014a) (i.e., hearing loss). Threshold shifts, or incremental hearing loss, may be temporary, returning to their baseline level, or permanent. Threshold shifts are defined as follows, as adapted from Southall et al. (2007) and Finneran et al. (2005):

- Temporary Threshold Shift (TTS) – the mildest form of hearing impairment; exposure to loud sound resulting in a non-permanent (reversible) elevation in hearing threshold, making it more difficult to hear sounds; TTS can last from minutes or hours to days; the magnitude of the TTS depends on the level and duration of the sound exposure, among other considerations.
- Permanent Threshold Shift (PTS) – permanent elevation in hearing threshold with physical damage (injury) to the sound receptors in the ear lasting indefinitely; in some cases, there can be total or partial deafness, whereas in other cases the animal has an impaired ability to hear sounds in specific frequency ranges. Repeated TTS, especially if the animal receives another loud sound exposure before recovering from the previous TTS, is thought to cause PTS. If the sound is intense enough, however, PTS may result without TTS.

The distinction between PTS and TTS is based on whether there is a complete recovery of a threshold shift or loss of sensitivity following a sound exposure. If the threshold shift eventually returns to zero (hearing returns to the pre-exposure normal), the threshold shift is a TTS.

Several factors determine the type and magnitude of hearing loss, including exposure level, frequency, duration, and temporal pattern of exposure. A range of mechanical effects (e.g., stress or damage to supporting cell structure) and metabolic processes (e.g., inner ear hair cell metabolism such as energy production, protein synthesis, and ion transport) within the auditory system underlie both TTS and PTS. See Appendix E for more information.

For TTS, full recovery of the hearing loss (to the pre-exposure threshold) is expected based on studies of marine mammals which determined that this recovery occurs within minutes to hours for the small amounts of TTS that have been experimentally induced (Finneran et al., 2005, 2010; Nachtigall et al., 2004). The recovery time is related to the exposure duration, sound exposure level, and the magnitude of the threshold shift, with larger threshold shifts and longer exposure durations requiring longer recovery times (Finneran et al., 2005, 2010; Mooney et al., 2009a, b). If the threshold shift does not return to zero but leaves some finite amount of threshold shift (loss in hearing sensitivity), then that remaining threshold shift is a PTS.

Studies have modeled the potential impacts (i.e., threshold shifts) (TTS: Kremser et al., 2005; PTS: Lurton and DeRuiter, 2011) in marine mammals exposed to echo sounders (such as those used for the NOS Proposed Action). The results from the studies suggest that TTS and PTS would be expected to occur in marine mammals generally at the distances of 100 m (328 ft) or less from the source in the cone ensonified by the modeled echo sounders, meaning only animals below the ship are exposed to these levels. On the side of the vessel, even at the same distances, animals are not exposed to these levels because of the conical nature of the sonar beam. Other studies involving echo sounders, such as experiments with captive common bottlenose dolphins, have shown that loud, short (1 second) tonal sounds can cause TTS (Schlundt et al., 2000), as can lower sound levels for periods up to 50 minutes (Finneran et al., 2005; Nachtigall et al., 2004, 2005). Sound sources used during NOS projects are likely to produce TTS or PTS in very few nearby marine mammals through exposure to the downward-directed echo sounder frequencies because the probability of a marine mammal swimming through the area of exposure (ensonified area) when an echo sounder emits a sound is small. The animal would have to pass the transducer at close range and/or be swimming at speeds similar to the vessel in order to accumulate enough sound energy to cause TTS or PTS. Detailed analysis of the impacts of active underwater acoustic sources potentially resulting in TTS or PTS is provided in Sections 3.5.2.3 through 3.5.3.5 for each type of marine mammal.

3.5.2.2.3 Masking

Auditory signal masking is the reduction in an animal's ability to perceive, recognize, or decode biologically relevant sounds because of interfering sounds. Masking can effectively limit the distance over which a marine mammal can communicate, detect biologically relevant sounds, and echolocate (for odontocetes). Masking only occurs in the presence of the masking noise and does not persist after the cessation of the noise (Navy, 2020). Masking can lead to vocal changes (e.g., Lombard effect, increasing amplitude, or changing frequency) and behavior changes (e.g., cessation of foraging, leaving an area) in both signalers and receivers, in an attempt to compensate for sound levels (Erbe et al., 2016). Masking can be caused by naturally occurring ambient sound produced from various sources, including wind, waves, precipitation, and other animals, or background sounds including human activities (e.g., impulsive sounds, sonar, and vessel sound).

Vocal changes in response to anthropogenic sound can occur across many sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing (Navy, 2020). Vocalization changes include increasing the source level, modifying the frequency, increasing the call repetition rate of vocalizations, or ceasing to vocalize in the presence of increased sound (Hotchkin and Parks, 2013). In cetaceans, vocalization changes were reported from exposure to anthropogenic sound sources such as sonar, vessel sound, and seismic surveying (Gordon et al., 2003; Holt et al., 2009; McDonald et al., 2009; Rolland et al., 2012). Vocal changes represent possible tactics by the sound-producing animal to reduce the impact of masking. The receiving animal can also reduce the impacts of masking by using active listening strategies such as orienting to the sound source, moving to a quieter location, or reducing self- sound from hydrodynamic flow by remaining still (Navy, 2020).

Masking could have adverse consequences to marine mammals. Marine mammals use sound to recognize predators (Allen et al., 2014; Curé et al., 2015). Auditory recognition may be reduced in the presence of a masking noise, particularly if it occurs in the same frequency band. Therefore, the occurrence of masking may prevent marine mammals from responding to the acoustic cues produced by their predators. This could depend on the duration of the masking and the likelihood of encountering a predator during the time that predator cues are impeded. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by mammal-eating killer whales. The seals acoustically discriminate between the calls of mammal-eating and fish-eating killer whales (Deecke et al., 2002), a capability that should increase survivorship while reducing the energy required to attend to all killer whale calls.

Masking has been documented from use of airguns in seismic surveys, which, unlike the echo sounders used by NOS, are a powerful, omnidirectional impulsive source. Sounds from seismic surveys contribute to ocean-wide masking (Hildebrand, 2009). Impulsive sounds produced during pile driving operations have been found to mask the calls of marine mammals at great distances (Madsen et al., 2006). Gordon et al. (2003) listed a range of possible effects of seismic impulses on cetacean behavior and communication, including masking of sounds used during foraging such as echolocation. Masking could occur in mysticetes due to the overlap between their low-frequency vocalizations and the dominant frequencies of impulsive sources; however, masking in odontocetes or pinnipeds is less likely unless the activity is in close range when the pulses are more broadband (Navy, 2020). For example, differential vocal responses in marine mammals were documented in the presence of seismic survey sound. An overall decrease in vocalizations during active surveying was noted in large marine mammal groups (Potter et al., 2007), while blue whale feeding and social calls increased when seismic exploration was underway (Di Iorio and Clark, 2009), indicative of a possible compensatory response to the increased sound level.

Masking by low-frequency or mid-frequency active sonar with relatively low duty cycles is unlikely for most cetaceans and pinnipeds as sonar signals occur over a relatively short duration and narrow bandwidth that does not overlap with vocalizations for most marine mammal species (Navy, 2020). While dolphin whistles and mid-frequency active sonar are similar in frequency, masking is limited due to the low-duty cycle of most sonars. Low-frequency active sonar could overlap with mysticete vocalizations (e.g., minke and humpback whales). For example, in the presence of low-frequency active sonar, humpback whales were observed to increase the length of their songs (Fristrup et al., 2003; Miller et al., 2000), possibly due to the overlap in frequencies between the whale song and the low-frequency active sonar. Although findings by the Navy (2020), Fristrup et al. (2003), and Miller et al. (2000) all refer to Navy tactical sonars, and most NOS acoustic sources produce sounds at higher frequencies which are out of the hearing range of most marine mammals, the effects of masking discussed in these findings could potentially also apply to some acoustic sources used by NOS, such as echo sounders and ADCPs, with potential similar effects on marine mammals.

Newer high-duty cycle or continuous active tactical sonars used by the Navy have more potential to mask vocalizations, particularly for delphinids and other mid-frequency cetaceans (Navy, 2020). These sonars transmit more frequently (greater than 80 percent duty cycle) than traditional sonars, but at a substantially lower source level. Similarly, high-frequency acoustic sources such as pingers (i.e., devices that transmit short high-pitched signals at brief intervals) that operate at higher repetition rates also operate at lower source levels (Culik et al., 2001). While the lower source levels limit the range of impact compared to traditional systems, animals close to the sonar source are likely to experience masking on a much longer time scale than those exposed to traditional tactical sonars. Because the frequency range at which high-duty cycle systems operate overlaps the vocalization frequency of many mid-frequency cetaceans, their use may cause disruptions to communication, social interactions, and behaviors such as foraging or reproductive activities. Similarly, because the systems are mid frequency, there is the potential for the acoustic signals to mask important environmental cues like predator vocalizations (e.g., killer whales), possibly affecting survivorship for targeted animals. Although the acoustic sources used in these studies differed from the NOS acoustic sources included in the Proposed Action, their effects on marine mammals could be similar. Masking due to these systems is likely analogous to masking produced by other continuous sources (e.g., vessel sound). Long-term consequences could include changes to vocal behavior and vocalization structure (Foote et al., 2004; Parks et al., 2007), abandonment of habitat if masking occurs frequently enough to significantly impair communication (Brumm and Slabbekoorn, 2005), a potential decrease in survivorship if predator vocalizations are masked (Brumm and Slabbekoorn, 2005), and a potential decrease in recruitment if masking interferes with reproductive activities or mother-calf communication (Gordon et al., 2003).

Masking is more likely to occur in the presence of broadband (i.e., data transmission using a wide range of frequencies) and relatively continuous sound sources such as from vessels. Over the past 50 years, commercial shipping, the largest contributor of masking noise (McDonald et al., 2008), has increased the ambient low-frequency sound levels (e.g., 100-400 Hz) in the deep ocean by 10-15 dB (Hatch and Wright, 2007). Hatch et al. (2012) estimate that calling North Atlantic right whales might have lost, on average, 63-67 percent of their active acoustic space due to shipping sounds. Right whales were also observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic sound (Parks et al., 2007) as well as increasing the amplitude (intensity) of their calls (Payne and Webb, 1971). Multiple delphinid species have been shown to increase the minimum or maximum frequencies of their whistles in the presence of anthropogenic sound (Papale et al., 2015). Holt et al. (2009; 2011) showed that Southern Resident killer whales in the waters surrounding the San Juan Islands increased their call source level as vessel sound increased. Hermannsen et al. (2014) estimated that broadband vessel sound could extend up to 160 kHz at ranges from 60 m (196 ft) to 1,200 m (3,937 ft), and that the higher frequency portion of that noise might mask harbor porpoise clicks. However, this may not be an issue as harbor porpoises may avoid vessels and may not be close enough to have their clicks masked (Polacheck and Thorpe, 1990). Liu et al. (2017) found that broadband shipping noise could cause masking of humpback dolphin whistles within 1.5 km (0.9 mi) to 3 km (1.8 mi), and masking of echolocation clicks within 0.5 km (0.3 mi) to 1.5 km (0.9 mi). Aerial and underwater vocalizations are also an important component of pinniped social behaviors, including delineation of territory, dominance posturing, and courtship (Supin et al., 2001). The low-frequency sounds generated by vessel operations are perceptible to pinnipeds and could mask ecologically important underwater vocalizations (Southall et al., 2003). Harbor seals have been found to increase the frequency and amplitude of their vocalizations while in the presence of vessel sound, while decreasing the duration of vocalizations (Matthews, 2017).

Underwater sound from sound sources used during NOS projects has the potential to mask marine mammal communication and monitoring of the environment around them. Masking of marine mammal calls and other natural sounds by pulsed sounds is expected to be limited during surveys because the narrow beam of most NOS active acoustic sources dictates that animals would not spend much time in ensonified zones (see Appendix E for calculations of the time animals spend in the beams of active acoustic sources). Vessel activity from NOS represents a very small proportion of all vessel traffic, so vessel sound from the Proposed Action is expected to contribute minimally to overall masking in the action area. Additionally, the intensity of the sound received by marine mammals is dependent on the size and speed of the vessel in question and the distance of the animal from the vessel. The sound level of the vessels used by NOS would be low relative to the sound level from shipping traffic as NOS uses smaller vessels with smaller engines traveling at lower speeds during surveys; thus, vessels used by NOS would contribute smaller masking impacts than shipping traffic.

3.5.2.2.4 Physiological Stress

Marine mammals naturally experience stressors within their environment and as part of their life histories, such as changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with members of the same species, and interactions with predators (Atkinson et al., 2015). Anthropogenic activities, such as fishery interactions, pollution, tourism, and ocean noise, have the potential to provide additional stressors to those that occur naturally (Meissner et al., 2015; Rolland et al., 2012). At this time, the sound characteristics that correlate with specific stress responses in marine mammals are poorly understood, as are the consequences due to these changes. With respect to acoustically induced stress, this includes not only determining how and to what degree various types of anthropogenic sounds cause stress in marine mammals, but what factors can mitigate those responses (Navy, 2020). Factors potentially affecting an animal's response to a stressor include the mammal's life history stage, sex, age, reproductive status, overall physiological and behavioral plasticity, and whether they are experienced with the sound (e.g., prior experience with a stressor may result in a reduced response due to habituation) (Finneran and Branstetter, 2013; St. Aubin and Dierauf, 2001).

The stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor (Moberg and Mench, 2000). However, if the magnitude and duration of the stress response is too great or too long, then it can have negative consequences to the organism (e.g., decreased immune function, decreased reproduction). The generalized stress response is classically characterized by the release of cortisol, a hormone that has many functions including elevation of blood sugar, suppression of the immune system, and alteration of the biochemical pathways that affect fat, protein, and carbohydrate metabolism. The endocrine response (glandular secretions of hormones into the blood) to a stressor can also extend to other hormones. These types of responses typically occur on the order of minutes to days, such as the "fight or flight" response, an acute stress response that is characterized by the very rapid release of hormones which stimulate glucose release, increase heart rate, and increase oxygen consumption (Navy, 2020). What is known about the function of the various stress hormones is based largely upon observations of the stress response in terrestrial mammals. The endocrine response of marine mammals to stress may not be the same as that of terrestrial mammals because of the selective pressures marine mammals faced during their evolution in an ocean environment (Atkinson et al., 2015).

Relatively little information exists on the linkage between anthropogenic sound exposure and stress in marine mammals, and even less information exists on the consequences of sound-induced stress responses. Most studies have focused on acute responses to sound either by measuring hormones or by measuring heart rate as an assumed proxy for an acute stress response. Whereas a limited amount of work has addressed the potential for acute sound exposures to produce a stress response, almost nothing is known about how chronic exposure to acoustic stressors affects stress hormones in marine mammals, particularly as it relates to survival or reproduction. A literature review by the Navy (2020) of recent studies which assessed sound exposure effects on marine mammal stress hormones and heart rates is incorporated here by reference.

Although there are only a small number of studies, different types of sounds have been shown to produce variable stress responses in marine mammals, and sound characteristics that correlate with specific stress responses are poorly understood. Therefore, a stress response to NOS activities is assumed if a physiological response such as a hearing loss is predicted, or if a substantial behavioral response occurs (i.e., constituting a moderate or major level of impact, see **Table 3.5-5**). Of the behavioral responses modeled, it is unlikely that any of these responses would be substantial, and all exposures are anticipated to be minor and of short duration. No repeat exposures, and thus no chronic exposures, are anticipated.

3.5.2.2.5 Behavioral Responses

Disturbance of marine mammals can range from short, subtle changes in behavior to more conspicuous dramatic changes in biologically important behaviors such as feeding or mating, and short- or long-term displacement from important habitats. Behavioral response is one of the main concerns of the potential impacts of anthropogenic sound on marine mammals. The extent by which an animal's behavior changes in response to underwater sounds varies greatly, even within the same species (Nowacek et al., 2004). The extent of an individual's response to a stimulus is determined by the number and combinations of possible sound sources acting together, which in turn is influenced by the context in which the stimulus is received and the relevance an animal attributes to the acoustic stimulus. The perceived relevance depends on a number of biological and environmental factors, such as age, sex, and behavioral state at the time of exposure (e.g., resting, foraging, or socializing), where the sounds originated from, and proximity and nature of the sound source. One common immediate response to anthropogenic sounds is that animals may temporarily avoid or move away from an ensonified area or source; however, they might also respond more conspicuously based on how close the sounds are to them. For instance, their vigilance, defined as scanning for the source of the stimulus, could increase. The more time animals invest in addressing noise means less time they can spend foraging (Purser and Radford, 2011), but this is not always easy to detect.

There is a wide range of possible behavioral responses to sound exposure, if the sound is audible to the particular animal, including (in approximate order of increasing severity but decreasing likelihood) (BOEM, 2014a):

- no observable response;
- looking at the sound source or increased alertness;
- small behavioral responses such as vocal modifications associated with masking;
- cessation of feeding or social interactions;
- temporary avoidance behavior;
- modification of group structure or activity state; and
- habitat abandonment.

Severity of responses can also vary depending on characteristics of the sound source (e.g., moving or stationary, number and spatial distribution of sound sources, similarity to predator sounds, etc.) (Southall et al., 2007; Barber et al., 2009; Ellison et al., 2012). There is species variability of marine mammals to sound exposure and a broad spectrum of behavioral responses. Variability can also occur within a species at the individual level where hearing sensitivity or prior experience with a certain sound type can influence whether or not an individual reacts (BOEM, 2014a).

Southall et al. (2007) synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions of marine mammals at specific sound levels. While the louder the sound source, the more intense the behavioral response; the proximity of a sound source and the animal's experience, motivation, and conditioning were also critical factors influencing the response (Southall et al., 2007). After examining the available data, Southall et al. (2007) determined that the derivation of thresholds for behavioral response based solely on exposure level was not supported because context of the animal at the time of sound exposure was an important factor in estimating response. However, in some conditions, consistent avoidance reactions were noted at higher sound levels dependent on the marine mammal species or group. Most low-frequency cetaceans (mysticetes) observed in studies usually avoided sound sources at levels of less than or equal to 160 dB re 1 µPa. Studies of mid-frequency cetaceans analyzed included sperm whales, belugas, bottlenose dolphins, and river dolphins. These groups showed no clear tendency, but for continuous sounds captive animals tolerated levels in excess of 170 dB re 1 µPa before showing behavioral reactions, such as avoidance, erratic swimming, and attacking the sound source. High-frequency cetaceans (observed from studies with harbor porpoises) exhibited changes in respiration and avoidance behavior at levels between 90 and 140 dB re 1 µPa, with marked avoidance behavior noted for levels exceeding this. Phocid seals showed avoidance reactions at or below 190 dB re 1 µPa, thus seals may actually receive levels adequate to produce TTS before avoiding the source.

Numerous studies on marine mammal behavioral responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate metric for assessing behavioral reactions. It is recognized that the context in which the sound is received affects the nature and extent of responses to a stimulus (Southall et al., 2007; Ellison and Frankel, 2012), and because of the complexity and variability of marine mammal behavioral responses to acoustic exposure, NMFS has not yet released technical guidance on behavioral thresholds for use in calculating animal exposures (NMFS, 2018a). NMFS currently uses a step function to assess behavioral impact and a threshold of 160 dB for behavioral responses (70 FR 1871, January 11, 2005; NMFS, 2018a).

An extensive literature review by the Navy (2020) on behavioral responses of marine mammals to sound is incorporated here by reference. This review discusses studies of behavioral responses to mid-frequency active sonar (MFAS), multibeam sonar, and continuous (e.g., vessels) sounds and their effects on cetaceans (mysticetes and odontocetes), pinnipeds, and fissipeds (sea otters). The impact of multibeam echo sounder (MBES) operations, similar to sound sources included in the NOS Proposed Action, on marine mammals has been less studied compared to military sonars (although at least two studies using MBES are discussed below). Despite similar source levels (216–245 dB re 1 µPa m) of MBES and MFAS, and an overlap in frequency range (10–400 kHz), there are inherent differences between the two sound sources, aside from operational frequency differences (Varghese et al., 2020). MFAS are used to detect targets, like submarines, at distant ranges (10s of km). These systems generally have a wide vertical ensonification beam with 360° horizontal coverage, producing pings (1–2 s in length) for several minutes at intervals ranging from 6 to 15 minutes apart and source levels in excess of 235 dB re 1 µPa m. MBES are primarily used for seafloor mapping, requiring precise beam positioning. These requirements equate to narrow downward directed beams, 120°-150° horizontal coverage, and short operational pulse lengths (10–100 milliseconds [ms]) that vary based on the ocean depth. The resulting MBES geometry leads to a much smaller area of direct ensonification and orders of magnitude shorter pulses in comparison to MFAS.

Reports of observed behavioral responses by marine mammals to sound from underwater acoustic equipment include:

- Surface feeding blue whales did not show a change in behavior in response to mid-frequency sonar sources with received levels between 90 and 179 dB re 1 µPa, but deep feeding and non-feeding whales showed temporary reactions including cessation of feeding, reduced initiation of deep foraging dives, generalized avoidance responses, and changes to dive behavior (DeRuiter et al., 2017; Goldbogen et al., 2013; Sivle et al., 2015).

- A minke whale responded to mid-frequency sonar at 146 dB re 1 µPa by strongly avoiding the sound source (Kvadsheim et al., 2017; Sivle et al., 2015). Although the minke whale increased its swim speed, directional movement, and respiration rate, none of these were greater than rates observed in baseline behavior, and its dive behavior remained similar to baseline dives.
- Observed reactions by Blainville's, Cuvier's, and Baird's beaked whales to mid-frequency sonar sounds included cessation of clicking, termination of foraging dives, changes in direction to avoid the sound source, slower ascent rates to the surface, longer deep and shallow dive durations, and other unusual dive behavior (DeRuiter et al., 2013; Miller et al., 2015; Stimpert et al., 2014; Tyack et al., 2011).
- Beaked whales' response to shipboard echo sounders with frequencies ranging from 12 to 400 kHz, source levels up to 230 dB re 1 µPa, and a very narrow beam indicated that the beaked whales may be avoiding the area and may cease foraging near the echo sounder (Cholewiak et al., 2017).
- A study of 12 kHz MBES surveys found that there was no consistent change in foraging behavior during the surveys that would suggest a clear response (Varghese et al., 2020). The animals did not leave the range nor stop foraging during MBES activity. These results are in stark contrast to those of analogous studies assessing the effect of Naval mid-frequency active sonar on beaked whale foraging, where beaked whales stopped echolocating and left the area.
- Quick et al. (2017) found no evidence for a change in foraging behavior in short-finned pilot whales when exposed to an EK60 scientific echo sounder, but they did observe that the whales changed their heading more frequently when the echo sounder was active. This response could represent increased vigilance in which whales maintained awareness of echo sounder location by increasing their heading variance and provides the first quantitative analysis on reactions of cetaceans to a scientific echo sounder.
- A study found that captive hooded seals reacted to 1–7 kHz sonar signals, in part with displacement (i.e., avoidance) to the areas of least sound pressure level (SPL), at levels between 160 and 170 dB re 1 µPa (Kvadsheim et al., 2010); however, the animals adapted to the sound and did not show the same avoidance behavior upon subsequent exposures. Captive harbor seals responded differently to three signals at 25 kHz with different waveform characteristics and duty cycles at received levels over 137 dB re 1 µPa by hauling out more, swimming faster, and raising their heads or jumping out of the water (Kastelein et al., 2015).
- Behavioral responses of captive California sea lions exposed to mid-frequency sonar at various received levels (125–185 dB re 1 µPa) included a refusal to participate, hauling out, an increase in respiration rate, and an increase in the time spent submerged (Houser et al., 2013).
- Davis et al. (1988) conducted a behavioral response study that included underwater acoustic harassment devices (10–20 kHz at 190 dB; designed to keep dolphins and pinnipeds from being caught in fishing nets) and found that the sea otters often remained undisturbed and quickly became tolerant of the various sounds; even when chased from a location by presentation of a purposefully harassing sound, they generally moved only a short distance 100–200 m (110-220 yards [yds]) before resuming normal activity.

Reports of observed behavioral responses by marine mammals to underwater sound from vessels include:

- North Atlantic right whales may change behaviors, specifically calling behavior (shifting call frequency), to compensate for increased low-frequency sound, such as vessel-related sound (Parks et al., 2007).

- Most beaked whales tend to avoid approaching vessels (Würsig et al., 1998) and may dive for an extended period when approached by a vessel. Northern bottlenose whales, on the other hand, are sometimes quite tolerant of slow-moving vessels (Hooker et al., 2001).
- Dolphins may tolerate boats of all sizes, often approaching and riding the bow and stern waves (Shane et al., 1986). At other times, dolphin species that are known to be attracted to boats will avoid them. Such avoidance is often linked to previous boat-based harassment of the animals (Richardson et al., 1995).
- Coastal bottlenose dolphins that are the object of whale watching activities have been observed to swim erratically (Acevedo, 1991), remain submerged for longer periods of time (Janik and Thompson, 1996; Nowacek et al., 2001), display less cohesiveness among group members (Cope et al., 2005), whistle more frequently (Scarpaci et al., 2000), and be restless often when boats were nearby (Constantine et al., 2004).
- Pantropical spotted dolphins and spinner dolphins in the eastern tropical Pacific, where they have been targeted by the tuna fishing industry because of their association with tuna, show avoidance of survey vessels up to 11 km (6.8 mi) away (Au and Perryman, 1982; Hewitt, 1985), whereas spinner dolphins in the Gulf of Mexico were observed bow riding the survey vessel in all 14 sightings of this species during one survey (Würsig et al., 1998).
- A recent study found that harbor seals and gray seals dive lower in the water column when in the presence of vessel sound (Mikkelsen et al., 2019). This observation is consistent with previous observations of changing diving behavior in elephant seals elicited by vessel sound (Burgess et al., 1998), which suggests a wider pattern of noise avoidance among pinnipeds.
- Manatees typically occupy habitats with low sound levels and avoid areas with high levels of vessel traffic and noise (Miksis-Olds et al., 2007). Generally, sounds from oncoming vessels are detectable to manatees within 93 m (305 ft) of the vessel and evoke flight responses in manatees within 50 m (164 ft) of the vessel, such as increased swimming speed or depth within the water column (Rycyk et al., 2018).
- Sea otters off the coast of California tended to avoid areas of high vessel traffic and exhibited disturbance behaviors in direct response to the transit vessels through the study area (Curland, 1997).

Active underwater sound sources and vessel operations proposed for use during NOS projects have the potential to produce behavioral responses in marine mammals. It is possible that if a marine mammal reacts briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, stock, or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on both individuals and the population could be of greater intensity. Detailed analysis of the impacts of vessel sounds and active underwater acoustic sources is provided below for each type of marine mammal in Sections 3.5.2.3 through 3.5.2.5.

3.5.2.3 Alternative A: No Action - Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

The discussion of impacts of Alternative A is organized by impact causing factors for each type of marine mammal (cetaceans, pinnipeds, sirenians, and fissipeds). Under Alternative A, NOS survey effort would cover a total of 2,633,374 nm (4,877,009 km) across all five regions over a five-year period (note that survey effort in the Great Lakes is not included as no marine mammals occur there). Although the survey effort under Alternative A would vary by year (see **Table 3.5-6**), over the five-year period of the Proposed Action, the greatest number of nautical miles surveyed every year would be in the Southeast Region (approximately 47 percent). The survey efforts in the other four regions are of a similar order of magnitude (approximately 10 percent in each region for each of the five years), although slightly greater in the Alaska Region where the percentage of survey effort would be approximately 18 percent. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, sound production and hearing frequency of the animals, and population density of marine mammals, that add nuance to this trend. Overall, NOS projects would comprise a very small part of all ocean activities as vessels used by NOS would represent a very small proportion of all vessel traffic in the action area (as discussed in Section 2.4.1). Additionally, whenever possible, the location and timing of a given project would be purposefully coordinated to ensure that areas are not repeatedly surveyed. This ensures that the potential environmental impacts directly resulting from proposed NOS activities would not be exacerbated by repeated surveys within a given area.

Table 3.5-6. Survey Effort under Alternative A, by Geographic Region by Year

Region	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Survey Effort (in nautical miles)						
Greater Atlantic Region (without Great Lakes)	60,822	105,757	50,971	46,912	46,912	311,375
Southeast Region	220,336	210,185	262,450	281,733	281,733	1,256,437
West Coast Region	59,558	57,909	55,973	58,204	58,204	289,848
Alaska Region	93,871	119,974	174,445	41,350	41,327	470,967
Pacific Islands Region	70,210	54,900	69,742	54,948	54,948	304,748

3.5.2.3.1 Cetaceans

The analysis of impacts on cetaceans, which live primarily underwater, does not consider air emissions. All the other impact causing factors are discussed below. Potential impacts could occur in all of the geographic regions as approximately 20 to 30 species, subspecies, or DPSs of cetaceans, including several ESA-listed species, occur in each region (see Section 3.5.1.1 above); all regions also include designated critical habitat for one or more listed cetacean species (see Section 3.5.1.1).

3.5.2.3.1.1 Active Underwater Acoustic Sources

Active underwater acoustic sources in Alternative A include echo sounders, ADCPs, and acoustic communication systems as discussed in Section 2.4. The sound sources of potential concern during active acoustic surveys are the moving Sound Navigation and Ranging (SONAR) sources. The equipment used during any individual survey depends on the final survey design, vessel availability, site conditions, and data needs. A list of all active sources, and their parameters, considered in this study can be found in Appendix D of the Technical Acoustic Analysis of Oceanographic Surveys report (Appendix E of this Final PEIS). Table 1 in Appendix E identifies the proposed survey equipment expected to operate at, or below, 200 kHz and lists the relevant acoustic parameters of each of these sources. A subset of the operational sources used by NOS was modeled for the technical acoustic analysis. These sources were selected to represent the largest ranges to PTS/injury exposures of similar source types (e.g., beam pattern, frequency range). Sources that would be operated at frequencies higher than 200 kHz (e.g., some multibeam echo sounders and side scan sonars) were not included in the analysis as they operate at frequencies above the hearing range of marine mammals. **Table 3.5-7** identifies the proposed survey equipment expected to operate at or below 200 kHz that was used in the modeling and lists the relevant acoustic parameters of each of these sources; these are the sources considered in the impact analysis below for active underwater acoustic sources**.**

Table 3.5-7. Active Underwater Sources and Acoustic Parameters Considered in Exposure Modeling

Manufacturer	Model	SL (dB re 1 µPa)	Frequency (kHz)	Signal duration (ms)	Ping rate (Hz)
Knudsen	320 B/R	222	3.5	10	5
Simrad	ES60	225	12	1	20
Kongsberg	EM124	242	12.5	15	0.17
Teledyne Odom	CV200	229	24	2	20
Simrad	EM302	214	30	5	10
Kongsberg	EM710	231	40	2	20
Teledyne Odom	CV200	229	50	2	20
Kongsberg	EM710	231	70	2	20
Klein	3000	234	100	0.4	10

Acoustic signals from echo sounders (which range from 0.5 kHz to 900 kHz) can fall within the frequency hearing ranges for all the cetacean hearing groups: mid-frequency and high-frequency odontocetes (which can hear up to ~160 kHz) and low-frequency mysticetes (which can hear up to 35 kHz) if the lower end of the sound frequency spectrum is used. Adverse impacts of echo sounder signals could include behavioral responses, loss of hearing, stress, and physical harm (as discussed above in Section 3.5.2.2). Given the directionality and small beam widths, there is low potential for TTS and PTS, and cetacean communications are not expected to be masked appreciably as the animals would not be in the direct sound field for more than a few pulses.

Acoustic signals from ADCPs (ranging from 35 kHz to 1200 kHz) are likely detectable by mid-frequency and high-frequency odontocetes (which can hear up to ~160 kHz), but not by low-frequency mysticetes (which can hear up to 35 kHz). The effects of underwater sound from ADCPs on cetaceans are similar to those discussed above for echo sounders as ADCPs have a narrow and directional beam width similar to single-beam echo sounders.

Acoustic communication systems emit sound in mid-frequency ranges (10s of kHz) and thus could be detected by low-frequency mysticetes as well as mid-frequency and high-frequency odontocetes. The impact of underwater sound on cetaceans from acoustic communication systems would be similar but less than that described above for the use of echo sounders because, although acoustic communication systems are omnidirectional, they have lower power, a lower duty cycle, and would be used less frequently than echo sounders.

Quantitative acoustic exposure to marine mammals, including cetaceans, from operation of sound sources was modeled for nine sources (see **Table 3.5-7**). Acoustic modeling was conducted by determining the size of the sound field expected from each source (referred to and depicted as an isopleth) and estimating the number of marine mammals that may be exposed above sound thresholds for PTS/injury and behavioral disruption during surveys (see Appendix E for more information). To gauge the potential for impacts, received sound levels that may result in injury or behavioral disruption to the animal were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR 72308, December 31, 2019) were used (see Appendix E). Species density estimates (animals/km^2) were derived from the best available data sources for each species and region. For the Pacific and Alaska regions, species abundance and distribution were obtained from the U.S. Pacific and Alaska Marine Mammal Stock Assessment Reports (SARs) (Carretta et al., 2022; Muto et al., 2022). For the east coast of the U.S. and the Gulf of Mexico, densities were obtained using the Duke University Marine Geospatial Ecology Laboratory model results (Roberts et al., 2016a, 2016b, 2017, 2018, 2021a, and 2021b). At the request/direction of NMFS, this is a change from the estimates reported in the Draft PEIS which used the SARs for all species (see below for additional discussion). Although for some species abundance data were either unknown, uncertain, or outdated, NOS used the best available scientific information on presence, density, and population status to determine exposure estimates in the acoustic modeling.

The estimated exposures have decreased overall for both PTS/injury and behavioral disruption between the Draft PEIS and the Final PEIS, although exposures for some species have increased. This can be attributed to three factors:

- A change in the timeframe for the Proposed Action from six years in the Draft PEIS to five years in the Final PEIS;
- Updated inputs to the acoustic model:
  - the use of Roberts et al. (2016a, 2016b, 2017, 2018, 2021a, and 2021b) density data for the Greater Atlantic and Southeast regions in the Final PEIS (versus [vs.] use of the SARs abundance data for those regions in the Draft PEIS);
  - the use of more current abundance data from the 2021 SARs for the Alaska, West Coast, and Pacific Islands regions (Carretta et al., 2022; Hayes et al., 2022; and Muto et al., 2022); and
- Identification of an incorrect averaging function[7] during the quality assurance/quality control (QA/QC) process for the acoustic modeling.

Due to the number of sources to be evaluated, the distance at which exposure above PTS threshold could occur was first estimated using the source level and a simple geometric spreading model. A criterion of 10 m, roughly approximated from the survey platform vessel sizes, was chosen as encounters at shorter ranges are precluded by the physical presence of the vessel hull. If the distance for potential injury was <10 m (33 ft), then the source was categorized as having a low potential for impact and not carried through for further exposure modeling. If the predicted range to injury was >10 m (33 ft), then a more accurate (ray-tracing) propagation model was used to refine the injury range estimate. If the refined range was <10 m (33 ft) then the source was again categorized as low impact and not considered in additional modeling. If the refined range was still >10 m (33 ft), then the sound field of a conservatively-chosen representative sound source in each frequency band (<30 kHz, 30-70 kHz, and 70-200 kHz) was used in scenario simulations that considered species-specific movement (i.e., agent-based modeling). These simulations

[7] During the first stage of post processing that occurs after running the animal movement and exposure model, the number of exposed animats is calculated to get an average for a 24-hour duration. To do this, all exposures are summed and then divided by the total number of 24-hour simulation steps. In this case, there were a total of 18 overlapping 24-hour simulation windows over a duration of 3 days. The divisor for the average should have been 18 (the number of windows) but was incorrectly set to 3 (the total number of days). After correcting this, the average number of 24-hour exposures for every species and every zone was lower by a factor of 6.

estimated the number of animals that could exceed injury threshold during representative surveys. More detailed descriptions of acoustic and exposure modeling methods can be found in Appendix E.

Caveats when interpreting acoustic impacts on marine mammals include:

- The modeled projections are annual estimates spanning five years by region; source locations and movement, animal locations and movement, oceanographic/acoustic conditions, equipment descriptions and specifications, and the time of the year and exact location for each project are not precisely known; and
- Marine mammal abundances, distributions, and behavior patterns are not precisely known and may change as animal populations vary from year to year and location to location.

Despite uncertainty, the use of models can provide estimates of potential impacts for likely actions. Modeled results, however, are only as good as the data on which they are based. Many parameters are required, and there are many unknowns. Representative sound sources were modeled at maximum power, which produces the highest level sounds that have the greatest impact. Likewise, marine mammal densities values used likely exceed actual densities (see Appendix E for further explanation), and models do not include the effect of mitigations in reducing exposure estimates.

3.5.2.3.1.1.1 Permanent Threshold Shift Exposure Estimates

Estimated PTS/injury exposures were calculated as shown in Appendix E and as noted above, the estimates should be considered conservative predictions of potential exposure based on modeling assumptions and qualifications. These estimates consider that all proposed activities would occur, that marine mammals do not avoid sounds, and that conservative population density estimates were used. Sources with a signal frequency 200 kHz or higher were expected to have no impact because the sounds are above the hearing frequency range of cetaceans (see Section 3.5.1.1.1). It was also expected that any source with a range to threshold for potential injury <10 m (33 ft) based on the geometric spreading model or ray-trace propagation model would result in minimal impacts because the range is similar to or smaller than the vessel used by NOS and that the acoustic impact very close to the vessel would not be as relevant a concern as a vessel strike (i.e., it is very unlikely that a cetacean would approach that close to a moving vessel). For sources with ranges to potential injury >10 m (33 ft), representative simulations were conducted to estimate the exposure of species for those sources in the various regions (Appendix E). Summarized total potential PTS/injury exposure over five years for all acoustic sources for cetaceans in each region are shown in **Table 3.5-8** (note that no PTS/injury exposure was predicted for any species in the Pacific Islands Region). For annual numbers, see **Table 13** and **Table E-2** in Appendix E. The range to the closest point of approach (CPA) for each of the species-specific animats (i.e., simulated animals) was recorded. The 95 Percent Exposure Range is the horizontal range that includes 95 percent of animat CPAs that exceed a given impact threshold (see Appendix E). Species that may be in the area but for which no impacts were predicted are not included in the table.

Table 3.5-8. Total Predicted Exposures for Cetacean Species and Range Accounting for 95 Percent of Exposure Above PTS Threshold Under Alternative A

Species	Total Exposures*	Exposure Range (m)
Southeast Region**		
Dwarf sperm whale	2.53	35
Pygmy sperm whale	1.85	35
Greater Atlantic Region		
Harbor porpoise	15.15	34
Dwarf sperm whale	0.94	32
Pygmy sperm whale	0.13	32
West Coast Region		
Harbor porpoise	5.59	28
Dall's porpoise	5.48	24
Alaska Region		
Harbor porpoise	4.18	27
Dall's porpoise	3.48	20

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure modeling for the Southeast Region was conducted for the Gulf of Mexico.

Exposure predictions are based on classifying the sources as non-impulsive sounds, which have higher thresholds than impulsive sounds (NMFS, 2018a), but are conservative because the exposures consider that neither the simulated animals nor the operators changed behaviors due to the presence of the other. Avoidance of sound sources, including the vessel, by the animal or mitigation measures by the vessel operator could reduce the exposure estimates. Including aversive behavior of harbor porpoise to loud sound levels would have reduced their expected injury exposures by >60 percent (Appendix E). Also, the model overestimates near-field sound levels because modeled predictions do not account for the reduced sound levels present in the near-field of the source.

As shown in **Table 3.5-8**, PTS/injury exposure of high-frequency cetaceans could occur in four of the five regions with ranges to exposures in the simulations ~30 m (~100 ft). High-frequency cetaceans (Dall's and harbor porpoises, and dwarf and pygmy sperm whales) have been shown to be more sensitive to sounds than other cetacean species, and therefore have comparatively low thresholds for PTS/injury exposures (NMFS, 2018a). Over the five-year timeframe, a total of 39 individuals could be exposed above the PTS/injury threshold across four regions. The numbers of animals exposed above threshold over the extensive project area and over five years would not be expected to result in population level adverse impacts, especially when comparing exposures to Potential Biological Removal (PBR) levels.

The PBR approach was developed to identify marine mammal populations experiencing human-caused mortality at levels that could result in population depletion. PBR can be used to consider the level of impact (i.e., removal of individuals) that a population can sustain before population-level impacts (e.g., breeding) are incurred. PBR is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. PBR is calculated using the product of minimum population size, one-half the maximum net productivity rate, and a recovery factor for ESA-listed species and depleted stocks. NOS emphasizes that PBR is used here to estimate population level impacts of mortalities, but PTS/injury exposures modelled as a response to NOS activities are not anticipated to arise in serious physical injuries or death. However, PBR can be a useful tool to contextualize the health or vulnerability of a population. When comparing the annual PTS/injury exposures for species listed in **Table 3.5-8** to the PBRs listed for each species in recent stock assessment reports (Carretta et al., 2022; Hayes et al., 2022; and Muto et al., 2022), the PTS/injury exposures are below, and often well below the PBR for all species (**Table 3.5-9**). For example, in the West Coast Region, the total exposure estimate for Dall's porpoise is 5.48 over five years, or on average 1.10 per year, and the PBR for that species in that region is 99; thus, population-level impacts are not predicted because the exposures do not exceed the PBR.

Table 3.5-9. Comparison of Exposure Above PTS Threshold for Cetacean Species Under Alternative A with Current Potential Biological Removal (PBR) Levels

Species	Total Exposures	Average Annual Exposures	PBR Levels *
Southeast Region			
Dwarf sperm whale	2.53	0.51	2.5**
Pygmy sperm whale	1.85	0.37	2.5**
Greater Atlantic Region			
Harbor porpoise	15.15	3.03	851
Dwarf sperm whale	0.94	0.19	46
Pygmy sperm whale	0.13	0.03	46
West Coast Region			
Harbor porpoise	5.59	1.12	35 to 349***
Dall's porpoise	5.48	1.10	99****
Alaska Region			
Harbor porpoise	4.18	0.84	2.2 to 11*****
Dall's porpoise	3.48	0.70	131

*Sources for PBR Levels: Carretta et al., 2022; Hayes et al., 2022; and Muto et al., 2022

**Differs from PBR levels reported in the Draft PEIS due to numbers presented in the Draft PEIS for incorrect stock.

***PBR levels for harbor porpoise in the West Coast Region is shown as the range across six stocks.

****Differs from PBR levels reported in the Draft PEIS due to changes between the 2019 and the 2021 SARs.

***** PBR levels for the Southeast Alaska stock; PBR levels are undetermined for the Gulf of Alaska and Bering Sea stocks.

In the Southeast and Greater Atlantic regions, where Roberts et al. (2016a, 2016b, 2017, 2018, 2021a, and 2021b) density data were used to predict exposure, a discrepancy may arise in abundance (and PBR) estimates between those derived from the Roberts et al. densities and those reported in the SARs. For example, the Roberts density model for *Kogia* spp. (dwarf and pygmy sperm whales) predicts an abundance of 2,234 individuals over the entire Gulf of Mexico, while the SAR predicts only 336 individuals in the same area. The reason that the abundance predicted from the Roberts et al. model is higher than the SARs abundance is due to underlying assumptions made when estimating abundance. To be conservative (i.e., obtain the lowest abundance), NOAA assumed that any animals at the surface along the vessel trackline would be detected during a survey, whereas Roberts et al. assumes that only a fraction of those animals would be detected (Roberts et al., 2015b). Had NOAA used the same probability of detecting an animal that occurs along a trackline that Roberts et al. used, the *Kogia* abundance estimates would have been three times higher and much closer to the Roberts abundance estimate. PBR is based on the lower SAR abundance estimate, while the acoustic exposure estimates are based on the higher Roberts density data. Although the use of the Roberts et al. density results in higher estimates than would come from use of the SAR abundance data, the average annual PTS/injury exposure estimate in the Southeast and Greater Atlantic regions is less than one individual dwarf or pygmy sperm whale, and two individual harbor porpoises; thus, population-level impacts are not predicted.

3.5.2.3.1.1.2 Behavioral Disruption Estimates

Behavioral disruption exposure estimates over the five-year period were calculated for sources with operational frequencies within the cetacean hearing frequency range (less than or equal to 200 kHz, see Section 3.5.1.1.1). As was the case for PTS/injury exposure estimates, the behavioral disruption exposure estimates consider that all proposed activities would occur; the estimates use the highest levels of anticipated cetacean densities and do not factor in effects of potential mitigation procedures or animals avoiding the sounds. Summarized total potential behavioral disruption exposures of cetaceans over five years for all sources in each region are shown in **Table 3.5-10**. For annual numbers, see **Table 16** and **Table E-5** in Appendix E. Species that may be in the area but for which no impacts were predicted are not included in the table.

Table 3.5-10. Total Predicted Exposures for Cetacean Species and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative A

Species	Total Exposures*	Average time above 160 dB (s)**
Alaska Region		
Pacific white-sided dolphin	784.14	63
Beluga whale	256.05	85
Harbor porpoise	80.29	88
Dall's porpoise	72.03	69
Bowhead whale	58.89	53
Common minke whale	56.48	47
Humpback whale, Central North Pacific	40.84	95
Resident killer whale	31.25	58
Fin whale	27.14	50
Transient killer whale	20.60	58
Beluga, Cooke Inlet	11.84	85
Humpback whale, Western North Pacific	4.46	95
Gray whale	1.55	51
Sperm whale	0.15	56
North Pacific right whale	0.03	53
Southeast Region* **		
Atlantic spotted dolphin	882.77	56
Common bottlenose dolphin	555.30	89

Species	Total Exposures*	Average time above 160 dB (s)**
Pantropical spotted dolphin	330.04	52
Clymene dolphin	113.80	52
Rough-toothed dolphin	62.02	75
Spinner dolphin	57.83	58
Risso’s dolphin	23.20	69
Striped dolphin	31.72	50
False killer whale	32.82	55
Pilot whale, short finned	17.02	60
Pilot whale, long finned	16.72	60
Pygmy sperm whale	16.39	52
Pygmy killer whale	4.70	52
Sperm whale	12.46	64
Melon-headed whale	12.48	50
Dwarf sperm whale	9.89	52
Fraser’s dolphin	7.67	50
Blainville beaked whale	7.18	67
Gervais’ beaked whale	7.18	67
Mesoplodont beaked whales (all)	7.18	67
Cuvier's beaked whale	2.22	64
Transient killer whale	2.02	58
Rice’s whale	0.65	82
Greater Atlantic Region		
Short-beaked common dolphin	2,587.99	102
Atlantic white-sided dolphin	2,322.53	101
Atlantic spotted dolphin	1,020.42	89
Common bottlenose dolphin	970.74	184
Harbor porpoise	780.49	120
Risso’s dolphin	418.21	112
Pilot whale, long finned	291.13	63
Fin whale	188.48	98
Pilot whale, short finned	185.73	63
Common minke whale	107.46	83
Humpback whale	96.84	97
Cuvier’s beaked whale	47.07	55
Dwarf sperm whale	46.57	57
Rough-toothed dolphin	45.04	110
Gervais beaked whale	35.62	55
Sowerby’s beaked whale	35.62	55
Blainville beaked whale	35.62	55
True’s beaked whale	35.62	55

Species	Total Exposures*	Average time above 160 dB (s)**
Mesoplodont beaked whales (all)	35.62	55
Striped dolphin	18.17	50
Pantropical spotted dolphin	13.94	62
Sperm whale	13.76	50
Sei whale	14.99	98
North Atlantic right whale	14.43	100
Melon-headed whale	7.34	50
Pygmy sperm whale	6.68	57
Clymene dolphin	4.57	62
Fraser’s dolphin	3.09	38
False killer whale	2.84	64
White-beaked dolphin	2.69	101
Spinner dolphin	1.29	41
Northern bottlenose whale	0.49	42
Bryde’s whale	0.35	112
Blue whale	0.06	43
West Coast Region		
Short-beaked common dolphin	23,788.53	55
Long-beaked common dolphin	15,896.35	82
Pacific white-sided dolphin	6,251.14	67
Striped dolphin	3,731.43	25
Northern right whale dolphin	2,550.46	25
Gray whale	2,212.68	51
Risso’s dolphin	260.00	66
Common bottlenose dolphin	257.45	110
Humpback whale, Central America	206.39	128
Common minke whale	180.10	51
Fin whale	129.13	62
Harbor porpoise	118.37	96
Dall's porpoise	115.10	75
Mesoplodont beaked whales (all)	66.83	26
Blue whale	62.78	27
Humpback whale, Central North Pacific	40.84	95
Sperm whale	32.97	29
Cuvier’s beaked whale	29.03	33
Baird's beaked whale	29.91	55
Sei whale	23.95	62
Offshore killer whale	20.75	64
Transient killer whale	19.66	64
Resident killer whale	18.15	64

Species	Total Exposures*	Average time above 160 dB (s)**
Pilot whale, short finned	16.22	82
Humpback whale, Western North Pacific	4.46	95
Pacific Islands Region		
Pygmy sperm whale	9,948.66	63
Rough-toothed dolphin	9,930.13	71
Striped dolphin	6,975.36	55
Pantropical spotted dolphin	3,261.02	62
Fraser's dolphin	2,774.83	50
Pygmy killer whale	942.31	64
False killer whale	345.82	56
Risso's dolphin	89.41	69
Common bottlenose dolphin	57.09	112
Spinner dolphin	41.38	84
Humpback whale, Central North Pacific	40.84	95
Melon-headed whale	30.24	59
Pilot whale, short finned	22.41	62
Humpback whale, Western North Pacific	4.46	95
Bryde’s whale	3.95	70
Sperm whale	3.48	67
Longman’s beaked whale	2.34	54
Cuvier’s beaked whale	2.32	54
Sei whale	2.17	75
Fin whale	1.48	75
Blainville beaked whale	1.16	55
Resident killer whale	0.58	56
Transient killer whale	0.58	56
Blue whale	0.21	54

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure above threshold over 24 hours.

***Exposure modeling for the Southeast Region was conducted for the Gulf of Mexico.

Under Alternative A, behavioral disruption exposures to cetaceans could occur in all five regions. Depending on the species, behavioral disruption exposure of cetaceans could affect from a few to thousands of individuals in each region over the five-year timeframe. However, for the simulated animals exposed above the 160 dB threshold, the average time above threshold is under two minutes, and often under one minute (**Table 3.5-10**). The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual’s behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals (Southall et al., 2016), as in the case of seismic surveys that have months’ worth of activity. Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals of some species could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals could be exposed above threshold over five years and over the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures (see Appendix D) to reduce potential impacts of active acoustic sources on marine mammals. NOS would continue to use the lowest power appropriate to perform surveys. NOS would also continue to use Protected Species Observers (PSOs) and would employ a robust suite of animal approach restrictions and reduced vessel speeds, described in more detail in Sections 3.5.2.3.1.2 and 3.5.2.3.1.3. For instance, NOS must maintain a 457-m (500-yd) minimum separation distance of the vessel from ESA-listed whales, and vessel operators would also take steps to avoid approaching any cetaceans (see mitigation measures in Appendix D). Since the radius for PTS/injury exposure is small (35 m [115 ft] or less; see **Table 3.5-8**), and the radius for behavioral disruption exposure is generally less than 457-m (500-yd) (with some exceptions for several species, such as beaked whales, Mesoplodont whales, northern right whale dolphin, striped dolphin, sperm whale, and blue whale, in the West Coast Region; see **Tables 7** through **11** in Appendix E), these approach restrictions would effectively reduce the number of marine mammals exposed to sound from active acoustic sources. The small radii for PTS/injury also reduce the need for and effectiveness of additional mitigation measures, such as equipment ramp-up (i.e., slowly increasing the sound of acoustic equipment to allow animals to exit the area). It is not practicable for NOS to power-down active acoustic sources upon sighting a marine mammal within a certain radius of the vessel because data continuity would be lost. For the Alaska Region, NOS would employ the additional mitigation measure:

- For use of High-Resolution Geophysical (HRG)[8] sound sources in all areas north of the Forelands in Cook Inlet, Alaska[9], contact the Alaska Region (akr.prd.section7@noaa.gov) for advice on how to proceed.

NOS also considered whether additional mitigation measures should be employed in BIAs. BIAs, as discussed in Section 3.5.1.1.2 of this PEIS, comprise locations where particular species engage in biologically important behaviors either year-round or seasonally. BIAs occur in every region throughout the NOS action area, but they do not present the totality of important habitat throughout a marine mammal's entire range. NOS considered the geographic extent of marine mammal exposures and the potential for exposures to occur in designated critical habitat or BIAs, such as preferred breeding, feeding, and nursery grounds or migratory routes. In general, marine mammal responses to acoustic stressors from the Proposed Action are anticipated to be minor and temporary, regardless of where the exposure occurs. NOS specifically considered the potential effectiveness and practicability of mitigation measures in BIAs for those species for which PTS/injury exposure was predicted by the acoustic modeling. Only the harbor porpoise has designated BIAs in regions where PTS/injury exposure was predicted: two separate small resident year-round populations in Morro Bay and Monterey Bay in the West Coast Region, and another small resident population in the Greater Atlantic Region, concentrated in waters less than 150 m (492 ft) deep in the Gulf of Maine between July and September. These BIA designations reflect a concentration of

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[8] HRG surveys are defined as surveys using an electromechanical source that operates at frequencies less than 180 kHz, other than those defined at § 217.184(c)(1) (i.e., side-scan sonar, multibeam echo sounder, or CHIRP sub-bottom profiler) per the 2020 BOEM BiOp on the Federally Regulated Oil and Gas Program Activities in the Gulf of Mexico.

[9] The Forelands in Cook Inlet are described as 60°43'10.9" north, 151°24'35.8" west (east side of the Inlet, Nikiski, Alaska) and West Foreland (60°42'48.1" north, 151°42'38.3" west).

marine mammals rather than areas where marine mammals engage in biologically important behaviors that could be impacted by active acoustic sources. NOS determined that avoiding harbor porpoise BIAs entirely would be impractical, in particular, year-round Morro Bay and Monterey Bay BIAs. If these areas are avoided and not surveyed, important information that supports habitat research and vessel safety would not be collected.

3.5.2.3.1.1.3 Conclusion

The effects of underwater sound from active acoustic sources on cetaceans under Alternative A would continue to be **adverse** and **minor.** Potential impacts include injury exposures in the form of hearing loss (PTS), but such injury would be rare and confined to a few individual high-frequency cetaceans in four regions (from four animals in the Southeast Region up to 17 animals in the Greater Atlantic Region over the five-year timeframe, see **Table 3.5-8**). While more individual animals are expected to experience behavioral disruptions than injury (on the order of hundreds or thousands of animals in each of the five regions over the five-year timeframe), the amount of time individuals may exceed the behavioral exposure threshold would be on average less than two minutes (**Table 3.5-10**). Similarly, the potential for masking would continue to be minimal during surveys because the narrow beams of most active acoustic sources mean that animals would not spend much time in ensonified zones. Overall, the potential impacts would likely continue to be limited to short-term disruption of acoustic habitat and behavioral patterns. Impacts would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication and/or echolocation, disturbance of individuals or groups of cetaceans, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of cetaceans from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat would be limited to the project area or its immediate surroundings. Thus, impacts of Alternative A on cetaceans, including ESA-listed species, would continue to be **insignificant**.

3.5.2.3.1.2 Vessel and Equipment Sound

All vessels produce underwater sound (10 Hz to 10 kHz) and are major contributors to overall background sound in the sea (see Appendix E). Under Alternative A, project activities would continue to generate low levels of vessel and equipment sound that could disturb marine mammals. The types of sound produced by these sources are non-pulsed, or continuous, transitory, and of relatively low frequency. Impacts of underwater sound depend on the duration of the sound source and the intensity of the sound output. The frequency range over which mysticetes are believed to hear sounds is approximately 7 Hz to 35 kHz (see Section 3.5.1.1.1), thus they are considered most sensitive to low-frequency sounds. The mid-frequency odontocetes have functional hearing from about 150 Hz to 160 kHz; the high-frequency hearing group has functional hearing from about 275 Hz to 160 kHz. Thus, all cetaceans could be impacted by vessel-generated sound. Behavioral responses of cetaceans to vessel and equipment sound are expected to be variable depending on the vessel speed, size, location, frequency, and pattern of travel, as discussed below.

The dominant source of sound from vessels is from the operation of propellers, including cavitation (which is the formation of water vapor cavities as water passes over propeller blades), singing (i.e., propeller singing is a phenomenon involving resonance between the natural frequency of the propeller blade tip and the vortex shedding frequency at the trailing edge of the blade, thus producing radiated sound), and propulsion (BOEM, 2014a). Vessel size, load, and speed affect intensity of sound. Traveling at low speed can reduce and avoid propeller cavitation noise. The vessels used by NOS typically produce source levels of 130 to 160 dB while transiting; in comparison, large and powerful watercraft such as ferries, container ships, and icebreakers have source levels of 200 dB or greater (Erbe et al., 2019). However, source levels may vary by 20 to 40 dB within a ship class due to variability in design, maintenance, and operational parameters (Simard et al., 2016). Operating speeds would vary by the marine conditions, the capabilities of the vessel, and the survey equipment being used. Vessels used by NOS could move at speeds of up to 25 knots when transiting and up to13 knots while surveying, but 5 to 8 knots would be more common.

Vessels used by NOS would be variable in size, producing variable sound levels, and could travel anywhere in navigable U.S waters including areas as shallow as 1.8 m (6 ft). The exact locations that would be surveyed in a given year would be based on a variety of factors, including the age of the existing data, the changeability of the local sea floor, user needs, the availability of vessels and crews, the opportunity for cooperative projects with other offices or agencies, and the availability of funds. Projects could occur any time of the year in mid-latitudes and in the spring and summer months in Alaska. However, vessels used by NOS would represent a very small proportion of total vessel traffic in the action area (see Section 2.4.1), and thus would not constitute a substantial portion of the existing volume of vessels already found within the EEZ.

Specific projects may comprise a single surveying pass while others may involve multiple adjacent passes in a designated area (i.e., to ensure 100 percent bottom coverage). The line spacing in these full coverage surveys would be narrow enough that a cetacean could perceive the vessel and/or its instruments more than once, depending on its mobility and reaction. However, whenever possible, the location and timing of a given project would be purposefully coordinated to ensure that areas are not repeatedly surveyed. This would ensure that the potential environmental impacts directly resulting from NOS activities would not be exacerbated by repeated surveys within a given area.

Vessel sound can cause behavioral disturbance in at least some individuals and stocks of cetaceans. However, the occurrence and nature of responses are variable, depending on species, location, novelty of the sound, vessel behavior, and habitat, among many other factors. Behavioral responses could include evasive maneuvers such as diving or changes in swimming direction and/or speed and dive duration, decreased time searching for food, and avoidance behaviors, as well as disruptions in breeding, nursing, and migration (BOEM, 2014a). Some cetaceans may be displaced a short distance, potentially from preferred or critical habitat, but they would not be anticipated to leave a project area entirely. Introduced underwater sound may also reduce (i.e., mask) the effective communication distance of cetaceans if the frequency of the source is close to that used as a signal by the species, and if the anthropogenic sound is present for a significant fraction of the time. Most cetaceans use sound for almost all aspects of their life, including mating, reproduction, feeding, predator and hazard avoidance, communication, and navigation. Among cetaceans, baleen whales are considered particularly vulnerable to masking by vessel sounds as they use low-frequency sound and communicate over great distances. Odontocetes are considered less sensitive to masking by low-frequency sounds than are mysticetes (Ketten, 2000). Sounds from vessels used by NOS would be at levels not expected to cause anything more than possible localized and temporary or short-term behavioral changes as vessel sound is already so prevalent that it is commonly considered a usual source of ambient underwater sound.

Animal approach restrictions and decreasing vessel speeds could contribute to decreased sound levels from vessels, as well as fewer ship-strikes (see Section 3.5.2.3.1.3); rerouting vessels to avoid animals and designated critical habitats would also help alleviate some detrimental impacts of underwater noise. Although federal agencies such as NOAA are exempt, given the sensitivity of the resource, NOS operators shall adhere to 50 CFR 224.105 which states no vessel of 20 m (65 ft) or greater in overall length may exceed a speed of 10 knots in designated seasonal management areas for the North Atlantic right whale.

Additionally, 50 CFR 224.103 lists special prohibitions for endangered marine mammals to which NOS operators shall adhere, specifically Part B of the regulation, which states that vessels must maintain a 91-m (100-yd) distance from endangered humpback whales in Alaska and cannot disrupt normal behavior; Part C of the regulation, which states that vessels must maintain a 457-m (500-yd) distance from North Atlantic and North Pacific right whales; and Part E of the regulation, which states that vessels must maintain a 365-m (400-yd) distance from killer whales in Washington.

Transits through North Pacific right whale critical habitat would be avoided. For unavoidable transits, vessels would maintain a speed of 10 knots or less. Nighttime operations would be prohibited in specific parts of the Gulf of Mexico that have been identified as important to the Rice's whale. Additionally, if an ESA-listed whale is identified within 457 m (500 yds) of the forward path of a vessel used by NOS, the vessel would steer a course that increases the distance from the whale at a speed of 10 knots or less until the 457 m (500 yds) minimum distance has been established. If an ESA-listed whale is identified within 91 m (100 yds) of the forward path of a vessel used by NOS, the vessel must reduce speed and shift the engine into neutral; the engines would not be engaged until the whale has moved outside of the vessel's path and beyond 457 m (500 yds).

Impacts from low-frequency underwater sound generated by remotely operated and autonomous vehicles and other equipment would be similar to those of surface vessels but at a much-reduced magnitude due to the far fewer nautical miles of proposed travel (i.e., approximately 518,000 nm [959,000 km] for surface vessels vs. 28,600 nm [53,000 km] for remotely operated and autonomous vehicles over the five-year period across all geographic regions).

Low-flying aircraft, such as seaplanes or helicopters, may be used to reach remote areas, especially in Alaska for such projects as tide gauge installation, and can disturb cetaceans. Aircraft generate sound from their engines, airframe, and propellers, and the physical presence of low-flying aircraft can disturb cetaceans because of both the sound and the visual disturbance. Levels of sound received underwater from passing aircraft depend on the aircraft's altitude, the aspect (direction and angle) of the aircraft relative to the receiver, receiver depth and water depth, and seafloor type (Richardson et al., 1995). Because of these physical variables, exposure of individual cetaceans to aircraft-related sound (including both airborne and underwater sound) would be expected to be brief in duration. Considering the relatively low level of aircraft activity that may occur (once or twice a year), along with the short duration of exposure to sound and visual disturbance, potential impacts from this activity on cetaceans are expected to be minimal.

Underwater sound from vessels and equipment may adversely affect the foraging or prey characteristics of critical habitat that support some ESA-listed cetaceans by impacting different life stages of fish and aquatic macroinvertebrate prey species. See Section 3.7 Fish and Section 3.8 Aquatic Macroinvertebrates for full discussions of the potential impacts on fish and aquatic macroinvertebrates from vessel sound and underwater acoustic sources.

Considering that the proposed number of vessels associated with NOS project activities within the EEZ is very low as compared with all other shipping and vessel traffic (see Section 2.4.1), and the assumption that individuals or groups of cetaceans may be familiar with various and common vessel-related sounds, particularly within frequented shipping lanes, the effects of vessel sound on cetaceans under Alternative

A would continue to be **adverse** and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups would continue to be temporary or short-term with no life-threatening injury to individual marine mammals. Displacement of cetaceans from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat would continue to be limited to the project area or its immediate surroundings. However, vessel sound is expected to result in **insignificant adverse** effects on individuals or populations of cetaceans, including ESA-listed species and critical habitat.

3.5.2.3.1.3 Vessel Presence and Movement of Equipment in the Water

Behavioral responses of cetaceans to vessel presence are expected to be variable, often depending on the vessel speed, size, location, frequency, and pattern of travel (as discussed above under Vessel and Equipment Sound). Reactions of cetaceans to vessel presence often include changes in general activity (e.g., from resting or feeding to active avoidance), changes in surfacing-respiration-dive cycles, and changes in speed or direction of movement. Past experience of the animals with vessels is also important in determining the degree and type of response elicited from an animal-vessel encounter. Whale reactions to slow moving vessels are less dramatic than to fast or erratic vessel movement. Some species, especially delphinids, commonly approach vessels (Shane et al., 1986) while others, including most beaked whales, avoid approaching vessels (Würsig et al., 1998). Others appear to show no reaction to a passing vessel (Hooker et al., 2001). Some cetaceans may be displaced a short distance, potentially away from preferred or critical habitat, but they would not be anticipated to leave a project area entirely. In all oceans of the world, vessel presence is currently so prevalent that it is commonly considered a usual source of disturbance. The presence of vessels used by NOS would not be at levels expected to cause anything more than possible localized and temporary or short-term behavioral changes in cetaceans.

Water disturbance by remotely operated and autonomous vehicles can temporarily disturb and displace nearby cetaceans. The impact should be minimal, and exposure of individual cetaceans would likely be brief in duration as the equipment would quickly pass by; however, impacts could increase if the frequency of disturbance becomes greater. In either case, if displaced, cetaceans are expected to return to the area and resume normal activities once the water disturbance ends. Surveying equipment such as echo sounders is typically attached to a crewed vessel, remotely operated or autonomous system, thus effects on cetaceans due to its movement in the water would occur from the presence and operation of the equipment carrier, rather than from the presence of the equipment itself. ADCPs and acoustic communication systems are often operated from tethered systems, buoys, fixed moorings, or they are hull mounted or on remotely operated or autonomous underwater vehicles. As with echo sounders, any effects on cetaceans would occur from the presence and operation of the vessel, rather than from presence of the equipment itself. Deployment of all autonomous systems, as well as other equipment and divers, would be suspended if any protected species is sighted within 91 m (100 yds) of the vessel. Work already in progress may continue if the activity is not expected to adversely affect the animal.

Sound speed data collection equipment, grab samplers, and drop/towed cameras are lowered and raised through the water column. This movement through the water could temporarily disturb and displace nearby cetaceans. These impacts would be temporary as cetaceans are expected to return once water column turbulence ceases. The ropes and wires used to lower a sound speed profiler or to connect a probe to the equipment on a ship can cause entanglements with cetaceans. This is not expected to interfere with cetacean movements, as whales, dolphins, and porpoises could swim below and avoid such equipment. Also, prior to using equipment NOS would ensure there is at least one PSO observing the area for protected species at all times.

Water disturbance by anchors and chains moving through the water can also temporarily disturb and displace nearby cetaceans. The impact on cetaceans should be minimal and cease when the anchoring system comes to rest or is taken out of the water. Cetaceans are expected to return to the area and resume normal activities once water column turbulence ceases. Anchoring would be a relatively infrequent activity; thus, impacts are expected to be minimal as they would rarely occur. Additionally, vessels would anchor in waters that are relatively shallow; the larger cetaceans would not generally be expected to occur in those areas and thus would not be impacted.

An important consideration to all crewed vessel operations is the possibility of a vessel striking a marine mammal, with whales being the most vulnerable and commonly impacted cetacean, although collisions with smaller species could also occur. Determining the exact numbers of whales killed through vessel strikes is considered difficult or impossible because strikes often go unnoticed or unreported. In the project area, a minimum of 217 whales were confirmed to be killed through vessel strikes from 2006 to 2020, including a minimum of 52 ESA-listed whales (Henry et al., 2020; Henry, 2022; NMFS, 2021a; NMFS, No Date-c; Shaban et al., 2021). One of the most affected species is the North Atlantic right whale, which is particularly vulnerable to ship-strikes and is often found in high traffic areas. Marine mammal species of concern for possible ship strike with vessels operating at speed primarily include slow-moving species (e.g., North Atlantic right whales) and deep-diving species while on the surface (e.g., sperm whales, pygmy/dwarf sperm whales, and beaked whales). It is expected, however, that the probability of such an encounter, and thus impact, is very low. However, vessel operations within areas such as the North Atlantic right whale critical habitat and migration corridor during calving and nursing or migration periods may increase the probability of vessel strikes due to a higher concentration of animals in the area. Also, certain cetacean species, including bottlenose dolphin and other dolphin species (e.g., *Stenella* spp.), may actively approach vessels moving at speed to swim within the pressure wave produced by the vessel's bow, thus increasing the potential for vessel strikes (BOEM, 2014a).

Vessel strikes can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds. Massive propeller wounds can be fatal; if more superficial, whales may be able to survive the collision. Most severe and lethal whale injuries involve larger ships (>80 m [260 ft]) moving at higher speeds (>15 knots). Animal approach restrictions and decreasing vessel speeds as discussed in Section 3.5.2.3.1.2 would help reduce the potential for ship strikes of some protected species. Additionally, if an ESA-listed whale is identified within 457 m (500 yds) of the forward path of a vessel used by NOS, the vessel would steer a course that increases the distance from the whale at a speed of 10 knots or less until the 457 m (500 yd) minimum distance has been established. If an ESA-listed whale is identified within 91 m (100 yds) of the forward path of a vessel used by NOS, the vessel must reduce speed and shift the engine into neutral; the engines would not be engaged until the whale has moved outside of the vessel's path and beyond 457 m (500 yds). If one or more cetaceans are sighted while a vessel is underway, attempts would be made to remain parallel to the animals' course and avoid excessive speed or changes in direction until the cetaceans have left the area. Vessels would not enter into Rice's whale CDA and the 100 - 400 m (328 – 1,312 ft) isobath in the Gulf of Mexico at night; if vessels are present in the CDA/isobath at night, the vessel must be anchored, moored, or otherwise immobile. In addition to complying with all seasonal management areas, NOS would check with various communication media for general ship strike information and specific details regarding North Atlantic right whale sighting locations. These sources include NOAA weather radio, U.S. Coast Guard NAVTEX broadcasts, and Notices to Mariners.

During NOS projects, waters surrounding the vessel would be visually monitored for any marine mammals by at least one PSO observing the area for protected species at all times. PSOs would use all means necessary to enhance visibility (e.g., spotlights, night vision) and would be trained as appropriate. In order to maintain safe navigation and avoid interactions with marine mammals and other sensitive species during transit, the vessel crew would be instructed to remain vigilant to the presence of marine mammals.

While vessel strikes would pose a direct threat to marine mammals, the likelihood of a collision between a vessel used by NOS and a marine mammal would be extremely unlikely because relatively low vessel speeds (particularly within seasonal restricted areas and inshore waterways and during data collection) and visual observation during all vessel operations (regardless of size) would avoid vessel strikes with all marine mammal species. Marine mammal strikes by ROVs and autonomous vehicles are of low concern because of their slow speeds, small size, and built-in proximity avoidance systems.

Vessel presence and movement of equipment in the water would not have any direct effects on the designated critical habitat of any species of cetacean. Indirectly, prey species such as fish and seals may be disturbed by vessels and equipment (see discussion in Section 3.7.2 Fish and Section 3.5.2.3.2 below). This could affect the North Atlantic right whale, North Pacific right whale, Beluga whale, and killer whale, all of which have critical habitat characteristics based on feeding and finding prey. However, it is not expected that impacts on prey species would be substantial, and thus impacts on critical habitat from vessel presence and movement of equipment are likely to be negligible to minor.

Since the likelihood of a vessel strike would continue to be very low, overall effects on cetaceans, including ESA-listed species and designated critical habitat, from vessel presence and movement of equipment in the water under Alternative A would continue to be **adverse** and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups would continue to be temporary or short-term with no life-threatening injury to individual marine mammals. Displacement of cetaceans from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat would continue to be limited to the project area or its immediate surroundings. Multiple activities in one area or in several areas across migratory corridors could lead to larger magnitudes and more widespread impacts due to vessel operations; however, impacts would still continue to be considered **insignificant**. In the unlikely event that a vessel strike occurs, its impact would depend on the population status of the species affected. Although extremely unlikely, debilitating injury or mortality of one or a few individuals could occur; if population-level impacts are not expected, then impacts would be **moderate**, although the magnitude of impact could be greater if an ESA-listed species is affected.

3.5.2.3.1.4 Human Activity

Human activity on vessels above the surface of the water would not be expected to have any effects on cetaceans underwater. During SCUBA operations, divers would move through the water column, possibly temporarily disturbing cetaceans that may be in the area. Cetaceans would continue with the activities they were engaged in once divers depart and water column turbulence ceases.

When using a boat or platform to conduct SCUBA operations, at least one PSO would maintain visual watch for protected species to ensure none are sighted within the working area. If a listed species moves into the work area, cessation of operation of any moving equipment within 15 m (50 ft) of the animal would occur and only resume when the species has left the project area. SCUBA divers involved in in-water activities would have proper training and be capable of responsible dive practices such that they minimize injury to organisms and avoid unnecessary habitat impacts. During all buoy deployment and retrieval operations, buoys would be lowered and raised slowly to minimize risk to listed species. In addition, observers would monitor for listed species in the area prior to and during deployment and retrieval. Work would be stopped if listed species are observed in the area to minimize entanglement risk.

The impacts of human activity on cetaceans, including ESA-listed species, under Alternative A would continue to be **adverse** and **negligible** as there would continue to be only be minimal disruptions of behavioral patterns and no displacement from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat; thus, the impacts would continue to be **insignificant**. It is not expected that human activity would have any impacts on designated critical habitat.

3.5.2.3.1.5 Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in release of oil, fuel, or chemicals by a vessel used by NOS. Spills occurring at the ocean surface would be expected to disperse to a very light sheen and weather rapidly (BOEM, 2014a). Volatile components of the contaminant would evaporate. Fuel such as diesel used for operation of vessels is light and would float on the ocean surface. There is the potential for a small proportion of heavier fuel components to adhere to particulate matter in the upper portion of the water column and sink.

Severity of oil and fuel spills on cetaceans depends on the type of contaminant, exposure pathway, and degree of weathering of the substance. Oil and fuel harm cetaceans via acute toxicity, sublethal health effects that reduce fitness, and disruption of marine communities (Walker et al., 2018). In the highly unlikely event of an accidental oil or fuel spill into the marine environment from a vessel used by NOS, cetaceans may be affected through various pathways: direct contact on skin, inhalation of volatile components, ingestion (directly or indirectly through the consumption of fouled prey species), and (for mysticetes) impairment of feeding by fouling of baleen (BOEM, 2014a). Mysticetes, such as humpback and right whales that feed in confined areas (e.g., bays), may be at greater risk of ingesting oil and fuel. The most likely effects of inhalation of volatile vapors would be irritation of respiratory membranes and absorption of hydrocarbons into the bloodstream. Cetacean skin is highly impermeable and is not seriously irritated by brief exposure to petroleum products. Ingestion (via contaminated prey) or inhalation may have negative effects for digestive, respiratory, and circulation systems; however, cetaceans exposed to an accidental spill from a vessel used by NOS are unlikely to ingest enough contaminants to cause serious internal damage because the volume of contaminants spilled would be fairly small given the size of vessel used in NOS projects. Death or life-threatening injury of individual cetaceans would not be expected from a small spill, nor would extended displacement of animals from preferred feeding or breeding habitats or migratory routes.

Cetaceans can be affected indirectly by oil, fuel, and chemical spills through changes in the ecosystem that adversely affect prey species and habitats, including degradation of water quality. Mortality of phytoplankton and zooplankton from oil and fuel spills could indirectly affect mysticetes which feed on them. However, even if a large number of plankton were affected, they can recover rapidly due to high reproductive rates, rapid replacement by cells from adjacent waters, widespread distribution, and exchange with tidal currents. Thus, the impact of an accidental spill on a pelagic phytoplankton community, and consequently on mysticetes, would not be substantial.

An accidental spill adjacent to or within critical habitat areas for the North Atlantic right whale and Beluga whale (both of which have critical habitat characteristics associated with nursery areas and calving) during calving periods may result in the direct contact of the spilled contaminants with both adult and newly born whales. Additionally, critical habitat areas designated for feeding and foraging characteristics for the North Atlantic right whale, North Pacific right whale, Beluga whale, and killer whale could be affected by adverse impacts on prey species from spilled fuel, oil, and other contaminants. Small spills could also make localized areas of critical habitat temporarily unavailable because of disturbance while clean up occurs, or temporarily decrease the value of critical habitat through contamination. However, impacts from such events are not likely to seriously injure individual whales, as discussed above, and the likelihood of occurrence of an accidental spill is expected to be very low.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. For example, on NOAA fleet vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the Commanding Officer takes appropriate action to minimize the effects of the spill. The Office of Marine and Aviation Operations (OMAO) Procedure 0701-06 'Shipboard Oil Pollution Emergency Plan & Non-Tank Vessel Response Plan (VRP/SOPEP)' provides policy and guidance to all NOAA vessels regarding oil pollution emergency planning and response, in accordance with MARPOL 73/78, Annex I. The plan contains all the information and instruction required for responding to shipboard oil spills, such as general spill mitigation and response, shipboard spill mitigation and response, reporting requirements, completing Corrective Action Assessments, trainings, drills, and exercises. This plan has been approved by the United States Coast Guard (USCG), and complies with the Oil Pollution Act of 1990 and Federal Water Pollution Act of 1973.

Since the likelihood of occurrence of an accidental spill from a vessel used by NOS would continue to be very low, impacts on cetaceans under Alternative A are expected to be **adverse** and **negligible**. In the event that an accidental spill does occur, the volume of oil, fuel, and/or chemicals would be fairly small given the size of vessels used by NOS and the amounts of fuel and other chemicals they typically carry. Additionally, all hazardous or regulated materials would continue to be handled in accordance with applicable laws, and crew members would continue to be appropriately trained in materials storage and usage. Thus, the impact on cetaceans would continue to be **adverse** and **minor** as impacts would continue to be temporary or short-term without any impacts on population levels. Displacement of cetaceans that move away to avoid spilled substances would continue to be short-term and limited to the project area or its immediate surroundings. Impacts on cetaceans, including ESA-listed species and designated critical habitat, would continue to be **insignificant**.

3.5.2.3.1.6 Trash and Debris

Marine debris, particularly items made of synthetic materials, is a major form of marine pollution. Ship-generated waste generally includes glass, metal, and plastic containers, organic and food waste, cardboard and paper packaging waste, and hazardous waste (e.g., batteries, noxious liquids, paint waste, pharmaceuticals) (Walker et al., 2018).

Marine debris poses two types of negative impacts on cetaceans: entanglement and ingestion. Entanglement is a far more likely cause of mortality to cetaceans than ingestion (BOEM, 2014a). Entanglements occur when cables, lines, nets, or other objects suspended in the water column become wrapped around marine mammals, potentially causing injury, interference with essential behaviors and functions, and possibly mortality. Entanglement is most common in pinnipeds (see Section 3.5.3.2 below), less common in mysticetes, and rare among odontocetes (Laist et al., 1999). Entanglement data for mysticetes reflects a high interaction rate with active fishing gear rather than marine debris (BOEM, 2014a). During proposed activities, numerous cables, lines, and other objects could be towed behind the vessel near the water's surface. Although it is possible that such lines and cables could detach from a vessel and become debris in which cetaceans could get entangled, it is not very likely.

Impacts from discarded trash and debris are expected to be avoided through vessel operators' required compliance with USCG and U.S. Environmental Protection Agency (EPA) regulations. In addition, no intentional vessel discharges would occur if a protected species is sighted within 91 m (100 yds) of the vessel used by NOS, and all MARPOL discharge protocols would be followed. Thus, impacts of discarded trash and debris on cetaceans, including ESA-listed species, under Alternative A would continue to be **adverse** and **negligible** as any disturbance of animals would continue to be temporary, no mortality or debilitating injury would be expected, and there would continue to be no displacement from preferred or designated critical habitat; impacts would continue to be **insignificant**. It is also not expected that trash and debris would have any impacts on designated critical habitat.

3.5.2.3.2 Pinnipeds

The analysis of impacts on pinnipeds considers all of the impact causing factors introduced above. Potential impacts could occur in all of the geographic regions as one or more pinniped species, subspecies, or DPS occur in each region (see Section 3.5.1.2 above). Three regions – West Coast, Alaska, and Pacific Islands – include one or more ESA-listed species, and two regions, Alaska and Pacific Islands, each include designated critical habitat for one listed species.

3.5.2.3.2.1 Active Underwater Acoustic Sources

While many pinnipeds forage near the water surface, others make deep and prolonged foraging dives of hundreds of meters (elephant seals are the deepest-diving pinnipeds); thus, they could be affected by underwater sound from acoustic sources used in NOS projects. Active underwater acoustic sources included in Alternative A comprise echo sounders, ADCPs, and acoustic communication systems as discussed in Section 2.4 and under cetaceans in Section 3.5.2.3.1.1. **Table 3.5-7** lists the representative equipment and frequency ranges used in acoustic modeling.

Sound frequencies produced by the echo sounders overlap the range of pinniped hearing (50 Hz to 86 kHz), and they can presumably hear these sounds if sufficiently close. Acoustic signals from echo sounders (ranging from 0.5 kHz to 900 kHz) are likely to be detectable by pinnipeds if the lower end of the sound frequency spectrum is used. The adverse impacts of such sound can include behavioral responses and short-term or permanent loss of hearing (TTS and PTS). Masking effects are expected to be minimal or non-existent given the beam directionality, the brief period when an individual pinniped would potentially be within the downward-directed beam from a transiting vessel, and the relatively low source level of an echo sounder. TTS and PTS through exposure to the downward-directed echo sounder sounds is unlikely to occur because the probability of a pinniped swimming through the area of exposure when an echo sounder emits a sound is small. The animal would have to pass the transducer at close range and be swimming at speeds similar to the vessel in order to be subjected to sound levels that could cause TTS or PTS.

Acoustic signals from ADCPs (ranging from 35 kHz to 1200 kHz) are likely to be detectable by pinnipeds underwater if the lower end of the sound frequency spectrum is used. The effects of underwater sound from ADCPs on pinnipeds would be similar to those from echo sounders, although there would potentially be no impacts at all as ADCPs, although capable of producing lower frequency sound, are usually operated at high to extremely high frequency.

Acoustic communication systems would emit sound in mid-frequency ranges (10s of kHz) and thus could be detectable by pinnipeds (which can hear from 50 Hz to 86 kHz) underwater. The impacts of underwater sound on pinnipeds from acoustic communication systems would be similar to but less than that described above for the use of echo sounders because, although acoustic communication systems are omnidirectional, they have lower power, a lower duty cycle, and would be used less frequently than echo sounders.

Quantitative acoustic exposure to marine mammals, including pinnipeds, from operation of sound sources was modeled for nine sources (see Appendix E). Acoustic modeling was conducted by determining the size of the sound field expected from each source (referred to and depicted as an isopleth) and estimating the number of pinnipeds that may be exposed above sound thresholds for PTS/injury and behavioral disruption (see Appendix E). To gauge the potential for impacts, received sound levels that could result in PTS/injury or behavioral disruption to the animal were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR 72308, December 31, 2019) were used (see Appendix E). The methodology for modeling the impacts of active underwater acoustic sources is presented in Appendix E. Additionally, Section 3.5.2.3.1.1 under Cetaceans discusses the assumptions made and the data sources used in the modeling scenarios to predict exposures of marine mammals, including pinnipeds.

Based on the modeling, and taking into account animal behavior, source characteristics, and animal hearing capability, no PTS/injury exposures of pinnipeds are expected to occur; thus, only behavioral disruption exposure is discussed below. Note that the estimated exposures have overall decreased between the Draft PEIS and the Final PEIS for the reasons discussed in Section 3.5.2.3.1.1 under Cetaceans.

3.5.2.3.2.1.1 Behavioral Disruption Exposure Estimates

Behavioral disruption exposure estimates over the five-year period were calculated for sources with operational frequencies within the pinniped hearing frequency range (<200 kHz, see Section 3.5.1.2.1). Behavioral disruption exposure estimates considered that all proposed activities would occur, used the highest levels of anticipated animal densities, and did not factor in effects of potential mitigation procedures or animals avoiding the sounds. Summarized total potential behavioral disruption exposures of pinnipeds over five years for all sources in the four regions where they could occur are shown in **Table 3.5-11**. For annual numbers, see Appendix E. Species that may be in the area but for which no impacts were predicted are not included in the table.

Table 3.5-11. Total Predicted Exposures for Pinniped Species and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative A

Species	Total Exposures*	Average time above 160 dB (s)**
Alaska Region		
Northern fur seal***	20,494.45	138
Spotted seal	10,026.01	104
Harbor seal	6,471.74	104
Northern elephant seal***	5,662.73	118
Bearded seal	1,451.04	104
Ribbon seal	1,372.51	104
Ringed seal	1,103.05	104
Walrus	593.19	95
Steller sea lion***	443.17	104

Species	Total Exposures*	Average time above 160 dB (s)**
Greater Atlantic Region		
Harp seal	691.06	174
Gray seal	559.35	168
Harbor seal	341.84	193
Hooded seal	321.20	174
West Coast Region		
California sea lion	29,566.71	96
Northern fur seal	20,976.33	138
Northern elephant seal	5,662.73	118
Harbor seal	5,425.79	138
Stellar sea lion	2,472.05	138
Guadalupe fur seal	227.24	138
Pacific Islands Region		
Hawaiian monk seal	548.17	86

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure above threshold over 24 hours.

***Populations span Alaska and West Coast regions.

Under Alternative A, behavioral disruption exposures to pinnipeds could occur in four regions. Depending on the species, behavioral disruption exposure of pinnipeds could affect hundreds to tens of thousands of animals in each region over the five-year timeframe. However, for the simulated animals exposed above the 160 dB threshold, the average time above threshold is under four minutes, and often less than two minutes (**Table 3.5-11**). The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual's behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals, as in the case of seismic surveys that have months' worth of activity (Southall et al., 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals of some species could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals could be exposed above threshold over the five years and the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures (see Appendix D) to reduce potential impacts of active acoustic sources on marine mammals. NOS would continue to use the lowest power appropriate to perform surveys. NOS would also continue to use PSOs and would employ a robust suite of animal approach restrictions and reduced vessel speeds, described in more detail in Sections 3.5.2.3.2.2 and 3.5.2.3.2.3, as well as the walrus-specific measures outlined in Section 3.5.2.3.2.2.

3.5.2.3.2.1.2 Conclusion

The effects of underwater sound from active acoustic sources on pinnipeds under Alternative A would continue to be **adverse** and **minor.** No injury exposures in the form of hearing loss (PTS) are expected to occur. While individual animals would be expected to experience behavioral disruptions (from thousands to tens of thousands of animals across four regions over the five-year timeframe), the amount of time individuals may exceed behavioral exposure thresholds would be on average less than four minutes (**Table 3.5-11**). Similarly, the potential for masking would continue to be minimal during surveys because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Overall, the potential impacts are likely limited to short-term disruption of acoustic habitat and behavioral patterns. Impacts would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication, disturbance of individuals or groups of pinnipeds, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of pinnipeds from preferred breeding, feeding, or nursery grounds or designated critical habitat would be limited to the project area or its immediate surroundings. Impacts of Alternative A on pinnipeds, including ESA-listed species, would continue to be **insignificant**.

3.5.2.3.2.2 Vessel and Equipment Sound

Pinnipeds can be classified within two separate functional hearing groups ("pinnipeds in water" [75 Hz-75 kHz] and "pinnipeds in air" [75 Hz-30 kHz]) since these species communicate acoustically in both air and water and have different hearing capabilities in the two media. Vessels and equipment used by NOS would generate transitory sound (10 to 10,000 Hz) into the air and underwater while in a project area that would allow them to be heard by pinnipeds.

Vessel sound in the air and underwater can cause behavioral disturbance in pinnipeds. However, the occurrence and nature of pinniped responses would be variable, depending on species, location, novelty of the sound, vessel behavior, and habitat, among many other factors (see Section 3.5.2.3.1.2 above for discussion of vessel variables). Behavioral responses could include evasive maneuvers such as diving, changes in swimming direction and/or speed, dive duration, decreased time searching for food, and avoidance behaviors, as well as disruptions in breeding and nursing. Introduced underwater sound may also reduce (i.e., mask) the effective communication distance of a pinniped if the frequency of the source is close to that used as a signal by the animal, and if the anthropogenic sound is present for a substantial fraction of the time. Vessel sounds, however, would be at levels not expected to cause anything more than possible reactions limited to startle or otherwise brief responses and temporary or short-term behavioral changes of no lasting consequence to the animals. Additionally, vessels would avoid approaching within 100 yards of in-water seals and sea lions.

Animal approach restrictions in part D of 50 CFR 224.103 list special prohibitions for Steller sea lions to which NOS operators would adhere:

- Per part D of the regulation, vessels must maintain a distance of 3 nm (5.6 km) from Steller sea lion rookery sites listed in the regulation (Table 1 to 50 CFR 224.103 - Listed Steller Sea Lion Rookery Sites).

Impacts from low-frequency underwater sound generated by remotely operated or autonomous vehicles and other equipment would be similar to those of surface vessels but at a much reduced magnitude due to the far fewer nautical miles of proposed travel (i.e., approximately 518,000 nm [959,000 km] for surface vessels vs. 28,600 nm [53,000 km] for remotely operated and autonomous vehicles over the five-year period across all geographic regions).

Low-flying aircraft used to reach remote areas, especially in Alaska for such projects as tide gauge installation, can disturb pinnipeds because of both airborne and underwater sound and visual disturbance, particularly to individuals resting on the sea surface or at haul out locations. Behavioral responses of pinnipeds to aircraft are highly variable and range from no observable reaction to diving or rapid changes in swimming speed or direction. Exposure of individual pinnipeds to aircraft-related sound would be expected to be brief in duration, and considering the relatively infrequent level of aircraft activity that may occur (only once or twice a year), potential impacts from this activity on pinnipeds are expected to be minimal. Walruses, however, are easily frightened when on haul outs and are more sensitive to disturbance than swimming individuals; walruses tend to pack closely together when hauled out so that a flight response by one animal can quickly travel through the herd, triggering a mass exodus to the water (BOEM, 2016; USFWS, 2016a). Stampedes are the greatest impact of aircraft and vessel disturbance and may result in cow-calf separations or injuries and mortalities. In recent years, upwards of 60,000 walrus have consistently hauled out on land near Point Lay, Alaska (USFWS, 2020). Disturbance at these types of haulouts would have a greater impact on walrus than on ice or on other land haulouts such as in Bristol Bay, Alaska since haulouts at Point Lay are primarily populated by females with pups, subadults and some males. A stampede at a haulout of this size with this demographic would likely incur more deaths, injuries, and separations than at other locations.

NOS may encounter walruses while conducting activities within the Bering Sea or Chukchi Sea, or along the associated coastline. Walrus are sensitive to disturbance from noise, sights, and smells associated with human activities and could result in significant behavioral response, injury, or death. Appendix D details the mitigation measures that have been suggested by USFWS and adopted by NOS to prevent such adverse effects and include:

- Maintain an appropriate minimum distance from walruses hauled out on ice or land: Marine vessels less than 15 m (50 ft) in length – 0.5 nm (1 km); Marine vessels 15 m (50 ft) or more but less than 30 m (100 ft) in length – 1 nm (1.8 km); and Marine vessels 30 m (100 ft) or more in length – 3 nm (5.5 km);
- Reduce noise levels near haulouts. Avoid abrupt maneuvers, sudden changes in engine noise, using loud speakers, loud deck equipment or other operations that produce noise when in the vicinity of walrus haulouts. Note that sound carries a long way across the water and often reverberates off of cliffs and bluffs adjacent to coastal walrus haulouts, amplifying noise. Do not operate the vessel in such a way as to separate members of a group of walruses from other members of the group;
- Reduce speed and maintain a minimum distance of 0.8 km (0.5 mi) from groups of walruses in the water;
- If walruses approach the vessel or are found to be in close proximity, place boat engines in neutral and allow the animals to pass. If vessel safety considerations prevent this, carefully steer around animals;
- When weather conditions require, such as when visibility drops, adjust speed accordingly to avoid the likelihood of injury to walruses;
- Do not fly autonomous system devices or single engine fixed wing aircraft over or within 0.8 km (0.5 mi) of walruses hauled out on land or ice;
- If weather or aircraft safety require flight operations within 0.8 km (0.5 mi) of a haulout site, maintain a 610 m (2,000 ft) minimum altitude;

- Do not fly helicopters over or within 1.6 km (1 mi) of walruses hauled out on land or ice;
- If weather or aircraft safety require crewed flight operations within 1.6 km (1 mi) of a haulout site, maintain a 915 m (3000 ft) minimum altitude;
- Landings, take-offs, and taxiing of autonomous system devices or single engine fixed wing aircraft should not occur within 0.8 km (0.5 mi) of hauled out walruses, or within 1.6 km (1 mi) for helicopters;
- Avoid circling or turning near walruses hauled out on land or ice; and
- If aircraft safety requires flight operations below recommended altitudes near a haulout, pass inland or seaward of the haulout site at the greatest lateral distance manageable for safe operation of the aircraft.

Underwater sound from vessels and equipment may adversely affect the foraging or prey characteristics of critical habitat that support some ESA-listed pinnipeds by impacting different life stages of fish and aquatic macroinvertebrate prey species. See Section 3.7 Fish and Section 3.8 Aquatic Macroinvertebrates for full discussions of the potential impacts on fish and aquatic macroinvertebrates from vessel sound and underwater acoustic sources.

Considering that the proposed volume of vessels associated with NOS project activities within the EEZ is very low as compared with all other shipping and vessel traffic (see Section 2.4.1), and the assumption that individuals or groups of pinnipeds may be familiar with various and common vessel-related sounds, particularly within frequented shipping lanes, the effects of vessel sound on pinnipeds under Alternative A would continue to be **adverse** and **minor**. If a walrus stampede occurs due to vessel or aircraft disturbance, the impact could be **moderate** or greater as debilitating injury or mortality could occur, but the continued viability of the population would not be threatened, especially when BMPs and guidelines are implemented. Small disruptions of behavioral patterns or displacement of individuals or groups would continue to be temporary or short-term with no life-threatening injury to individual pinnipeds. Displacement of pinnipeds from preferred breeding, feeding, or nursery grounds, or designated critical habitat would continue to be limited to the project area or its immediate surroundings. Multiple activities in one area could lead to larger magnitudes and more widespread impacts. However, vessel sound is expected to result in **insignificant adverse** effects on individuals or populations of pinnipeds, including ESA-listed species and designated critical habitat.

3.5.2.3.2.3 Vessel Presence and Movement of Equipment in the Water

As with vessel sound, behavioral responses of pinnipeds to vessel presence and movement are also expected to be variable. Some species may tolerate slow moving vessels within several hundred meters, especially when the vessel is not directed towards the animal or making sudden changes in direction or engine speed. Reactions of pinnipeds to vessel presence and movement include attraction to the vessel, increased alertness, modification of vocalization, cessation of feeding or interacting, alteration of swimming or diving behavior (change in direction or speed), habitat abandonment, and possibly panic reactions such as stampeding (particularly in walruses). Disturbance from vessels can include localized displacement of pinnipeds in close proximity from haul out locations. The presence of vessels used by NOS, however, would not be at levels expected to cause anything more than possible localized and temporary or short-term behavioral changes in pinnipeds.

An important consideration for all crewed vessel operations is the possibility of marine mammal vessel strikes. Vessel strikes can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds. However, vessel strikes are unlikely as pinnipeds in general are very agile, are able to swim much faster than the vessels used by NOS, and can easily swim away from or under vessels traveling at full speed. When feeding, pinnipeds may be distracted and thus inattentive to vessels; however, they can probably move away quickly enough to avoid collisions. As NOS would ensure visual observation during all vessel operations (regardless of size), along with animal approach restrictions discussed above in Section 3.5.2.3.2.2, vessels used by NOS would be unlikely to strike pinnipeds. Marine mammal strikes by ROVs and autonomous vehicles are of low concern because of their slow speeds, small size, and built-in proximity avoidance systems.

Water disturbance by remotely operated and autonomous vehicles can temporarily disturb and displace nearby pinnipeds both in the water and those who are hauled out. The impact should be minimal and likely brief in duration as the ROV or equipment would quickly pass by; however, impacts could increase if the frequency of disturbance becomes greater or if an ROV gets too close to haul out locations. In either case, if displaced, pinnipeds are expected to return to the area and resume normal activities once the water disturbance is no longer present. Equipment such as echo sounders is typically attached to a crewed vessel or remotely operated or autonomous vehicle; thus, effects on pinnipeds would occur from the presence and operation of their carriers as discussed above, rather than from the presence of the equipment itself. ADCPs and acoustic communication systems are often operated from tethered systems, buoys, fixed moorings, or they are hull mounted or on remotely operated or autonomous underwater vehicles. As with echo sounders, any effects on pinnipeds would occur from the presence and operation of the vessel, rather than from presence of the equipment itself. Deployment of all autonomous systems, as well as other equipment and divers, would be suspended if any protected species is sighted within 91 m (100 yds) of the vessel. Work already in progress may continue if the activity is not expected to adversely affect the animal. Additionally, the mitigation measures discussed in Section 3.5.2.3.2.2 for protecting walruses also apply for vessel presence and movement of equipment in the water.

Sound speed data collection equipment, grab samplers, and drop/towed cameras are lowered and raised through the water column. This movement through the water could temporarily disturb and displace nearby pinnipeds. These impacts would be temporary as pinnipeds are expected to return once water column turbulence ceases. The ropes and wires used to lower such equipment, or to connect a probe to the equipment on a ship, can also cause entanglements with pinnipeds. However, this is not expected to interfere with pinniped movements as, prior to using equipment, NOS would ensure there is at least one PSO observing the area for protected species at all times.

Water turbulence by anchors and chains moving through the water can also temporarily disturb and displace nearby pinnipeds. The impact on pinnipeds should be minimal and cease when the anchoring system comes to rest or is taken out of the water. Pinnipeds are expected to return to the area and resume normal activities once water column turbulence ceases. It is possible that vessels anchoring near haul out locations could disturb or displace hauled out pinnipeds. Such impacts could be avoided by using designated anchorage areas or previously surveyed areas when available, and if an appropriate distance away so as not to disturb animals. Anchoring would be a relatively infrequent activity; thus, impacts on pinnipeds would be expected to be minimal as they would rarely occur.

Vessel presence and movement of equipment in the water would not have any direct effects on the critical habitat of any pinniped species. Indirectly, prey species such as fish may be disturbed by vessels and equipment (see discussion in Section 3.7.2 Fish). This could affect the Steller sea lion and Hawaiian monk seal, both of which have critical habitat characteristics that are based on feeding and finding prey. However, it is not expected that impacts on prey species would be substantial, and thus impacts on critical habitat from vessel presence are likely to be temporary and small. Additionally, vessel operations have the potential to interfere with the haul out, rookery, and nursing characteristics of designated critical habitat for the Steller sea lion and Hawaiian monk seal if these species are displaced or otherwise prevented from using the habitat when vessels are present.

The mitigation measures discussed in Section 3.5.2.3.2.2 for reducing the impacts of vessel and equipment sound on pinnipeds also apply for reducing impacts of vessel presence and movement of equipment in the water.

Since the likelihood of a vessel strike would continue to be very low, the overall effects on pinnipeds, including ESA-listed species and designated critical habitat, from vessel presence and movement of equipment in the water under Alternative A would continue to be **adverse** and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups would continue to be temporary or short-term with no life-threatening injury to individual pinnipeds. Displacement of pinnipeds from preferred breeding, feeding, or nursery grounds, or designated critical habitat would continue to be limited to the project area or its immediate surroundings. Multiple activities in one area could lead to larger magnitudes and more widespread impacts due to vessel operations; however, impacts would still continue to be considered **insignificant**. In the unlikely event that a vessel strike occurs, its impact would depend on the population status of the species affected. Although very unlikely, debilitating injury or mortality of one or a few individuals could occur; since population-level impacts are not expected, impacts would be **moderate**, although the magnitude of impact could be greater if an ESA-listed species is affected.

3.5.2.3.2.4 Human Activity

Human activity could affect pinnipeds primarily during activities on land, such as tide gauge and shore-based reference station installation, maintenance, and removal. Sound and movement from human activity onboard vessels could also affect pinnipeds that are hauled out; however, the sound and presence from the vessels themselves would likely be the greater cause of impacts, as discussed above.

Onshore human activity during tide gauge installation near pinniped haul out sites could disturb activities such as communication, feeding, or reproduction and displace animals from haul outs temporarily or over the short-term. Tide gauge operation would not generally affect pinnipeds as tide gauges operate autonomously. Occasionally, there could be some disturbance or displacement of nearby pinnipeds from sound and activity if field personnel need to do maintenance in such situations as when a buoy breaks its mooring, the gauge stops sending messages, or batteries need to be recharged. Sound and activity from tide gauge removal could also cause temporary or short-term, localized disturbance and changes in behavior of nearby hauled out pinnipeds, similar to impacts during installation. During all buoy deployment and retrieval operations, buoys would be lowered and raised slowly to minimize risk to listed species. In addition, observers would monitor for listed species in the area prior to and during deployment and retrieval. Work would be stopped if listed species are observed in the area to minimize entanglement risk.

Impacts from installation of a shore-based GPS reference station could potentially occur if the site is located near a pinniped haul out location, similar to impacts during tide gauge installation. In addition, shore and/or coastal habitat could be disturbed or altered because a small area of ground would be covered by the GPS reference station. Although this could affect habitat at haul out locations, it is not likely that the ground disturbance would be large enough to alter habitat to the point where pinnipeds could no longer use the site.

During SCUBA operations, divers would move through the water column, possibly temporarily disturbing pinnipeds that may be in the area. Pinnipeds would continue with the activities they were engaged in once divers depart and water column turbulence ceases. When using a boat or platform to conduct SCUBA operations, at least one PSO would maintain visual watch for protected species to ensure none are sighted within the working area. If a listed species moves into the work area, cessation of operation of any moving equipment within 15 m (50 ft) of the animal would occur and only resume when the species has left the project area. SCUBA divers involved in in-water activities would have proper training and be capable of responsible dive practices such that they minimize injury to organisms and avoid unnecessary habitat impacts.

Overall, the impacts of human activity on pinnipeds, including ESA-listed species, under Alternative A would continue to be **adverse** and **minor** as there would only continue to be small disruptions of behavioral patterns and any displacement would continue to be limited to the project area or immediate surroundings, and thus **insignificant**. It is not expected that human activity would have any impacts on designated critical habitat as the locations for tide gauges and GPS reference stations would not likely be located in or adjacent to critical habitat areas.

3.5.2.3.2.5 Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

Severity of oil, fuel, and chemical spills on pinnipeds depends on the type of contaminant, exposure pathway, and degree of weathering of the substance. Oil and fuel can harm pinnipeds via acute toxicity, sublethal health effects that reduce fitness, and disruption of marine communities. In the highly unlikely event of an accidental spill into the marine environment from a vessel used by NOS, pinnipeds could be coated with oil or fuel, could ingest oil or fuel with water or contaminated food, or could absorb oil or fuel components through the respiratory tract. Oil can destroy the insulating qualities of hair or fur, resulting in hypothermia. Thus, pinnipeds that depend on fur rather than a thick layer of fat for insulation, such as fur seals and newborn pups, are most sensitive to oiling. If oil or fuel is ingested, some of it would be voided in vomit or feces or metabolized at rates that prevent significant bioaccumulation, but some could be absorbed and could cause toxic effects. However, pinnipeds exposed to a small oil or fuel spill from vessels used by NOS are unlikely to ingest enough to cause serious internal damage. A small spill would not be likely to result in the death or life-threatening injury of individual pinnipeds, or the long-term displacement of these animals from preferred feeding or breeding habitats. It is expected that spilled oil or fuel would rapidly disperse on the sea surface to a very light sheen and weather rapidly (BOEM, 2014a).

Pinnipeds could be affected indirectly by oil, fuel, and chemical spills through changes in the ecosystem that adversely affect prey species and habitats, including degradation of water quality. Water quality and visibility could be temporarily impacted, which could indirectly affect the ability of pinnipeds to locate prey (primarily fish or invertebrates). This could also affect critical habitat areas designated for feeding and foraging characteristics for the Steller sea lion and Hawaiian monk seal. Small spills could also make localized areas of critical habitat temporarily unavailable because of disturbance while clean up occurs, or temporarily decrease the value of critical habitat through contamination. However, since it would be highly unlikely that an accidental spill would occur, adverse impacts on prey and habitat, including critical habitat, would be very low.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. For example, on NOAA fleet vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the

Commanding Officer takes appropriate action to minimize the effects of the spill. OMAO Procedure 0701-06 VRP/SOPEP provides policy and guidance to all NOAA vessels regarding oil pollution emergency planning and response, in accordance with MARPOL 73/78, Annex I. The plan contains all the information and instruction required for responding to shipboard oil spills, such as general spill mitigation and response, shipboard spill mitigation and response, reporting requirements, completing Corrective Action Assessments, trainings, drills, and exercises. This plan has been approved by the USCG, and complies with the Oil Pollution Act of 1990 and Federal Water Pollution Act of 1973.

Since the likelihood of occurrence of an accidental spill from a vessel used by NOS would continue to be very low, impacts on pinnipeds under Alternative A are expected to be **adverse** and **negligible**. In the event that an accidental spill does occur, the volume of oil, fuel, and/or chemicals would continue to be fairly small given the size of vessels used by NOS and the amounts of fuel and other chemicals they typically carry. Additionally, all hazardous or regulated materials would continue to be handled in accordance with applicable laws, and crew members would continue to be appropriately trained in materials storage and usage. Thus, the impact on pinnipeds would continue to be **adverse** and **minor** as impacts would continue to be temporary or short-term without any impacts on population levels. Displacement of pinnipeds that move away to avoid spilled substances would continue to be short-term and limited to the project area or its immediate surroundings. Impacts on pinnipeds, including ESA-listed species and designated critical habitat, would continue to be **insignificant**.

3.5.2.3.2.6 Trash and Debris

Marine debris poses two types of negative impacts on pinnipeds: entanglement and ingestion. Entanglement is a far more likely cause of mortality to marine mammals than ingestion and is most common in pinnipeds. Entanglements occur when cables, lines, nets, or other objects suspended in the water column become wrapped around animals, potentially causing injury, interference with essential behaviors and functions, and possibly mortality. Northern fur seals have been particularly susceptible to entanglement from commercial fishing debris, primarily trawl net webbing, plastic packing straps, and monofilament line (NMFS, No Date-d). However, the tendency of pinnipeds to generally avoid approaching vessels used by NOS (in contrast with their tendency to congregate around fishing vessels) presumably reduces the risk of entanglement. During proposed activities, cables, lines, and other objects could be towed behind the vessel near the water surface. Although it is possible that such lines and cables could detach from a vessel and become debris in which pinnipeds could get entangled, the likelihood of this occurring would be low.

Impacts from discarded trash and debris are expected to be avoided through vessel operators' required compliance with USCG and EPA regulations. In addition, no intentional vessel discharges would occur if a protected species is sighted within 91 m (100 yds) of the vessel used by NOS, and all MARPOL discharge protocols would be followed. Thus, impacts of discarded trash and debris on pinnipeds, including ESA-listed species, under Alternative A would continue to be **adverse** and **negligible** as any disturbance of animals would continue to be temporary, no mortality or debilitating injury would be expected, and there would be no displacement from preferred or designated critical habitat; impacts would continue to be **insignificant**. It is expected that trash and debris would continue to not have any impacts on designated critical habitat under Alternative A.

3.5.2.3.2.7 Air Emissions

Since the pre-industrial era, increased emissions of anthropogenic greenhouse gases (GHG) [carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)] have resulted in higher atmospheric concentrations of these gases and influenced atmospheric, terrestrial, and oceanic conditions (Limpinsel et al., 2017).

Smokestack and two-stroke outboard motor emissions from vessels used by NOS would release air pollutants. The type and amount of air emissions from vessels used by NOS would depend on the type of fuel, engine, and engine efficiency. Pinnipeds which are hauled out may be exposed to airborne smokestack or outboard motor emissions; however, such emissions would be temporary and ephemeral as they would dissipate rapidly into the air and may not reach hauled out animals.

Burning fossil fuels pollutes not just the air but also the oceans as the waters absorb carbon dioxide, which lowers the pH of surface waters and leads to acidification. Changes in seawater carbon chemistry, in particular interference with the formation of calcium carbonate ($CaCO_3$) in marine shells and skeletons, may affect marine biota through a variety of biochemical, physiological, and physical processes. However, the amount of emissions from vessels used by NOS would continue to be a very small fraction as compared to emissions from all other vessel activity in the oceans. Thus, impacts on pinnipeds, including ESA-listed species and designated critical habitat, from air emissions under Alternative A are expected to be **adverse** and **negligible** as there would continue to be no disturbance of communication or behavior, no displacement, and no debilitating injury of individuals; impacts would continue to be **insignificant**.

3.5.2.3.3 Sirenians

The analysis of impacts on sirenians, which live primarily underwater, does not consider air emissions. All the other impact causing factors for marine mammals are analyzed below for sirenians. Potential impacts could occur in one of the geographic regions, the Southeast Region, as it is the only region where sirenians (two subspecies of manatees) occur (see Section 3.5.1.3 above); this region also includes designated critical habitat for one of the manatee subspecies. Manatees occur mainly in the Southeast Region, although they have been found on occasion to travel further north into the Greater Atlantic Region; thus, the analysis of underwater acoustic impacts below also includes the Greater Atlantic Region.

Critical habitat consists of both a geographic area and PCEs within that area (i.e., the physical or biological features essential to the conservation of a species upon which its designated or proposed critical habitat is based). The Florida manatee was among the first species for which critical habitat was designated, and PCEs were not listed as they have been for other species (e.g., PCEs for other marine mammals include such characteristics of critical habitat use as feeding, breeding, escape from predators, and haul outs). Without a list of PCEs, analyzing the impacts of the Proposed Action on manatee critical habitat is difficult other than in a general way assuming that the designated critical habitat is for protection of the species.

3.5.2.3.3.1 Active Underwater Acoustic Sources

Active underwater acoustic sources included in the Proposed Action comprise echo sounders, ADCPs, and acoustic communication systems as discussed in Section 2.4 and under cetaceans in Section 3.5.2.3.1.1. **Table 3.5-7** lists the representative equipment and frequency ranges used in acoustic modeling.

Acoustic signals from echo sounders (ranging from 0.5 kHz to 900 kHz) are likely to be detectable by manatees (whose hearing ranges from approximately 5 kHz to 60 kHz). The ability to detect high frequencies may be an adaptation to shallow water, where the propagation of low-frequency sound is limited. Manatees are known or likely to use the same mid to high frequencies as produced by echo sounders. The adverse impacts of such sound can include behavioral responses (i.e., reactions are expected to be limited to startle or otherwise brief responses of no lasting consequence to the animals) and possibly loss of hearing. Given the directionality and small beam widths, and the intermittent and downward-directed nature of the echo sounder signals, manatee communications are not expected to be masked appreciably and would result in no more than one or two brief exposures to an animal that happened to swim under the vessel. TTS and PTS through exposure to the downward-directed echo sounder sounds are highly unlikely to occur because the probability of a manatee swimming through the area of exposure when an echo sounder emits a sound is small. The animal would have to pass the transducer at close range and be swimming at speeds similar to the vessel in order to be subjected to sound levels that could cause TTS or PTS.

ADCPs produce sound at frequencies between 35 kHz and 1200 kHz. While many ADCPs produce sounds outside of the hearing frequency range of manatees, others produce sounds detectable by manatees (whose hearing ranges from 5 kHz to 60 kHz). The effects of underwater sound from ADCPs on manatees would be similar to those discussed above for echo sounders, although there would potentially be no impacts at all as ADCPs, which can produce lower frequency sound, are usually operated at high to extremely high frequency.

Acoustic communication systems would emit sound in mid-frequency ranges (10s of kHz). The impact of underwater sound on manatees from acoustic communication systems would be similar to but less than that described above for the use of echo sounders because, although acoustic communication systems are omnidirectional, they have lower power, a lower duty cycle, and would be used less frequently than echo sounders.

Quantitative acoustic exposure to marine mammals, including sirenians, from operation of sound sources was modeled for nine sources (see Appendix E). Acoustic modeling was conducted by determining the sound field expected from each source and estimating the number of manatees that may be exposed above sound thresholds for PTS/injury and behavioral disruption during surveys (see Appendix E). To gauge the potential for impacts, received sound levels that may result in PTS/injury or behavioral disruption to the animal were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR 72308, December 31, 2019) were used (see Appendix E). Methodology for modeling the impacts of active underwater acoustic sources is presented in Appendix E. Additionally, Section 3.5.2.3.1.1 under Cetaceans discusses the assumptions made and the data sources used in the modeling scenarios to predict exposures of marine mammals, including sirenians.

Based on the modeling and taking into account animal behavior, source characteristics, and animal hearing capability, no PTS/injury exposure of manatees is expected to occur; thus, only behavioral disruption exposure is discussed below. Note that the estimated exposures have overall decreased between the Draft PEIS and the Final PEIS for the reasons discussed in Section 3.5.2.3.1.1 under Cetaceans.

3.5.2.3.3.1.1 Behavioral Disruption Exposure Estimates

Behavioral disruption exposure estimates over the five-year period were calculated for sources with operational frequencies within the sirenian hearing frequency range (5 kHz to 60 kHz, see Section 3.5.1.3.1). Behavioral disruption exposure estimates consider that all proposed activities would occur, would expect the highest levels of anticipated animal densities, and do not factor in effects of potential mitigation procedures or animals avoiding the sounds. Summarized total potential behavioral disruption exposure of manatees over five years for all sources, which could occur in two regions, are shown in **Table 3.5-12**. For annual numbers, see Appendix E.

Table 3.5-12. Total Predicted Exposures for Manatees and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative A

Species	Total Exposures*	Average time above 160 dB (s)**
Greater Atlantic Region		
Manatee	226.65	196
Southeast Region***		
Manatee	84.73	196

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure above threshold over 24 hours.

***Exposure modeling for the Southeast Region was conducted for the Gulf of Mexico and Caribbean.

Under Alternative A, behavioral disruption exposures to sirenians could occur in two regions. Behavioral disruption exposure of manatees could affect up to 312 individuals over the five-year timeframe. However, for the simulated animals exposed above the 160 dB threshold, the average time above threshold is under four minutes (**Table 3.5-12**). The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual's behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals, as in the case of seismic surveys that have months' worth of activity (Southall et al., 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals of some species could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals could be exposed above threshold over five years and over the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures (see Appendix D) to reduce potential impacts of active acoustic sources on marine mammals. NOS would continue to use the lowest power appropriate to perform surveys. NOS would also continue to use PSOs and would employ a robust suite of animal approach restrictions and reduced vessel speeds, described in more detail in Sections 3.5.2.3.3.3 and 3.5.2.3.3.4, as well as the manatee-specific measures to prevent disturbance and harassment.

3.5.2.3.3.1.2 Conclusion

The effects of underwater sound from active acoustic sources on sirenians under Alternative A would continue to be **adverse** and **minor.** No PTS/injury exposure is expected to occur. Some individual animals are expected to experience behavioral disruptions (<312 animals over the five-year timeframe in two regions), but the amount of time they may exceed the behavioral exposure thresholds would be less than four minutes (**Table 3.5-12**). Similarly, the potential for masking would continue to be minimal during surveys because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Overall, the potential impacts are likely limited to short-term disruption of acoustic habitat and behavioral patterns. Impacts would be temporary or short-term and would not be considered outside the natural range of variability of manatee populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication, disturbance of individuals or groups of manatees, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of manatees from preferred breeding, feeding, or nursery grounds or designated critical habitat would be limited to the project area or its immediate surroundings. Impacts of Alternative A on manatees would continue to be **insignificant**.

3.5.2.3.3.2 Vessel and Equipment Sound

Vessels and equipment used by NOS would generate transitory sound (10 to 10,000 Hz) while in a project area. Manatees hear from low frequencies (< 5 kHz) to above 60 kHz, thus they would be able to hear the low-frequency sound emitted by ship engines and vessel hulls underwater. Especially in the freshwater habitats of their range in Florida (i.e., in rivers, sloughs, marshes, and lakes) manatees are often exposed to considerable levels of background or ambient sound from numerous small and medium-sized boats with outboard and inboard motors.

Vessel sound underwater can cause behavioral disturbance in manatees. However, the occurrence and nature of manatee responses are variable, depending on location, novelty of the sound, vessel behavior, and habitat, among many other factors (see Section 3.5.2.3.1.2 above for discussion of vessel variables). Manatee vocalizations, including chirps and squeaks, range between 0.6 and 16 kHz, although most vocalizations occur between 2.5 and 5 kHz. Sounds may attenuate more quickly in seabed habitat, particularly for sounds at frequencies less than 2 kHz such as the dominant sounds from vessels. Manatees, particularly mothers with calves, may select quieter habitats that attenuate sound, such as seagrass beds that facilitate their ability to tolerate high sound levels while also providing for nutritional needs. The potential for masking by vessel sound is reduced in seagrass foraging habitats. Thus, the potential for masking of manatee sounds is considered minimal, especially when combined with the intermittent nature and short duration of vessel sound. If manatees react briefly to vessels or underwater sounds by minimally changing their behavior or moving a short distance, the impacts of the change are unlikely to be substantial. However, if a sound displaces manatees from an important breeding or feeding area for a prolonged period, impacts on the animals could be more significant.

Impacts from low-frequency underwater sound generated by remotely operated or autonomous vehicles would be similar to those of surface vessels but at a much reduced magnitude due to the far fewer nautical miles of proposed travel (i.e., approximately 518,000 nm [959,000 km] for surface vessels vs. 28,600 nm [53,000 km] for remotely operated and autonomous vehicles over the five-year period across all geographic regions).

Considering that the proposed volume of vessels associated with project activities within the Southeast Region is very small as compared with all other shipping and vessel traffic, and the assumption that individuals or groups of manatees may be familiar with various and common vessel-related sounds, particularly within frequented shipping lanes, the effects of vessel sound on sirenians under Alternative A would continue to be **adverse** and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups would continue to be temporary or short-term with no life-threatening injury to individual sirenians. Displacement of manatees from preferred breeding, feeding, or nursery grounds, or designated critical habitat would continue to be limited to the project area or its immediate surroundings. Multiple activities in one area could lead to larger magnitudes and more widespread impacts, but they would still continue to be considered **insignificant**. It is also not expected that vessel sound would have any impacts on designated critical habitat.

3.5.2.3.3.3 Vessel Presence and Movement of Equipment in the Water

As with vessel sound, behavioral responses of manatees to vessel presence and movement are also expected to be variable. Manatees have been found to reduce their use of important habitats when continually disturbed by boats in some areas. In other locations, manatee density is higher where there is the greatest boat traffic. They may even adapt to boat disturbance by concentrating their feeding between dusk and dawn when boat traffic and/or fishing activities are low. The presence of vessels used by NOS would not be at levels expected to cause anything more than possible localized and temporary or short-term behavioral changes.

Water disturbance by remotely operated and autonomous vehicles can temporarily disturb and displace nearby manatees. The impact should be minimal, and exposure of individual manatees is likely brief in duration as the ROVs or equipment would quickly pass by; however, impacts could increase if the frequency of disturbance becomes greater. In either case, if displaced, manatees are expected to return to the area and resume normal activities once the water disturbance is no longer present. Equipment such as echo sounders is typically attached to a crewed vessel or a remotely operated or autonomous vehicle, thus effects on manatees due to equipment in the water would occur from the presence and operation of the carriers, rather than from the presence of the equipment itself. ADCPs and acoustic communication systems are often operated from tethered systems, buoys, fixed moorings, or are hull mounted or on remotely operated or autonomous underwater vehicles. As with echo sounders, any effects on manatees would occur from the presence and operation of the vessel, rather than from presence of the equipment itself. Deployment of all autonomous systems, as well as other equipment and divers, would be suspended if any protected species is sighted within 91 m (100 yds) of the vessel. Work already in progress may continue if the activity is not expected to adversely affect the animal.

Sound speed data collection equipment, grab samplers, and drop/towed cameras are lowered and raised through the water column. This movement through the water could temporarily disturb and displace nearby manatees. These impacts would be temporary as manatees are expected to return once water column turbulence ceases. The ropes and wires used to lower a sound speed profiler or to connect a probe to the equipment on a ship can cause entanglements with manatees. However, this is not expected to interfere with manatee movements as, prior to using equipment, NOS would ensure there is at least one PSO observing the area for protected species at all times.

Water disturbance by anchors and chains moving through the water can temporarily disturb and displace nearby manatees. The impact on manatees should be minimal and cease when the anchoring system comes to rest or is taken out of the water. Manatees are expected to return to the area and resume normal activities once water column turbulence ceases. Additionally, anchoring is a relatively infrequent activity, thus any potential impacts are expected to be minimal as they would rarely occur.

An important consideration for all crewed marine vessel operation is the possibility of marine mammal vessel strikes, and the relatively slow-moving manatee, which is often found at or just beneath the water surface, is known to be at great risk of mortality or injury from boat strikes. For example, in Florida the largest known cause of manatee deaths is collisions with the hulls and/or propellers of boats and ships. Ship strikes can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds. Massive propeller wounds can be fatal. However, NOS would ensure visual observation during all vessel operations (regardless of size) so as to avoid manatees. Marine mammal strikes by ROVs and autonomous vehicles are of low concern because of their slow speeds, small size, and built-in proximity avoidance systems.

Mitigation measures (see Appendix D) that would avoid or reduce impacts from vessels on manatees include:

- Instructing personnel about the presence of manatees, manatee speed zones, and the need to avoid collisions with and injury to manatees;
- All vessels associated with NOS projects shall operate at "Idle Speed/No Wake" at all times while in the immediate area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom;
- All vessels will follow routes of deep water whenever possible;
- All in-water operations, including vessels, must be shut down if a manatee(s) comes within 15 m (50 ft) of the operation. Activities will not resume until the manatee(s) has moved beyond the 15-m (50-ft) radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 15 m (50 ft) of the operation. Animals must not be herded away or harassed into leaving; and
- Any collision with or injury to a manatee shall be reported immediately.

Since the likelihood of a vessel strike would continue to be very low, the overall effects on manatees from vessel presence and movement of equipment in the water under Alternative A would continue to be **adverse** and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups would continue to be temporary or short-term with no life-threatening injury to individual manatees. Displacement of manatees from preferred breeding, feeding, or nursery grounds, or designated critical habitat would continue to be limited to the project area or its immediate surroundings. Vessel presence in designated critical habitat could affect the protection capability of the habitat if animals are disturbed, displaced, or injured. Multiple activities in one area could lead to larger magnitudes and more widespread impacts due to vessel operations; however, impacts on manatees and critical habitat would still continue to be considered **insignificant**. In the unlikely event that a vessel strike occurs, its impact would depend on the status of the local manatee population and severity of injury. Although very unlikely, debilitating injury or mortality of one or a few individuals could occur; if population-level impacts are not expected, then impacts would be **moderate**, although it is possible that the magnitude of impacts could be greater since manatees are an ESA-listed species.

3.5.2.3.3.4 Human Activity

Human activity on vessels above the surface of the water would continue to not be expected to have any effects on manatees which live underwater. During SCUBA operations, divers would move through the water column, possibly temporarily disturbing manatees that may be in the area. When using a boat or platform to conduct SCUBA operations, at least one PSO would maintain visual watch for protected species to ensure none are sighted within the working area. If a listed species moves into the work area, cessation of operation of any moving equipment within 15 m (50 ft) of the animal would occur and only resume when the species has left the project area. SCUBA divers involved in in-water activities would have proper training and be capable of responsible dive practices such that they minimize injury to organisms and avoid unnecessary habitat impacts. During all buoy deployment and retrieval operations, buoys would be lowered and raised slowly to minimize risk to listed species. In addition, observers would monitor for listed species in the area prior to and during deployment and retrieval. Work would be stopped if listed species are observed in the area to minimize entanglement risk. Manatees would continue with the activities they were engaged in once divers depart and water column turbulence ceases. Many manatees thrive in areas with heavy human presence and seem relatively undisturbed by human activity around them. The impacts of human activity on manatees under Alternative A would continue to be **adverse** and **negligible** as there would continue to only be minimal disruptions of behavioral patterns and no displacement from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat. Impacts would therefore be **insignificant**. It is not expected that human activity would have any impacts on designated critical habitat.

3.5.2.3.3.5 Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

Severity of oil, fuel, and chemical spills on manatees depends on the type of contaminant, exposure pathway, and degree of weathering of the substance. Oil and fuel harms manatees via acute toxicity, sublethal health effects that reduce fitness, and disruption of marine communities. In the highly unlikely event of an accidental oil or fuel spill into the marine environment from a vessel used by NOS, manatees may be affected through various pathways: direct contact, inhalation of volatile components, and ingestion (directly or indirectly through the consumption of fouled vegetation). Manatees are expected to be less vulnerable to oil and fuel spills than some other marine mammals due to their lack of insulating fur, and thus their inability to ingest oil by intense fur grooming. A small spill would not be likely to result in the death or life-threatening injury of individual manatees or the long-term displacement of these animals from preferred feeding or breeding habitats. It is expected that spilled oil or fuel would rapidly disperse on the sea surface to a very light sheen and would weather rapidly.

Manatees can be affected indirectly by oil, fuel, and chemical spills through changes in the ecosystem that adversely affect food (vegetation) and habitats, including degradation of water quality. Spills could also affect critical habitat in coastal areas, inland waterways, headwaters, bays, estuaries, and rivers in Florida. Small spills could also make localized areas of critical habitat temporarily unavailable because of disturbance while clean up occurs, or temporarily decrease the value of critical habitat through contamination. However, since it would be highly unlikely that an accidental spill would occur, adverse impacts on critical habitat would be very low.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. For example, on NOAA fleet vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the Commanding Officer takes appropriate action to minimize the effects of the spill. OMAO Procedure 0701-06 VRP/SOPEP provides policy and guidance to all NOAA vessels regarding oil pollution emergency planning and response, in accordance with MARPOL 73/78, Annex I. The plan contains all the information and instruction required for responding to shipboard oil spills, such as general spill mitigation and response, shipboard spill mitigation and response, reporting requirements, completing Corrective Action Assessments, trainings, drills, and exercises. This plan has been approved by the USCG, and complies with the Oil Pollution Act of 1990 and Federal Water Pollution Act of 1973.

Since the likelihood of occurrence of an accidental spill from a vessel used by NOS would continue to be very low, impacts on sirenians under Alternative A are expected to be **adverse** and **negligible**. In the event that an accidental spill does occur, the volume of oil, fuel, and/or chemicals would continue to be fairly small given the size of vessels used by NOS and the amounts of fuel and other chemicals they typically carry. Additionally, all hazardous or regulated materials would continue to be handled in accordance with applicable laws, and crew members would continue to be appropriately trained in materials storage and usage. Thus, the impact on sirenians would continue to be **adverse** and **minor** as impacts would continue to be temporary or short-term without any impacts on population levels. Displacement of sirenians that move away to avoid spilled substances would continue to be short-term and limited to the project area or its immediate surroundings. Impacts on sirenians, which are ESA-listed species, including designated critical habitat, would continue to be **insignificant**.

3.5.2.3.3.6 Trash and Debris

Marine debris poses two types of negative impacts on marine mammals: entanglement and ingestion. Entanglement is a far more likely cause of mortality to marine mammals than ingestion. Entanglements occur when cables, lines, nets, or other objects suspended in the water column become wrapped around marine mammals, potentially causing injury, interference with essential behaviors and functions, and possibly mortality. Manatees are known to become entangled in various types of fishing gear and other marine debris. Entanglement was documented as the leading anthropogenic reason for rescue of manatees in Florida between 1993-2012 (Reinert et al., 2017). During proposed activities, numerous cables, lines, and other objects could be towed behind the vessel near the water surface. Although it is possible that such lines and cables could detach from a vessel and become debris in which manatees could get entangled, it is not very likely.

Impacts from discarded trash and debris are expected to be avoided through vessel operators' required compliance with USCG and EPA regulations. In addition, no intentional vessel discharges would occur if a protected species is sighted within 91 m (100 yds) of the vessel used by NOS, and all MARPOL discharge protocols would be followed. Thus, impacts of trash and debris on manatees under Alternative A would continue to be **adverse** and **negligible** as any disturbance of animals would continue to be temporary, no mortality or debilitating injury would be expected, and there would continue to be no displacement from preferred or designated critical habitat. For these reasons, impacts would continue to be **insignificant**. It is also not expected that trash and debris from NOS projects would have any impacts on designated critical habitat.

3.5.2.3.4 Fissipeds

The analysis of impacts on fissipeds considers all of the impact causing factors introduced above. Potential impacts could occur in two of the geographic regions: the West Coast and Alaska regions, as two to three fissiped species, subspecies, or DPS, including ESA-listed species, occur in each region (see Section 3.5.1.4 above). The Alaska Region also includes designated critical habitat for two of the listed species.

3.5.2.3.4.1 Active Underwater Acoustic Sources

Active underwater acoustic sources included in the Proposed Action comprise echo sounders, ADCPs, and acoustic communication systems as discussed in Section 2.4 and under cetaceans in Section 3.5.2.3.1.1. **Table 3.5-7** lists the representative equipment and frequency ranges used in acoustic modeling.

Sound frequencies produced by the echo sounders overlap the range of fissiped hearing and they can presumably hear these sounds if sufficiently close. Acoustic signals from echo sounders (ranging from 0.5 kHz to 900 kHz) are likely to be detectable by fissipeds if the lower end of the sound frequency spectrum is used. Polar bears generally do not dive much below the water surface and they normally swim with their heads above the surface, where sounds produced underwater are weak. Thus, it is very unlikely that polar bears would be exposed to very loud underwater sounds to the point where they might be injured or even disturbed.

Sea otters may be less responsive to underwater sound than other marine mammals, such as cetaceans, since they spend a great deal of time on the water's surface feeding and grooming. While at the surface, the potential exposure of sea otters to underwater sound would be much reduced. Reactions to echo sounders are expected to be limited to startle or otherwise brief responses. Although there could be no lasting consequence to the animals, a startle response may also lead to an abandoned foraging attempt, and possibly multiple foraging attempts. Sea otters require up to 30 percent of their body weight in food every day, even more for females caring for pups, thus the consequences of missed foraging may have lasting consequences to individuals. Although sea otters use the mid to high frequencies produced by echo sounders, masking effects are expected to be negligible due to their use of in-air calls rather than underwater calls.

Acoustic signals from ADCPs (ranging from 35 kHz to 1200 kHz) are not likely to be detectable by polar bears underwater as they generally hear in the less than 25 kHz range. Sea otters, which hear in the less than 38 kHz range, could overlap with the lower end of ADCP signals, although their best hearing sensitivity underwater is less than 26 kHz. There would not be any impacts on polar bears as ADCPs usually produce high to extremely high-frequency sound. Additionally, polar bears tend to spend more time above the water surface than underwater. Sea otters spend between 40 and 60 percent of a 24-hour period foraging underwater (Esslinger et al., 2014; Laidre et al., 2009; Yeates et al., 2007; Tinker et al., 2008), and thus could be affected if the lowest end of the ADCP frequency range is used.

Acoustic communication systems would emit sound in mid-frequency ranges (10s of kHz), and thus could be detectable by fissipeds underwater. The impacts of underwater sound on fissipeds from acoustic communication systems would be similar to but less than that described above for the use of echo sounders because, although acoustic communication systems are omnidirectional, they have lower power, a lower duty cycle, and would be used less frequently than echo sounders. However, there would potentially be no impacts at all on polar bears as they tend to spend more time above the water's surface than underwater. The hearing range of sea otters (<38 kHz) and polar bears (<25 kHz) is on the low side of the potential frequency range; thus, there may be no impacts because sound from acoustic communications systems is above the hearing frequency range of fissipeds.

Quantitative acoustic exposure to marine mammals, including fissipeds, from operation of sound sources was modeled for nine sources (see Appendix E). Acoustic modeling was conducted by determining the sound field expected from each source and estimating the number of fissipeds that may be exposed above sound thresholds for PTS/injury and behavioral disruption during surveys (see Appendix E). To gauge the potential for impacts, received sound levels that may result in PTS/injury or behavioral disruption to the animal were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR 72308, December 31, 2019) were used (see Appendix E). Methodology for modeling the impacts of active underwater acoustic sources is presented in Appendix E. Additionally, Section 3.5.2.3.1.1 under Cetaceans discusses the assumptions made and the data sources used in the modeling scenarios to predict exposures of marine mammals, including fissipeds.

Based on the modeling and taking into account animal behavior, source characteristics, and animal hearing capability, no PTS/injury exposures of fissipeds are expected to occur; thus, only behavioral disruption exposure is discussed below. Note that the estimated exposures have overall decreased between the Draft PEIS and the Final PEIS for the reasons discussed in Section 3.5.2.3.1.1 under Cetaceans.

3.5.2.3.4.1.1 Behavioral Disruption Exposure Estimates

Behavioral disruption exposure estimates over the five-year period were calculated for sources with operational frequencies within the fissiped hearing frequency range (<200 kHz, see Section 3.5.1.4.1). Behavioral disruption exposure estimates consider that all proposed activities would occur, would expect the highest levels of anticipated animal densities, and do not factor in effects of potential mitigation procedures or animals avoiding the sounds. Summarized total potential behavioral disruption exposure of fissipeds over five years for all sources in the two regions where they could occur are shown in **Table 3.5-13**. For annual numbers, see Appendix E.

Table 3.5-13. Total Predicted Exposures for Fissiped Species and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative A

Species	Total Exposures*	Average time above 160 dB (s)**
Alaska Region		
Sea otter, SE	432.74	124
Sea otter, SC	317.41	124
Polar Bear	54.17	177
West Coast Region		
Sea otter, CA	595.70	124
Sea otter, SE	432.74	124
Sea otters, WA	192.18	124

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure above threshold over 24 hours.

Under Alternative A, behavioral disruption exposures to fissipeds could occur in two regions. Depending on the species, behavioral disruption exposure of fissipeds could affect up to 55 polar bears and a few hundred sea otters in each region over the five-year timeframe. However, for the simulated animals exposed above the 160 dB threshold, the average time above threshold is under three minutes (**Table 3.5-13**). The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual's behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals, as in the case of seismic surveys that have months' worth of activity (Southall et al., 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals of some species could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals could be exposed above threshold over five years and over the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures (see Appendix D) to reduce potential impacts of active acoustic sources on marine mammals. NOS would continue to use the lowest power appropriate to perform surveys. NOS would also continue to use PSOs and would employ a robust suite of animal approach restrictions and reduced vessel speeds, described in more detail in Sections 3.5.2.3.4.2 and 3.5.2.3.4.3, as well as the polar bear- and sea otter-specific measures to prevent adverse effects on fissipeds.

3.5.2.3.4.1.2 Conclusion

The effects of underwater sound from active acoustic sources on fissipeds under Alternative A would continue to be **adverse** and **minor**. No PTS/injury exposure is expected to occur. While individual animals are expected to experience behavioral disruptions (<55 polar bears and a few hundred sea otters across the two regions over the five-year timeframe), the amount of time they are exposed to sound that exceeds the behavioral exposure threshold would be on average less than three minutes (**Table 3.5-13**). Similarly, the potential for masking would continue to be minimal during surveys because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Overall, the potential impacts would likely be limited to short-term disruption of acoustic habitat and behavioral patterns. Impacts would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication, disturbance of individuals or groups of fissipeds, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of fissipeds from preferred breeding, feeding, or nursery grounds or designated critical habitat would be limited to the project area or its immediate surroundings. Impacts of Alternative A on fissipeds, including ESA-listed species, would continue to be **insignificant**.

3.5.2.3.4.2 Vessel and Equipment Sound

Vessels and equipment used by NOS would generate transitory sound (10 to 10,000 Hz) into the air and water while in a project area that would allow them to be heard by sea otters, which can hear in the 125 Hz–38 kHz range, with best hearing sensitivity less than 27 kHz in the air and less than 26 kHz underwater. Polar bears generally hear in the less than 25 kHz range underwater and in the range of 14 Hz up to 25 kHz in the air; thus, vessel sound could be heard by polar bears.

Vessel sound in the air and underwater can cause behavioral disturbance in fissipeds. However, the occurrence and nature of fissiped responses are variable depending on location, novelty of the sound, vessel behavior, and habitat, among many other factors (see Section 3.5.2.3.1.2 above for discussion of vessel variables). Short-term behavioral effects are possible during vessel operations, although effects may be reduced for sea otters as they do not appear to rely heavily on underwater communication and spend considerable time out of water. Additionally, masking effects are expected to be negligible in the case of sea otters due to their use of in-air calls rather than underwater calls. Polar bears normally keep their heads above or at the water's surface when swimming, where underwater sound is weak or undetectable, and they generally do not dive much below the water surface (Richardson et al., 1995). Underwater sound would minimally affect polar bears because they are unlikely to hear underwater sound when above the water on ice or on land. Vessel sounds would be at levels not expected to cause anything more than possible localized and temporary behavioral changes in fissipeds.

Impacts from low-frequency underwater sound generated by remotely operated or autonomous vehicles would be similar to those of surface vessels but at a much reduced magnitude due to the far fewer nautical miles of proposed travel for remotely operated and autonomous vehicles as compared to surface vessels (i.e., approximately 518,000 nm [959,000 km] for surface vessels vs. 28,600 nm [53,000 km] for remotely operated and autonomous vehicles over the five-year period across all geographic regions). Reactions to remotely operated and autonomous vehicles are expected to be limited to startle or otherwise brief responses. Although there could be no lasting consequence to the animals, a startle response may also lead to an abandoned foraging attempt, and possibly multiple foraging attempts. Sea otters require up to 30 percent of their body weight in food every day, and even more for females caring for pups, thus the consequences of missed foraging may have lasting consequences to individuals.

Low-flying aircraft used to reach remote areas, especially in Alaska during such projects as tide gauge installation, can disturb fissipeds because of both airborne and underwater sound and visual disturbance. Low altitude flights could disturb polar bears or sea otters resting on ice, on barrier islands, or at coastal haul outs. Denning bears have been known to abandon or depart their dens early in response to repeated sound produced by extensive aircraft overflights (NMFS, 2016a; BOEM, 2015a), although that would not be expected to occur from NOS projects as aircraft use would be infrequent. In response to aircraft overflights, polar bears may initially run away from the area, or dive into the water if on land or ice, but then resume their normal activities within minutes. The effects of fleeing are likely to be minimal if the event is temporary, the animal is otherwise unstressed, and it is a cool day. However, on a warm spring or summer day, a short run may be enough to overheat a polar bear; and a bear already experiencing stress that swims a long distance could require rest for a long period prior to reinitiating essential life functions such as feeding. Additionally, small cubs could become separated from their mothers (USFWS, 2016a).

The visual presence of aircraft alone is unlikely to cause disturbance of sea otters. If sea otters are disturbed, it would more likely be due to the airborne sound. Some otters would likely show startle responses, change direction of travel, or dive. Sea otters reacting to overflights may divert time and attention from biologically important behaviors, such as feeding. In a recent questionnaire study conducted by the USFWS (83 FR 18330, April 26, 2018), respondent sea otter survey biologists indicated that only 26 percent of sea otters located directly below aircraft (flight heights unspecified) reacted to the presence of the aircraft, and only about 10 percent reacted at a distance of 250 m (820 ft) perpendicular to the flight line. Therefore, aircraft overflights are expected to disturb only a fraction of the otters overflown, especially considering their infrequent use by NOS.

Appendix D details the fissiped-specific mitigation measures that have been suggested by USFWS and adopted by NOS to prevent disturbance and harassment of polar bears and sea otters by vessels and aircraft. These measures include:

- Do not operate vessels in such a way as to separate northern sea otters from other members of their group;
- If northern sea otters are observed in groups of fewer than 10 animals, do not approach within 100 m (109 yds). If the group size is greater than 10, do not approach within 500 m (547 yds);
- Ensure that vessels maintain a 1.6 km (1 mi) separation distance from polar bears observed on ice, land, or water;
- If a swimming bear(s) is encountered, allow it to continue unhindered. Never approach, herd, chase, or attempt to lure swimming bear(s). Reduce speed when visibility is low and avoid sudden changes in travel direction;
- Navigate slowly, steer around polar bears, and do not approach, circle, pursue or otherwise force bears to change direction when observed in the water;
- Avoid multiple changes in direction and speed and do not restrict bears' movements on land or sea;
- Do not conduct activities within 1.6 km (1 mi) of known or suspected polar bear dens;
- Maintain an altitude of at least 457 m (1500 ft) when flying within 85 m (0.5 mi) of polar bears;
- Unless taking off from or landing at an airport/airstrip, pilots should maintain a minimum of 457 m (1,500 ft) flight altitude and 0.8-km (0.5-mi) horizontal distance from polar bears in the water, and on ice or land. Avoid circling or turning aircraft near polar bears;
- Maintain an altitude of at least 205 m (1000 ft) when flying over northern sea otters; and

- Avoid disturbing denning bears. Between November and April, special care is needed to avoid disturbance of denning bears. If activities are to take place during that time period, USFWS should be contacted to determine if any additional mitigation is required. In general, activities are not permitted within one mile of known den sites.

Vessel sound would not have any effects on the critical habitat of sea otters. Polar bear critical habitat has characteristics based on feeding and finding prey such as seals. Vessel sound could displace seals from pupping lairs or haul outs, seals could abandon breathing holes, and polar bears could be scared away from seal kills. (Additional discussion of impacts on prey species such as seals can be found in Section 3.5.2.3.3 Pinnipeds). Thus, the ability of critical habitat to provide foraging opportunities to polar bears may be adversely affected. However, it is not expected that impacts on prey species would be substantial, and impacts on critical habitat from vessel sound are likely to be temporary and localized.

Considering that the proposed volume of vessels associated with NOS project activities within the West Coast and Alaska Regions would be very small as compared with all other shipping and vessel traffic, and the assumption that individuals or groups of fissipeds may be familiar with various and common vessel-related sounds, particularly within frequented shipping lanes, the effects of vessel sound on fissipeds under Alternative A would continue to be **adverse** and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups would continue to be temporary or short-term with no life-threatening injury to individual fissipeds. Displacement of fissipeds from preferred breeding, feeding, or nursery grounds, or designated critical habitat would continue to be limited to the project area or its immediate surroundings. Multiple activities in one area could lead to larger magnitudes and more widespread impacts. However, vessel sound is expected to result in **insignificant adverse** effects on individuals or populations of pinnipeds, including ESA-listed species and designated critical habitat.

3.5.2.3.4.3 Vessel Presence and Movement of Equipment in the Water

The presence of vessels used by NOS and associated project equipment have the potential to disturb polar bears. Reactions and responses of polar bears to vessel presence could range from walking, running, or swimming away, to no response at all. Polar bear encounters could occur anywhere but are most likely to occur near coastal areas. Vessel operations which occur in open water are unlikely to greatly affect polar bears because few polar bears are likely to be present in the water far from shore. However, some vessels have occasionally reported seeing a swimming polar bear in open water (NMFS, 2016a). Swimming can be energetically expensive for polar bears, particularly for bears that engage in long-distance travel between the leading ice edge and land. However, if an encounter between a vessel and a swimming bear occurs, it would most likely result in only a small disturbance (e.g., the bear may change its direction or temporarily swim faster) as the vessel passes the swimming bear. Most disturbance by vessels would likely occur while polar bears are on ice or land. Vessel presence may temporarily disturb small numbers of polar bears resting or foraging on marine mammal carcasses along the coast or on barrier islands. Since vessels used by NOS would not typically be concentrated in any one area for extended periods, any impacts to polar bears would be limited to temporary or short-term disturbances. Polar bears could also be affected indirectly if operation of vessels used by NOS disturbs or scatters their fish or seal prey species.

Sea otters are easily disturbed by human presence and typically respond to an approaching vessel by swimming away from the area (AKDOT, 2006). Such disturbance would be temporary and would only last during a project. Also, the presence of vessels used by NOS would not be at numbers or frequencies expected to cause anything more than possible localized and temporary behavioral changes in sea otters.

Water disturbance by remotely operated and autonomous vehicles can temporarily disturb and displace nearby fissipeds both in the water and on land or ice. The impact should be minimal and likely brief in duration as the ROV or equipment would quickly pass by; however, impacts could increase if the frequency of disturbance becomes greater or if the equipment gets too close to land or ice in locations where fissipeds occur. In either case, if displaced, fissipeds are expected to return to the area and resume normal activities once the disturbance is no longer present. Equipment such as echo sounders is typically attached to a crewed vessel or remotely operated or autonomous vehicle, thus effects on fissipeds would occur from the presence and operation of the carrier rather than from the presence of the equipment itself. ADCPs and acoustic communication systems are often operated from tethered systems, buoys, fixed moorings, or are hull mounted or on remotely operated or autonomous underwater vehicles. As with echo sounders, any effects on fissipeds would occur from the presence and operation of the vessel, rather than from presence of the equipment itself. Deployment of all autonomous systems, as well as other equipment and divers, would be suspended if any protected species is sighted within 91 m (100 yds) of the vessel. Work already in progress may continue if the activity is not expected to adversely affect the animal.

Sound speed data collection equipment, grab samplers, and drop/towed cameras are lowered and raised through the water column. This movement through the water could temporarily disturb and displace nearby fissipeds. These impacts would be temporary as fissipeds are expected to return once water column turbulence ceases or the equipment has departed from the area. The ropes and wires used to lower a sound speed profiler or to connect a probe to the equipment on a ship can cause entanglements with sea otters, but this would be unlikely to occur with polar bears as they spend most of their time on land or ice and generally keep clear of vessels. Sea otters are known to be vulnerable to entanglements with fishing gear, but the tendency of many marine mammals, including sea otters, to avoid approaching vessels (in contrast with their tendency to congregate around fishing vessels) presumably reduces the risk of entanglement. Additionally, prior to using the equipment, NOS would ensure there is at least one PSO observing the area for protected species at all times.

An important consideration for all crewed vessel operation is the possibility of marine mammal vessel strikes. Ship strikes can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds. Ship strikes are not known to be a significant cause of sea otter mortality. There is also very little risk of polar bears being injured or killed as a result of ship strikes because of the infrequency of polar bears in open-water areas and their ability to detect and avoid vessels as they approach in the water. Additionally, NOS would ensure visual observation during all vessel operations (regardless of size) so as to avoid polar bears and sea otters. Marine mammal strikes by ROVs and autonomous vehicles are of low concern because of their slow speeds, small size, and built-in proximity avoidance systems.

Polar bears can den on land and on sea ice. The presence of vessels, as well as vessel sound, could disturb bears at den sites, and depending on the timing in the denning cycle, could have varying effects on the female bear and family group. During the early stages of denning, when the pregnant female has limited investment at the site, disturbance could cause her to abandon the site in search of another one. At emergence, cubs are acclimating to their new environment, and the female bear is vigilant to protect her offspring (BOEM, 2015a). Visual and acoustic stimuli may disturb the female to the point of abandoning the den site before the cubs are physiologically ready to move. Also, it is possible that vessels anchoring near ice floes or denning locations could disturb or displace polar bears.

The mitigation measures discussed in Section 3.5.2.3.4.2 for reducing the impacts of vessel and equipment sound on fissipeds also apply for reducing impacts from vessel presence and movement of equipment in the water.

Vessel presence and movement of equipment in the water may affect the critical habitat of both sea otters and polar bears. Prey species of polar bears, such as fish and seals, may be disturbed by vessels and equipment (see discussion in Section 3.7.2 Fish and 3.5.2.3.3 Pinnipeds). This could affect the polar bear, which has critical habitat characteristics based on feeding and finding prey. However, it is not expected that impacts on prey species would be substantial, and thus impacts on critical habitat from vessel presence and movement of equipment are likely to be temporary and localized. Vessel presence is not likely to substantially affect aquatic macroinvertebrates, the main prey species of sea otters (see Section 3.8 Aquatic Macroinvertebrates). However, vessel operations have the potential to disrupt kelp beds, which are a PCE of sea otter critical habitat used for resting and for protection from marine predators.

Since the likelihood of a vessel strike would continue to be very low, the overall effects on fissipeds, including ESA-listed species and designated critical habitat, from vessel presence and movement of equipment in the water under Alternative A would continue to be **adverse** and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups of fissipeds would continue to be temporary or short-term with no life-threatening injury to individual pinnipeds. Displacement of fissipeds from preferred breeding, feeding, or nursery grounds, or designated critical habitat would continue to be limited to the project area or its immediate surroundings. Multiple activities in one area could lead to larger magnitudes and more widespread impacts due to vessel operations; however, impacts would still continue to be considered **insignificant**. In the unlikely event that a vessel strike occurs, its impact would depend on the population status of the species affected. Although very unlikely, debilitating injury or mortality of one or a few individuals could occur; if population-level impacts are not expected, then impacts would be **moderate**, although the magnitude of impact could be greater if an ESA-listed species is affected. Additionally, if polar bears are disturbed at denning sites, impacts on both animals and critical habitat designated to protect denning areas could be **moderate** as there could be extended displacement of individuals from preferred breeding habitat and/or designated critical habitat, but the continued viability of the population would not be threatened.

3.5.2.3.4.4 Human Activity

Human activity could affect fissipeds primarily during activities on land, such as tide gauge and shore-based reference station installation maintenance, and removal. Sound and movement from human activity onboard vessels could also affect fissipeds that are on land or ice; however, the sound and presence from the vessels themselves would likely be the greater cause of impacts, as discussed above.

Onshore human activity during tide gauge installation and shore-based GPS reference station installation could temporarily disturb and displace any polar bears in the area; it is not expected that sea otters would be affected by onshore activities. Female polar bears denning within approximately 1.6 km (1 mile) of an onshore activity could be disturbed by sound. Disturbance of females in maternity dens could result in either abandonment of the cubs or premature exposure of cubs to the elements, resulting in mortality (see discussion above in Section 3.5.2.3.4.3 on disturbance of polar bears at denning sites).

Since polar bears are curious, there is the potential for human-bear interactions during tide gauge and GPS reference station installation, potentially resulting in injury or mortality of both bears and humans. NOS would follow human/bear interaction guidelines as issued by USFWS.

Occasionally, there could be some disturbance or displacement of nearby polar bears due to sound and activity if field personnel need to conduct maintenance in such situations as when a buoy breaks its mooring, a tide gauge stops sending messages, or batteries need to be recharged. Additionally, in remote areas reached by boat or aircraft, impacts on polar bears could occur and would be similar to those for tide gauge installation and described above in Sections 3.5.2.3.4.2 and3.5.2.3.4.3 for vessel sound and vessel presence. Sound and activity from tide gauge and shore-based GPS reference station removal could cause temporary or short-term localized disturbance and changes in behavior of nearby polar bears, similar to tide gauge installation. In addition, shore/coastal habitat could be disturbed or altered as a small area of ground would be covered by a GPS reference station. Although this could affect polar bear habitat, it is not likely that the disturbance would be large enough to alter the habitat to the point where polar bears would no longer use the site. Mitigation measures that would minimize adverse impacts on polar bears from the use of aircraft are discussed in Section 3.5.2.3.4.2.

During SCUBA operations, divers would move through the water column, possibly temporarily disturbing sea otters that may be in the area; it is very unlikely that SCUBA would occur near a polar bear. Sea otters would continue with the activities they were engaged in once divers depart and water column turbulence ceases. When using a boat or platform to conduct SCUBA operations, at least one PSO would maintain visual watch for protected species to ensure none are sighted within the working area. If a listed species moves into the work area, cessation of operation of any moving equipment within 15 m (50 ft) of the animal would occur and only resume when the species has left the project area. SCUBA divers involved in in-water activities would have proper training and be capable of responsible dive practices such that they minimize injury to organisms and avoid unnecessary habitat impacts. During all buoy deployment and retrieval operations, buoys would be lowered and raised slowly to minimize risk to listed species. In addition, observers would monitor for listed species in the area prior to and during deployment and retrieval. Work would be stopped if listed species are observed in the area to minimize entanglement risk.

Overall, the impacts of human activity on fissipeds, including ESA-listed species, under Alternative A would continue to be **adverse** and **minor** as there would continue to be only small disruptions of behavioral patterns and any displacement would continue to be limited to the project area or immediate surroundings. Impacts would thus be **insignificant**. It is not expected that human activity would impact designated critical habitat where the locations for tide gauges and GPS reference stations would continue to be located away from critical habitat areas. However, if polar bears are disturbed at denning sites, impacts on both animals and critical habitat designated to protect denning areas could be **moderate** as there could be extended displacement of individuals from preferred breeding habitat and/or designated critical habitat, but the continued viability of the population would not be threatened. Additionally, if polar bear-human interactions occur, impacts could also be **moderate**, although population-level impacts would not be expected.

3.5.2.3.4.5 Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

Severity of oil, fuel, and chemical spills on fissipeds depends on the type of contaminant, exposure pathway, and degree of weathering of the substance. Oil and fuel harm fissipeds via acute toxicity, sublethal health effects that reduce fitness, and disruption of marine communities. In the highly unlikely event of an accidental oil or fuel spill into the marine environment from a vessel used by NOS, sea otters and polar bears would be particularly vulnerable due to their reliance on fur to maintain body heat. Polar bears could be exposed to oil while swimming or coming ashore onto impacted beaches. Sea otters are susceptible to oiling because they depend on the insulation of dense fur to keep warm and may ingest oil during grooming and feeding (AKDOT, 2006). Once oiled, sea otters quickly become hypothermic as oil compromises the insulative property of their fur. Oiling of polar bear fur reduces its insulation value, causes irritation or damage to the skin, and may further contribute to impaired thermoregulation (USFWS, 2016a). Both species can be adversely impacted by inhaling volatile oil and fuel components and through ingestion while grooming, resulting in gastrointestinal disorders. Polar bears could also ingest oil while grooming and feeding on oiled seals (ringed and bearded seals are the primary prey of polar bears) or scavenging oiled carcasses. However, a small spill would not be likely to result in death or life-threatening injuries, and the risk of fissipeds being exposed to oil and fuel spills would be very low.

Fissipeds can also be affected indirectly by oil, fuel, and chemical spills through changes in the ecosystem that adversely affect prey species and habitats, including degradation of water quality. This could also affect critical habitat areas designated for feeding and foraging characteristics for sea otters and polar bears as both of them prey on species that could be impacted by accidental spills. Small spills could also make localized areas of critical habitat temporarily unavailable because of disturbance while cleanup occurs, or temporarily decrease the value of critical habitat through contamination. However, since it would be highly unlikely that an accidental spill would occur, adverse impacts on prey and habitat, including critical habitat, would be very low.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. For example, on NOAA fleet vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the Commanding Officer takes appropriate action to minimize the effects of the spill. OMAO Procedure 0701-06 VRP/SOPEP provides policy and guidance to all NOAA vessels regarding oil pollution emergency planning and response, in accordance with MARPOL 73/78, Annex I. The plan contains all the information and instruction required for responding to shipboard oil spills, such as general spill mitigation and response, shipboard spill mitigation and response, reporting requirements, completing Corrective Action Assessments, trainings, drills, and exercises. This plan has been approved by the USCG, and complies with the Oil Pollution Act of 1990 and Federal Water Pollution Act of 1973.

Since the likelihood of occurrence of an accidental spill from a vessel used by NOS would continue to be very low, impacts on fissipeds under Alternative A are expected to be **adverse** and **negligible**. In the event that an accidental spill does occur, the volume of oil, fuel, and/or chemicals would continue to be fairly small given the size of vessels used by NOS and the amounts of fuel and other chemicals they typically carry. Additionally, all hazardous or regulated materials would continue to be handled in accordance with applicable laws, and crew members would continue to be appropriately trained in materials storage and usage. Thus, the impact on fissipeds would continue to be **adverse** and **minor** as impacts would continue to be temporary or short-term without any impacts on population levels. Displacement of fissipeds that move away to avoid spilled substances would continue to be short-term and limited to the project area or its immediate surroundings. Impacts on fissipeds, including ESA-listed species and designated critical habitat, would continue to be **insignificant**.

3.5.2.3.4.6 Trash and Debris

Marine debris poses two types of negative impacts on marine mammals: entanglement and ingestion. Entanglement is a far more likely cause of mortality to marine mammals than ingestion. Entanglements occur when cables, lines, nets, or other objects suspended in the water column become wrapped around marine mammals, potentially causing injury, interference with essential behaviors and functions, and possibly mortality. During proposed activities, numerous cables, lines, and other objects could be towed behind the vessel near the water surface. Although it is possible that such lines and cables could detach from a vessel and become debris in which fissipeds could get entangled, it is not very likely. It is not expected that polar bears would be susceptible to entanglement since they spend most of their time on land or ice. Conversely, sea otters are known to be vulnerable to entanglements, particularly with fishing gear; however, the likelihood of vessels used by NOS producing debris in which they could become entangled is low.

Impacts from discarded trash and debris are expected to be avoided through vessel operators' required compliance with USCG and EPA regulations. In addition, no intentional vessel discharges would occur if a protected species is sighted within 91 m (100 yds) of the vessel used by NOS, and all MARPOL discharge protocols would be followed. Thus, impacts of trash and debris on fissipeds, including ESA-listed species, under Alternative A would continue to be **adverse** and **negligible** as any disturbance of animals would continue to be temporary, no mortality or debilitating injury would be expected, and there would continue to be no displacement from preferred or designated critical habitat; thus, impacts would continue to be **insignificant**. It is also not expected that trash and debris would have any impacts on designated critical habitat.

3.5.2.3.4.7 Air Emissions

Since the pre-industrial era, increased emissions of anthropogenic GHGs (CO_2, CH_4, and N_2O) have resulted in higher atmospheric concentrations of these gases and have influenced atmospheric, terrestrial, and oceanic conditions (Limpinsel et al., 2017). Smokestack and two-stroke outboard motor emissions from vessels would release air pollutants. The type and amount of air emissions from vessels used by NOS would depend on the type of fuel, engine, and engine efficiency. Fissipeds may be exposed to smokestack or outboard motor emissions when breathing the air; however, such emissions would be temporary and ephemeral as they would dissipate rapidly into the air and may not reach animals on land or ice.

Burning fossil fuels pollutes not just the air but also the oceans as the waters absorb carbon dioxide, which lowers the pH of surface waters and leads to acidification. Changes in seawater carbon chemistry, in particular interference with the formation of $CaCO_3$ in marine shells and skeletons, may affect marine biota through a variety of biochemical, physiological, and physical processes. Furthermore, the amount of emissions from vessels used by NOS would continue to be a very small fraction as compared to emissions from all other vessel activity in the oceans. Thus, impacts on fissipeds, including ESA-listed species and designated critical habitat, from air emissions under Alternative A are expected to be **adverse** and **negligible** as there would continue to be no disturbance of communication or behavior, no displacement, and no debilitating injury of individuals; thus, impacts would continue to be **insignificant**.

3.5.2.3.5 Conclusion

Since the effects of impact causing factors on marine mammals range from negligible to minor, the overall impact of Alternative A on marine mammals, including ESA-listed species and designated critical habitat, would continue to be **adverse** and **minor**; thus, impacts of Alternative A would continue to be **insignificant**.

3.5.2.4 Alternative B: Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations

As under Alternative A, impacts of Alternative B are considered for the same impact causing factors for each type of marine mammal (cetaceans, pinnipeds, sirenians, and fissipeds). Under Alternative B, all of the activities and equipment operations proposed in Alternative A would continue but at a higher level of effort, although the percentage of nautical miles covered by project activities in each region would be the same as under Alternative A. Thus, the greatest number of nautical miles surveyed each year would be in the Southeast Region (approximately 47 percent of the survey effort). The level of effort in the other four regions would be at similar levels (approximately 10 percent of the survey effort in each region), although slightly greater in the Alaska Region where the percentage of survey effort would be approximately 18 percent (see **Table 3.5-14**). In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, sound production and hearing frequency of the animals, and population density of marine mammals, that add nuance to this trend. Overall, NOS projects would comprise a very small part of all ocean activities as vessels used by NOS would represent a very small proportion of all vessel traffic in the action area (as discussed in Section 2.4.1). Additionally, whenever possible, the location and timing of a given project would be purposefully coordinated to ensure that areas are not repeatedly surveyed. This ensures that the potential environmental impacts directly resulting from NOS projects would not be exacerbated by repeated projects within a given area.

Projects under Alternative B would take place in the same geographic areas and timeframes as under Alternative A; however, Alternative B would include more projects and activities, and thus more nautical miles traveled, than Alternative A. Under Alternative B, NOS projects would cover a total of 2,896,712 nm (5,364,710 km) across all five regions over the five-year period (note that survey effort in the Great Lakes is not included as no marine mammals occur there). Overall, vessels used by NOS would cover an additional 263,337 nm (487,701 km) under Alternative B (see **Table 3.5-14**) as compared to Alternative A (2,633,374nm [4,877,009 km] total) across all regions over the five-year period.

Table 3.5-14. Survey Effort under Alternative B, by Geographic Region by Year

Region	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Survey Effort (in nautical miles)						
Greater Atlantic Region (without Great Lakes)	66,904	116,333	56,068	51,603	51,603	342,512
Southeast Region	242,369	231,204	288,695	309,906	309,906	1,382,080
West Coast Region	65,514	63,700	61,571	64,024	64,024	318,833
Alaska Region	103,258	131,971	191,890	45,485	45,460	518,064
Pacific Islands Region	77,231	60,390	76,716	60,443	60,443	335,223

The types and mechanisms of impacts would remain the same in Alternative B as discussed for Alternative A. Therefore, in general, the difference between the two alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative B as compared to Alternative A. Section 2.5 discusses the differences between Alternatives A and B, and **Table 2.6-1** provides a comparison of annually planned and performed NOS projects and activities. While the total number of activities increases by approximately 10 percent between Alternatives A and B, the numbers for individual activities do not increase uniformly. For example, the number of nautical miles for crewed vessel operations increases by 11 percent from Alternative A to B; however, the number of nautical miles using ADCPs increases by 90 percent, and ROV use increases by 202 percent.

Under Alternative B there would be projects using crewed vessel operations covering 577,000 nm (1,070,000 km), as compared to 518,000 nm (959,000 km) under Alternative A. Vessel operations could contribute to impacts on marine mammals related to vessel and equipment sound, vessel presence and movement, accidental spills, trash and debris, and air emissions. Although the amount of crewed vessel operations would be greater under Alternative B than under Alternative A, additional projects over 59,000 nm (111,000 km) across five regions would result in greater impacts overall, but not so great that the magnitude of a particular impact causing factor would increase (e.g., from negligible to minor). The increase in use of active underwater acoustic equipment and ROVs would be more pronounced than increases in other activities. Projects involving echo sounders, ADCPs, and acoustic communication systems would increase under Alternative B as compared to Alternative A. This reflects the increased use of technology under Alternative B and is a greater increase than for other activities on a percentage basis, but overall, the increase is still not very high, especially as compared to the extent of the action area.

3.5.2.4.1 Cetaceans

Impacts of Alternative B on cetaceans, including ESA-listed species and designated critical habitat, would be the same or slightly, but not appreciably, larger than those under Alternative A for the following impact causing factors: vessel and equipment sound; vessel presence and movement of equipment in the water; human activity; accidental leakage or spillage of oil, fuel, and chemicals; and trash and debris. Although the impacts of active underwater acoustic sources would also be similar under Alternative B as under Alternative A, they are discussed in detail below because the impacts of underwater sound on marine mammals are of main concern and to show the modeled increase in PTS/injury exposures and behavioral disruption exposures of cetaceans from the projected increase in the use of echo sounders, ADCPs, and acoustic communication systems (see Appendix E).

3.5.2.4.1.1 Active Underwater Acoustic Sources

As with Alternative A, active underwater acoustic sources under Alternative B would include echo sounders, ADCPs, and acoustic communication systems as described in Section 2.4. Descriptions of all active sources considered in this study can be found in Appendix E; the representative sources used in exposure modeling are the same as described in Alternative A and listed in **Table 3.5-7**.

The active underwater acoustic sources were evaluated in the same way under Alternative B as for Alternative A. Quantitative acoustic exposure to marine mammals, including cetaceans, from operation of sound sources was modeled for nine sources (see Appendix E). Acoustic modeling was conducted by determining the sound field expected from each source and estimating the number of marine mammals that may be exposed above sound thresholds for PTS/injury and behavioral disruption during surveys (see Appendix E for more information). To gauge potential for impact, received sound levels that may result in PTS/injury or behavioral disruption to the animal were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR 72308, December 31, 2019) were used (see Appendix E). Additionally, Section 3.5.2.3.1.1 under Alternative A for cetaceans discusses the assumptions made and the data sources used in the modeling scenarios to predict exposures of marine mammals.

Summarized total potential PTS/injury exposures over five years for all sources for cetaceans in each region are shown in **Table 3.5-15** (no PTS/injury exposure was predicted for any species in the Pacific Islands Region). Note that the estimated exposures have overall decreased between the Draft PEIS and the Final PEIS for the reasons discussed in Section 3.5.2.3.1.1 under Alternative A. Summarized total potential behavioral disruption exposures of cetaceans for all sources in each region are shown in **Table 3.5-17**. For annual numbers, see Appendix E. Species that may be in the area but for which no impacts were predicted are not included in the tables. Discussion of how PTS/injury exposures and behavioral disruption exposures were modeled and calculated can be found in Sections 3.5.2.3.1.1.1 and 3.5.2.3.1.1.2 and in Appendix E.

Table 3.5-15. Total Predicted Exposures for Cetacean Species and Range Accounting for 95 Percent of Exposure Above PTS Threshold Under Alternative B

Species	Total Exposures*	Exposure Range (m)
Southeast Region**		
Dwarf sperm whale	3.17	35
Pygmy sperm whale	2.37	35
Greater Atlantic Region		
Harbor porpoise	14.57	34
Dwarf sperm whale	1.18	32
Pygmy sperm whale	0.15	32
West Coast Region		
Dall's porpoise	6.78	24
Harbor porpoise	6.01	28
Alaska Region		
Harbor porpoise	4.96	27
Dall's porpoise	4.33	20

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure modeling for the Southeast Region was conducted for the Gulf of Mexico.

Under Alternative B, PTS/injury exposures to high-frequency cetaceans could occur in four of the five regions with ranges to exposures in the simulations ~30 m (~100 ft). High-frequency cetaceans (Dall's and harbor porpoises, and dwarf and pygmy sperm whales) have been shown to be more sensitive to sounds than other cetacean species, and therefore have comparatively low thresholds for PTS/injury exposures (NMFS, 2018a). Compared to Alternative A, use of underwater acoustic sources under Alternative B would continue at a higher level of effort. Over the five-year timeframe, a total of up to five additional animals would be exposed above the PTS/injury threshold across four regions under Alternative B as compared to Alternative A. Such small increases in animals exposed above threshold over the extensive project area and over five years would not be expected to result in population level adverse impacts, particularly as supported by the comparison to PBR levels (see Section 3.5.2.3.1.1.1 for discussion and **Table 3.5-16**).

Table 3.5-16. Comparison of Exposure Above PTS Threshold for Cetacean Species Under Alternative B with Current Potential Biological Removal (PBR) Levels

Species	Total Exposures	Average Annual Exposures	PBR Levels*
Southeast Region			
Dwarf sperm whale	3.17	0.63	2.5**
Pygmy sperm whale	2.37	0.47	2.5**

Species	Total Exposures	Average Annual Exposures	PBR Levels*
Greater Atlantic Region			
Harbor porpoise	14.57	2.91	851
Dwarf sperm whale	1.18	0.24	46
Pygmy sperm whale	0.15	0.03	46
West Coast Region			
Dall's porpoise	6.78	1.36	99***
Harbor porpoise	6.01	1.20	35 to 349****
Alaska Region			
Harbor porpoise	4.96	0.99	2.2 to 11*****
Dall's porpoise	4.33	0.87	131

*Sources for PBR Levels: Carretta et al., 2022; Hayes et al., 2022; and Muto et al., 2021

**Differs from PBR levels reported in the Draft PEIS due to numbers presented in the Draft PEIS for incorrect stock.

***Differs from PBR levels reported in the Draft PEIS due to changes between the 2019 and the 2021 SARs.

****PBR levels for harbor porpoise in the West Coast Region is shown as the range across six stocks.

**** PBR levels for the Southeast Alaska stock; PBR levels are undetermined for the Gulf of Alaska and Bering Sea stocks.

Table 3.5-17. Total Predicted Exposures for Cetacean Species and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative B

Species	Total Exposures*	Average time above 160 dB (s)**
Alaska Region		
Pacific white-sided dolphin	944.80	63
Beluga whale	281.66	85
Harbor porpoise	94.21	88
Dall's porpoise	89.91	69
Common minke whale	65.30	47
Bowhead whale	64.79	53
Humpback whale, Central North Pacific	48.76	95
Resident killer whale	37.79	58
Fin whale	30.83	50
Transient killer whale	25.06	58
Beluga, Cooke Inlet	14.02	85
Humpback whale, Western North Pacific	5.35	95
Gray whale	1.83	51
Sperm whale	0.15	56
North Pacific right whale	0.03	53

Species	Total Exposures*	Average time above 160 dB (s)**
Southeast Region* **		
Atlantic spotted dolphin	1,068.80	56
Common bottlenose dolphin	652.30	89
Pantropical spotted dolphin	412.28	52
Clymene dolphin	137.02	52
Rough-toothed dolphin	74.56	75
Spinner dolphin	72.21	58
Risso's dolphin	64.43	69
Striped dolphin	39.64	50
False killer whale	39.49	55
Pilot whale, short finned	20.62	60
Pilot whale, long finned	20.28	60
Pygmy sperm whale	19.70	52
Pygmy killer whale	17.68	52
Sperm whale	15.59	64
Melon-headed whale	15.59	50
Dwarf sperm whale	12.35	52
Fraser's dolphin	9.58	50
Blainville beaked whale	8.97	67
Gervais' beaked whale	8.97	67
Mesoplodont beaked whales (all)	8.97	67
Cuvier's beaked whale	2.78	64
Transient killer whale	2.45	58
Rice's whale	0.81	82
Greater Atlantic Region		
Short-beaked common dolphin	2,949.76	102
Atlantic white-sided dolphin	2,189.32	101
Atlantic spotted dolphin	1,219.79	89
Common bottlenose dolphin	1,095.20	184
Harbor porpoise	716.00	55
Risso's dolphin	490.49	112
Pilot whale, long finned	340.51	63
Pilot whale, short finned	217.60	63
Fin whale	189.84	98
Humpback whale	94.53	97
Common minke whale	105.75	101
Cuvier's beaked whale	58.87	55
Dwarf sperm whale	58.12	57
Rough-toothed dolphin	51.96	110
Gervais beaked whale	44.52	55

Species	Total Exposures*	Average time above 160 dB (s)**
Sowerby's beaked whale	44.52	55
Blainville beaked whale	44.52	55
True's beaked whale	44.52	55
Mesoplodont beaked whales (all)	44.52	55
Striped dolphin	22.74	50
Sperm whale	17.21	50
Pantropical spotted dolphin	17.47	62
Sei whale	15.16	98
North Atlantic right whale	14.37	62
Melon-headed whale	9.24	50
Pygmy sperm whale	8.06	57
Clymene dolphin	5.10	100
Fraser's dolphin	3.90	38
False killer whale	3.11	64
White-beaked dolphin	2.75	83
Spinner dolphin	1.66	41
Northern bottlenose whale	0.64	42
Bryde's whale	0.41	112
Blue whale	0.06	43
West Coast Region		
Short-beaked common dolphin	27,131.09	55
Long-beaked common dolphin	18,138.00	82
Pacific white-sided dolphin	7,176.51	67
Striped dolphin	4,412.32	25
Northern right whale dolphin	2,753.60	25
Gray whale	2,591.46	51
Risso's dolphin	304.75	66
Common bottlenose dolphin	278.03	110
Humpback whale, Central America	241.77	128
Common minke whale	206.62	51
Fin whale	151.52	62
Dall's porpoise	141.78	75
Harbor porpoise	122.12	96
Mesoplodont beaked whales (all)	80.60	26
Sperm whale	39.68	29
Blue whale	75.72	27
Humpback whale, Central North Pacific	48.76	95
Cuvier's beaked whale	36.24	33
Baird's beaked whale	36.10	55
Sei whale	28.10	62

Species	Total Exposures*	Average time above 160 dB (s)**
Offshore killer whale	24.26	64
Transient killer whale	23.94	64
Resident killer whale	22.18	64
Pilot whale, short finned	19.00	82
Humpback whale, Western North Pacific	5.35	95
Pacific Islands Region		
Pygmy sperm whale	12,435.84	63
Rough-toothed dolphin	12,412.61	71
Striped dolphin	8,719.21	55
Pantropical spotted dolphin	4,076.24	62
Fraser’s dolphin	3,468.50	50
Pygmy killer whale	1,177.85	64
False killer whale	432.27	56
Risso’s dolphin	111.72	69
Common bottlenose dolphin	71.34	112
Spinner dolphin	51.72	84
Humpback whale, Central North Pacific	48.76	95
Melon-headed whale	37.82	59
Pilot whale, short finned	28.00	62
Humpback whale, Western North Pacific	5.35	95
Bryde’s whale	4.94	70
Sperm whale	4.31	67
Longman’s beaked whale	2.91	54
Cuvier’s beaked whale	2.87	54
Sei whale	2.74	75
Fin whale	1.84	75
Blainville beaked whale	1.46	55
Resident killer whale	0.77	56
Transient killer whale	0.77	56
Blue whale	0.23	54

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure above threshold over 24 hours.

***Exposure modeling for the Southeast Region was conducted for the Gulf of Mexico.

Under Alternative B, behavioral disruption exposures to cetaceans could occur in all five regions. Compared to Alternative A, use of underwater acoustic sources under Alternative B would occur at a higher level of effort. Depending on the species, behavioral disruption exposure of cetaceans under Alternative B could increase from one to a few thousand animals in each region over the five-year timeframe as compared to Alternative A. However, for the simulated animals exposed above the 160 dB threshold, the average amount of time an individual receives sound levels above the behavioral threshold remains less than two minutes, and often less than one minute. The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual's behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals, as in the case of seismic surveys that have months' worth of activity (Southall et al., 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals of some species could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals are exposed above threshold over five years and over the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures to reduce potential impacts of active acoustic sources on marine mammals (as discussed in Section 3.5.2.3.1.1 under Alternative A, and see Appendix E).

The potential impacts of Alternative B on cetaceans include injury exposures in the form of hearing loss (PTS), but such injury would be rare and confined to a few high-frequency cetaceans in four regions (from six animals in the Southeast Region up to 15 animals in the Greater Atlantic Region over the five-year timeframe, see **Table 3.5-15**). While more individual animals are expected to experience behavioral disruptions than injury (on the order of tens of thousands of animals across all five regions over the five-year timeframe), the amount of time individuals may exceed the behavioral threshold would be on average less than two minutes (**Table 3.5-17**). Similarly, the potential for masking would be minimal during surveys because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Overall, the potential impacts are likely limited to short-term disruption of acoustic habitat and behavioral patterns. Although both PTS/injury and behavioral disruption exposure of cetaceans would be higher under Alternative B than under Alternative A, the effects of underwater sound from active acoustic sources on cetaceans under Alternative B would still be **adverse** and **minor** because impacts would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication and/or echolocation, disturbance of individuals or groups of cetaceans, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of cetaceans from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat would be limited to the project area or its immediate surroundings. Impacts of Alternative B on cetaceans, including ESA-listed species, would be **insignificant**.

3.5.2.4.2 Pinnipeds

Impacts of Alternative B on pinnipeds, including ESA-listed species and designated critical habitat, would be the same or slightly, but not appreciably, larger than those under Alternative A for the following impact causing factors: vessel and equipment sound; vessel presence and movement of equipment in the water; human activity; accidental leakage or spillage of oil, fuel, and chemicals; trash and debris; and air emissions. Although the impacts of active underwater acoustic sources would also be similar under Alternative B as under Alternative A, they are discussed below because the impacts of underwater sound on marine mammals are of main concern and to show the modeled increase in behavioral disruption exposures of pinnipeds from the projected increase in the use of echo sounders, ADCPs, and acoustic communication systems (see Appendix E).

3.5.2.4.2.1 Active Underwater Acoustic Sources

As with Alternative A, active underwater acoustic sources under Alternative B would include echo sounders, ADCPs, and acoustic communication systems as described in Section 2.4. Descriptions of all active sources considered in this study can be found in Appendix E, Technical Acoustic Analysis of Oceanographic Surveys; the representative sources used in exposure modeling are the same as described in Alternative A and listed in **Table 3.5-7**. Since Alternative B involves improvements in techniques and technology with an increased use of underwater acoustic sources, the behavioral disruption exposure estimates are higher than under Alternative A.

The active underwater acoustic sources were evaluated in the same way under Alternative B as for Alternative A. Quantitative acoustic exposure to marine mammals, including pinnipeds, from operation of sound sources was modeled for nine sources (see Appendix E). Acoustic modeling was conducted by determining the sound field expected from each source and estimating the number of pinnipeds that may be exposed above sound thresholds for PTS/injury and behavioral disruption during surveys. To gauge potential for impact, received sound levels that may result in PTS/injury or behavioral disruption to the animal were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR 72308, December 31, 2019) were used (see Appendix E). Methodology for modeling the impacts of active underwater acoustic sources is presented in Appendix E. Additionally, Section 3.5.2.3.1.1 under Cetaceans discusses the assumptions made and the data sources used in the modeling scenarios to predict exposures of marine mammals, including pinnipeds.

Based on the modeling, and taking into account animal behavior, source characteristics, and animal hearing capability, no PTS/injury exposures of pinnipeds is expected to occur. Note that the estimated exposures have overall decreased between the Draft PEIS and the Final PEIS for the reasons discussed in Section 3.5.2.3.1.1 under Cetaceans. Summarized total potential behavioral disruption exposures of pinnipeds over five years for all sources are shown in **Table 3.5-18**. For annual numbers, see Appendix E. Species that may be in the area but for which no impacts were predicted are not included in the tables. Discussion of how behavioral disruption exposure was modeled and calculated can be found in Section 3.5.2.3.2.1.1 and in Appendix E.

Table 3.5-18. Total Predicted Exposures for Pinniped Species and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative B

Species	Total Exposures*	Average time above 160 dB (s)**
Alaska Region		
Northern fur seal***	23,136.32	138
Spotted seal	11,028.62	104
Harbor seal	7,826.85	104
Northern elephant seal***	6,635.49	118
Bearded seal	1,596.14	104
Ribbon seal	1,537.25	104
Ringed seal	1,213.36	104
Walrus	652.52	95
Steller sea lion***	513.13	104

Species	Total Exposures*	Average time above 160 dB (s)**
Greater Atlantic Region		
Harp seal	669.17	174
Gray seal	541.65	168
Harbor seal	331.13	193
Hooded seal	304.77	174
West Coast Region		
California sea lion	36,685.87	96
Northern fur seal	23,730.92	138
Northern elephant seal	6,635.49	118
Harbor seal	6,428.05	138
Stellar sea lion	2,945.39	138
Guadalupe fur seal	266.86	138
Pacific Islands Region		
Hawaiian monk seal	685.25	86

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure above threshold over 24 hours.

***Populations span Alaska and West Coast regions.

Under Alternative B, behavioral disruption exposures of pinnipeds could occur in four regions. Compared to Alternative A, use of underwater acoustic sources under Alternative B would occur at a higher level of effort. Depending on the species, behavioral disruption exposure of pinnipeds under Alternative B could increase from a few dozen to a few thousand animals in each region over the five-year timeframe as compared to Alternative A. However, for the simulated animals exposed above the 160 dB threshold, the average amount of time an individual receives sound levels above the behavioral threshold remains less than four minutes, and often less than two minutes. The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual's behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals, as in the case of seismic surveys that have months' worth of activity (Southall et al., 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals of some species could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals are exposed above threshold over five years and over the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures to reduce potential impacts of active acoustic sources on marine mammals (as discussed in Section 3.5.2.3.2.1 under Alternative A, and see Appendix D).

Under Alternative B, no PTS/injury exposure is expected. While individual animals would be expected to experience behavioral disruptions (from hundreds to tens of thousands of animals across four regions over the five-year timeframe), the amount of time individuals may exceed the behavioral exposure threshold would be on average less than four minutes (**Table 3.5-18**). Similarly, the potential for masking would be minimal during surveys because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Overall, the potential impacts are likely limited to short-term disruption of acoustic habitat and behavioral patterns. Although behavioral disruption exposure of pinnipeds would be higher under Alternative B than under Alternative A, the effects of underwater sound from active acoustic sources on pinnipeds under Alternative B would still be **adverse** and **minor** because impacts would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication and disturbance of individuals or groups of pinnipeds, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of pinnipeds from preferred breeding, feeding, or nursery grounds or designated critical habitat would be limited to the project area or its immediate surroundings. Impacts of Alternative B on pinnipeds, including ESA-listed species, would be **insignificant**.

3.5.2.4.3 Sirenians

Impacts of Alternative B on sirenians, including ESA-listed species and designated critical habitat, would be the same or slightly, but not appreciably, larger than those under Alternative A for the following impact causing factors: vessel and equipment sound; vessel presence and movement of equipment in the water; human activity; accidental leakage or spillage of oil, fuel, and chemicals; and trash and debris. Although the impacts of active underwater acoustic sources would also be similar under Alternative B as under Alternative A, they are discussed below because the impacts of underwater sound on marine mammals are of main concern and to show the modeled increase in behavioral disruption exposures of sirenians from the projected increase in the use of echo sounders, ADCPs, and acoustic communication systems (see Appendix E).

3.5.2.4.3.1 Active Underwater Acoustic Sources

As with Alternative A, active underwater acoustic sources under Alternative B would include echo sounders, ADCPs, and acoustic communication systems as described in Section 2.4. Descriptions of all active sources considered in this study can be found in Appendix E; the representative sources used in exposure modeling are the same as described in Alternative A and listed in **Table 3.5-7**. Since Alternative B involves improvements in techniques and technology with an increased use of underwater acoustic sources, the behavioral disruption exposure estimates are higher than under Alternative A.

The active underwater acoustic sources were evaluated in the same way under Alternative B as for Alternative A. Quantitative acoustic exposure to marine mammals, including sirenians, from operation of acoustic sources was modeled for nine sources (see Appendix E). Acoustic modeling was conducted by determining the sound field expected from each source and estimating the number of manatees that may be exposed above sound thresholds for PTS/injury and behavioral disruption during surveys. To gauge the potential for impact, received sound levels that may result in PTS/injury or behavioral disruption to the animals were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR 72308, December 31, 2019) were used (see Appendix E). Methodology for modeling the impacts of active underwater acoustic sources is presented in Appendix E. Additionally, Section 3.5.2.3.1.1 under Cetaceans discusses the assumptions made and the data sources used in the modeling scenarios to predict exposures of marine mammals, including sirenians.

Based on the modeling and taking into account animal behavior, source characteristics, and animal hearing capability, no PTS/injury exposures of manatees are expected to occur. Note that the estimated exposures have overall decreased between the Draft PEIS and the Final PEIS for the reasons discussed in

Section 3.5.2.3.1.1 under Cetaceans. Summarized total potential behavioral disruption exposures of manatees over five years for all sources are shown in **Table 3.5-19**. For annual numbers, see Appendix E. Discussion of how behavioral disruption exposures were modeled and calculated can be found in Sections 3.5.2.3.3.1.1 and in Appendix E.

Table 3.5-19. Total Predicted Exposures for Manatees and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative B

Species	Total Exposures*	Average time above 160 dB (s)**
Greater Atlantic Region		
Manatee	255.56	196
Southeast Region* **		
Manatee	78.19	196

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure above threshold over 24 hours.

***Exposure modeling for the Southeast Region was conducted for the Gulf of Mexico and Caribbean.

Under Alternative B, behavioral disruption exposures of sirenians could occur in two regions. Compared to Alternative A, use of underwater acoustic sources under Alternative B would occur at a higher level of effort. Behavioral disruption exposure of manatees under Alternative B could increase up to 22 animals over the five-year timeframe as compared to Alternative A. However, for the simulated animals exposed above the 160 dB threshold, the average amount of time an individual receives sound levels above the behavioral threshold remains less than four minutes. The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual's behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals, as in the case of seismic surveys that have months' worth of activity (Southall et al., 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals are exposed above threshold over five years and over the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures to reduce potential impacts of active acoustic sources on marine mammals (as discussed in Section 3.5.2.3.3.1 under Alternative A, and see Appendix D).

Under Alternative B, no PTS/injury exposure is expected. While some individual animals are expected to experience behavioral disruptions (<334 individuals in two regions over the five-year timeframe), the amount of time they may exceed the behavioral exposure threshold would be less than four minutes (**Table 3.5-19**). Similarly, the potential for masking would be minimal during surveys because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Overall, the potential impacts are likely limited to short-term disruption of acoustic habitat and behavioral patterns. Although behavioral disruption exposure of manatees would be higher under Alternative B than under Alternative A, the effects of underwater sound from active acoustic sources on sirenians under

Alternative B would still be **adverse** and **minor** because impacts would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication and disturbance of individuals or groups of sirenians, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of sirenians from preferred breeding, feeding, or nursery grounds or designated critical habitat would be limited to the project area or its immediate surroundings. Impacts of Alternative B on sirenians would be **insignificant**.

3.5.2.4.4 Fissipeds

Impacts of Alternative B on fissipeds, including ESA-listed species and designated critical habitat, would be the same or slightly, but not appreciably, larger than those under Alternative A for the following impact causing factors: vessel and equipment sound; vessel presence and movement of equipment in the water; human activity; accidental leakage or spillage of oil, fuel, and chemicals; trash and debris; and air emissions. Although the impacts of active underwater acoustic sources would also be similar under Alternative B as under Alternative A, they are discussed below because the impacts of underwater sound on marine mammals are of main concern and to show the modeled increase in behavioral disruption exposures of fissipeds from the projected increase in the use of echo sounders, ADCPs, and acoustic communication systems (see Appendix E).

3.5.2.4.4.1 Active Underwater Acoustic Sources

As with Alternative A, active underwater acoustic sources under Alternative B would include echo sounders, ADCPs, and acoustic communication systems as described in Section 2.4. Descriptions of all active sources considered in this study can be found in Appendix E; the representative sources used in exposure modeling are the same as described in Alternative A and listed in **Table 3.5-7**. Since Alternative B involves improvements in techniques and technology with an increased use of underwater acoustic sources, the behavioral disruption exposure estimates are higher than under Alternative A.

The active underwater acoustic sources were evaluated in the same way under Alternative B as for Alternative A. Quantitative acoustic exposure of, marine mammals, including fissipeds, from operation of sound sources was modeled for nine sources (see Appendix E). Acoustic modeling was conducted by determining the sound field expected from each source and estimating the number of fissipeds that may be exposed above sound thresholds for PTS/injury and behavioral disruption during surveys. To gauge potential for impact, received sound levels that may result in PTS/injury or behavioral disruption to the animal were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR 72308, December 31, 2019) were used (see Appendix E). Methodology for modeling the impacts of active underwater acoustic sources is presented in Appendix E. Additionally, Section 3.5.2.3.1.1 under Cetaceans discusses the assumptions made and the data sources used in the modeling scenarios to predict exposures of marine mammals, including fissipeds.

Based on the modeling and taking into account animal behavior, source characteristics, and animal hearing capability, no PTS/injury exposures of fissipeds are expected to occur. Note that the estimated exposures have overall decreased between the Draft PEIS and the Final PEIS for the reasons discussed in Section 3.5.2.3.1.1 under Cetaceans. Summarized total potential behavioral disruption exposures of fissipeds over five years for all sources are shown in **Table 3.5-20**. For annual numbers, see Appendix E. Species that may be in the area but for which no impacts were predicted are not included in the tables.

Discussion of how behavioral disruption exposures were modeled and calculated can be found in Sections 3.5.2.3.4.1.1 and in Appendix E.

Table 3.5-20. Total Predicted Exposures for Fissiped Species and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative B

Species	Total Exposures*	Average time above 160 dB (s)**
Alaska Region		
Sea otter, SE	533.98	124
Sea otter, SC	373.89	124
Polar bear	59.60	177
West Coast Region		
Sea otter, CA	591.56	124
Sea otter, SE	533.98	124
Sea otter, WA	212.40	124

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure above threshold over 24 hours.

Under Alternative B, behavioral disruption exposures of fissipeds could occur in two regions. Compared to Alternative A, use of underwater acoustic sources under Alternative B would occur at a higher level of effort. Behavioral disruption exposure of fissipeds under Alternative B could increase by approximately five polar bears and a few hundred sea otters in each region over the five-year timeframe as compared to Alternative A. However, for the simulated animals exposed above the 160 dB threshold, the average amount of time an individual receives sound levels above the behavioral threshold remains less than three minutes. The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual's behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals, as in the case of seismic surveys that have months' worth of activity (Southall et al., 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals of some species could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals are exposed above threshold over five years and over the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures to reduce potential impacts of active acoustic sources on marine mammals (as discussed in Section 3.5.2.3.4.1 under Alternative A, and see Appendix D).

Under Alternative B, no PTS/injury exposure is expected. While individual animals are expected to experience behavioral disruptions (<60 polar bears and a few thousand sea otters across the two regions and over the five-year timeframe), the amount of time they may exceed the behavioral disruption threshold would be on average less than three minutes (**Table 3.5-20**). Similarly, the potential for masking would be minimal during surveys because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Overall, the potential impacts are likely limited to short-term disruption of acoustic habitat and behavioral patterns. Although behavioral disruption exposure of fissipeds would be higher under Alternative B than under Alternative A, the effects of underwater sound from active acoustic sources on fissipeds under Alternative B would still be **adverse** and **minor** because impacts would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication and disturbance of individuals or groups of fissipeds, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of fissipeds from preferred breeding, feeding, or nursery grounds or designated critical habitat would be limited to the project area or its immediate surroundings. Impacts of Alternative B on fissipeds, including ESA-listed species, would be **insignificant**.

3.5.2.4.5 Conclusion

Since the effects of impact causing factors on marine mammals range from negligible to minor, the overall impact of Alternative B on marine mammals, including ESA-listed species and designated critical habitat, would be **adverse** and **minor**; thus, impacts of Alternative B would be **insignificant**.

3.5.2.5 Alternative C: Upgrades and Improvements with Greater Funding Support

As for Alternatives A and B, impacts of Alternative C are discussed for the same impact causing factors for each type of marine mammal (cetaceans, pinnipeds, sirenians, and fissipeds). Under Alternative C, all of the activities and equipment operations proposed in Alternatives A and B would continue but at a higher level of effort, because there would be an overall funding increase of 20 percent relative to Alternative B. However, the percentage of nautical miles in each region would be the same as under Alternatives A and B. Thus, the greatest number of nautical miles surveyed each year would be in the Southeast Region (with approximately 47 percent of the survey effort). The other four regions would be at similar levels of effort (approximately 10 percent of the survey effort in each region), although slightly greater in the Alaska Region where the percentage of survey effort would be approximately 18 percent (see **Table 3.5-21**). In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, sound production and hearing frequency of the animals, and population density of marine mammals, that add nuance to this trend. Overall, NOS projects would comprise a very small part of all ocean activities as vessels used by NOS would represent a very small proportion of all vessel traffic in the action area (as discussed in Section 2.4.1). Additionally, whenever possible, the location and timing of a given project would be purposefully coordinated to ensure that areas are not repeatedly surveyed. This ensures that the potential environmental impacts directly resulting from NOS projects would not be exacerbated by repeated projects within a given area.

Table 3.5-21. Survey Effort under Alternative C, by Geographic Region by Year

Region	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Survey Effort (in nautical miles)						
Greater Atlantic Region (without Great Lakes)	72,986	126,909	61,166	56,295	56,295	373,650
Southeast Region	264,403	252,222	314,940	338,080	338,080	1,507,724
West Coast Region	71,470	69,491	67,168	69,845	69,845	347,818
Alaska Region	112,645	143,968	209,334	49,620	49,592	565,160
Pacific Islands Region	84,252	65,880	83,690	65,938	65,938	365,698

Projects under Alternative C would take place in the same geographic areas and timeframes as under Alternatives A and B; however, Alternative C would include more projects and activities, and thus more nautical miles traveled, than Alternatives A and B. Under Alternative C, NOS projects would cover a total of 3,160,049 nm (5,852,411 km) across all five regions over the five-year period (note that survey effort in the Great Lakes is not included as no marine mammals occur there). Overall, there would be an additional 263,337 nm (487,701 km) covered by vessels under Alternative C (see **Table 3.5-21**) as compared to Alternative B (2,896,712 nm [5,364,710 km] total), and an additional 526,675 nm (975,402 km) as compared to Alternative A (2,633,374 nm [4,877,009 km] total) across all regions over the five-year period. The types and mechanisms of impacts would remain the same in Alternative C as discussed for Alternatives A and B across all regions over the five-year period. Therefore, in general, the difference between the alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative C as compared to Alternatives A and B. While the total number of activities increases by approximately 10 percent between each subsequent alternative, the numbers for individual activities do not increase uniformly between alternatives. For example, the number of nautical miles crewed vessel operations increases by 23 percent from Alternative A to C and 10 percent from Alternative B to C. However, the number of nautical miles using ADCPs increases by 137 percent from Alternative A to C and 36 percent from Alternative B to C; and ROV use increases 257 percent from Alternative A to C and 19 percent from Alternative B to C.

Under Alternative C, there would be projects using crewed vessel operations covering 637,000 nm (1,180,000 km), as compared to 518,000 nm (959,000 km) under Alternative A. Vessel operations could contribute to impacts on marine mammals related to vessel and equipment sound, vessel presence and movement, accidental spills, trash and debris, and air emissions. Although the amount of crewed vessel operations would be greater under Alternative C than under Alternative A, an additional 119,000 nm (220,000 km) across five regions would result in greater impacts overall, but not so great that the magnitude of a particular impact causing factor would increase (e.g., from negligible to minor). The increase in use of active underwater acoustic equipment and ROVs would be more pronounced than increases in other activities. Projects involving echo sounders, ADCPs, and acoustic communication systems would increase under Alternative C as compared to Alternatives A and B. This reflects the increased use of technology and increased funding under Alternative C and is a greater increase than for other activities on a percentage basis, but overall, the increase is still not very high, especially as compared to the extent of the action area.

3.5.2.5.1 Cetaceans

Impacts of Alternative C on cetaceans, including ESA-listed species and designated critical habitat, would be the same or slightly, but not appreciably, larger as those under Alternatives A and B for the following impact causing factors: vessel and equipment sound; vessel presence and movement of equipment in the water, human activity, accidental leakage or spillage of oil, fuel, and chemicals; and trash and debris. Overall, impacts on cetaceans from these factors would be insignificant. Although the impacts of active underwater acoustic sources would also be similar under Alternative C as under Alternatives A and B, they are discussed below because the impacts of underwater sound on marine mammals are of main concern and to show the modeled increase in PTS/injury exposures and behavioral disruption exposures of cetaceans from the projected increase in the use of echo sounders, ADCPs, and acoustic communication systems (see Appendix E).

3.5.2.5.1.1 Active Underwater Acoustic Sources

As with Alternatives A and B, active underwater acoustic sources under Alternative C include echo sounders, ADCPs, and acoustic communication systems as discussed in Section 2.4. Descriptions of all active sources considered in this study can be found in Appendix E. The representative sources used in exposure modeling are the same as described in Alternative A and listed in **Table 3.5-7**. Since Alternative C involves improvements in techniques and technology with an increased use of underwater acoustic sources, as well as an overall funding increase of 20 percent relative to Alternative B, the PTS/injury and behavioral disruption exposure estimates are somewhat higher than under Alternatives A and B.

The active underwater acoustic sources were evaluated in the same way under Alternative C as for Alternatives A and B. Quantitative acoustic exposure to marine mammals, including cetaceans, from operating the sources was modeled for nine sources (see Appendix E). Acoustic modeling was conducted by determining the size of the sound field expected from each source and estimating the number of marine mammals that may be exposed above sound thresholds for PTS/injury and behavioral disruption during surveys. To gauge potential for impact, received sound levels that may result in PTS/injury or behavioral disruption to the animal were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR 72308, December 31, 2019) were used. Methodology for modeling the impacts of active underwater acoustic sources is presented in Appendix E. Additionally, Section 3.5.2.3.1.1 under Cetaceans discusses the assumptions made and the data sources used in the modeling scenarios to predict exposures of marine mammals.

Summarized total potential PTS/injury exposures over five years for all sources for cetaceans in each region are shown in **Table 3.5-22** (no PTS/injury exposure was predicted for any species in the Pacific Islands Region). Note that the estimated exposures have overall decreased between the Draft PEIS and the Final PEIS for the reasons discussed in Section 3.5.2.3.1.1 under Alternative A. Summarized total potential behavioral disruption exposures of cetaceans for all sources in each region are shown in **Table 3.5-24**. For annual numbers, see Appendix E. Species that may be in the area but for which no impacts were predicted are not included in the tables. Discussion of how PTS/injury exposures and behavioral disruption exposures were modeled and calculated can be found in Sections 3.5.2.3.1.1.1 and 3.5.2.3.1.1.2 and in Appendix E.

Table 3.5-22. Total Predicted Exposures for Cetacean Species and Range Accounting for 95 Percent of Exposure Above PTS Threshold Under Alternative C

Species	Total Exposures*	Exposure Range (m)
Southeast Region**		
Dwarf sperm whale	3.83	35
Pygmy sperm whale	2.79	35
Greater Atlantic Region		
Harbor porpoise	13.62	34
Dwarf sperm whale	1.47	32
Pygmy sperm whale	0.17	32
West Coast Region		
Harbor porpoise	8.11	28
Dall’s porpoise	6.57	24

Species	Total Exposures*	Exposure Range (m)
Alaska Region		
Harbor porpoise	5.70	27
Dall's porpoise	5.23	20

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure modeling for the Southeast Region was conducted for the Gulf of Mexico.

Under Alternative C, PTS/injury exposure of high-frequency cetaceans could occur in four of the five regions with ranges to exposures in the simulations ~30 m (~100 ft). High-frequency cetaceans (Dall's and harbor porpoises, and dwarf and pygmy sperm whales) have been shown to be more sensitive to sounds than other cetacean species, and therefore have comparatively low thresholds for PTS/injury exposures (NMFS, 2018a). Compared to Alternatives A and B, use of underwater acoustic sources under Alternative C would continue at a higher level of effort. Over the five-year timeframe, a total of up to eight additional animals compared to Alternative A and up to four additional animals compared to Alternative B would be exposed above the PTS/injury threshold across four regions. Such small increases in animals exposed above threshold over the extensive project area and over five years would not be expected to result in population level adverse impacts, particularly as supported by the comparison to PBR levels (see Section 3.5.2.3.1.1.1 for discussion and **Table 3.5-23**).

Table 3.5-23. Comparison of Exposure Above PTS Threshold for Cetacean Species Under Alternative C with Current Potential Biological Removal (PBR) Levels

Species	Total Exposures	Average Annual Exposures	PBR Levels*
Southeast Region			
Dwarf sperm whale	3.83	0.77	2.5**
Pygmy sperm whale	2.79	0.56	2.5**
Greater Atlantic Region			
Harbor porpoise	13.62	2.72	851
Dwarf sperm whale	1.47	0.29	46
Pygmy sperm whale	0.17		46
West Coast Region			
Dall's porpoise	8.11	1.62	99***
Harbor porpoise	6.57	1.31	35 to 349****
Alaska Region			
Harbor porpoise	5.70	1.14	2.2 to 11*****
Dall's porpoise	5.23	51.05	131

*Sources for PBR Levels: Carretta et al., 2022; Hayes et al., 2022; and Muto et al., 2022

**Differs from PBR levels reported in the Draft PEIS due to numbers presented in the Draft PEIS for incorrect stock.

***Differs from PBR levels reported in the Draft PEIS due to changes between the 2019 and the 2021 SARs.

****PBR levels for harbor porpoise in the West Coast Region is shown as the range across six stocks.

***** PBR levels for the Southeast Alaska stock; PBR levels are undetermined for the Gulf of Alaska and Bering Sea stocks.

Table 3.5-24. Total Predicted Exposures for Cetacean Species and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative C

Species	Total Exposures*	Average time above 160 dB (s)**
Alaska Region		
Pacific white-sided dolphin	1,105.50	63
Beluga whale	307.27	85
Harbor porpoise	108.08	88
Dall's porpoise	107.84	69
Common minke whale	74.13	47
Bowhead whale	70.67	53
Humpback whale, Central North Pacific	56.69	95
Resident killer whale	44.21	58
Fin whale	34.54	50
Transient killer whale	29.59	58
Beluga, Cooke Inlet	16.24	85
Humpback whale, Western North Pacific	6.21	95
Gray whale	2.13	51
Sperm whale	0.16	56
North Pacific right whale	0.03	53
Southeast Region* **		
Atlantic spotted dolphin	1,254.12	56
Common bottlenose dolphin	748.43	89
Pantropical spotted dolphin	494.54	52
Clymene dolphin	160.09	52
Rough-toothed dolphin	87.04	75
Spinner dolphin	86.62	58
Risso's dolphin	75.64	69
Striped dolphin	47.55	50
False killer whale	46.10	55
Pilot whale, short finned	24.22	60
Pilot whale, long finned	23.80	60
Pygmy sperm whale	23.03	52
Pygmy killer whale	20.64	52
Sperm whale	18.70	64
Melon-headed whale	18.70	50
Dwarf sperm whale	14.83	52
Fraser’s dolphin	11.49	50

Species	Total Exposures*	Average time above 160 dB (s)**
Blainville beaked whale	10.78	67
Gervais' beaked whale	10.78	67
Mesoplodont beaked whales (all)	10.78	67
Cuvier's beaked whale	3.32	64
Transient killer whale	2.90	58
Rice's whale	0.96	82
Greater Atlantic Region		
Short-beaked common dolphin	3,298.64	102
Atlantic white-sided dolphin	1,990.71	101
Atlantic spotted dolphin	1,418.39	89
Common bottlenose dolphin	1,217.20	184
Harbor porpoise	627.10	55
Risso's dolphin	561.77	112
Pilot whale, long finned	389.55	63
Pilot whale, short finned	249.25	63
Fin whale	187.53	98
Humpback whale	89.89	97
Common minke whale	101.72	101
Cuvier's beaked whale	70.61	55
Dwarf sperm whale	69.72	57
Rough-toothed dolphin	59.31	110
Gervais beaked whale	53.42	55
Sowerby's beaked whale	53.42	55
Blainville beaked whale	53.42	55
True's beaked whale	53.42	55
Mesoplodont beaked whales (all)	53.42	55
Striped dolphin	27.28	50
Sperm whale	20.72	50
Pantropical spotted dolphin	20.93	62
North Atlantic right whale	14.00	62
Sei whale	15.00	98
Melon-headed whale	11.06	50
Pygmy sperm whale	9.44	57
Clymene dolphin	5.73	100
Fraser's dolphin	4.69	38
False killer whale	3.25	64
White-beaked dolphin	2.78	83
Spinner dolphin	2.01	41
Northern bottlenose whale	0.74	42
Bryde's whale	0.47	112

Species	Total Exposures*	Average time above 160 dB (s)**
Blue whale	0.09	43
West Coast Region		
Short-beaked common dolphin	30,778.10	55
Long-beaked common dolphin	20,574.03	82
Pacific white-sided dolphin	8,167.96	67
Striped dolphin	5,142.33	25
Gray whale	2,993.57	55
Northern right whale dolphin	2,987.79	25
Risso’s dolphin	352.21	66
Common bottlenose dolphin	301.76	110
Humpback whale, Central America	279.29	128
Common minke whale	235.52	51
Fin whale	175.22	62
Dall's porpoise	169.00	75
Harbor porpoise	128.40	96
Mesoplodont beaked whales (all)	95.05	26
Blue whale	89.25	27
Humpback whale, Central North Pacific	56.69	95
Sperm whale	46.73	29
Cuvier's beaked whale	43.66	33
Baird's beaked whale	42.56	51
Sei whale	32.48	62
Transient killer whale	28.28	64
Offshore killer whale	28.02	64
Resident killer whale (SRKW)	26.17	64
Pilot whale, short finned	21.92	82
Humpback whale, Western North Pacific		95
Pacific Islands Region		
Rough-toothed dolphin	14,913.64	71
Striped dolphin	10,463.03	55
Pantropical spotted dolphin	4,891.49	62
Fraser's dolphin	4,162.23	50
Pygmy killer whale	1,415.19	64
False killer whale	519.37	56
Risso’s dolphin	134.22	69
Common bottlenose dolphin	85.78	112
Spinner dolphin	62.09	84
Humpback whale, Central North Pacific	56.69	95
Melon-headed whale	45.37	59
Pilot whale, short finned	33.61	62

Species	Total Exposures*	Average time above 160 dB (s)**
Humpback whale, Western North Pacific	6.21	95
Bryde's whale	5.93	70
Sperm whale	5.19	67
Longman's beaked whale	3.50	54
Cuvier's beaked whale	3.40	54
Sei whale	3.28	75
Fin whale	2.21	75
Blainville beaked whale	1.71	55
Resident killer whale	0.91	56
Transient killer whale	0.91	56
Blue whale	0.25	54

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure above threshold over 24 hours.

***Exposure modeling for the Southeast Region was conducted for the Gulf of Mexico.

Under Alternative C, behavioral disruption exposures to cetaceans could occur in all five regions. Compared to Alternatives A and B, use of underwater acoustic sources under Alternative B would occur at a higher level of effort. Depending on the species, behavioral disruption exposure of cetaceans under Alternative C could increase from one to a few thousand animals in each region over the five-year timeframe as compared to Alternatives A and B. However, for the simulated animals exposed above the 160 dB threshold, the average amount of time an individual would receive sound levels above the behavioral threshold remains less than two minutes, and often less than one minute. The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual's behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals, as in the case of seismic surveys that have months' worth of activity (Southall et al., 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals of some species could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals are exposed above threshold over five years and over the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures to reduce potential impacts of active acoustic sources on marine mammals (as discussed in Section 3.5.2.3.1.1 under Alternative A, and see Appendix D).

The potential impacts of Alternative C on cetaceans include injury exposures in the form of hearing loss (PTS), but such injury would be rare and confined to a few high-frequency cetaceans in four regions (from seven animals in the Southeast Region up to 16 animals in the Greater Atlantic Region over the five-year timeframe, see **Table 3.5-22**). While more individual animals are expected to experience behavioral disruptions than injury (on the order of greater than one hundred thousand animals across all five regions over the five-year timeframe), the amount of time individuals may exceed behavioral threshold would be on average for less than two minutes (**Table 3.5-24**). Similarly, the potential for masking would be minimal during surveys because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Overall, the potential impacts are likely limited to short-term disruption of acoustic habitat and behavioral patterns. Although both PTS/injury exposures and behavioral disruption exposures of cetaceans would be higher under Alternative C than under Alternatives A and B, the effects of underwater sound from active acoustic sources on cetaceans under Alternative C would still be **adverse** and **minor** because impacts would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication and/or echolocation, disturbance of individuals or groups of cetaceans, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of cetaceans from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat would be limited to the project area or its immediate surroundings. Impacts of Alternative C on cetaceans, including ESA-listed species, would be **insignificant**.

3.5.2.5.2 Pinnipeds

Impacts of Alternative C on pinnipeds, including ESA-listed species and designated critical habitat, would be the same or slightly, but not appreciably, larger as those under Alternatives A and B for the following impact causing factors: vessel and equipment sound; vessel presence and movement of equipment in the water, human activity, accidental leakage or spillage of oil, fuel, and chemicals; trash and debris; and air emissions. Overall, impacts on pinnipeds from these factors would be insignificant. Although the impacts of active underwater acoustic sources would also be similar under Alternative C as under Alternatives A and B, they are discussed below because the impacts of underwater sound on marine mammals are of main concern and to show the modeled increase in behavioral disruption exposures of pinnipeds from the projected increase in the use of echo sounders, ADCPs, and acoustic communication systems (see Appendix E).

3.5.2.5.2.1 Active Underwater Acoustic Sources

As with Alternatives A and B, active underwater acoustic sources under Alternative C include echo sounders, ADCPs, and acoustic communication systems as discussed in Section 2.4. Descriptions of all active sources considered in this study can be found in Appendix E. The representative sources used in exposure modeling are the same as described in Alternative A and listed in **Table 3.5-7**. Since Alternative C involves improvements in techniques and technology with an increased use of underwater acoustic sources, as well as an overall funding increase of 20 percent relative to Alternative B, the behavioral disruption exposure estimates are higher than under Alternatives A and B.

The active underwater acoustic sources were evaluated in the same way under Alternative C as for Alternatives A and B. Quantitative acoustic exposure to marine mammals, including pinnipeds, from operating the sources were modeled for nine sources (see Appendix E). Acoustic modeling was conducted by determining the sound field expected from each source and estimating the number of marine mammals that may be exposed above sound thresholds for PTS/injury and behavioral disruption during surveys. To gauge potential for impact, received sound levels that may result in PTS/injury or behavioral disruption to the animal were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR 72308, December 31, 2019) were used). Methodology for modeling the impacts of active underwater acoustic sources is presented in Appendix E. Additionally, Section 3.5.2.3.1.1 under Cetaceans discusses the assumptions made and the data sources used in the modeling scenarios to predict exposures of marine mammals, including pinnipeds.

Based on the modeling, and taking into account animal behavior, source characteristics, and animal hearing capability, no PTS/injury exposures of pinnipeds is expected to occur. Note that the estimated exposures have overall decreased between the Draft PEIS and the Final PEIS for the reasons discussed in Section 3.5.2.3.1.1 under Cetaceans. Summarized total potential behavioral disruption exposures of pinnipeds over five years for all sources in the four regions where they could occur are shown in **Table 3.5-25**. For annual numbers, see Appendix E. Species that may be in the area but for which no impacts were predicted are not included in the tables. Discussion of how behavioral disruption exposures were modeled and calculated can be found in Section 3.5.2.3.2.1.1 and in Appendix E.

Table 3.5-25. Total Predicted Exposures for Pinniped Species and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative C

Species	Total Exposures*	Average time above 160 dB (s)**
Alaska Region		
Northern fur seal***	25,778.11	138
Spotted seal	12,031.20	104
Harbor seal	9,181.91	104
Northern elephant seal***	7,656.14	118
Bearded seal	1,741.25	104
Ribbon seal	1,701.92	104
Ringed seal	1,323.67	104
Steller sea lion***	583.14	104
Walrus	711.84	95
Greater Atlantic Region		
Harp seal	629.76	174
Gray seal	509.72	168
Harbor seal	311.75	193
Hooded seal	279.63	174
West Coast Region		
Northern fur seal	26,485.39	138
California sea lion	43,805.08	96
Northern elephant seal	7,656.14	118
Harbor seal	7,481.23	138
Stellar sea lion	3,414.94	138
Guadalupe fur seal	308.98	138
Pacific Islands Region		
Hawaiian monk seal	823.93	86

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

** Exposure above threshold over 24 hours.

*** Populations span Alaska and West Coast regions.

Under Alternative C, behavioral disruption exposures of pinnipeds could occur in four regions. Compared to Alternatives A and B, use of underwater acoustic sources under Alternative C would occur at a higher level of effort. Depending on the species, behavioral disruption exposure of pinnipeds under Alternative C could increase from a few hundred to a few thousand animals in each region over the five-year timeframe as compared to Alternatives A and B. However, for the simulated animals exposed above the 160 dB threshold, the average amount of time an individual receives sound levels above the behavioral threshold remains less than four minutes, and often less than two minutes. The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual's behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals, as in the case of seismic surveys that have months' worth of activity (Southall et al., 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals of some species could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals are exposed above threshold over five years and over the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures to reduce potential impacts of active acoustic sources on marine mammals (as discussed in Section 3.5.2.3.2.1 under Alternative A, and see Appendix D).

Under Alternative C, no PTS/injury exposure is expected. While individual animals would be expected to experience behavioral disruptions (from hundreds to tens of thousands of animals across four regions over the five-year timeframe), the amount of time individuals may exceed the behavioral threshold would be on average less than four minutes (**Table 3.5-25**). Similarly, the potential for masking would be minimal during surveys because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Overall, the potential impacts are likely limited to short-term disruption of acoustic habitat and behavioral patterns. Although behavioral disruption exposure of pinnipeds would be higher under Alternative C than under Alternatives A and B, the effects of underwater sound from active acoustic sources on pinnipeds under Alternative C would still be **adverse** and **minor** because impacts would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication and disturbance of individuals or groups of pinnipeds, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of pinnipeds from preferred breeding, feeding, or nursery grounds or designated critical habitat would be limited to the project area or its immediate surroundings. Impacts of Alternative C on pinnipeds, including ESA-listed species, would be **insignificant**.

3.5.2.5.3 Sirenians

Impacts of Alternative C on sirenians, as well as designated critical habitat, would be the same or slightly, but not appreciably, larger as those under Alternatives A and B for the following impact causing factors: vessel and equipment sound; vessel presence and movement of equipment in the water, human activity, accidental leakage or spillage of oil, fuel, and chemicals; and trash and debris. Overall, impacts on sirenians from these factors would be insignificant. Although the impacts of active underwater acoustic sources would also be similar under Alternative C as under Alternatives A and B, they are discussed below because the impacts of underwater sound on marine mammals are of main concern and to show the modeled increase in behavioral disruption exposures of sirenians from the projected increase in the use of echo sounders, ADCPs, and acoustic communication systems (see Appendix E).

3.5.2.5.3.1 Active Underwater Acoustic Sources

As with Alternatives A and B, active underwater acoustic sources under Alternative C include echo sounders, ADCPs, and acoustic communication systems as discussed in Section 2.4. Descriptions of all active sources considered in this study can be found in Appendix E, Technical Acoustic Analysis of Oceanographic Surveys The representative sources used in exposure modeling are the same as described in Alternative A and listed in **Table 3.5-7**. Since Alternative C involves improvements in techniques and technology with an increased use of underwater acoustic sources, as well as an overall funding increase of 20 percent relative to Alternative B, the behavioral disruption exposure estimates are higher than under Alternatives A and B.

The active underwater acoustic sources were evaluated in the same way under Alternative C as for Alternatives A and B. Quantitative acoustic exposure to marine mammals, including sirenians, from operating the sources was modeled for nine sources (see Appendix E). Acoustic modeling was conducted by determining the sound field expected from each source and estimating the number of marine mammals that may be exposed above sound thresholds for PTS/injury and behavioral disruption during surveys. To gauge potential for impact, received sound levels that may result in PTS/injury or behavioral disruption to the animal were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR72308, December 31, 2019) were used. Methodology for modeling the impacts of active underwater acoustic sources is presented in Appendix E. Additionally, Section 3.5.2.3.1.1 under Cetaceans discusses the assumptions made and the data sources used in the modeling scenarios to predict exposures of marine mammals, including sirenians.

Based on the modeling and taking into account animal behavior, source characteristics, and animal hearing capability, no PTS/injury exposures of manatees are expected to occur. Note that the estimated exposures have overall decreased between the Draft PEIS and the Final PEIS for the reasons discussed in Section 3.5.2.3.1.1 under Cetaceans. Summarized total potential behavioral disruption exposures of manatees over five years for all sources are shown in **Table 3.5-26**. For annual numbers, see Appendix E. Discussion of how behavioral disruption exposures were modeled and calculated can be found in Sections 3.5.2.3.3.1.1 and in Appendix E.

Table 3.5-26. Total Predicted Exposures for Manatees and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative C

Species	Total Exposures*	Average time above 160 dB (s)**
Greater Atlantic Region		
Manatee	291.82	196
Southeast Region* **		
Manatee	78.95	196

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure above threshold over 24 hours.

***Exposure modeling for the Southeast Region was conducted for the Gulf of Mexico and Caribbean.

Under Alternative C, behavioral disruption exposures of sirenians could occur in two regions. Compared to Alternatives A and B, use of underwater acoustic sources under Alternative C would occur at a higher level of effort. Behavioral disruption exposure of manatees under Alternative C could increase by 59 animals as compared to Alternative A and 37 animals as compared to Alternative B over the five-year timeframe. However, for the simulated animals exposed above the 160 dB threshold, the average amount of time an individual receives sound levels above the 237 behavioral threshold remains less than four minutes. The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual's behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals, as in the case of seismic surveys that have months' worth of activity (Southall et al., 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals are exposed above threshold over five years and over the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures to reduce potential impacts of active acoustic sources on marine mammals (as discussed in Section 3.5.2.3.3.1 under Alternative A, and see Appendix D).

Under Alternative C, no PTS/injury exposure is expected. Some individual animals are expected to experience behavioral disruptions (<371 individuals in two regions over the five-year timeframe), the amount of time they may exceed the behavioral threshold would be less than four minutes (**Table 3.5-26**). Similarly, the potential for masking would be minimal during surveys because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Overall, the potential impacts are likely limited to short-term disruption of acoustic habitat and behavioral patterns. Although behavioral disruption exposure of manatees would be higher under Alternative C than under Alternatives A and B, the effects of underwater sound from active acoustic sources on sirenians under Alternative C would still be **adverse** and **minor** because impacts would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication and disturbance of individuals or groups of sirenians, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of sirenians from preferred breeding, feeding, or nursery grounds or designated critical habitat would be limited to the project area or its immediate surroundings. Impacts of Alternative C on sirenians would be **insignificant**.

3.5.2.5.4 Fissipeds

Impacts of Alternative C on fissipeds, including ESA-listed species and designated critical habitat, would be the same or slightly, but not appreciably, larger as those under Alternatives A and B for the following impact causing factors: vessel and equipment sound; vessel presence and movement of equipment in the water, human activity, accidental leakage or spillage of oil, fuel, and chemicals; trash and debris; and air emissions. Overall, impacts on fissipeds from these factors would be insignificant. Although the impacts of active underwater acoustic sources would also be similar under Alternative C as under Alternatives A and B, they are discussed below because the impacts of underwater sound on marine mammals are of main concern and to show the modeled increase in behavioral disruption exposures of fissipeds from the projected increase in the use of echo sounders, ADCPs, and acoustic communication systems (see Appendix E).

3.5.2.5.4.1 Active Underwater Acoustic Sources

As with Alternatives A and B, active underwater acoustic sources under Alternative C include echo sounders, ADCPs, and acoustic communication systems as discussed in Section 2.4. Descriptions of all active sources considered in this study can be found in Appendix E. The representative sources used in exposure modeling are the same as described in Alternatives A and B and listed in **Table 3.5-7**. Since Alternative C involves improvements in techniques and technology with an increased use of underwater acoustic sources, as well as an overall funding increase of 20 percent relative to Alternatives A and B, the behavioral disruption exposure estimates are higher than under Alternatives A and B.

The active underwater acoustic sources were evaluated in the same way under Alternative C as for Alternatives A and B. Quantitative acoustic exposure to marine mammals, including fissipeds, from operation of sound sources was modeled for nine sources (see Appendix E). Acoustic modeling was conducted by determining the sound field expected from each source and estimating the number of marine mammals that may be exposed above sound thresholds for PTS/injury and behavioral disruption during surveys. To gauge potential for impact, received sound levels that may result in PTS/injury or behavioral disruption to the animal were needed. For this study, the current NMFS criteria for both PTS/injury (NMFS, 2018a) and behavioral disruption (84 FR 72308, December 31, 2019) were used). Methodology for modeling the impacts of active underwater acoustic sources is presented in Appendix E. Additionally, Section 3.5.2.3.1.1 under Cetaceans discusses the assumptions made and the data sources used in the modeling scenarios to predict exposures of marine mammals, including fissipeds.

Based on the modeling and taking into account animal behavior, source characteristics, and animal hearing capability, no PTS/injury exposures of fissipeds are expected to occur. Note that the estimated exposures have overall decreased between the Draft PEIS and the Final PEIS for the reasons discussed in Section 3.5.2.3.1.1 under Cetaceans. Summarized total potential behavioral disruption exposures of fissipeds over five years for all sources are shown in **Table 3.5-27**. For annual numbers, see Appendix E. Species that may be in the area but for which no impacts were predicted are not included in the tables. Discussion of how behavioral disruption exposures were modeled and calculated can be found in Sections 3.5.2.3.4.1.1 and in Appendix E.

Table 3.5-27. Total Predicted Exposures for Fissiped Species and Time in Seconds Above the Behavioral Disruption Threshold Under Alternative C

Species	Total Exposures*	Average time above 160 dB (s)**
Alaska Region		
Sea otters, SE	635.22	124
Sea otter, SC	430.34	124
Polar bear	65.01	177
West Coast Region		
Sea otter, CA	609.49	124
Sea otter, SE	635.22	124
Sea otter, WA	230.14	124

*Exposures are based on a probabilistic model that is scaled by animal density and may therefore include fractional counts.

**Exposure above threshold over 24 hours.

Under Alternative C, behavioral disruption exposures of fissipeds could occur in two regions. Compared to Alternatives A and B, use of underwater acoustic sources under Alternative C would occur at a higher level of effort. Behavioral disruption exposure of fissipeds under Alternative C could increase by ten polar bears and a thousand sea otters over the five-year timeframe as compared to Alternative A, and five polar bears and a few hundred sea otters as compared to Alternative B. However, for the simulated animals exposed above the 160 dB threshold, the average amount of time an individual receives sound levels above the behavioral threshold remains less than three minutes. The disturbances, therefore, are expected to be transient, and surveys, once completed in an area, would not generally be repeated, thus limiting an individual's behavioral disruption. Behavioral exposures need to occur over the timespan of weeks to have a population level effect on marine mammals, as in the case of seismic surveys that have months' worth of activity (Southall et al., 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Thus, although many individuals of some species could experience behavioral disturbance from NOS acoustic sources, the small increments of time that the animals are exposed above threshold over five years and over the extensive project area would not be expected to result in population level adverse impacts.

In coordination with NMFS and USFWS, NOS has developed mitigation measures to reduce potential impacts of active acoustic sources on marine mammals (as discussed in Section 3.5.2.3.4.1 under Alternative A, and see Appendix D).

Under Alternative C, no PTS/injury exposure is expected. While individual animals are expected to experience behavioral disruptions (<66 polar bears and a few thousand sea otters across the two regions and over the five-year timeframe), the amount of time they would exceed the behavioral threshold would be on average less than three minutes (**Table 3.5-27**). Similarly, the potential for masking would be minimal during surveys because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Overall, the potential impacts are likely limited to short-term disruption of acoustic habitat and behavioral patterns. Although behavioral disruption exposures of fissipeds would be higher under Alternative C than under Alternatives A and B, the effects of underwater sound from active acoustic sources on fissipeds under Alternative C would still be **adverse** and **minor** because impacts would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Impacts could include disruptions of behavioral patterns such as temporary disruption of communication and disturbance of individuals or groups of fissipeds, and possible displacement of individuals or groups, but without substantial interference to feeding, reproduction, or other biologically important functions affecting population levels. Displacement of fissipeds from preferred breeding, feeding, or nursery grounds or designated critical habitat would be limited to the project area or its immediate surroundings. Impacts of Alternative C on fissipeds, including ESA-listed species, would be **insignificant**.

3.5.2.5.5 Conclusion

Since the effects of impact causing factors on marine mammals range from negligible to minor, the overall impact of Alternative C on marine mammals, including ESA-listed species and designated critical habitat, would be **adverse** and **minor**; thus, impacts of Alternative C would be **insignificant**.

3.5.2.6 Endangered Species Act Effects Determinations

Federal agencies are required under the ESA to formally determine whether their actions may affect listed species or their designated critical habitat. Effect determinations divide potential effects into three categories:

- No Effect;
- May Affect, but Not Likely to Adversely Affect; and
- May Affect, and is Likely to Adversely Affect.

Actions receiving a "No Effect" designation do not impact listed species or their designated critical habitat (hereafter listed resources) either positively or negatively and this designation is typically only used in situations where no listed resources are present in the action area. Actions receiving a "May Affect, but Not Likely to Adversely Affect" designation have only beneficial, insignificant, or discountable effects to listed resources. Effects are considered insignificant if they are of low relative impact, undetectable, not measurable, or cannot be evaluated. Adverse effects are considered discountable if they are extremely unlikely to occur. Actions designated as "May Affect, and is Likely to Adversely Affect" will negatively impact any exposed listed resources.

Potential impacts of underwater sound from active acoustic sources include injury exposures in the form of hearing loss (PTS), but such injury would be rare and confined to a few individuals of high-frequency cetaceans. While more individual animals comprising cetaceans, pinnipeds, sirenians, and fissipeds are expected to experience behavioral disruption exposures, the amount of time individuals may exceed the behavioral disruption threshold would only be for a few minutes. Similarly, the potential for masking would continue to be minimal during surveys because the narrow beam of most active acoustic sources means animals would not spend much time in ensonified zones. Overall, the potential impacts would likely continue to be limited to short-term disruption of acoustic habitat and behavioral patterns.

The acoustic modeling presented in the sections above and in Appendix E does not predict PTS/injury exposures of any ESA-listed species, only of four species of cetaceans which are not listed under the ESA. The modeling predicts behavioral disruption exposures of ESA-listed cetaceans in all five regions, ESA-listed pinnipeds in the Alaska, West Coast, and Pacific Islands regions, ESA-listed sirenians in the Greater Atlantic and Southeast regions, and ESA-listed fissipeds in the Alaska and West Coast regions. The amount of time that the animals would be exposed above the behavioral threshold is an important factor, in addition to considering if the sources are emitting sounds within the hearing range of the animals, for determining potential impacts. The duration of the time above threshold from NOS acoustic sources is typically on the order of two to five minutes; therefore, there would be a limited temporal disruption, and overall potential behavioral exposures would be limited. Behavioral exposures need to occur over the timespan of weeks to have a population level effect, as in the case of seismic surveys that have months' worth of activity (Southall et al, 2016). Any disruption that occurs for a matter of hours or for less than a day would not likely have a population-level impact. Additionally, mitigation measures to further reduce impacts from underwater acoustic sources include those listed in Appendix D. Thus, NOS determines "May Affect, but Not Likely to Adversely Affect" for all species exposed above the behavioral threshold. **Table 3.5-28** summarizes the effects determinations for all ESA-listed marine mammals in the action area.

Sound from the proposed number of vessels used by NOS within the EEZ, as compared with all other shipping and vessel traffic and the assumption that individuals or groups of marine mammals may be familiar with various and common vessel-related sounds, could result in masking when operating in the vicinity of a busy shipping lane but would be temporary or short-term and limited to the project area or its immediate surroundings; thus, the effects on ESA-listed species from vessel sound would be discountable, and injury or mortality of ESA-listed species is not expected from vessel and equipment sound.

Given that the likelihood of a vessel strike would be expected to be discountable (i.e., extremely unlikely to occur), the effects of vessel presence and movement of equipment in the water would only cause small disruptions of behavioral patterns or displacement of individuals or groups that would be temporary or short-term, and displacement would be limited to the project area or its immediate surroundings. NOS has developed a suite of mitigation measures through consultation with the NMFS Office of Protected Resources (OPR) to further minimize the likelihood of vessel strikes included in Appendix D. Thus, the effects on ESA-listed species would be discountable, and injury or mortality of ESA-listed species is not expected from NOS vessel presence and movement.

The effects of human activity on cetaceans and sirenians would only be minimal disruptions of behavioral patterns and no expected displacement of animals. This would generally be the same for pinnipeds and fissipeds; however, there may be some short-term displacement limited to the project area or immediate surroundings. In the event of a polar bear sighting during tide gauge and GPS reference station installation, NOS would follow human/bear interaction guidelines as issued by USFWS. For polar bears, the implementation of mitigation measures with time and space restrictions would ensure that the effects of human activity, such as disturbance of polar bear dens and potential human-bear interactions would be avoided, thus effects would not reasonably occur, and injury or mortality of ESA-listed species is not expected from human activity.

The likelihood for an accidental spill is expected to be discountable (i.e., extremely unlikely to occur), and exposure of ESA-listed marine mammals and critical habitats to oil, fuel, and other contaminants is not expected. Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. Thus, effects from chemical contamination on ESA-listed species are not reasonably certain to occur.

Impacts from discarded trash and debris are expected to be avoided through vessel operators’ required compliance with USCG and EPA regulations. Thus, effects from entanglement and ingestion of trash and debris on ESA-listed species are expected to be discountable (i.e., extremely unlikely to occur). Additionally, mitigation measures that would reduce or avoid entanglement impacts are included in Appendix D. As the emissions from vessels used by NOS would continue to be a very small fraction as compared to emissions from all other vessel activity in the oceans, the effects on ESA-listed species would be discountable (i.e., extremely unlikely to occur).

Since project activities may occur in some areas within or adjacent to designated critical habitats, there is the potential for impacts on critical habitat characteristics that support ESA-listed marine mammals. Critical habitat may be minimally disturbed but would remain functional to maintain viability of the species dependent on it. No destruction or adverse modification of any critical habitat would occur. Although prey species may be disturbed by some of the impact causing factors, which can affect critical habitat characteristics based on feeding and finding prey, it is not expected that impacts on prey species would be substantial enough to affect the fitness of individual animals. Due to the potential for effects on critical habitat that could be negligible or minor, as discussed in the impact analysis above, the Proposed

Action "May Affect, but Not Likely to Adversely Affect" the designated critical habitat of marine mammals occurring in the action area (**Table 3.5-28**).

Table 3.5-28. Summary of Effects Determinations for ESA-Listed Marine Mammals and Critical Habitat

ESA- Listed Marine Mammals	Species Determination	Critical Habitat Determination
Cetaceans – Mysticetes		
Bowhead whale	May Affect, but Not Likely to Adversely Affect	N/A* (no critical habitat designated)
Sei whale	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Rice's whale	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Blue whale	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Fin whale	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Gray whale (Western North Pacific DPS)	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
North Atlantic right whale	May Affect, but Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
North Pacific right whale	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Humpback whale (Mexico DPS)	May Affect, but Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Humpback whale (Central America DPS)	May Affect, but Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Humpback whale (Western North Pacific DPS)	May Affect, but Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Cetaceans – Odontocetes		
Beluga whale (Cook Inlet DPS)	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Killer whale (Southern Resident DPS)	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Sperm whale	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
False killer whale (Main Hawaiian Islands Insular DPS)	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect

ESA- Listed Marine Mammals	Species Determination	Critical Habitat Determination
Pinnipeds – Otariids		
Guadalupe fur seal	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Steller sea lion (Western DPS)	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Pinnipeds – Phocids		
Bearded seal (Beringia DPS)	May Affect, but Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Hawaiian monk seal	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Ringed seal (Arctic subspecies)	May Affect, but Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Sirenians – Manatees		
West Indian manatee (Antillean subspecies)	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
West Indian manatee (Florida subspecies)	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Fissipeds – Mustelids		
Northern sea otter (Southwest Alaska DPS)	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Southern sea otter	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Fissipeds – Ursids		
Polar bear	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect

*N/A = Not Applicable

3.6 SEA TURTLES

There are seven species of sea turtles worldwide: loggerhead, green, hawksbill, Kemp's ridley, olive ridley, flatback, and leatherback. All but the flatback (which is endemic to northern Australia) are present throughout U.S. coastal and marine waters, including all navigationally significant U.S. waters, extending seaward to the limits of the EEZ. A list of sea turtle species in the action area, including current status and region of occurrence, is provided in **Table 3.6-1**.

All sea turtles in U.S. waters are protected under the ESA by NMFS while in water and by the USFWS while onshore. Under the ESA, a species is considered endangered if it is "in danger of extinction throughout all or a significant portion of its range." A species is considered threatened if it "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Sea turtles and their nests are also protected to varying degrees by some states and localities.

3.6.1 Affected Environment

The following sections provide discussions of sea turtle species including acoustic capability, regional distribution, and descriptions of ESA-listed listed species.

The order Testudines includes all turtles and tortoises. The Cheloniidae family includes hard-shelled turtles and comprises six of the seven sea turtle species. The Dermochelyidae family lacks a bony shell and includes only one sea turtle species, the leatherback.

Sea turtles are air breathing reptiles that are primarily aquatic, generally coming ashore only to lay eggs. Hatchlings immediately enter the sea and migrate to the pelagic zone where they may shelter and feed in drift communities for 1 to 15 years. All but two species then return to coastal zones at the early-to-mid juvenile stage. The turtles then remain in the coastal zone unless their migration routes to breeding and nesting areas include movements through pelagic habitat. The exceptions to this are leatherbacks and olive ridleys, which remain in the pelagic zone for the majority of their lives. Adult sea turtles range in size from the Kemp's ridley, measuring about 0.6 m (2 ft) and weighing 45 kilograms (kgs) (100 pounds [lbs]), to the leatherback, reaching up to 1.7 m (5.5 ft) and 1,000 kgs (2,200 lbs) (NMFS, No Date-a). All species are thought to be long-lived, with life spans expected to range from at least 30 years to over 80 years. Sea turtle bodies are fusiform, that is, tapering at the front and rear. This improves their movements in aquatic environments but prevents retraction of their heads and limbs. Sea turtle limbs are adapted to aquatic movements and feeding. Their diets differ by species and life-stage, including herbivory, carnivory, and omnivory. Likewise, feeding strategies also vary by species and life stage. Sea turtles breathe by coming to the surface.

All sea turtles are protected by the ESA throughout their ranges. Additionally, four species have critical habitat designated for their entire range or one of their constituent DPSs. **Table 3.6-1** lists the six species of sea turtles and nine DPSs occurring in the action area. Three entire species are listed as endangered along with four DPSs. One species is listed as threatened along with the five remaining DPSs.

Table 3.6-1. Sea Turtles Occurring in the Action Area

DPS (if applicable)	ESA Status	Lead Agency	Region*	Critical Habitat	General Habitat
Loggerhead – *Caretta caretta*					
Northwest Atlantic	Threatened	NMFS, USFWS	GAR, SER	Yes	Nesting: occurs from April to September, peaking in June and July. Within the action area, nesting for the Northwest Atlantic DPS typically occurs on high energy, narrow, steep, coarse-grained beaches from Texas to Virginia. Most nesting within the action area occurs within Florida, Georgia, South Carolina, and North Carolina. Outside the action area, the North Pacific DPS nests in Japan and the South Pacific DPS nests mainly in Queensland, Australia. Post hatchling: local downwellings with floating algae and/or seaweed. Pelagic developmental phase (7-15 years): offshore oceanic zone. Late juvenile and adult: nearshore coastal and/or continental shelf.
North Pacific	Endangered	NMFS, USFWS	WCR, AR	No	
South Pacific	Endangered	NMFS	PIR	No	
Green - *Chelonia mydas*					
North Atlantic	Threatened	NMFS, USFWS	GAR, SER	Yes	Nesting: Occurs from June to September. Nesting typically occurs on beaches with a sloping platform and minimal disturbance. Most nesting within the action area occurs in Florida and Hawai'i, with some nesting occurring in the U.S. Virgin Islands, Puerto Rico, Georgia, South Carolina, and North Carolina. Pelagic developmental phase (5 to 7 years): offshore oceanic zone, pelagic drift communities. Late juvenile and adult: Nearshore, bays, lagoons, reefs, especially areas with seagrass beds.
South Atlantic	Threatened	NMFS, USFWS	SER	No	
Central North Pacific	Threatened	NMFS, USFWS	PIR	No	
Central West Pacific	Endangered	NMFS, USFWS	PIR	No	
Central South Pacific	Endangered	NMFS, USFWS	PIR	No	
East Pacific	Threatened	NMFS, USFWS	WCR	No	

DPS (if applicable)	ESA Status	Lead Agency	Region*	Critical Habitat	General Habitat
Hawksbill - *Eretmochelys imbricate*					
--	Endangered	NMFS, USFWS	GAR, SER, WCR, PIR	Yes	Nesting: Occurs April to November. Nesting occurs on beaches and “pocket” beaches with little or no sand. Most nesting within the action area occurs within the U.S. Virgin Islands, Puerto Rico, and Hawai’i. Nest sites have also been documented in American Samoa and Guam. Pelagic developmental phase: offshore oceanic zone, floating algal mats, flotsam and jetsam drift lines. Late juvenile and adult: shallow coastal zones, coral reefs, high-energy shoals, and mangroves.
Kemp’s Ridley - *Lepidochelys kempii*					
--	Endangered	NMFS, USFWS	GAR, SER	No	Nesting: Occurs from April to July. Nesting within the action area occurs primarily on Texas beaches of the Gulf of Mexico, although nest sites have been documented on Atlantic beaches of North Carolina, South Carolina, and Florida. Pelagic developmental phase (1 to 2 years): offshore oceanic zone primarily of the Gulf of Mexico but also the Atlantic by way of the Gulf Stream, floating Sargassum mats. Juvenile and adult: nearshore, areas of the Gulf of Mexico or northwestern Atlantic.
Olive Ridley - *Lepidochelys olivacea*					
--	Threatened	NMFS, USFWS	SER, WCR, PIR	No	Nesting: Occurs from June to December up to 3 times in a single nesting season. Nesting occurs outside the action area in the Pacific beaches of Mexico and Costa Rica; and

DPS (if applicable)	ESA Status	Lead Agency	Region*	Critical Habitat	General Habitat
					in Indian Ocean beaches of India, Bangladesh, Myanmar, Malaysia, and Pakistan. Breeding: coastal areas Juvenile/adult: mainly pelagic, but can inhabit coastal areas, bays, and estuaries.
Leatherback - *Dermochelys coriacea*					
--	Endangered	NMFS, USFWS	All	Yes	Nesting: Occurs from March to July on beaches. Nesting within the action area occurs on the Atlantic coast of Florida, the U.S. Virgin Islands, and Puerto Rico. Juvenile/adult: pelagic

Sources: ECOS, No Date-a; NMFS, No Date-a

*GAR = Greater Atlantic Region (includes the U.S. portions of the Great Lakes, New England, and the mid-Atlantic); SER = Southeast Region (includes the southern portion of the U.S. Eastern Seaboard, the U.S. Caribbean Islands [Puerto Rico and the U.S. Virgin Islands], and the Gulf of Mexico); AR = Alaska Region (includes Alaskan waters and the Arctic); WCR = West Coast Region (includes coastal California, Oregon and Washington); PIR = Pacific Islands Region (includes Hawai'i and territories of the U.S.)

3.6.1.1 Sound Production and Hearing

NOAA's Ocean Noise Strategy Roadmap (NOAA, 2016) recognizes that the biological importance of hearing in sea turtles has not been studied in great detail, but that it "seems likely that they use sound for navigation, to locate prey, to avoid predators, and for general environmental awareness". It is thought to be unlikely that turtles use sound for communication, though recent research is exploring this hypothesis. Sea turtle hearing has been inferred from studies of the animals' physiology and morphology and from electrophysiological studies.

Sea turtle hearing is better suited to aquatic than open-air conditions and varies by species, size, and age, with smaller and younger turtles having the broadest sensitivity ranges and larger, older turtles having the narrowest. Sea turtle hearing in aquatic conditions generally ranges from 50 Hz to 1600 Hz, with the highest sensitivities falling in the 200 Hz to 400 Hz range (BOEM, 2014b; NOAA, 2016; Piniak, 2012; and Southwood et al., 2008). Avoidance is generally observed at 166 to 174 dB re 1 µPa and behavioral harassment is considered to occur at sound intensities equal to or greater than 175 dB re 1 µPa, though studies have been limited and the Bureau of Ocean Energy Management (BOEM) recognized that this results in incomplete or unavailable information with regard to sea turtle physiology and behavioral response to intense sounds (BOEM, 2014b).

3.6.1.2 Regional Distribution

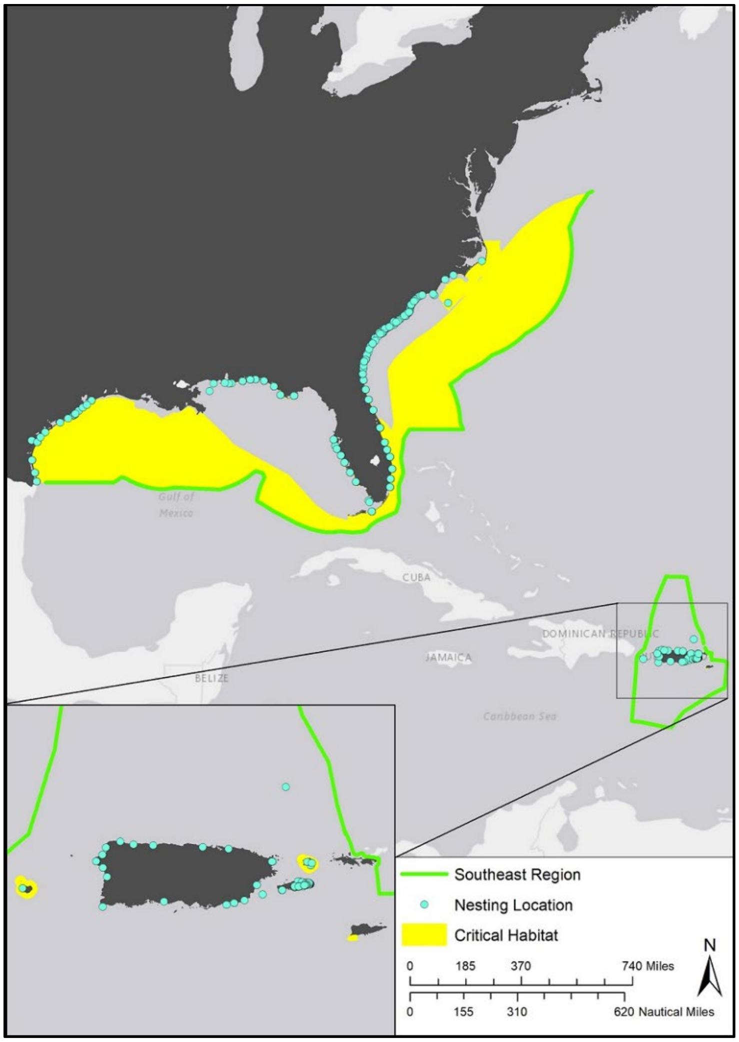
Sea turtles are found throughout the action area. Like marine mammals, sea turtles are known to make wide-ranging movements and may not be present in a specific region year-round; however, some species are considered distinct populations and do not migrate as broadly. Range varies by species and DPS, with some migrating up to 16,000 km (10,000 mi) per year and diving to nearly 1,200 m (4,000 ft) deep (NMFS, No Date-a). The distribution of sea turtles may be influenced by ecological conditions, physical features, and seasonal movements. Movements are most often associated with development stage and seasonal feeding, breeding, and nesting activities.

3.6.1.2.1 Greater Atlantic Region

Five of the six sea turtle species in the action area occur in the Greater Atlantic Region, as indicated in **Table 3.6-1**. Only the olive ridley are absent. The loggerhead Northwest Atlantic DPS and green North Atlantic DPS are listed as threatened. The hawksbill (rare in this region), Kemp's ridley, and leatherback are listed as endangered. There is no designated critical habitat and few known nest sites in the Greater Atlantic Region, although loggerhead sea turtles nests have recently been documented in Delaware and Maryland coastal areas.

3.6.1.2.2 Southeast Region

All six of the sea turtle species in the action area occur in the Southeast Region, as indicated in **Table 3.6-1**. The loggerhead Northwest Atlantic DPS, green North Atlantic DPS, and olive ridley are listed as threatened. The hawksbill, Kemp's ridley, and leatherback are listed as endangered. Critical habitat is designated in the region for leatherback, green, hawksbill, and loggerhead (**Figure 3.6-1**). Leatherback, hawksbill, green, loggerhead, and Kemp's ridley sea turtles are known to nest in the Southeast region (**Figure 3.6-1**).

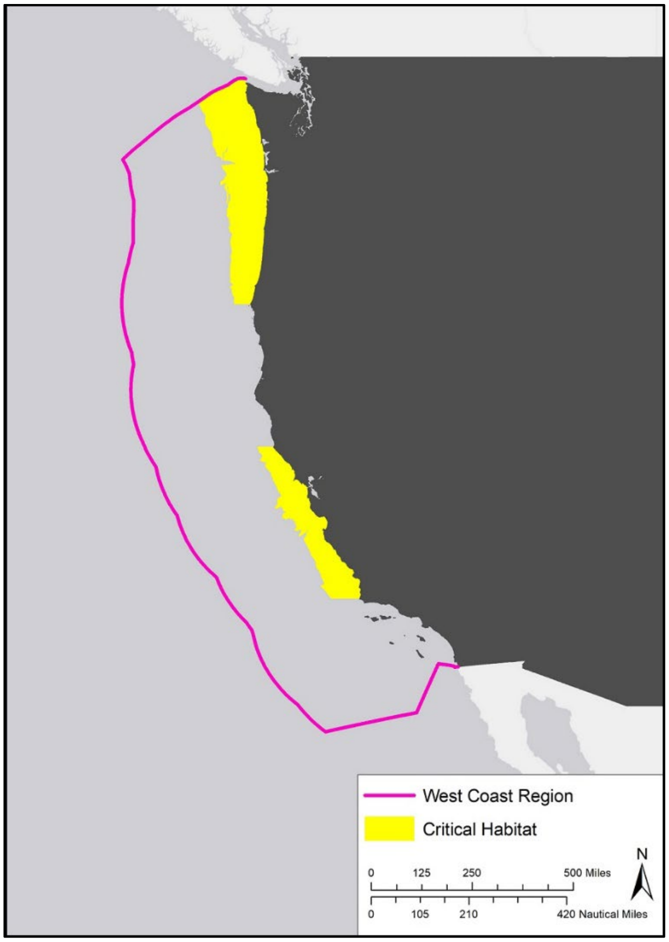


Sources: ECOS, No Date-a; NMFS, No Date-a; SWOT, No Date

Figure 3.6-1. Southeast Region Sea Turtle Designated Critical Habitat and Nesting Sites

3.6.1.2.3 West Coast Region

Five of the six sea turtle species in the action area occur in the West Coast Region, as indicated in **Table 3.6-1**. Only the Kemp's ridley are absent. The loggerhead North Pacific DPS, hawksbill, and leatherback are listed as endangered. The green East Pacific DPS and olive ridley are listed as threatened. Critical habitat is designated in the region for leatherback sea turtles (**Figure 3.6-2**), but there are no known nest locations for any species of sea turtle.



Sources: ECOS, No Date-a; NMFS, No Date-a

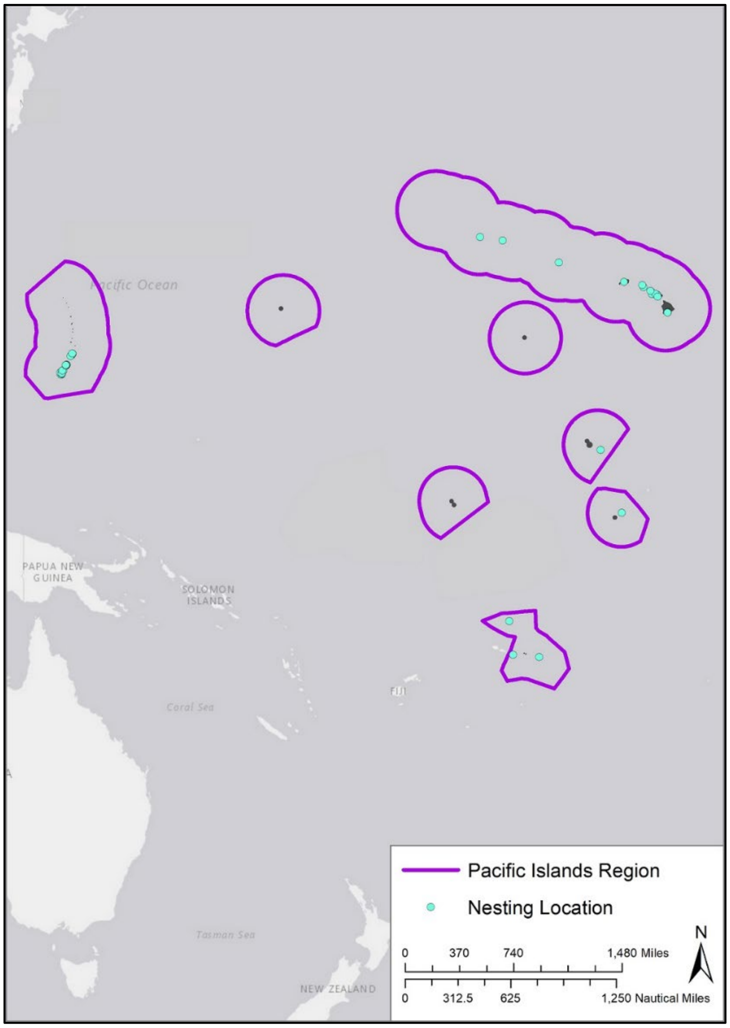
Figure 3.6-2. West Coast Region Sea Turtle Designated Critical Habitat

3.6.1.2.4 Alaska Region

Four of the six species of sea turtles in the action area have ranges or have been sighted in the Alaska Region. Leatherback sea turtles have the broadest range in the region, though green sea turtles also have a limited range in southeastern areas. Alaska Department of Fish and Game (ADF&G) also lists sightings, but no range, of olive ridley and loggerheads (ADF&G, No Date-a). Leatherbacks are listed as endangered throughout their range. The loggerhead North Pacific DPS includes the Alaska region and is listed as endangered. Though DPS descriptions for green turtles do not extend into the Alaska region, the nearest DPSs are the East Pacific, listed as endangered, and Central North Pacific, listed as threatened. Olive ridleys are listed as threatened throughout their range. No critical habitat is designated for sea turtles in the region, and there are no known sea turtle nest sites.

3.6.1.2.5 Pacific Islands Region

Five of the six sea turtle species in the action area occur in the Greater Atlantic Region, as indicated in **Table 3.6-1**. Only the Kemp's ridley are absent. The loggerhead South Pacific DPS, green Central West Pacific DPS, green Central South Pacific DPS, hawksbill, and leatherback are listed as endangered. The green Central North Pacific DPS and olive ridley are listed as threatened. No critical habitat for sea turtles has been designated in the Pacific Islands Region, although green, hawksbill, leatherback, and loggerhead sea turtles are known to nest there (**Figure 3.6-3**).



Sources: ECOS, No Date-a; NMFS, No Date-a, SWOT, No Date

Figure 3.6-3. Pacific Islands Region Sea Turtle Nesting Sites

3.6.1.3 Threatened and Endangered Species

All six species of sea turtles and their constituent DPSs are federally listed in the action area. Four species or their constituent DPSs also have designated critical habitat. These species are shown in **Table 3.6-1** and described in detail below.

3.6.1.3.1 Loggerhead (Northwest Atlantic, North Pacific, and South Pacific Distinct Population Segment)

Loggerhead sea turtles (**Figure 3.6-4**) can generally be found in temperate and tropical waters around the world. Upon hatching, loggerheads swim to sea for up to several days before settling at localized downwellings where floating materials, such as rafts of Sargassum, may accumulate. In this habitat, they expend little energy while floating and feeding opportunistically on small animals (Conant et al., 2009). Currents eventually move the young turtles into the pelagic zone where they remain for 7 to 15 years before migrating to coastal areas. As juveniles and adults, loggerheads are primarily carnivorous and have large heads with strong jaws with which to feed on benthic invertebrates, whelks, mollusks, horseshoe crabs and sea urchins. Loggerheads may take 20 to 30 years to mature and at full growth reach approximately 1 m (3 ft) in length and weigh up to 113 kgs (250 lbs). Upon reaching maturity, loggerheads nest every 2 to 3 years on the beaches where they hatched. The lifespan of the turtles is thought to be 70 to 80 years or more (NMFS, No Date-a).

Figure 3.6-4. Young Loggerhead

Photo credit: Nathalie Jacque, Solv LLC

Historically, human encroachment on nesting beaches, harvest of eggs, harvest of subadults and adults, depredation, insufficiency of protective regulations, and incidental fishing takes led to the decline of loggerhead populations. In 1979, loggerheads were listed as threatened under the ESA wherever the species occurs (Conant et al., 2009). In 2011, USFWS determined that loggerheads comprise nine DPSs, of which four are listed under the ESA as threatened and five as endangered (ECOS, No Date-a). Loggerheads continue to face threats from bycatch in fishing gear, ocean pollution and debris, and intentional killing (NMFS, No Date-a).

Three DPSs occur in the action area: North Pacific, South Pacific, and Northwest Atlantic. The North Pacific DPS includes individuals that hatch on beaches in Japan and spend their entire lives in the north Pacific without crossing the equator. After hatching, the turtles initially move in a passive manner with the North Pacific gyre, and then use the Kuroshi and North Pacific currents on their developmental migration, which serves to isolate them from the South Pacific DPS. As adults, the turtles return to nest on the beaches where they were hatched, thus maintaining the pattern of separation. North Pacific DPS turtles forage off the west coast of North America as far south as Baja California Sur, Mexico (Conant et al., 2009) and have been observed as far north as Alaska (NMFS, No Date-a). The North Pacific DPS is listed as endangered and has no designated critical habitat (ECOS, No Date-a). Populations are estimated to be small, declining, and at risk of extinction (Conant et al., 2009).

The South Pacific DPS includes individuals hatched mainly in Queensland, Australia, but also in New Caledonia, Vanuatu, and Tokelau. These genetically distinct sea turtles are the only loggerheads inhabiting the Pacific south of the equator. New hatchlings travel passively generally with the South Pacific gyre and spend developmental phases in the central and southeastern Pacific before returning to the west to mate and nest (Conant et al., 2009). The South Pacific DPS is listed as endangered and has no designated critical habitat (ECOS, No Date-a). Populations are at risk of extinction (Conant et al., 2009).

The Northwest Atlantic DPS includes loggerheads hatched primarily in the southeast U.S. and the Yucatan Peninsula of Mexico and Central America, and secondarily from other nesting sites throughout the Caribbean and western Atlantic as far south as northern South America. Hatchlings and juveniles use the North Atlantic gyre for early life stage movements before generally returning to neritic habitats nearby the areas where they hatched. Northwest Atlantic DPS juvenile loggerheads have some overlap in distribution with Northeast Atlantic and Mediterranean DPSs. Later-stage juveniles and adults inhabit neritic zones from Florida to Massachusetts, the Bahamas, Cuba, and the Gulf of Mexico (Conant et al., 2009). The DPS is listed as threatened and 38 discrete areas of critical habitat have been designated in the Gulf of Mexico and the Atlantic (ECOS, No Date-a). Populations are at risk of extinction (Conant et al., 2009).

3.6.1.3.2 Green (North Atlantic, South Atlantic, Central North Pacific, Central South Pacific, Central West Pacific, and East Pacific Distinct Population Segment)

Green sea turtles (**Figure 3.6-5**) can be found across broad ranges of the Atlantic and Pacific. Young green sea turtles inhabit the pelagic zone for 5 to 7 years before migrating to coastal areas, bays, and lagoons for later stages of life. They primarily feed on algae and seagrass, though sponges and invertebrates occasionally make up part of their diet. Green sea turtles may take 25 to 35 years to mature and at full growth reach approximately 1 m (3-4 ft) in length and weigh up to 160 kgs (350 lbs). Upon reaching maturity, they nest every 2 to 5 years. The lifespan of the turtles is thought to be 60 years or more (NMFS, No Date-a).

Figure 3.6-5. Green Sea Turtle

Photo Credit: Ali Bayless, NOAA/NMFS/PIFSC

In 1978, green sea turtles were listed as threatened wherever found except for the breeding colonies in Florida and the Pacific coast of Mexico, which were listed as endangered. In 1998, marine critical habitat was designated around Culebra Island in Puerto Rico (NMFS and USFWS, 2007). In 2016, 11 green sea turtle DPSs were designated as endangered or threatened (81 FR 20058, April 6, 2016). Six of these DPSs occur in the action area: the threatened North Atlantic, South Atlantic, East Pacific, and Central North Pacific DPSs and the endangered Central West Pacific and Central South Pacific DPSs (ECOS, No Date-a). Green sea turtles currently face threats from bycatch in fishing gear, ocean pollution and debris, disease, harvest of eggs, and intentional killing (NMFS, No Date-a).

The North Atlantic DPS includes turtles that nest and hatch on beaches along the Atlantic, Caribbean, and Gulf coasts of Central and North America and islands of the northwest Caribbean, and the Atlantic coast of Mauritania. The population is widespread. There are approximately 167,500 nesting females in the DPS at 74 known nesting sites, with 79 percent nesting at a single site in Costa Rica. Of the nesting sites with enough data to establish population trends, three sites were stable and four were increasing as of 2015 (Seminoff, 2015).

The South Atlantic DPS includes turtles that nest and hatch along the Atlantic and Caribbean coasts of South America, southeast Caribbean islands, and west coast of Africa. The population is widespread. There are approximately 63,300 nesting females in the DPS at 51 known nesting sites, with 51 percent nesting at a single site in Bissau. Of the nesting sites with enough data to establish population trends, two sites were stable and one could not be determined as of 2015 (Seminoff, 2015).

The East Pacific DPS includes turtles that nest and hatch on beaches along the Pacific coasts of North, Central, and South America and islands of the eastern Pacific. The population exhibits a limited spatial range. There are approximately 20,000 nesting females in the DPS at 39 known nesting sites, with 58 percent nesting at a single site in Mexico. The only nesting site with enough data to establish a population trend was increasing as of 2015 (Seminoff, 2015).

The Central North Pacific DPS includes turtles that nest and hatch on the islands of the Hawaiian Archipelago. The population exhibits a limited spatial range. There are approximately 3,800 nesting females in the DPS at 13 known nesting sites, with 96 percent nesting at a single site in Hawai'i. The only nesting site with enough data to establish a population trend was increasing as of 2015 (Seminoff, 2015).

The Central West Pacific DPS includes turtles that nest and hatch in an area very roughly bounded as follows: 41° north to 13° south latitude and 129° east to 175° west longitude. The highest levels of nesting in the area include sites in Micronesia, two islands of Japan, Marshall Islands, and Palau. The population is moderately dispersed. There are approximately 6,500 nesting females in the DPS at 51 known nesting sites, with 22 percent nesting at a single site in Micronesia. The only nesting site with enough data to establish a population trend was increasing as of 2015 (Seminoff, 2015).

The Central South Pacific DPS includes turtles that nest and hatch in an area very roughly bounded as follows: nine degrees north to 40° south latitude and 171° east to 96° west longitude. This includes a portion of New Zealand, Fiji, Tuvalu, Kiribati, French Polynesia, American Samoa, Cook Islands, Tokelau, Tonga, and Easter Island, Chile. The population is widespread. There are approximately 167,500 nesting females in the DPS at 59 known nesting sites, with 36 percent nesting at a single site in French Polynesia. No nesting sites had enough data to establish population trends as of 2015 (Seminoff, 2015).

3.6.1.3.3 Hawksbill

Hawksbill sea turtles (**Figure 3.6-6**) can generally be found in tropical waters of the Atlantic and Pacific, as well as the Gulf of Mexico, Caribbean Sea, and along the east coast of the U.S. as far north as Massachusetts. Young hawksbills spend a few years among drift materials in the pelagic zone before moving to coastal areas. As adults, the turtles can be found in coral reef, hard bottom, sea grass, algal bed, mangrove, and estuary habitats. Hawksbills are omnivorous, feeding on sponges, algae, corals, invertebrates, and inorganic material. The shapes of hawksbill mouths and beaks give the turtles their name and help them obtain food from small holes and difficult to reach areas of coral reefs. They take 20 to 35 years to mature and at full growth reach approximately 1 m (30 to 35 in) in length and weigh up to 70 kgs (150 lbs). Upon reaching maturity, hawksbills nest every 2 to 7 years in the vicinity of beaches where they hatched. Hawksbills can migrate from 80 to over 1,600 km (50-1,000 mi) between feeding and nesting grounds. The lifespan of the turtles is unknown but expected to be relatively long (NMFS, No Date-a; NMFS and USFWS, 2013a).

Figure 3.6-6. Hawksbill

Photo credit: Don McLeish, NOAA/NMFS/PIFSC

Historically, a combination of factors led to the decline of hawksbill populations, the most detrimental of which was the taking of turtles for their shells. The shells exhibit a unique marbled appearance and were the source of “tortoise shell” used in jewelry, handicrafts and other decorative applications. The tortoise shell trade led to the near extinction of the species. In 1970, hawksbills were listed as threatened wherever the species occurs (ECOS, No Date-a) and trade in their shells has been internationally banned (NMFS, No Date-a). In 1982, terrestrial critical habitat for hawksbill was designated in Puerto Rico in the vicinity of Isla Mona, Culebra Island, Cayo Norte, and Isla Culebrita. In 1998, marine critical habitat was designated around Isla Mona and Isla Munito, Puerto Rico (NMFS and USFWS, 2013a).

Hawksbills currently face threats primarily from habitat loss, but also from bycatch in fishing gear, vessel strikes, pollution and debris, intentional killing, and hybridization. Global populations modelled at 88 sites showed that all 63 of the sites with conclusive data had population declines over the last 100 years, while 25 sites were inconclusive. More recently, 41 sites were assessed and showed about two thirds of the sites were still in decline, while about a quarter were increasing and the remaining were stable (NMFS and USFWS, 2013a). Internationally, the species is currently identified as critically endangered with declining populations (IUCN, 2022).

3.6.1.3.4 Kemp’s Ridley

Kemp’s ridley sea turtles (**Figure 3.6-7**) can generally be found in the Gulf of Mexico and the northwest Atlantic as far north as the Grand Banks and Nova Scotia. Nesting occurs on beaches along the Gulf coasts of Mexico and the U.S. and at isolated locations along the Atlantic coast from Florida through North Carolina (NMFS and USFWS, 2015). Young Kemp’s ridleys move into the pelagic zone of the Gulf of Mexico and sometimes the Atlantic and spend 1 to 2 years amongst Sargassum floats. Upon reaching about 20 cm (8 in) in size the turtles migrate to coastal zones for the remainder of their development and adult lives. Kemp’s ridleys are omnivorous as young and early juveniles feeding among Sargassum mats, but generally prefer crabs as late-juveniles and adults when inhabiting coastal waters; they may also perform scavenging roles. They take about 13 years to mature and at full growth reach approximately 0.7 m (2.25 ft) in length and weigh up to 45 kgs (100 lbs). Upon reaching maturity, Kemp’s ridleys nest every 1 to 3 years en masse in arribadas (large waves of arriving females). The lifespan of the turtles is unknown but expected to be at least 30 years (NMFS, No Date-a).

Figure 3.6-7. Kemp's Ridley Sea Turtle

Photo credit: Kate Sampson, NOAA Fisheries

Kemp's ridley sea turtles were once abundant in the Gulf of Mexico, with a single arribada observed in 1947 containing up to 40,000 turtles. By the late 1960s, the largest recorded arribadas contained 1,500 to 5,000 turtles. Nesting sites that hosted tens of thousands of turtles in the 1940s were estimated to be used by only 250 females in 1985. The historical decline of Kemp's ridley populations has been attributed to egg collection, killing of nesting females, and bycatch (NMFS and USFWS, 2015). In December 1970, Kemp's ridleys were listed as endangered wherever the species occurs (ECOS, No Date-a). No critical habitat has been designated for the species.

Although the Kemp's ridley made a limited recovery from its low in the mid-1980s, overall nests again declined from 2009. The turtles currently face threats from chemical pollution, fisheries interactions, and habitat degradation and loss (NMFS and USFWS, 2015; NMFS, No Date-a).

3.6.1.3.5 Olive Ridley

Olive ridleys (**Figure 3.6-8**) are the most numerous of the sea turtles with global estimates of 800,000 females nesting annually (NMFS, No Date-a). Olive ridleys can generally be found in tropical waters of the Pacific and Atlantic, though they have been observed as far north as Alaska. In the Atlantic they are generally observed only south of Florida. Olive ridleys do not nest in the U.S. (NMFS and USFWS, 2014). They are one of two sea turtle species that inhabit pelagic zones throughout their lives, apart from migrating to breeding and nesting grounds and occasional instances of populations inhabiting coastal waters. Olive ridleys are omnivorous foragers and have been observed over 3,800 km (2,400 mi) from shore. They take 7 to 17 years to mature and at full growth reach approximately 0.5m (22 to 31 in) in length and weigh up to 45 kgs (100 lbs). Upon reaching maturity, olive ridleys nest yearly en masse in arribadas. The lifespan of the turtles is unknown but expected to be relatively long (NMFS, No Date-a).

In 1978, olive ridleys were listed as threatened wherever the species occurs except for the endangered breeding colony populations on the Pacific coast of Mexico (ECOS, No Date-a). No critical habitat has been identified for olive ridleys.

Endangered olive ridley populations in Mexico seem to have stabilized. Threatened populations in the eastern Pacific are in decline at some nesting beaches, while they are stable or increasing at others, with too little data to assign an overall trend. Threatened populations in the western Atlantic are very small, with some nesting populations declining and others increasing (NMFS and USFWS, 2014). Olive ridley populations continue to face threats from bycatch in fishing gear, vessel strikes, pollution and debris, harvest of eggs, and killing of adults (NMFS, No Date-a).

Figure 3.6-8. Olive Ridley Sea Turtle

Source: World Wildlife Fund

3.6.1.3.6 Leatherback

Leatherback sea turtles (**Figure 3.6-9**) can generally be found in very broad ranges of the Atlantic and Pacific, with known ranges along nearly the entire coastline of the continental U.S., Hawai'i, Puerto Rico, the U.S. Virgin Islands, and observations as far north as Alaska (NMFS and USFWS, 2013b). They are one of two sea turtle species that spends the majority of its life in pelagic habitat apart from nesting. Leatherbacks' mouths are adapted to their carnivorous diet of soft-bodied jellyfish and salps (planktonic tunicates). It is believed that the turtles take 9 to 29 years to mature. At full growth leatherbacks reach approximately 1.5 m (4.5 to 5.5 ft) in length and weigh up to 1,000 kgs (2,200 lbs). Upon reaching maturity, they nest every 2 to 3 years, often on different beaches. The turtles can migrate up to 16,000 km (10,000 mi) each year, including up to 6,000 km (3,700 mi) each way to and from foraging and nesting grounds. Leatherbacks can dive to almost 1,200 m (4,000 ft) below the ocean surface. The lifespan of the turtles is unknown but expected to be relatively long (NMFS, No Date-a).

Figure 3.6-9. Leatherback Sea Turtle

Photo credit: Dru Devlin, NOAA

In 1970, leatherbacks were listed as endangered wherever the species occurs. In 1978, terrestrial critical habitat was designated in the U.S. Virgin Islands on the southwestern side of St. Croix at Sandy Point National Wildlife Refuge, and the following year marine critical habitat was designated along the same coast. In 2012, additional marine critical habitat was designated off the coasts of California, Oregon, and Washington (NMFS and USFWS, 2013b).

Leatherbacks currently face threats from habitat alteration and loss, bycatch in fishing gear, vessel strikes, pollution and debris, harvest of eggs, intentional killing (NMFS, No Date-a), and depredation (NMFS and USFWS, 2013b). Eastern Pacific populations of leatherbacks have collapsed, while Atlantic populations seem to be stable or increasing. This could be due to more consistent availability and quality of forage in the Atlantic resulting in higher reproduction rates (NMFS and USFWS, 2013b).

3.6.2 Environmental Consequences for Sea Turtles

This section discusses the potential impacts on sea turtles, all of which are ESA-listed, and sea turtle habitat of Alternatives A, B, and C. Activities described in Sections 2.4.1 through 2.4.13 that occur on NOS projects and that could be expected to have impacts on sea turtles and their habitats in the action area include crewed vessel operations, anchoring, ROV and autonomous vehicles, use of echo sounders, use of ADCPs, use of acoustic communication systems, use of sound speed data collection equipment, operation of drop/towed cameras and video systems, collection of bottom grab samples, tide gauge installation/maintenance/removal, GPS reference station installation, and SCUBA operations.

3.6.2.1 Methodology

The factors from NOS activities that could impact sea turtles and sea turtle habitat include: (1) active underwater acoustic sources (e.g., echo sounders, ADCPs, and acoustic communication systems); (2) vessel and equipment sound (e.g., from surface vessels, ROVs, and autonomous vehicles); (3) vessel presence and movement (e.g., surface vessels, ROVs, and autonomous vehicles); (4) vessel wakes (e.g., from surface vessels; ROVs; and autonomous vehicles); (5) accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters (e.g., from vessel operations); (6) underwater activities (e.g., use of underwater survey equipment; anchors; and divers); and (7) onshore activities (e.g., installation, maintenance, and removal of tide gauges and GPS reference stations). These potential impact causing factors and their associated impacts on sea turtles and sea turtle habitat are discussed below. Note that use of the term “sea floor” in the analysis below also includes lake and river bottoms where NOS activities could occur.

As discussed in Section 3.2.2, significance criteria were developed for each resource to provide a structured framework for assessing impacts from the alternatives and the significance of the impacts. The significance criteria for impacts to sea turtles were developed to encompass the context and intensity of NOS activities as they relate to direct and indirect impacts to sea turtles and designated critical sea turtle habitat. The significance criteria for sea turtles are shown in **Table 3.6-2**.

Table 3.6-2. Significance Criteria for the Analysis of Impacts to Sea Turtles

Impact Descriptor	Context and Intensity	Significance Conclusion
Negligible	Impacts to sea turtles would be limited to temporary (lasting several hours) behavioral disturbances to individuals located within the project area. No mortality or debilitating injury to any individual sea turtle would occur. There would be no displacements of sea turtles from preferred breeding and feeding areas, nesting beaches, or migratory routes. Impacts (e.g.,	Insignificant

Impact Descriptor	Context and Intensity	Significance Conclusion
	increased water turbidity, displacement of marine macroinvertebrate prey) on sea turtle habitat would be temporary with no lasting damage or alteration.	
Minor	Impacts to sea turtles would be temporary or short-term (lasting several days to several weeks) and within the natural range of variability of species' populations, habitats, and the natural processes sustaining them. This could include non-life-threatening injury to individual sea turtles and small short-term disruptions of time-sensitive behaviors such as breeding, nesting, or the emergence and dispersal of hatchlings. Displacement of sea turtles from preferred breeding and feeding areas, nesting beaches, or migratory routes would be short-term and limited to the project area and immediately surrounding areas. Any resulting increased competition, additional energy expenditure, or loss of hatchlings would not affect overall sea turtle population numbers or demographic structure. Impacts on habitat (e.g., short-term displacement of marine macroinvertebrate prey, increased turbidity) would be easily recoverable with no long-term or permanent damage or alteration.	
Moderate	Impacts to sea turtles would be short-term or long-term (lasting several months or longer) and outside the natural range of variability of species' populations, habitats, and the natural processes sustaining them. This could include debilitating injury or mortality and some short-term disruption of time-sensitive behaviors such as breeding, nesting, or the emergence and dispersal of hatchlings. Behavioral responses and displacement would be expected from individual sea turtles within the project area, its immediate surroundings, or beyond. Long-term displacement of individuals from preferred breeding and feeding areas, nesting beaches, or migratory routes would occur. Resulting increased competition and energy expenditure would cause losses of breeding or egg-bearing adults and hatchlings, but not at large enough scales to negatively impact overall sea turtle population numbers or demographic structure. Impacts would not threaten the continued existence of any species. Habitat would be damaged or altered potentially over the long term (e.g., degradation of seagrass beds) but would continue to support dependent species.	
Major	Impacts to sea turtles would be short-term or long-term and well outside the natural range of variability of species' populations, habitats, or the natural processes sustaining them. This could include extensive (i.e., affecting a large proportion of the local population), life-threatening, or debilitating injury and mortality, and substantial disruption of time-sensitive behaviors such as breeding, nesting, or the emergence and dispersal of hatchlings.	Significant

Impact Descriptor	Context and Intensity	Significance Conclusion
	Long-term displacement of sea turtles from preferred breeding or feeding areas, nesting beaches, or migratory routes would occur within project areas, their immediate surroundings, and beyond. Behavioral disruptions and displacement would result in the loss of breeding and egg-bearing adults and hatchlings due to increased competition or energy expenditure at scales large enough to affect overall sea turtle population numbers or demographic structure. Full recovery of sea turtle populations would not be expected to occur in a reasonable time. Habitat would be degraded over the long term or permanently such that it would no longer be able to support dependent populations of sea turtles.	

3.6.2.2 Alternative A: No Action - Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

Impacts of Alternative A are discussed below by impact causing factors for sea turtles and their associated habitat. Under Alternative A, excluding survey effort in the Great Lakes which would not impact sea turtles, NOS survey effort would continue to cover a total of 2,633,374 nm (4,877,009 km) across all five regions over the five-year period. Although the survey effort under Alternative A would vary by year (see **Table 3.5-6**), approximately 47 percent of the total linear nautical miles surveyed over the five-year period would continue to be in the Southeast Region. The survey effort in each of the other four regions would continue to be approximately 10 percent of the total survey effort. A slightly higher level of effort would occur in the Alaska Region, which contains approximately 18 percent of the total survey effort, but this area is only rarely visited by sea turtles. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, hearing frequency of the animals, and population density of sea turtles, that add nuance to this trend.

The analysis of impacts on sea turtles considers all of the impact causing factors introduced above and their impacts on sea turtles and sea turtle habitat. Potential impacts could occur in all of the geographic regions. All regions include several sea turtle species and designated critical habitat. The Pacific Islands Region contains the greatest number of sea turtle species, and the Greater Atlantic and Southeast Regions contain the most designated critical habitat areas (see **Table 3.6-1**).

3.6.2.2.1 Active Underwater Acoustic Sources

Active underwater acoustic sources are used to survey a variety of ocean features and could cause impacts to sea turtles from the propagation of underwater sound. The intermittent acoustic pulses used in NOS active surveying range from 0.5 to 1,200 kHz and decrease in intensity with distance from the vessel used by NOS; acoustic characteristics of the active acoustic underwater equipment used by NOS are detailed in Section 2.4. As such, acoustic pulses are typically considered a potential temporary disturbance limited to the immediate vicinity of the vessel used by NOS. Sea turtles are low frequency specialists with a generalized hearing range of 30 to 2,000 Hz (0.03 to 2 kHz) and are most sensitive to sound between 200 and 400 Hz (0.2 and 0.4 kHz) (BOEM, 2014b; NMFS, 2018b; NOAA, 2016; Piniak et al., 2012; and Southwood et al., 2008). Hearing below 80 Hz is less sensitive but still possible (Lenhardt, 1994). Sea turtles may be able to hear low frequency sources that go down to 0.5 kHz. These low frequency sources are used in deeper water, so animals exposed would likely be farther away from the source. However, underwater sound produced by active underwater acoustic sources would mostly be at frequencies reaching up to orders of magnitude above the documented sea turtle hearing range and would therefore be imperceptible to sea turtles and unlikely to cause direct injury, hearing threshold shifts, auditory masking, or behavioral changes.

Similarly, active underwater acoustic sources are not perceptible to sea turtle macroinvertebrate prey (see Section 3.8.2.2.1.1) and would not affect any other characteristics of sea turtle habitat, including designated critical habitat. Sea turtles and their prey are expected to return to project areas after the completion of NOS activities and are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure. Any resulting impacts from active acoustic underwater sources to sea turtles and sea turtle habitat, including designated critical habitat, would continue to be potentially **adverse,** but **negligible** and therefore **insignificant**.

3.6.2.2.2 Vessel and Equipment Sound

Vessel and equipment sound (hereafter vessel sound) represent the majority of the ambient ocean auditory environment and are becoming more prominent with increased human marine activity. Vessel sound is a combination of tonal sounds (sounds with discrete frequencies such as music notes) and broadband sounds (sounds with a combination of many frequencies such as a choir harmonizing) (Richardson et al., 1995), which respectively contribute to hearing threshold shifts and acoustic masking. Vessel sound ranges in frequency from 10 Hz to 10 kHz and is generated predominantly through propeller operation, including cavitation, singing, and propulsion. The intensity of the sound received by sea turtles is dependent on the size and speed of the vessel in question and the distance of the sea turtle from the vessel. Vessel sound has the potential to disrupt normal sea turtle behavior because of their high hearing sensitivity between 200 and 400 Hz.

Underwater sound has the potential to impact sea turtles through hearing threshold shifts or auditory masking. Hearing threshold shifts refer to changes in the hearing range of an organism due to exposure to high intensity sounds. Threshold shifts can be short-term or long-term depending on the intensity of the sound exposure and can result in permanently reduced hearing capabilities of the affected organism. Although hearing threshold shifts in sea turtles are not well studied, the U.S. Navy estimates that exposure to sound intensities of 189 dB and 204 dB could respectively cause temporary and permanent threshold shifts in sea turtles (Navy, 2017b). These estimates were derived using the best available data on sea turtle hearing thresholds and mathematical relationships of threshold shifts in similar species. However, the vessels used by NOS typically produce source levels of 130 to 160 dB while transiting, and only larger vessels outside the scope of this Final PEIS, such as tankers or icebreakers, emit sound with the potential to cause threshold shifts in sea turtles (Erbe, 2013; Erbe et al., 2019). Note that this discussion of impacts on sea turtles from sound intensity (measured in dB) should not be confused with impacts from sound frequency (measured in Hz and kHz); see discussion of underwater sound in Section 3.0. Auditory masking refers to those sounds which do not cause direct changes to hearing thresholds, but have the potential to obscure ecologically relevant sounds to sea turtles. Masking sounds can interfere with the acquisition of prey or mates, the avoidance of predators, and the identification of appropriate nesting sites. There is a small possibility that sound from vessels used by NOS could contribute to auditory masking, but it is unclear whether masking would realistically have any effect on sea turtles since the role of hearing in sea turtle ecology is unknown; there are no quantitative data demonstrating masking effects for sea turtles (BOEM, 2014b).

Underwater sound intensities of 175 to 176 dB, which are roughly equivalent to the airborne sound intensity of a motorcycle engine, evoke erratic behavioral changes in green and leatherback turtles, including evasive maneuvers such as diving or changes in swimming direction or speed (McCauley et al., 2000a). Source levels as low as 166 dB can induce avoidance behaviors in sea turtles and may temporarily displace them from project areas. Although sound produced by vessels used by NOS would typically be outside of this range, source levels may vary by 20 to 40 dB within a ship class due to variability in design, maintenance, and operational parameters (Simard et al., 2016) and could potentially elicit behavioral responses in sea turtles. However, vessel sound attenuates quickly towards the surface of the water column and would not likely be perceptible to sea turtles outside several meters of the immediate vicinity of the vessel or persist after the conclusion of vessel activity. As such, any behavioral changes and displacements would last only for the duration of vessel activity within a given area and would not cause any long-term or permanent changes in sea turtle habitat use, prey availability, or competition.

Vessel sound could potentially have an adverse effect on sea turtle habitat, including designated critical habitat, through the disturbance and displacement of prey populations. Sea turtles, depending on the species, eat seagrasses, algae, fish eggs, and marine macroinvertebrates such as sponges, sea squirts, squid, shrimp, crabs, jellyfish, cuttlefish, or sea cucumbers. Marine invertebrates, including squid, jellyfish, and cuttlefish, are sensitive to low frequency sound ranging from 50 to 400 Hz, although the exact range of invertebrate sound perception is unknown (Mooney et al., 2010; Solé et al., 2016). These important sea turtle prey species could temporarily be disturbed or displaced from project areas by vessel sound (see Section 3.8 Aquatic Macroinvertebrates). However, displacement would likely only last for the duration of vessel operation in the immediate area, and vessel sound is not expected to cause any long-term changes in marine invertebrate behavior or habitat use. Any increased foraging effort, competition, or energy expenditure resulting from displacement of prey species is not expected to substantially affect sea turtles.

Vessel sound would likely only displace sea turtles and prey within the immediate vicinity of vessels used by NOS and would not cause any mortality or direct injury to sea turtles. Sea turtles and their prey are expected to return to project areas after the completion of NOS activities and are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure. Sound is a common byproduct of oceanic vessel activity, and the impacts created by sound from vessels used by NOS would be indistinguishable from those produced by all other vessels. As such, the impacts to sea turtles and sea turtle habitat, including designated critical habitat, from vessel and equipment sound generated during NOS activities would continue to be **adverse**, **negligible**, and therefore **insignificant**.

3.6.2.2.3 Vessel Presence and Movement

Although many NOS projects involve vessel operations and activity, they comprise only a very small proportion of the total amount of vessel operations within the action area (see Section 2.4.1). As such, the resulting impacts of vessel operations on sea turtles only contribute marginally to the overall impact of all vessel presence and movement within a given area. Nevertheless, vessel presence and movement as a result of NOS projects could cause sea turtle–vessel interactions including visual disturbance, vessel strikes, underwater turbulence from vessel wakes, and reduction or displacement of sea turtle prey. To minimize turtle-vessel interactions, if one or more sea turtles is sighted while the vessel is underway, attempts would be made to maintain a distance of 45 m (50 yards) or greater whenever possible.

Much like vessel sound, the visual presence of vessels used by NOS could disrupt normal sea turtle behavior and displace individuals from project areas. Very little research exists on sea turtle responses to vessel disturbance, but one study suggests that sea turtles may habituate to vessel sound and may be more likely to respond to the presence of vessels (Hazel et al., 2007). The visual presence of vessels used by NOS in a given area could potentially cause behavioral changes in nearby sea turtles, including evasive maneuvers such as diving or changes in swimming direction or speed. Sea turtles would also likely be temporarily displaced from project areas while vessels are present. However, only sea turtles within approximately 10 m (33 ft) of vessels appear to alter their behavior, regardless of the primary vessel stressor (i.e., sight or sound) motivating the response (Hazel et al., 2007). These behavioral changes and displacements would last only for the duration of vessel activity within a given area and would not cause any long-term or permanent changes in sea turtle habitat use, prey availability, or competition. Vessels operating at night would also use the appropriate lighting necessary to comply with navigation rules and best safety practice in order to avoid visual disturbances to nesting sea turtles and emerging hatchling. As such, increased evasive behavior and additional energy expenditure as a result of vessel presence is not expected to harm individuals or the population.

Vessels used by NOS within the action area could potentially collide with sea turtles, resulting in debilitating injury or death of individuals. Propeller and collision injuries to sea turtles arising from interactions with boats and ships are relatively common; 20.5 percent of observed leatherback sea turtles in the Atlantic Ocean and Gulf of Mexico had sustained propeller injuries in 2004 (NMFS and USFWS, 2008). The sea turtle collision probability of any vessel is contingent upon its size and speed. Larger, relatively slow-moving vessels are less likely to strike sea turtles than smaller vessels travelling at higher speeds because turtles more easily recognize and avoid larger, slow-moving vessels. Given the low speed and small size of most vessels used by NOS (see Section 2.4.1) and NOS would constantly monitor for protected species, collisions are expected to be generally avoided during NOS projects and during transit to a project site. However, behavioral observations of sea turtle vessel avoidance reveal that some sea turtles may be susceptible to vessel strikes at speeds as low as two knots (Hazel et al., 2007). Regardless, the overall probability of collision between vessels used by NOS and sea turtles remains low given that adult and sub-adult sea turtles only spend small proportions of their time at the water surface where they are most susceptible to vessel strikes. Poor visibility conditions at night would impede the ability of vessels used by NOS and sea turtles to recognize and avoid each other, potentially resulting in a higher risk of vessels striking sea turtles engaged in nocturnal feeding, mate searching, and movement towards nesting beaches. Additionally, project areas would be continuously monitored for protected species at all times during vessel operations. However, as sea turtles are predominantly diurnal and do not surface often during the night, and because NOS operations are uncommon at night, the overall probability of nighttime collisions is expected to be very low. As such, the probability of vessels used by NOS striking sea turtles would be very low.

Wakes associated with the movements of vessels used by NOS could also disturb the water column and adversely impact sea turtles within the project area. Moving vessels would displace large amounts of water, and the resulting underwater turbulence could disturb and displace nearby sea turtles. However, this displacement would be temporary, and would occur only while vessels used by NOS are within 10 m (33 ft) of sea turtles (Hazel et al., 2007). Any evasive behavior and energy expenditure as a result of water disturbance from vessel wakes is not expected to substantially affect individuals or populations; sea turtles are expected to return to preferred feeding, breeding, and migratory routes upon departure of the vessel used by NOS. Impacts to sea turtles as a result of displacement would likely increase if the frequency of disturbance increases (i.e., spatially or temporally replicated passes in a given project area), but NOS projects would be coordinated carefully to ensure project areas are not repeatedly sampled unnecessarily (see Section 2.2).

The presence and movement of vessels used by NOS could affect sea turtle habitat, including designated critical habitat, through the disturbance and displacement of macroinvertebrate prey. As with active underwater acoustic sources and vessel sound discussed above, vessel presence and movement would likely displace motile (capable of self-powered motion) macroinvertebrate prey species from project areas through underwater visual disturbance or turbulence from wakes. Prey are expected to return to project areas immediately following vessel activity, and any increased foraging effort, competition, or energy expenditure resulting from the displacement of macroinvertebrate prey is not expected to harm sea turtle individuals or overall sea turtle populations.

Any injury or death to sea turtles would constitute a **moderate** or greater impact, depending on the species, given the protection status afforded to sea turtles by the ESA. However, there is a very low likelihood of vessel strikes, displacement of sea turtles and their prey by vessel presence or wakes would be limited to the immediate project vicinity, and the duration of NOS projects would be on the order of hours, days, or weeks, although a small number of projects may last several months spread across years (see Section 2.4.1). As such, any resulting impacts to individual sea turtles or to overall sea turtle populations, sea turtle prey, and their respective habitat availability would be well within the natural range of variability. Furthermore, vessels used by NOS only represent a negligible portion of overall vessel traffic within the U.S. EEZ, and the impacts created by the movement of vessels used by NOS would be indistinguishable from those produced by all other vessels. Overall, the effects of vessel presence and movement on sea turtles and their habitat, including designated critical habitat, would continue to be **adverse**, **negligible** to **minor**, and therefore **insignificant**.

3.6.2.2.4 Accidental Leakage or Spillage of Oil, Fuel, Chemicals, and Waste

Accidental oil, fuel, or chemical spills as a result of NOS projects could affect sea turtles through various pathways including direct contact, inhalation of the oil or fuel and its volatile components, and ingestion. Several aspects of sea turtle biology and behavior place them particularly at risk for exposure to spilled fuels, including lack of avoidance behavior, indiscriminate feeding in areas where ocean currents converge, and inhalation of large volumes of air before dives (Shigenaka et al., 2021). Turtles surfacing within or near an oil or fuel release may inhale petroleum vapors, causing respiratory stress. Ingested oil or fuel, particularly the lighter fractions, can be acutely toxic to sea turtles. The direct exposure of sensitive tissues (e.g., eyes or other mucous membranes) and soft tissues to diesel fuel or volatile hydrocarbons could produce irritation and inflammation. Oil and fuel also can adhere to turtle skin or shells, prolonging and exacerbating the direct effects of tissue exposure. Larger spills would contaminate areas beyond the immediate project area and increase the likelihood of sea turtle exposure to volatile chemicals and resulting injury or mortality. However, the vast majority of spills or releases are confined to the immediate project area and would disperse quickly within the ocean typically within a day or less (NOAA, 2020a). A small spill would not be likely to result in the death or life-threatening injury of individual turtles or hatchlings, or the long-term displacement of adult turtles from preferred feeding, breeding, or nesting habitats or migratory routes.

All crewed vessels produce some waste through normal operations; during activities, vessels operated by NOS could accidentally lose or discard debris, a major form of marine pollution (Laist, 1997). Vessels used by NOS would generate some waste in the form of metal, wood, glass, paper, and plastic, primarily through galley and food service operations on larger vessels. Marine debris can potentially impact sea turtles through entanglement and ingestion. Entanglement with marine debris is a far more likely cause of mortality to sea turtles than its ingestion; loggerhead turtles have been found entangled in debris ranging from fishing lines to onion sacks (NMFS and USFWS, 2008). Impacts from discarded trash and debris are expected to be avoided through vessel operators’ required compliance with USCG and EPA regulations. In addition, no intentional vessel discharges would occur if a protected species is sighted within 91 m (100 yds) of the vessel used by NOS, and all MARPOL discharge protocols would be followed.

Accidental discharge of oil, fuel, chemicals, or waste could potentially affect sea turtle habitat, including designated critical habitat, through the contamination of prey and sensitive foraging areas. Important sea turtle food sources, such as macroinvertebrates and seagrasses, could become contaminated and bioaccumulate (concentrate ingested substances in tissue) spilled contaminants. These food resources would be additional routes for exposure to and ingestion of volatile chemicals by sea turtles. Breeding and nesting habitat along coastlines adjacent to spills could also potentially be degraded as spilled substances are washed ashore. However, it is unlikely that a small spill in the ocean would reach turtle nests, which are usually located above the high tide line. Large spills that extend beyond the immediate project area have a much greater likelihood of degrading sensitive sea turtle foraging and nesting habitat and could result in long-term changes in sea turtle habitat availability. Assuming proper adherence to waste disposal regulations, prey species would very rarely be exposed to trash and debris from NOS projects. As such, the exposure of sea turtles to oil, fuel, chemicals, or waste from contaminated prey would be negligible and is not expected to threaten individual sea turtles or sea turtle populations.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. For example, on NOAA fleet vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the Commanding Officer takes appropriate action to minimize the effects of the spill. OMAO Procedure 0701-06 VRP/SOPEP provides policy and guidance to all NOAA vessels regarding oil pollution emergency planning and response, in accordance with MARPOL 73/78, Annex I. The plan contains all the information and instruction required for responding to shipboard oil spills, such as general spill mitigation and response, shipboard spill mitigation and response, reporting requirements, completing Corrective Action Assessments, trainings, drills, and exercises. This plan has been approved by the USCG, and complies with the Oil Pollution Act of 1990 and Federal Water Pollution Act of 1973.

Any injury or death to sea turtles would constitute a **moderate** or larger impact, depending on the species, given the protection status afforded to sea turtles by the ESA, NMFS, and USFWS. However, there is only a very low likelihood of small spill occurrence and no possibility of large spills given the size of vessels used by NOS. Displacement of sea turtles and their prey by small amounts of discharged oil, fuel, chemicals, or waste would likely be limited to the immediate vicinity of vessels and dispersal period of the discharged substance. Any resulting impacts to individual sea turtles or sea turtle populations, sea turtle prey, and their respective habitat availability would be well within the natural range of variability. Small spills are a normal byproduct of oceanic vessel activity, and the impacts created by potentially small NOS spills would be indistinguishable from those produced by all other vessels. As such, adverse impacts to sea turtles and sea turtle habitat, including designated critical habitat, from accidental leakage or spillage of oil, fuel, chemicals and waste would continue to be **adverse**, **negligible** to **minor** depending on the spill size and location, and therefore **insignificant**.

3.6.2.2.5 Underwater Activities

The vast majority of NOS underwater activities would result in temporary disturbance to the water column, potentially impacting sea turtles. The lowering and raising of echo sounders, anchors and chains, CTD equipment, sound speed data collection equipment, camera and video systems, and grab samplers could temporarily displace sea turtles and disrupt their behavior. Any evasive behavior and energy expenditure as a result of water disturbance is not expected to affect individuals or populations in the long term; if displaced, sea turtles are expected to return to preferred feeding, breeding, and migratory routes and resume normal activities after completion of NOS projects in the area. The impact on sea turtles should be minimal and cease when the anchoring system or equipment comes to rest or is taken out of the water. However, sea turtles are particularly sensitive to disturbances during seasonal breeding periods and within coastal areas adjacent to nesting habitat. Repeated, prolonged underwater activities in these areas could disrupt important, time-sensitive behaviors, which would likely have more severe or more intense adverse effects on turtles.

Similarly, a number of NOS activities involve trailing the equipment listed above with lines or wire behind and beneath vessels used by NOS, which poses a risk of entangling nearby sea turtles. Although sea turtle entanglement with marine debris is recognized as a major source of mortality, entanglement with equipment is not well studied and is typically limited to fishery-related bycatch (Duncan et al., 2017). Anecdotal accounts indicate that sea turtle mortalities have resulted from entanglement with trailed seismic equipment off the West Coast of Africa (Nelms et al., 2016), which suggests that sea turtles could also become entangled in the various trailed equipment used by NOS during projects. Entangled sea turtles may drown or starve or be struck by vessels due to restricted mobility in addition to potentially suffering physical trauma and/or systemic infections (NMFS, 2018b). However, the trailed equipment used during NOS would only be submerged for periods of time ranging from minutes to hours (see Section 2.4), limiting the potential exposure to sea turtles and possible entanglement. Trailed equipment is also typically more conspicuous than common entanglement hazards such as discarded monofilament fishing line, and nearby sea turtles would likely be able to recognize and avoid trailing equipment. Furthermore, the majority of trailed equipment would stay within meters of the towing vessel and would only potentially impact sea turtles within close range; however, they would likely be displaced by the visual disturbance and sound of the vessel itself (Section 3.6.2.2.2) before they could interact with any trailed equipment. As such, entanglement with trailed NOS equipment is not expected to be a substantial threat to sea turtles.

SCUBA diving activities are included in 248 NOS projects under Alternative A (see **Table 2.6-1**) and have the potential to adversely affect sea turtles through behavioral responses to diver presence. Although SCUBA diving is largely considered a non-invasive activity, exposure to human presence can alter sea turtle behavioral patterns. Recent studies demonstrate that sea turtles are susceptible to disturbance by divers (Schofield et al., 2006; Dunbar et al., 2008) and spend less time foraging when divers are present (Hayes et al., 2017). These behavioral changes would only last for the duration of diver activity in the immediate area and any increased energy expenditure, competition, or nutritional deficiencies are not expected to affect individual sea turtles or the overall sea turtle population. Prolonged or repeated disturbances in seagrass habitat, migratory routes, or sensitive coastal areas adjacent to nesting beaches could disrupt important, time-sensitive behaviors, which would likely have more severe, adverse effects on turtles.

Underwater activities including anchoring, bottom sampling, drop cameras, and mobile ADCPs can disturb the sea floor, increasing sedimentation and potentially adversely affecting sea turtle habitat, including designated critical habitat. Seagrass and macroalgae, important sources of forage for some species of sea turtle, can be directly uprooted by disturbance to the sea floor and are highly sensitive to changes in water quality. Seagrass fields in the Southeast and Greater Atlantic Regions are designated as critical habitat for turtles; direct destruction of seagrass in these areas would adversely impact sea turtle populations. Furthermore, reductions in water quality can also result in displacement of marine macroinvertebrate sea turtle prey. However, seafloor disturbance would be limited to relatively small portions of a given project area and any resulting changes to water quality would be quickly dissipated by the prevailing ocean currents in the area.

To minimize or avoid the potential adverse effects of underwater activities, mitigation measures would be implemented, including (also see Appendix D):

- NOS would not drag anchor chains and would ensure that anchors are properly secured so as to minimize bottom disturbance.
- Deployment of all autonomous systems, instruments, and divers would be suspended if any protected species is sighted within 92 m (100 yards) of the vessel. Work already in progress may continue if the activity is not expected to adversely affect the animal.
- During all buoy deployment and retrieval operations, buoys would be lowered and raised slowly to minimize risk to listed species. In addition, observers would monitor for listed species in the area prior to and during deployment and retrieval. Work would be stopped if listed species are observed in the area to minimize entanglement risk.
- When using a boat or platform to conduct SCUBA operations, at least one person would maintain visual watch for protected species to ensure none are sighted within the working area. If a listed species moves into the work area, cessation of operation of any moving equipment within 15 m (50 ft) of the animal would occur and only resume when the species has left the project area. SCUBA divers involved in in-water activities would have proper training and be capable of responsible dive practices such that they minimize injury to organisms and avoid unnecessary habitat impacts.

Underwater activities would likely only displace sea turtles and prey within the immediate vicinity of vessels used by NOS or divers and would not cause any mortality or direct injury to sea turtles. Sea turtles and their prey are expected to return to project areas after the completion of NOS underwater activities and are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure. As such, the impacts to sea turtles and sea turtle habitat, including designated critical habitat, from underwater activities would continue to be **adverse**, **negligible** to **minor**, and therefore **insignificant**.

3.6.2.2.6 Onshore Activities

NOS onshore projects would comprise installation, operation, and maintenance of shore-based GPS reference stations and installation and maintenance of tide gauges. The majority of sea turtle species move seasonally between foraging and nesting areas (Mansfield et al., 2009; Hawkes et al., 2011). Impacts from onshore projects could potentially occur if the site is located near a nesting beach, in which case it is likely that large numbers of sea turtles would be present both on the beach and within nearshore waters during the nesting season. Female sea turtles are particularly sensitive to human and other artificial disturbances (e.g., anthropogenic light sources) while selecting nest sites, and disturbance resulting from onshore projects could disrupt nesting behavior and decrease nest success. However, since female sea turtles come ashore and dig their nests at night, there is little likelihood of any NOS activities conducted onshore during daytime hours directly disturbing them. Sea turtles are long-lived organisms that have a very low likelihood of surviving to sexual maturity (Davenport, 1997), and decreased nest success would have long-term, adverse effects on the populations of all sea turtle species.

Low-flying aircraft, specifically helicopters, are infrequently used to access GPS reference stations and tide gauges in remote areas of the Alaska Region and could also disturb sea turtles through sound and visual disturbance. Behavioral responses to low-flying aircraft are similar to those caused by vessel sound, presence, and movement and include evasive diving or rapid changes in swimming speed and direction. The level of sea turtle disturbance caused by passing aircraft is contingent upon the aircraft's altitude, the aspect (direction and angle) of the aircraft relative to the receiver, receiver depth and water depth, and seafloor type. However, any exposure of individual sea turtles to aircraft-related sound would be expected to cause only temporary disturbance or displacement from the project area. Furthermore, sea turtles only rarely occur within the Alaskan region, which substantially lowers the likelihood of their exposure to aircraft.

Onshore activity would likely only displace sea turtles and prey within the immediate vicinity of the project area and would not cause any mortality or direct injury to sea turtles. Sea turtles and their prey are expected to return to project areas after the completion of NOS onshore activities and are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure. Given the relatively low level of onshore project activity anticipated, along with the short duration of exposure to sound and visual disturbance, the impacts to sea turtles and sea turtle habitat, including critical habitat, from NOS onshore activities would continue to be **adverse**, **negligible**, and therefore **insignificant**.

3.6.2.2.7 Air Emissions

Smokestack and two-stroke outboard motor emissions from vessels used by NOS would release pollutants, including CO_2, into the atmosphere of the project area and immediately surrounding areas. Higher atmospheric CO_2 levels increase dissolved CO_2 and bicarbonate ions in seawater, which subsequently leads to a decrease in seawater pH and carbonate ions. In general, a decrease in pH corresponds to a simultaneous increase in acidity, termed "ocean acidification." Changes in seawater carbon chemistry may adversely affect marine biota through a variety of biochemical, physiological, and physical processes and interactions. Ocean acidification resulting from higher atmospheric CO_2 levels due to anthropogenic emissions is within the range of sea turtle tolerance and is not expected to cause any direct harm to individuals and the population. Nonetheless, air emissions could potentially degrade sea turtle habitat indirectly, including designated critical habitat, by reducing the availability of macroinvertebrate prey species which are particularly sensitive to acidity during their larval life stages.

It is important to note that vessels used by NOS make up only a small proportion of the total amount of vessel operation (Section 2.4.1) and would only marginally contribute to the overall level of emissions within the action area. However, any emissions of anthropogenic GHG (CO_2, CH_4, and N_2O) by vessels used by NOS would contribute negligibly to ongoing changes in oceanic conditions (as well as atmospheric and terrestrial conditions) (Limpinsel et al., 2017). Thus, NOS projects would not substantially increase air emissions in the oceans and any increased sea turtle competition, foraging effort, or energy expenditure as a result of reduced prey availability from ocean acidification is not expected to substantially affect sea turtle individuals or populations.

Air emissions or their resulting contribution to ocean acidification would not cause any mortality or direct injury to sea turtles. Sea turtle macroinvertebrate prey populations could potentially be affected by ocean acidification, but any changes in population size would be well within the natural range of variability. Sea turtles are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure from air emissions as the amount of emissions from vessels used by NOS would be negligible when compared to emissions from all other vessel activity in the action area. Thus, impacts to sea turtles and sea turtle habitat, including critical habitat, from air emissions would continue to be **adverse**, **negligible** to **minor** due to the ability of air emissions to travel beyond the immediate project area, and therefore **insignificant**.

3.6.2.2.8 Conclusion

Although the effects of impact causing factors on sea turtles and their associated habitat range from negligible to moderate, moderate impacts are only expected in the very unlikely occurrence of an accidental spill of oil, fuel, or chemicals. Since all other impacts range from negligible to minor, the overall impact of Alternative A on sea turtles and their habitat, including designated critical habitat, would continue to be **adverse** and **minor**; therefore, impacts of Alternative A would continue to be **insignificant**.

3.6.2.3 Alternative B: Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations

Projects under Alternative B would take place in the same geographic areas and timeframes as under Alternative A; however, Alternative B would include more projects, activities, and nautical miles traveled than Alternative A. Under Alternative B, excluding survey effort in the Great Lakes which would not impact sea turtles. NOS survey effort would cover a total of 2,896,712 nm (5,364,710 km) across all five regions over the five-year period. Overall, survey effort would cover an additional 263,337 nm (487,701 km) under Alternative B (see **Table 3.5-14**), a 10 percent increase over Alternative A (2,633,374 nm [4,877,009 km] total) across all regions over the five-year period. Thus, the greatest number of nautical miles surveyed each year would be in the Southeast Region (with approximately 47 percent of the survey effort); the level of effort in the other four regions would be at similar levels (approximately 10 percent of the survey effort in each region), and perhaps slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 18 percent), but this area is only rarely visited by sea turtles. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, hearing frequency of the animals, and population density of sea turtles, that add nuance to this trend.

Under Alternative B there would be crewed vessel operations covering 577,000 nm (1,070,000 km), as compared to 518,000 nm (959,000 km) under Alternative A. Vessel operations are among the most disruptive NOS activities to sea turtle populations and could contribute to impacts on sea turtles and sea turtle habitat through visual disturbance, direct collision, vessel sound, vessel wake and underwater turbulence, trailing equipment, accidental spills or waste disposal, and air emissions. Although the amount of crewed vessel operations would be greater under Alternative B than under Alternative A, the additional 59,000 nm (109,000 km) would be distributed across the five regions of the EEZ. While these additional operations would result in greater impacts overall, the associated impact-causing factors would not be concentrated enough in any given area to substantially increase the magnitude of impact (e.g., from negligible to minor). This relationship is consistent for all other impact causing factors from proposed activities, such as onshore disturbance from the installation, maintenance, and removal of tide gauges and installation GPS reference stations; and entanglement risk from anchoring, bottom sample collection, and trailing video equipment.

Impacts of Alternative B on sea turtles and sea turtle habitat, including designated critical habitat, would be the same or slightly, but not appreciably, larger than those discussed above under Alternative A for each impact causing factor given that impacts do not scale proportionally with survey effort. Impacts to sea turtles resulting from Alternative A do not cause long-term changes in habitat use or behavior and would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts on sea turtles and their habitat, including designated critical habitat, would be **adverse**, **minor**, and therefore **insignificant**.

3.6.2.4 Alternative C: Upgrades and Improvements with Greater Funding Support

Projects under Alternative C would take place in the same geographic areas and timeframes as under Alternatives A and B; however, Alternative C would include more projects, activities, and nautical miles traveled, than Alternatives A and B. Under Alternative C, excluding survey effort in the Great Lakes which would not impact sea turtles, NOS survey effort would cover a total of 3,160,049 nm (5,852,411 km) across all five regions over the five-year period. Overall, NOS survey effort would cover an additional 263,337 nm (487,701 km) under Alternative C (see **Table 3.5-21**), an approximate nine percent increase over Alternative B (2,896,712 nm [5,364,710 km] total); and an additional 526,675 nm (975,402 km), an approximate 20 percent increase over Alternative A (2,633,374 nm [4,877,009 km] total) across all regions over the five-year period. Thus, the greatest number of nautical miles surveyed each year would be in the Southeast Region (with approximately 47 percent of the survey effort); the level of effort in the other four regions would be at similar levels (approximately 10 percent of the survey effort in each region), and perhaps slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 18 percent), but this area is only rarely visited by sea turtles. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, hearing frequency of the animals, and population density of sea turtles, that add nuance to this trend.

Under Alternative C, crewed vessel operations would cover 637,000 nm (1,180,000 km), as compared to the 577,000 nm (1,070,000 km) under Alternative B and the 518,000 nm (959,000 km) under Alternative A. Vessel operations are among the most disruptive NOS activities to sea turtle populations and could contribute to impacts on sea turtles and their habitat through visual disturbance, direct collision, vessel sound, vessel wake and underwater turbulence, trailing equipment, accidental spills or waste disposal, and air emissions. Although the amount of crewed vessel operations would be greater under Alternative C than under Alternatives A and B, the additional 119,000 nm (220,388 km) as compared to Alternative A and the additional 60,000 nm (111,000 km) as compared to Alternative B would be distributed across the five regions of the EEZ. While these additional operations would result in greater impacts overall, the associated impact-causing factors would not be concentrated enough in any given area to substantially increase the magnitude of impact (e.g., from negligible to minor). This relationship is consistent for all other proposed activities contributing potential impacts, such as onshore disturbance from the installation, maintenance, and removal of tide gauges and installation GPS reference stations; and entanglement risk from anchoring, bottom sample collection, and trailing video equipment.

Impacts of Alternative C on sea turtles and sea turtle habitat, including designated critical habitat, would be the same or slightly, but not appreciably, larger than those discussed above under Alternative A for each impact causing factor. Impacts to sea turtles resulting from Alternative A do not cause long-term changes in habitat use or behavior and would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts on sea turtles and their habitat, including designated critical habitat, would be **adverse**, **minor**, and therefore **insignificant**.

3.6.2.5 Endangered Species Act Effects Determination

All species of sea turtles occurring within the action area are listed under the ESA, and federal agencies are required under the ESA to formally determine whether their actions may affect sea turtles or their designated critical habitat. Effects determinations divide potential effects into three categories:

- No Effect;
- May Affect, but Not Likely to Adversely Affect; and
- May Affect, and is Likely to Adversely Affect.

Actions receiving a “No Effect” designation do not impact listed species or their designated critical habitat (hereafter listed resources) either positively or negatively; this designation is typically only used in situations where no listed resources are present in the action area. Actions receiving a “May Affect, but Not Likely to Adversely Affect” designation have only beneficial, insignificant, or discountable effects to listed resources. Effects are considered insignificant if they are of low relative impact, undetectable, not measurable, or cannot be evaluated. Adverse effects are considered discountable if they are extremely unlikely to occur. Actions designated as “May Affect, and is Likely to Adversely Affect” will negatively impact any exposed listed resources.

Sea turtles cannot hear the frequencies emitted by active underwater acoustic sources. Furthermore, due to the mobile and temporary nature of the projects, the small area of the sea floor affected during the projects relative to the entire EEZ, and the possibility of any individual sea turtles and their prey temporarily moving away from sounds, the impacts of sound propagation from active underwater acoustic sources to sea turtles would be short term, limited to only a few individuals, and therefore discountable (i.e., extremely unlikely to occur).

The proposed amount of vessel traffic associated with activities would be small in comparison to all the other non-project related vessel traffic in the EEZ. Disturbances from increased vessel traffic, including sound, presence and movement, water column disruption, and accidental waste discharge would be temporary to short-term and would likely only temporarily affect a few individual sea turtles. Additionally, mitigation measures for minimizing or avoiding impacts when one or more sea turtles are sighted while the vessel is underway are included in Appendix D. Because sound disturbance would be of temporary or of short duration and would occur infrequently in any given project area, the response by sea turtles to sound, wakes, and increased traffic from vessels used by NOS would be short term, limited to only a few individuals, and therefore discountable (i.e., extremely unlikely to occur).

The likelihood of an accidental spill is expected to be discountable (i.e., extremely unlikely to occur), and exposure of sea turtles and critical habitats to oil, fuel, and other contaminants is not expected. Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. Thus, effects from chemical contamination on sea turtles are discountable (i.e., extremely unlikely likely to occur).

Although underwater activities and equipment, such as ROVs, ADCPs, bottom samplers, drop cameras, and SCUBA divers could temporarily disturb and displace nearby sea turtles, effects would be temporary and negligible. Mitigation measures that would further minimize any disturbance are included in Appendix D. No large areas of seafloor disturbance by NOS underwater equipment and activities is planned or expected. Thus, the response to underwater equipment and activities by sea turtles would be short term, limited to only a few individuals, and therefore discountable (i.e., extremely unlikely to occur).

Onshore activities, such as aircraft use and the installation of onshore equipment, could potentially disturb and displace sea turtles from sensitive nesting areas, although if this occurs, it would be on a small scale and not widespread (e.g., limited to a few individuals). No substantial changes in sea turtle behavior or habitat use are expected in response to onshore activity; the response of sea turtles to onshore activity would be short term, limited to only a few individuals, and therefore discountable (i.e., extremely unlikely to occur).

NOS concludes that the Proposed Action "May Affect, but Not Likely to Adversely Affect" all sea turtle species occurring in the action area, as listed in **Table 3.6-3**, except hawksbill turtles in the GAR. This species very rarely occurs within GAR and likely would not be encountered during any NOS projects or activities occurring under any of the action alternatives. As such, NOS concludes that the proposed project would have "No Effect" to hawksbill turtles within the GAR.

Since activities may occur in some areas within or adjacent to designated critical habitats, there is the potential for impacts on critical habitat that support sea turtles. Critical habitat may be minimally disturbed through short-term displacements or reductions of sea turtle prey and forage but would remain functional to maintain viability of dependent species. Due to the potential for effects that could range from negligible to minor as described in Sections 3.6.2.2-4, the Proposed Action "May Affect, but Not Likely to Adversely Affect" the designated critical habitat occurring in the action area (except for hawksbill turtles in the GAR as discussed above) as listed in **Table 3.6-3**.

Table 3.6-3. Summary of Effects Determinations for ESA-Listed Sea Turtles and Critical Habitat

ESA- Listed Sea Turtles, DPS (if applicable)	Species Determination	Critical Habitat Determination
Loggerhead – *Caretta caretta*		
Northwest Atlantic	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
North Pacific	May Affect, but Not Likely to Adversely Affect	N/A* (no critical habitat designated)
Green – *Chelonia mydas*		
North Atlantic	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
South Atlantic	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Central North Pacific	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Central West Pacific	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Central South Pacific	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
East Pacific	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Hawksbill – *Eretmochelys imbricate*		
Hawksbill turtles within the SER, WCR, and PIR	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Hawksbill turtles within the GAR	No Effect	No Effect

ESA- Listed Sea Turtles, DPS (if applicable)	Species Determination	Critical Habitat Determination
Kemp's Ridley – *Lepidochelys kempii*		
--	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Olive Ridley – *Lepidochelys olivacea*		
--	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Leatherback – *Dermochelys coriacea*		
--	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect

3.7 FISH

This section discusses the affected environment and environmental consequences that would result under each alternative for fish in the action area.

3.7.1 Affected Environment

This section provides an overview of fish in the action area, and specifically addresses fish of ecological or economic concern. The action area includes both marine fish in the U.S. EEZ and freshwater fish in the Great Lakes and rivers. These include fish species that are listed under the ESA, are associated with designated EFH (see Section 3.9 for a complete discussion of EFH), or are considered the basis of important fisheries. These fish are further addressed and discussed relative to their sensitivity to sound associated with proposed activities. The following sections provide descriptions of the fish, their hearing ability and sensitivity to sound, threatened and endangered designations, and regional distributions of fish and critical habitat.

Globally, there are over 30,000 species of fish, existing in marine (salt water) and freshwater environments. Some fish are diadromous species that spend a portion of their life cycle in both fresh water and salt water. Anadromous fish, a subset of diadromous species, hatch in fresh water, spend most of their lives in the salt water of the ocean, and then return to fresh water to spawn (e.g., salmon, smelt, shad, striped bass, and sturgeon). Catadromous fish, another subset of diadromous species, do the opposite; they live in fresh water and enter salt water to spawn (e.g., eels). Marine and freshwater fish are discussed separately, but the discussion of hearing ability and sensitivity to sound applies to all fish.

3.7.1.1 Marine Fish

Marine fish that live in the ocean consist of:

- Coastal fish that inhabit the sea between the shoreline and the edge of the continental shelf;
- Deep sea fish that live below the photic zone of the ocean, i.e., where not enough light penetrates for photosynthesis to occur;
- Pelagic fish that live near the surface of the ocean;
- Demersal fish that live on or near the bottom of the ocean; and
- Coral reef fish that are associated with coral reefs.

Marine fish occupy a wide variety of water depths and habitats. The vast majority of marine fishes are free-swimming pelagic forms. Other diverse and sometimes abundant fish species inhabit near-bottom and demersal (bottom) habitats (**Figure 3.7-1**), including flatfishes (Order Pleuronectiformes including soles, halibuts, and allies); sharks, skates, and rays; hagfishes; sturgeons; cods; rat-tails; and many others (Nelson, 2016). In general, sturgeons (Order Acipenseriformes), the herring-like fishes (Order Clupeiformes), and the cod-like fishes (Order Gadiformes) tend to occur only within the confines of the continental shelf. Other higher groups of fish are more widely dispersed. Some are highly migratory (e.g., tunas, lampreys, herrings, salmons) while others show high site fidelity (e.g., lingcod, some rockfishes, tropical reef fishes) (NSF and USGS, 2011). **Figure 3.7-2** depicts these ecological diversities among the higher groups of fish.

Figure 3.7-1. Demersal Flatfishes

Photo Credit: BreakingTheWalls

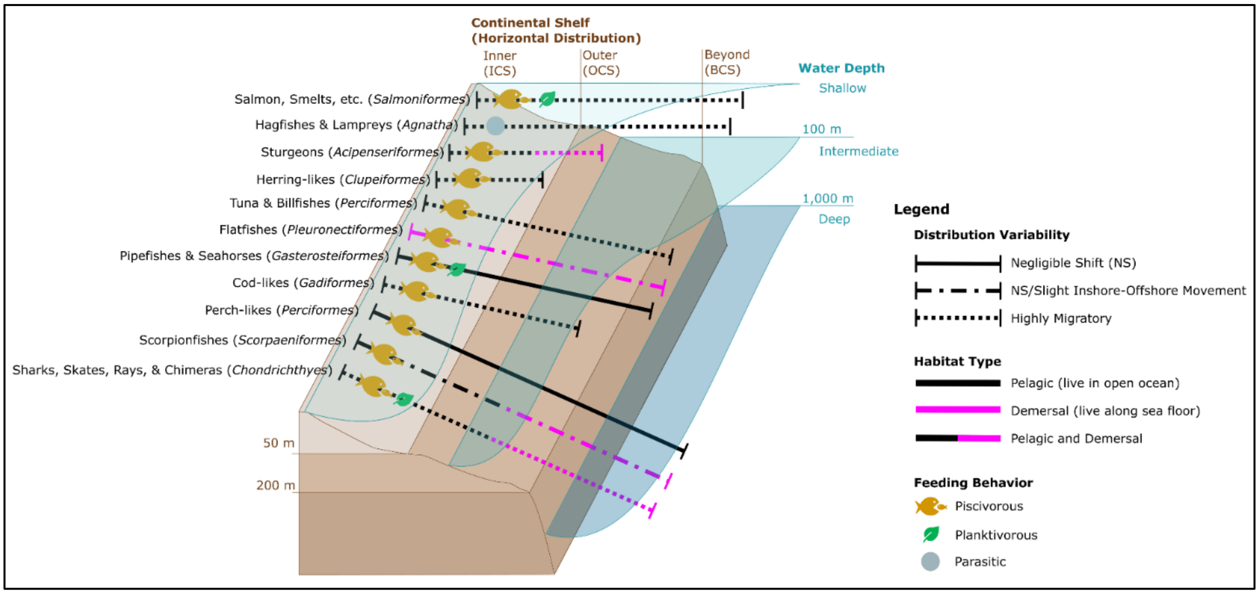
Most marine fish are piscivorous, meaning they primarily eat other fish. A few, such as anchovies, whale sharks, and basking sharks, are predominantly or exclusively planktivorous, consuming primarily small invertebrates (e.g., krill, zooplankton). Relatively few are primarily dependent on phytoplankton or macroalgae (e.g., seaweed like kelp) as food for much of their life cycle (NSF and USGS, 2011).

One system for classifying marine fish involves categorizing them into 11 main higher taxonomic groups (Sea Around Us, No Date). This classification system revolves around commercial species, but excludes many species of fish that are not commercial and might not fall into any of these higher groups. Therefore, marine fish can also be organized into groups based on ecology and habitat preferences. Taxa with special status (i.e., listed under ESA) occur within five of the higher groups: two Perciformes, eight Salmoniformes, two Scorpaeniformes, four Chondrichthyes, and three Acipenseriformes (see **Table 3.7-1**). The taxonomic groups, general ecology (i.e., habitat and feeding behavior), and general distribution and migratory movements of the marine fish in the action area are summarized in **Figure 3.7-2** and discussed briefly below.

Fish species distributions vary relative to major environmental factors such as water depth, salinity, temperature, and habitat type; but when viewed on a broad scale, they collectively segregate into recognizable multi-species assemblages. Many species overlap to some degree in these ecological groups, due in part to the different habitat areas used by different life stages (NMFS, 2016a). Based on general ecology and the three-dimensional occurrence of marine fish in the sea, fish can be grouped into the following assemblages: nearshore-demersal, nearshore-pelagic, oceanic-demersal, and oceanic-pelagic. An additional assemblage unique to polar regions is the cryopelagic fish assemblage. The term cryopelagic is used to describe fish that actively swim in nearshore or oceanic waters but are associated during their life cycle with ice or water immediately below the ice (NMFS, 2016a). An example is the Arctic cod which often occurs in ice holes, near the ice edge, or among broken ice.

Demersal resources include hard bottom fishes and soft bottom fishes. Hard bottom generally refers to exposed rock but includes other substrata such as coral and artificial structures. Hard bottom features provide structurally complex shelter, feeding opportunities, and hydrodynamic benefits for permanent and temporary fish associates (BOEM, 2014a). Hard bottom supports assemblages of sessile (non-mobile) organisms including algae, sponges, octocorals, and stony corals. Common families of hard bottom associated fishes are moray eels (Muraenidae), squirrelfishes (Holocentridae), groupers and sea basses

(Serranidae), scorpionfishes (Scorpaenidae), grunts (Haemulidae), snappers (Lutjanidae), porgies (Sparidae), wrasses (Labridae), damselfishes (Pomacentridae), angelfishes (Pomacanthidae), blennies (Labrisomidae and Blenniidae), and triggerfishes (Balistidae). Individual species from these families exhibit differential distributions across the continental shelf (or shelf), generally depending on water depth.



Sources: NMFS, No Date-a; Sea Around Us, No Date; ECOS, No Date-a

Notes:

Typical water depth: S = shallow (<100 m), I = intermediate (100-1,000 m), D = deep (>1,000 m).

Habitat Type: D = demersal; P = pelagic.

Feeding behavior: PV = piscivorous, PN = planktivorous, PS = parasitic, S = scavenger.

Horizontal Distribution: ICS = inner continental shelf (<50 m water depth), OCS = outer continental shelf (50-200 m), BCS = beyond continental shelf (>200 m).

Distribution Variability: NS = negligible shift, IO = slight inshore-offshore movement, HM = highly migratory.

Figure 3.7-2. Summary of the Status, General Ecology, and General Distribution and Movement of Marine Fish Groups Potentially Occurring within the Action Area

Soft bottom or sedimentary habitat is composed of medium to coarse carbonate sands distributed over an extensive continental shelf (BOEM, 2014a). Soft bottom is not always flat or featureless but forms structures at various spatial scales, including large shoals, medium sand waves, smaller sand ripples, and interstitial space among sediment grains. The presence and form of these features vary with distance from shore, latitude, water depth, proximity to river discharge, prevailing currents, and wave energy. Families of soft bottom demersal fishes include skates (Rajidae), rays (Dasyatidae, Myliobatidae, and Gymnuridae), snake eels (Ophichthidae), searobins (Triglidae), drums and croakers (Sciaenidae), lizardfishes (Synodontidae), sand flounders (Paralichthyidae), and tonguefishes (Cynoglossidae). Members of these families, as well as others, are distributed widely across the continental shelf and upper slope (the outer shelf), and individual species are represented in different depth-related assemblages.

Although nearshore-pelagic species associate with structured bottom, they respond primarily to water column structure (temperature, salinity, DO) and circulation (currents, eddies, fronts), which vary seasonally and spatially (BOEM, 2014a). Large-scale influences on water column structure and circulation also vary across the shelf. Inner shelf waters are driven primarily by river discharge, winds, and tidal action.

Intermediate shelf waters are mostly wind driven, whereas shelf-edge and upper slope waters are influenced primarily by actions such as the Gulf Stream. Coastal pelagic fishes include requiem sharks (Carcharhinidae), dogfish sharks (Squalidae), anchovies (Engraulidae), herrings (Clupeidae), mackerels (Scombridae), jacks (Carangidae), mullets (Mugilidae), bluefish (Pomatomidae), and cobia (Rachycentridae). Coastal pelagic species traverse shelf waters throughout the year, and many migrate during particular seasons.

The oceanic-pelagic assemblage consists of epipelagic and mesopelagic fish. Epipelagic fishes inhabit the upper 200 m (656 ft) of the water column in oceanic waters beyond the continental shelf edge (BOEM, 2014a). Families of epipelagic fishes include sharks (Lamnidae and Sphyrnidae), flyingfishes (Exocoetidae), halfbeaks (Hemiramphidae), oarfishes (Regalecidae and Lophotidae), snake mackerels (Gempylidae), jacks (Carangidae), dolphin (Coryphaenidae), pomfrets (Bramidae), marlins, sailfish and spearfish (Istiophoridae), swordfish (Xiphiidae), tunas (Scombridae), medusafishes (Centrolophidae), molas (Molidae), and triggerfishes (Balistidae). A number of these species, such as mahi-mahi (*Coryphaena hippurus*), sailfish (*Istiophorus platypterus*), white marlin (*Kajikia albida*), blue marlin (*Makaira nigricans*), and tunas (**Figure 3.7-3**), are important to commercial and recreational fisheries. Below the epipelagic zone, the water column may be layered into mesopelagic (200-1,000 m [656-3,280 ft]) and bathypelagic (>1,000 m [3,280 ft]) zones. Taken together, these two zones and their inhabitants may be referred to as midwater. In the mesopelagic zone, fish assemblages are numerically dominated by lanternfishes (Myctophidae), bristlemouths (Gonostomatidae), and hatchetfishes (Sternoptychidae). Mesopelagic fishes, while less commonly known, are ecologically important because they transfer significant amounts of energy between mesopelagic and epipelagic zones over each daily cycle. Lanternfishes are important prey for meso- and epipelagic predators (e.g., tunas), upper slope hard bottom fishes, and particularly the mesopelagic dragonfishes (Stomiiformes). The bathypelagic group is composed of little-known species such as snipe eels (Nemichthyidae), slimeheads (Trachichthyidae), deep-sea anglers (Melanocetidae), bigscales (Melamphaidae), and whalefishes (Cetomimidae). Most bathypelagic species are capable of producing and emitting light (bioluminescence) to aid in communicating in an environment devoid of sunlight (BOEM, 2014a).

Figure 3.7-3. Pelagic Atlantic Tunas

Photo Credit: Jeff Muir *©ISSF*

Important ecological considerations for fish resources of concern with respect to NOS activities are life-history and reproductive characteristics. These are important determinants of population-scale vulnerability or robustness to disturbance. However, the reproductive strategies of marine fishes vary greatly, including those that bear live young, those that disperse their young as larvae, those that fertilize externally and broadcast their eggs, those that spawn into bottom-attached egg masses, or the nests (redds) of river spawners. More fecund fishes that have large ranges and high rates of dispersal tend to be more resilient to exploitation, disturbance, or other population-level stressors than those that are restricted to smaller areas and specific microhabitats.

In terms of commercial value, the herring-like fishes (e.g., herrings, sardines, shads, and anchovies) and cod-like fishes (e.g., cods, haddocks, hakes, pollocks, and whitings) are the most economically important. Next are perch-like fishes (the most modern, diverse, and speciose order, the Perciformes). The salmons and smelts (Order Salmoniformes) are also of great commercial importance.

The U.S. Geological Survey Nonindigenous Aquatic Species database tracks distributions of non-native marine fish, as well as other introduced aquatic species (USGS, No Date). One species that has become established along the southeast coast of the U.S., the Caribbean, and in parts of the Gulf of Mexico at unprecedented and alarming speed is the Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) which is native to the tropical and subtropical areas of the southwest Pacific and Indian Oceans.

3.7.1.2 Freshwater Fish

Nearly half of all fish species live in fresh water. Freshwater fish spend some or all of their lives in fresh water, such as rivers and lakes, with a salinity of less than 1.05 percent. These environments differ from marine conditions in many ways, the most obvious being the difference in levels of salinity. Freshwater fish are generally separated into one of three different categories (warmwater, coldwater, or coolwater) based on water temperature and the associated amount of oxygen in the water at each temperature range. For example, cold water holds more oxygen than warm water, which means coldwater fish require higher oxygen levels in order to survive.

Warmwater fish species, such as largemouth bass (*Micropterus salmoides*), bluegill, catfish, crappies, and sunfish, can live in a wide range of conditions. Although they can survive cold winters in the northern states and can be found throughout most of the U.S., warmwater species thrive best when water temperatures are around 26ºC (80ºF). Coldwater fish live in water cold enough throughout the year to support species such as brook and rainbow trout, Atlantic salmon, slimy sculpin, blacknosed and longnose dace, white suckers, and the non-native brown trout. Coldwater lakes and rivers generally occur in northern states with a temperature range of 4-15°C (40-60°F). Muskellunge, northern pike, walleye, and yellow perch are common coolwater fish species. These types of freshwater fish prefer water temperatures in-between the other two categories. Because these species grow best in water temperatures that range in the 15-21ºC (60-70ºF), they are most often found in the northern and midwestern states.

More than 150 native fish species occur in the Great Lakes. There are three major thermal groupings for fish communities in the Great Lakes based on their preferred summer temperature preference: warmwater (e.g., shad [Clupeidae family], catfishes [Ictaluridae family], basses and sunfishes [Centrarchidae family], and drum [Sciaenidae family]); coolwater (e.g., yellow perch [*Perca flavescens*], walleye [*Sander vitreus*], sturgeon [Acipenseriformes], and pikes [*Esox* spp.]); and coldwater (e.g., trout and salmon [Salmonidae family], whitefishes [*Coregonus* spp.], and deepwater sculpin [*Myoxocephalus thompsonii*]) (USACE, 2019).

Given these temperature tolerances, fish species diversity, composition, and productivity differ to various degrees among the five Great Lakes, in part because of the latitudinal temperature gradient from Lake Superior to Lake Erie. In Lake Erie, warm-water species like walleye are common, while salmonids predominate in the rest of the four cooler lakes. Within the lakes, abundance and diversity are generally highest in nearshore habitats because of the higher plankton productivity and complex habitat structure. Year-round species in nearshore waters are typically warm- or cool-water species, although nearshore waters are used seasonally for spawning by fish that primarily inhabit cold, deep water (USACE, 2019). Examples of deepwater species using nearshore waters for spawning are lake trout (*Salvelinus namaycush*), lake whitefish (*Coregonus clupeaformis*), burbot (*Lota lota*), and sculpins (Corridae family). Commercially and recreationally important species can be found in all the lake habitats. Economically valuable native fishes in the Great Lakes include smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), yellow perch, whitefish, and walleye. Nonnative species, like the Pacific salmonids (*Oncorhynchus* spp.), brown trout (*Salmo trutta*), and rainbow trout (*Oncorhynchus mykiss*) are also economically important.

Non-native fish species in the Great Lakes include common carp (*Cyprinus carpio*), alewife (*Alosa pseudoharengus*), sea lamprey (*Petromyzon marinus*) (**Figure 3.7-4**), round goby (*Neogobius melanostomus*), and rainbow smelt (*Osmerus mordax*) (USACE, 2019). There has also been intentional introduction of nonnative Pacific salmon into the Great Lakes including coho salmon (*Oncorhynchus kisutch*) and Chinook salmon (*O. tshawytscha*) (USACE, 2019).

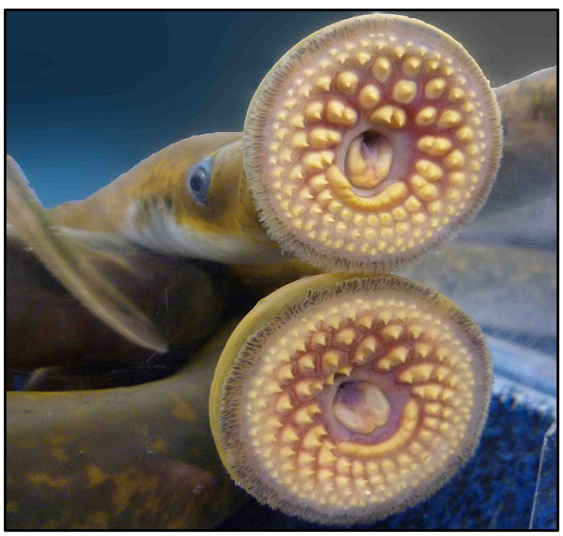


Figure 3.7-4. Sea Lamprey

Photo Credit: Ted Lawrence/Great Lakes Fishery Commission

3.7.1.3 Sound Production and Hearing

Sound plays a major role in the lives of all fish (e.g., Zelick et al., 1999; Fay and Popper, 2000). This is particularly the case since sound travels much farther in water than other potential signals and is not impeded by darkness, currents, or obstacles in the environment. Thus, fish can glean a great deal of information about biotic (living) and abiotic (environmental) sources and get information about the environment at a very substantial distance from the source (e.g., the presence of a reef, or the sounds produced by swimming predators). Many species of bony fishes communicate with sounds and use sounds in a wide range of behaviors including mating and territorial interactions (BOEM, 2014a).

Hearing has been studied in only a few of the >30,000 species of fish. While fish may vary in their ability to detect and use sound and vary in their potential susceptibility to damage by sound, it is evident that there are common mechanisms of fish hearing (Popper et al., 2003).

Sound is detected by fish with their inner ear, which in many ways is similar to the vestibular apparatus of mammals. Fish do not have external openings to the ear and sound is not coupled to the ear as it is with terrestrial animals. Because fish have a similar acoustic impedance as the water, they move with the water in a passing sound wave (Yan, 2004). The otoliths of fish otolithic end organs (their inner ears) are denser than water and consequently move less during an acoustic disturbance than the fish as a whole. It is this relative motion of the otolith and the rest of the fish that all fish are able to sense as sound (Fay, 1988), and this mechanism of hearing means that fish naturally sense the particle motion aspect of sound as opposed to the pressure aspect that terrestrial animals sense. Pressure and particle motion are part of any sound wave, and some fish have specialized adaptations that allow them to additionally sense the pressure aspect of sound. Fish that are additionally sensitive to pressure use a gas-filled internal cavity near the ears, such as the swim bladder, that deforms with the pressure wave. The deformation of the gas bubble relays pressure information to the ears either because of its close proximity to the ears or because of direct mechanical coupling to the ears (e.g., Weberian ossicles).

The hearing frequency range of most fish is below approximately 1,500 Hz with the most sensitive range below 800 Hz. The hearing range of pressure-sensing fish is typically extended to a few kHz (up to about 4 kHz). It should be noted, however, that at least three species of herring-like fishes detect sounds above 20 kHz (ultrasound). This does not apply for the Atlantic herring (*Clupea harengus*) (Mann et al., 1997). These fish are thought to have evolved high-frequency sound detection in response to dolphin predation, but the mechanism for sensing the sound is not well understood.

Fishes can be categorized acoustically depending on how they might be affected by sounds based on the presence or absence of a swim bladder and on the potential for that swim bladder to improve the hearing sensitivity and range of hearing (Popper et al., 2014; BOEM, 2014a):

- <u>Fishes with no swim bladder or other gas chamber</u>. These species are less susceptible to barotrauma (injury from excessive water pressure) and only detect particle motion, not sound pressure. However, some barotrauma may result from exposure to sound pressure. The highest frequency of hearing is likely to be no greater than 400 Hz, with poor sensitivity compared to fishes with a swim bladder. Fishes within this group include flatfish, some gobies, some tunas, and all sharks and rays (and relatives).
- <u>Fishes with swim bladders in which hearing does not involve the swim bladder or other gas volume</u>. These species are susceptible to barotrauma although hearing only involves particle motion, not sound pressure. These fishes detect sounds from below 50 Hz to perhaps 800-1,000 Hz (though several probably detect sounds only to 600-800 Hz). A wide range of species fall into this category, including tuna with swim bladders, sturgeons, salmonids, etc. These species detect both particle motion and pressure, and the differences between species are related to how well the species can use the pressure signal.
- <u>Fishes that have some kind of structure that mechanically couples the inner ear to the swim bladder</u> (or other gas bubble), thereby resulting in detection of a wider bandwidth of sounds and lower intensities than fishes in other groups. These fishes detect sounds up to 3,000 Hz or more. There are not many marine species known to fit in this group, but it may include some species of sciaenids. It is also possible that a number of deep-sea species fall within this category based on

the morphology of their auditory system. Other members of this group would include all of the Otophysan fishes, though few of these species other than catfishes are found in marine waters.

- Fishes in which hearing involves a swim bladder or other gas volume. These species are susceptible to barotrauma and detect sound pressure as well as particle motion. All of these fishes are members of the herring family and their relatives (Clupeiformes). Their hearing below 1,000 Hz is generally similar to fishes in the first group, but their hearing range extends to at least 4,000 Hz, and some species (e.g., American shad) are able to detect sounds to over 180 kHz.

3.7.1.4 Threatened and Endangered Species

Nineteen ESA-listed fish species (comprising 49 distinct species, subspecies, Evolutionarily Significant Units [ESUs], or DPS total) potentially occur throughout the action area (**Table 3.7-1**). Additionally, there is one salmon ESU that is a candidate for listing. Of all the species, two are perch-likes, eight are salmonid species, two are scorpionfishes, four are sharks and rays, and three are sturgeons. All but eight of the listed fish also have designated critical habitat (**Table 3.7-1**). There are no federally-listed threatened or endangered fish species present within the Great Lakes.

Table 3.7-1. ESA-Listed Fish Occurring in the Action Area

Common Name	Scientific Name	ESA Status	Lead Agency	Region*	Critical Habitat
Perch-likes (Perciformes)					
Nassau grouper	*Epinephelus striatus*	Threatened	NMFS	SER	No
Tidewater goby	*Eucyclogobius newberryi*	Endangered	USFWS	WCR	Yes
Salmon, Smelts, etc. (Salmoniformes)					
Atlantic salmon (Gulf of Maine DPS)	*Salmo salar*	Endangered	USFWS/ NMFS	GAR	Yes
Chinook salmon (California Coastal ESU)	*Oncorhynchus tshawytscha*	Threatened	NMFS	WCR	Yes
Chinook salmon (Central Valley Spring-run ESU)	*Oncorhynchus tshawytscha*	Threatened	NMFS	WCR	Yes
Chinook salmon (Lower Columbia River ESU)	*Oncorhynchus tshawytscha*	Threatened	NMFS	WCR	Yes
Chinook salmon (Puget Sound ESU)	*Oncorhynchus tshawytscha*	Threatened	NMFS	WCR	Yes
Chinook salmon (Sacramento River Winter-run ESU)	*Oncorhynchus tshawytscha*	Endangered	NMFS	WCR	Yes
Chinook salmon (Snake River Fall-run ESU)	*Oncorhynchus tshawytscha*	Threatened	NMFS	WCR	Yes
Chinook salmon (Snake River Spring/Summer-run ESU)	*Oncorhynchus tshawytscha*	Threatened	NMFS	WCR	Yes

Common Name	Scientific Name	ESA Status	Lead Agency	Region*	Critical Habitat
Chinook salmon (Upper Columbia River Spring-run ESU)	*Oncorhynchus tshawytscha*	Endangered	NMFS	WCR	Yes
Chinook salmon (Upper Willamette River ESU)	*Oncorhynchus tshawytscha*	Threatened	NMFS	WCR	Yes
Chinook salmon (Upper Klamath-Trinity River)	*Oncorhynchus tshawytscha*	Candidate	NMFS	WCR	--
Chum salmon (Columbia River ESU)	*Oncorhynchus keta*	Threatened	NMFS	WCR	Yes
Chum salmon (Hood Canal Summer-run ESU)	*Oncorhynchus keta*	Threatened	NMFS	WCR	Yes
Coho salmon (Central California Coast ESU)	*Oncorhynchus kisutch*	Endangered	NMFS	WCR	Yes
Coho salmon (Lower Columbia River ESU)	*Oncorhynchus kisutch*	Threatened	NMFS	WCR	Yes
Coho salmon (Oregon Coast ESU)	*Oncorhynchus kisutch*	Threatened	NMFS	WCR	Yes
Coho salmon (Southern Oregon/Northern California Coast ESU)	*Oncorhynchus kisutch*	Threatened	NMFS	WCR	Yes
Sockeye salmon (Ozette Lake ESU)	*Oncorhynchus nerka*	Threatened	NMFS	WCR	Yes
Sockeye salmon (Snake River ESU)	*Oncorhynchus nerka*	Endangered	NMFS	WCR	Yes
Steelhead (California Central Valley DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes
Steelhead (Central California Coast DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes
Steelhead (Lower Columbia River DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes
Steelhead (Middle Columbia River DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes
Steelhead (Northern California DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes
Steelhead (Puget Sound DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes
Steelhead (Snake River Basin DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes

Common Name	Scientific Name	ESA Status	Lead Agency	Region*	Critical Habitat
Steelhead (South Central California Coast DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes
Steelhead (Southern California DPS)	*Oncorhynchus mykiss*	Endangered	NMFS	WCR	Yes
Steelhead (Upper Columbia River DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes
Steelhead (Upper Willamette River DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes
Bull trout (Coastal Recovery Unit)	*Salvelinus confluentus*	Threatened	USFWS	WCR	Yes
Eulachon (Southern DPS)	*Thaleichthys pacificus*	Threatened	NMFS	WCR, AR	Yes
Scorpionfishes (Scorpaeniformes)					
Bocaccio (Puget Sound/Georgia Basin DPS)	*Sebastes paucispinis*	Endangered	NMFS	WCR, AR	No
Yelloweye rockfish (Puget Sound/Georgia Basin DPS)	*Sebastes ruberrimus*	Threatened	NMFS	WCR, AR	Yes
Sharks, Skates, Rays, & Chimeras (Chondrichthyes)					
Giant manta ray	*Manta birostris*	Threatened	NMFS	GAR, SER, PIR	No
Scalloped hammerhead shark (Eastern Pacific DPS)	*Sphyrna lewini*	Endangered	NMFS	WCR, PIR	No
Scalloped hammerhead shark (Central and Southwest Atlantic DPS)	*Sphyrna lewini*	Threatened	NMFS	SER	No
Scalloped hammerhead shark (Indo-West Pacific DPS)	*Sphyrna lewini*	Threatened	NMFS	PIR	No
Largetooth sawfish	*Pristis pristis*	Endangered	NMFS	SER	No
Smalltooth sawfish	*Pristis pectinata*	Endangered	NMFS	SER	No
Sturgeons (Acipenseriformes)					
Atlantic sturgeon (New York Bight DPS)**	*Acipenser oxyrinchus*	Endangered	NMFS	GAR	Yes
Atlantic sturgeon (Carolina DPS)**	*Acipenser oxyrinchus*	Endangered	NMFS	SER	Yes
Atlantic sturgeon (Chesapeake Bay DPS)**	*Acipenser oxyrinchus*	Endangered	NMFS	GAR	Yes
Atlantic sturgeon (South Atlantic DPS)**	*Acipenser oxyrinchus*	Endangered	NMFS	SER	Yes

Common Name	Scientific Name	ESA Status	Lead Agency	Region*	Critical Habitat
Atlantic sturgeon (Gulf of Maine DPS)**	*Acipenser oxyrinchus*	Threatened	NMFS	GAR	Yes
Atlantic sturgeon (Gulf of Mexico subspecies)	*Acipenser oxyrinchus desotoi*	Threatened	USFWS/ NMFS	SER	Yes
Green sturgeon (Southern DPS)	*Acipenser medirostris*	Threatened	NMFS	WCR	Yes
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered	NMFS	GAR, SER	No

Sources: ECOS, No Date-a; NMFS, No Date-a

*GAR = Greater Atlantic Region (includes the U.S. portions of the Great Lakes, New England, and the mid-Atlantic); SER = Southeast Region (includes the southern portion of the U.S. Eastern Seaboard, the U.S. Caribbean Islands [Puerto Rico and the U.S. Virgin Islands], and the Gulf of Mexico); AR = Alaska Region (includes Alaskan waters and the Arctic); WCR = West Coast Region (includes coastal California, Oregon and Washington); PIR = Pacific Islands Region (includes Hawai'i and territories of the U.S.)

** All five Atlantic sturgeon DPSs mix in the offshore/marine environment (i.e., an adult Atlantic sturgeon encountered in the Atlantic Ocean could be from any one of the five DPSs).

3.7.1.4.1 Nassau Grouper

The Nassau grouper (**Figure 3.7-5**) is a reef fish associated with hard structures such as reefs, rocks, and ledges. They are late-maturing, long-lived, top-level predators. Nassau grouper used to be one of the most common species of grouper in the U.S. but became scarce due to commercial and recreational fishing (NMFS, No Date-a). The remaining stocks are overexploited, but all harvest of Nassau grouper is prohibited in the U.S. Some countries have limited or no regulations in place to protect Nassau grouper.

Figure 3.7-5. Nassau Grouper

Photo Credit: NMFS

The Nassau grouper was listed as threatened under the ESA in 2016. Data are scarce on historical Nassau grouper numbers. Currently, Nassau grouper are occasionally reported during underwater reef surveys at low density. Based on the size and number of current spawning aggregations, the Nassau grouper population appears to be just a fraction of its historical size (NMFS, No Date-a).

Nassau grouper are ambush predators that are not selective with their prey. Adults eat only fish, while juveniles eat a variety of fish and invertebrates (e.g., shrimp and crabs). They take advantage of lower light levels at dawn and dusk, combined with the higher number of prey during changeover between diurnal and nocturnal fishes (NMFS, No Date-a).

Nassau grouper are found in tropical and subtropical waters of the western North Atlantic. This includes Bermuda, Florida, Bahamas, the Yucatan Peninsula, and throughout the Caribbean to southern Brazil. They generally live among shallow reefs, but can be found in depths to 130 m (426 ft) (NMFS, No Date-a). The Nassau grouper is considered a reef fish, but it transitions in habitat and diet as it grows. As larvae, they eat plankton. As juveniles, they are found in nearshore shallow waters in seagrass habitats. They shift deeper as they grow to predominantly reef habitat.

Water clarity, habitat, and benthos are important to determining the distribution of Nassau grouper (NMFS, No Date-a). Their depth range may be influenced more by the availability of suitable habitat than by food resources since their diet is highly varied and has more to do with body size than of water depth. Nassau grouper tend to spend a lot of time in one spot, often on high-relief coral reefs or rocks in clear water. Larger fish tend to occupy deeper reef areas with greater vertical relief. Both adults and juveniles use either natural or artificial reefs.

Nassau grouper spawn in aggregations, gathering in hundreds, thousands, or tens of thousands. The aggregations form from November through February around the full moon when water temperatures are around 26°C (79°F) (NMFS, No Date-a). The timing and synchronization of spawning may be to accommodate widely dispersed adults, facilitate egg dispersal, or reduce predation on adults or eggs. As spawning time approaches, adults move from the reefs where they live to specific spawning areas. Some of them travel only a few kilometers/miles; others are known to travel up to several hundred kilometers to the aggregation sites. Sites have been found near the edges of reefs as little as 46 m (150 ft) from the shore and near drop-offs into deeper water across a wide range of depths (6-60 m [20-200 ft]) and environments (including soft corals, sponges, stony coral outcrops, and sandy depressions).

3.7.1.4.2 Tidewater Goby

The tidewater goby, endemic to California, is a small fish rarely more than 2 inches in length. It was listed as threatened under the ESA in 1994, and critical habitat was designated in 2000. Populations of the tidewater goby are described as being discontinuously distributed along most of the California coast. Tidewater gobies are found spread across their original range; however, within that range, 17 percent of the populations have been extirpated, and 41-52 percent of the populations are so small and degraded that their long-term survival appears uncertain (EPA, 2010). Gaps in distribution along the coast may be natural due to steep coastlines, or due to the extirpation of populations. Because the tidewater goby is adapted to a narrow range of salinity tolerance, the marine environment limits genetic exchange between populations and recolonization of habitat following extirpations.

The tidewater goby is threatened by modification and loss of habitat as a result of coastal development, channelization of habitat, diversions of water flows, groundwater overdrafting, and alteration of water flows (USFWS, 2005). Potential threats to the tidewater goby include discharge of agricultural and sewage effluents, increased sedimentation due to cattle grazing and feral pig activity, summer breaching of lagoons, upstream alteration of sediment flows into the lagoon areas, introduction of exotic gobies (e.g., yellowfin goby [*Acanthogobius flavimanus*] and shimofuri goby [*Tridentiger bifasciatus*]) and rainwater killifish (*Lucina parva*), habitat damage, and watercourse contamination resulting from vehicular activity in the vicinity of lagoons.

Tidewater gobies are nearly unique among Pacific coast fish in that they inhabit the fresh-saltwater interface where salinity is less than 10 to 12 parts per thousand. This occurs both at the upper edge of tidal bays (such as Tomales, Bolinas, and San Francisco Bays) near the entrance of freshwater tributaries and in coastal lagoons formed at the mouths of coastal rivers, streams, and seasonally wet canyons (EPA, 2010). These habitats provide the relatively shallow and still, but not stagnant, water that tidewater gobies prefer. Seasonal variation such as spring floods can scour lagoons, breaching the sandbar barriers established during the previous season, and flushing tidewater gobies into an unfavorable marine environment. The deeper, backwater habitats offer safe harbor for tidewater gobies during the spring floods. Half-grown and adult tidewater gobies may migrate upstream from the estuaries into tributaries, a distance of 0.8 km (0.5 mi) to 5-8 km (3-5 mi) (EPA, 2010).

Upstream locations appear to be used for reproduction, which can occur year-round, peaking in April-May after the lagoons close to the ocean, and again later in summer. Males dig burrows in clean, coarse sand. Females compete with one another for access to these burrows, where they deposit a clutch of eggs. The male goby then remains in the burrow with the eggs until they hatch 9-11 days later (EPA, 2010). For a couple of days, the young hang out in midwater, before becoming benthic (settling to the bottom to live and feed). Tidewater gobies prey on chironomid midge larvae, mysid shrimp, ostracods, and amphipods. In turn, they are prey for young steelhead, staghorn sculpin, tule, and Sacramento perch, nonnative fish such as bass and shimofuri gobies, and many birds such as egrets, herons, mergansers, grebes, and loons (EPA, 2010).

Critical habitat includes stream channels and their associated wetlands, flood plains, and estuaries along the California coast (USFWS, 2005). These habitat areas provide for the primary biological needs of foraging, sheltering, reproduction, and dispersal, which are essential for the conservation of the tidewater goby.

3.7.1.4.3 Atlantic Salmon (Gulf of Maine Distinct Population Segment)

The anadromous Atlantic salmon (**Figure 3.7-6**) are vulnerable to many stressors and threats, including blocked access to spawning grounds, habitat degradation caused by dams and culverts, and poor marine survival (NMFS, No Date-a). They are considered an indicator species: when a river ecosystem is clean and well-connected, its salmon population is typically healthy and robust; when a river ecosystem is not clean or well-connected, its salmon population will usually decline. Atlantic salmon in the U.S. were once native to almost every coastal river northeast of the Hudson River in New York. Commercial fishing reduced their population size until the fisheries closed in 1948. Commercial and recreational fishing for wild sea run Atlantic salmon is still prohibited in the U.S.

Currently, the last wild populations of U.S. Atlantic salmon are found in at least eight rivers in Maine. These populations comprise the Gulf of Maine DPS which was listed as endangered under the ESA in 2009. This DPS includes all naturally reproducing wild populations and those river-specific hatchery populations of Atlantic salmon that have historical, river-specific characteristics. These populations are found north of and including tributaries of the lower Kennebec River to, but not including, the mouth of the St. Croix River at the U.S.-Canada border. Critical habitat was also designated for the Gulf of Maine DPS in 2009. Worldwide, Atlantic salmon populations in single rivers range from thousands to nearly a quarter million; however, some populations are small, numbering in the low hundreds or even single individuals (NMFS, No Date-a).

Figure 3.7-6. Atlantic Salmon

Photo Credit: Design Pics Inc.

Adult Atlantic salmon can migrate several times to spawn, though repeat spawners are becoming increasingly rare (NMFS, No Date-a). They travel long distances from the mouths of rivers to the Atlantic Ocean before returning to their natal rivers. For example, U.S. salmon leave Maine rivers in the spring and reach the seas off Newfoundland and Labrador, Canada, by mid-summer. They spend their first winter at sea south of Greenland and their second growing season at sea off the coast west of Greenland and sometimes east of Greenland. Maturing fish travel back to their native rivers in Maine to spawn after 1 to 3 years. The diet of Atlantic salmon depends on their age. Young salmon eat insects, invertebrates, and plankton. The preferred diet of adult salmon is capelin, which are elongated silvery baitfish.

There are three groups of Atlantic salmon: North American, European, and Baltic (NMFS, No Date-a). These groups are found in the waters of North America, Iceland, Greenland, Europe, and Russia. Atlantic salmon spawn in the coastal rivers of northeastern North America, Iceland, Europe, and northwestern Russia. After spawning, they migrate through various portions of the North Atlantic Ocean. European and North American populations of Atlantic salmon intermix while living in the ocean, where they share summer feeding grounds off Greenland. The North American group historically ranged from northern Quebec to Newfoundland and to Long Island Sound. This group includes Canadian populations and U.S. populations.

Designated critical habitat comprises 45 specific areas in Maine occupied by Atlantic salmon at the time of listing with approximately 19,571 km (12,161 mi) of perennial river, stream, and estuary habitat and 799 km^2 (308 mi^2) of lake habitat within the range of the Gulf of Maine DPS and in which are found those physical and biological features essential to the conservation of the species (74 FR 39903, August 10, 2009). The critical habitat is defined by seven habitat features essential to spawning and rearing and six habitat features essential to migration.

3.7.1.4.4 Pacific Salmon

Pacific salmon are anadromous, with a life cycle occurring in a chain of connected environments as the salmon travel through freshwater streams, estuaries, nearshore areas, and the ocean. Each of these habitats provides crucial elements for the salmon's survival as they cycle through incubation, emergence, freshwater rearing, estuary transition, ocean residence, migration, and spawning. Pacific salmon are also semelparous, meaning that they die after spawning only once. Their total energies are devoted to producing the next generation, and their bodies help enrich the stream for that generation and other wildlife species (NMFS, 2007a).

Salmonid species' homing propensity (their tendency to return to the locations where they originated) creates unique patterns of genetic variation and connectivity among spawning areas across the landscape. Diverse genetic, life history, and morphological characteristics have evolved in salmon over generations, creating runs adapted to diverse environments. Two criteria define an ESU of salmon: (1) it must be substantially reproductively isolated from other conspecific units, and (2) it must represent an important component of the evolutionary legacy of the species. An ESU can contain multiple populations that are connected by some degree of migration, and hence may have a broad geographic range across watersheds, river basins, and political jurisdictions (NMFS, 2013).

For salmon, and other anadromous fish, the essential features of designated critical habitat include substrate, water quality, water quantity, water temperature, food, riparian vegetation, access, water, velocity, space, and safe passage. These features also describe the habitat factors associated with viability for all ESUs (NMFS, 2009). Designated critical habitats for Pacific salmon comprise the specific areas, or portions of the areas, where the runs are located.

3.7.1.4.5 Chinook Salmon (California Coastal Evolutionarily Significant Unit, Central Valley Spring-run Evolutionarily Significant Unit, Lower Columbia River Evolutionarily Significant Unit, Puget Sound Evolutionarily Significant Unit, Sacramento River Winter-run Evolutionarily Significant Unit, Snake River Fall-run Evolutionarily Significant Unit, Snake River Spring/Summer-run Evolutionarily Significant Unit, Upper Columbia River Spring-run Evolutionarily Significant Unit, Upper Willamette River Evolutionarily Significant Unit)

Chinook are the largest of the Pacific salmon species with adults usually exceeding 0.45 kg (40 lbs), and often over 45 kg (100 lbs). Chinook salmon are often referred to as king salmon. They generally spawn between September and January. Wild Chinook salmon populations have been, and continue to be, threatened by a legacy of habitat degradation, hydropower impacts, harvest, and hatchery production (NMFS, 2013). Each listed ESU of Chinook salmon is briefly described below.

The California Coastal ESU was listed as threatened under the ESA in 1999, and critical habitat was designated in 2005. This ESU extends from Redwood Creek (Humboldt County, California) south to the Russian River (Sonoma County, California) (NMFS, 2016b). The ESU was historically composed of 38 populations (32 fall run and six spring run); all six of the spring-run populations in the ESU are now considered extinct. Chinook salmon have declined substantially in coastal populations of central and northern California over the past 70 years, and all life stages of Chinook salmon are impaired by degraded habitat conditions. These impairments are due to a lack of complexity and shelter formed by instream wood, high sediment loads, lack of refugia during winter, low summer flows, reduced quality and extent of coastal estuaries and lagoons, and reduced access to historic spawning and rearing habitat. The major sources of these impairments are roads, water diversions and impoundments, logging, residential and commercial development, severe weather patterns, and channel modification. In 1965, the estimated adult population for this ESU was over 76,000 (NMFS, 2016b). The most current available data indicate ESU and population-level abundances are now considerably lower; but in the Russian River, adult returns have apparently improved in recent years.

The Central Valley Spring-run ESU was listed as threatened under the ESA in 1999, and critical habitat was designated in 2005. This ESU includes naturally spawned spring-run Chinook salmon originating from the Sacramento River in California and its tributaries, and also spring-run Chinook salmon from the Feather River Hatchery Spring-run Chinook Program (NMFS, 2014a). Historically, spring-run Chinook salmon occurred in the headwaters of all major river systems in the California Central Valley where natural barriers to migration were absent. The Central Valley as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s. Beginning in the 1880s, harvest, water development, construction of dams that prevented access to headwater areas, and habitat degradation significantly reduced the number and range of spring-run Chinook salmon. From 1970 through 2012, Central Valley spring-run Chinook salmon annual run size estimates fluctuated from highs near 30,000 to lows near 3,000 (NMFS, 2014a).

The Lower Columbia River ESU was listed as threatened under the ESA in 1999, and critical habitat was designated in 2005. This ESU includes all naturally spawned populations of Chinook salmon from the Columbia River and its tributaries from the river's mouth at the Pacific Ocean upstream to and including the Hood River in Oregon and the White Salmon River in Washington, including the Willamette River to Willamette Falls, Oregon, but excluding spring run Chinook salmon in the Clackamas River (NMFS, 2013). It also includes Chinook salmon from 17 artificial propagation programs. Lower Columbia River Chinook salmon are classified as spring, fall, or late fall based on when adults return to fresh water. Other life history differences among run types include the timing of spawning, incubation, emergence in fresh water, migration to the ocean, maturation, and return to fresh water. This life history diversity allows different runs of Chinook salmon to use streams as small as 3 m (10 ft) wide and rivers as large as the mainstem Columbia River. Depending on run type, Chinook rear for a few months to a year or more in freshwater streams, rivers, or the estuary before migrating to the ocean in spring, summer, or fall. All runs migrate far into the North Pacific on a multi-year journey along the continental shelf to Alaska before circling back to their river of origin. Out of the 32 populations that make up this ESU, only the two late-fall runs, the North Fork Lewis and Sandy, are considered viable. Most populations (26 out of 32) have a very low probability of persistence over the next 100 years, and some have been extirpated or nearly so (NMFS, 2013).

The Puget Sound ESU was listed as threatened under the ESA in 1999; critical habitat was designated in 2005. This ESU includes the Nooksack River in the north to southern Puget Sound, including the Hood Canal, and extends westerly out the Strait of Juan de Fuca to the Elwha River in Washington (NMFS, 2007a). The Skagit River and its tributaries constitute what was historically the predominant system in Puget Sound containing naturally spawning populations. Although 22 populations of Chinook salmon have been identified in Puget Sound, historically it is believed that there may have been 30-37 populations or spawning aggregations. Threats to the ESU include access to important spawning and rearing areas eliminated as a result of dams, culverts and other barriers, and fragmented, modified, and lost habitat. Chinook populations in the Nooksack, Lake Washington, mid-Hood Canal, Puyallup, and Dungeness basins have recently had returns of less than 200 adult fish annually. Only two populations, the Upper Skagit and Green/Duwamish have had annual average returns in excess of 10,000 adult Chinook (NMFS, 2007a).

The Sacramento River Winter-run ESU was first listed as threatened under the ESA in 1989 and reclassified as endangered in 1994; critical habitat was designated in 1993. This ESU includes winter-run Chinook salmon spawning naturally in the Sacramento River and its tributaries in California, as well as winter-run Chinook salmon that are part of the conservation hatchery program at the Livingston Stone National Fish Hatchery (NFH) (NMFS, 2014a). Winter-run Chinook salmon are unique because they spawn during summer months when air temperatures usually approach their yearly maximum. A major factor affecting Chinook salmon in the Central Valley was hydraulic gold mining, which began in the 1850s. By 1859, an estimated 8,000 km (5,000 mi) of mining flumes and canals diverted streams used by salmonids for spawning and nursery habitat, and an estimated 1.5 billion cubic yards of debris was sluiced into the streams and rivers of the Central Valley. Additionally, one of the main threats to the Sacramento River winter-run Chinook salmon ESU is that it consists of only one small population. This population declined from nearly 100,000 spawners in the late 1960s to fewer than 200 in the early 1990s. In 2017, the population estimate was an average of 1,155 returning winter-run Chinook salmon (CDFW, 2018).

The Snake River Fall-run ESU was listed as threatened under the ESA in 1992; critical habitat was designated in 1993. This ESU includes all natural-origin fall-run Chinook salmon from the mainstem Snake River below Hells Canyon Dam (the lowest of three impassable dams that form the Hells Canyon Complex) and from the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins in Idaho, Oregon, and Washington (NMFS, 2017a). Fall-run Chinook salmon from four artificial propagation programs are also considered part of the ESU: Lyons Ferry Hatchery Program, Fall Chinook Acclimation Ponds Program, Nez Perce Tribal Hatchery Program, and the Oxbow Hatchery Program. At one time approximately half a million adult fall Chinook salmon traveled 485 km (300 mi) up the Columbia River and into the Snake River basin each year. The fish spawned throughout the 965-km (600-mi) reach of the mainstem Snake River from its confluence with the Columbia River upstream to Shoshone Falls, as well as in several major tributaries. The fall Chinook salmon run began to decline in the late 1800s and continued to decline through the 1900s as a result of overfishing and other human activities including the construction of major dams on the mainstem Snake River and tributaries that barred fish access to primary spawning and rearing habitats. By the late 1980s, average runs of natural-origin fall Chinook salmon to the Snake River had dropped to approximately 100 adults annually. Only about 78 natural-origin adult fish returned to spawn in 1990. The abundance for the 10 years of annual spawner estimates from 2005-2014 is approximately 6,400 adult fish (NMFS, 2017a).

The Snake River Spring/Summer-run ESU was listed as threatened under the ESA in 1992, and critical habitat was designated in 1993. This ESU includes all naturally spawned spring/summer Chinook salmon originating from the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, as well as spring/summer Chinook salmon from 11 hatchery programs in Idaho, Oregon, and Washington (NMFS, 2017b). Spring/summer-run Chinook salmon from the Snake River basin represent two of four different seasonal (i.e., spring, summer, fall, or winter) runs in the Chinook salmon migration from the ocean to fresh water. These runs reflect the timing of when adult Chinook salmon enter fresh water to begin their spawning migration. Historically, the Snake River was the Columbia River basin’s most productive drainage for salmon, supporting more than 40 percent of all Columbia River spring and summer Chinook salmon. Rates of harvest on the runs soared in the late 1800s and early 1900s, but deterioration of habitat conditions due to logging, mining, grazing, farming, hydropower development, and other practices led to declines and, along with migration barriers, continue to threaten the ESU salmon. While the historical run in the Snake River likely exceeded 1 million fish annually in the late 1800s, the run declined to near 100,000 adults per year by the 1950s, reaching a low of 2,200 fish in 1995 (NMFS, 2017b).

The Upper Columbia River Spring-run ESU was listed as endangered under the ESA in 2005, and critical habitat was also designated in 2005. This ESU includes naturally spawned spring-run Chinook salmon originating from Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River subbasin), as well as spring-run Chinook salmon from six artificial propagation programs in Washington (NMFS, 2007b). The ESU includes three extant populations (Wenatchee, Entiat, and Methow), as well as one extinct population in the Okanogan subbasin. Populations of spring Chinook within the Upper Columbia River Basin were first affected by the intensive commercial fisheries in the lower Columbia River in the latter half of the 1800s and into the 1900s. Human population growth within the basin was increasing and land uses and the construction of dams and diversions, some without passage, blocked salmon migrations, isolated or fragmented populations, and killed upstream and downstream migrating fish. At that time of listing, fish counts were declining severely, and the individual 31 populations within the ESU were small, with none averaging more than 150 adults annually. Trends were mostly downward and a few local populations exhibited rates of decline exceeding 20 percent per year. Since 2000, adult spring Chinook numbers have increased in the Upper Columbia Basin (NMFS, 2007b).

The Upper Willamette River ESU was listed as endangered under the ESA in 2005, and critical habitat was also designated in 2005. This ESU includes naturally spawned spring-run Chinook salmon originating from the Clackamas River and from the Willamette River and its tributaries above Willamette Falls, as well as spring-run Chinook salmon from six artificial propagation programs in Oregon (NMFS, 2011). Of the seven populations that historically comprised this ESU, the subbasins supporting these populations are tributaries within the Willamette River basin, but current significant natural production occurs in only the Clackamas and McKenzie populations. Flood control/hydropower development has blocked or impaired fish passage for adults and juveniles, caused loss of some riverine habitat and associated functional connectivity due to reservoirs, reduced in instream flow volume due to water withdrawals, altered physical habitat structure, and altered water temperature and flow regimes. The ESU is considered to be extremely depressed, likely numbering less than 10,000 adult fish annually compared to a historical abundance estimate of 300,000 (NMFS, 2011).

3.7.1.4.6 Chum Salmon (Columbia River Evolutionarily Significant Unit and Hood Canal Summer-run Evolutionarily Significant Unit)

Chum salmon are second only to Chinook salmon in adult size, with individuals reported up to 43 inches in length and 21 kg (46 lbs) in weight (with an average around 4 to 7 kg (8 to 15 lbs) (NMFS, 2007a). Chum salmon are often referred to as dog salmon. Chum salmon spend more of their life history in marine waters than any other Pacific salmonid species. Also, unlike other salmon species, chum salmon form schools. Threats include widespread loss of estuary and lower floodplain habitat, negative interactions with hatchery fish, and high predation by marine mammals (NMFS, 2007a). The Columbia River and Hood Canal summer-run ESUs were listed as threatened under the ESA in 1999. Critical habitat for both chum salmon ESUs was designated in 2005.

The Columbia River ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Oregon and Washington and chum salmon from three artificial propagation programs. Columbia River chum salmon once were widely distributed throughout the lower Columbia Basin and spawned in the mainstem Columbia and the lower reaches of most lower Columbia River tributaries. Historically, spawning occurred as far upstream as the Umatilla and Walla Walla rivers, but it now is restricted largely to tributary and mainstem areas downstream of Bonneville (NMFS, 2013). Although chum salmon are strong swimmers, they rarely pass river blockages and waterfalls that pose no hindrance to other salmon; thus, they spawn in low-gradient, low-elevation reaches and side channels. Adult chum salmon returning to the Columbia River at the present time are virtually all fall-run fish, entering fresh water from mid-October through November and spawning from early November to late December. Over the last century, Columbia River chum salmon returns have collapsed from hundreds of thousands to just a few thousand per year. Of the 17 populations that historically made up this ESU, 15 of them (six in Oregon and nine in Washington) are so depleted that either their baseline probability of persistence is very low or they are extirpated or nearly so. Currently, almost all natural production occurs in just two populations: the Grays/Chinook and the Lower Gorge (NMFS, 2013).

The Hood Canal summer-run ESU includes all naturally spawned populations of summer-run chum salmon in tributaries to the Hood Canal and in Discovery Bay, Sequim Bay, and the Dungeness River on the Strait of Juan de Fuca in Washington (NMFS, 2007a). Sixteen historic populations comprise the Hood Canal summer-run chum ESU, of which eight currently have existing runs. Threats to the ESU include access to important spawning and rearing areas eliminated as a result of dams, culverts, and other barriers, and fragmented, modified, and loss of habitat. Hood Canal and Strait of Juan de Fuca summer chum experienced a severe drop in abundance in the 1980s, and returns decreased to all-time lows in 1989 and 1990 with less than a thousand spawners each year. Population estimates of summer chum in Hood Canal and Strait of Juan de Fuca streams ranges from a low of 10 spawners in Jimmycomelately Creek to just over 4,500 in the Big/Little Quilcene River (NMFS, 2007a).

3.7.1.4.7 Coho Salmon (Central California Coast Evolutionarily Significant Unit, Lower Columbia River Evolutionarily Significant Unit, Oregon Coast Evolutionarily Significant Unit, Southern Oregon/Northern California Coast Evolutionarily Significant Unit)

Coho salmon (**Figure 3.7-7**) are often referred to as silver salmon. The anadromous life cycle for coho salmon begins in their home stream, normally a small tributary with moderate to low gradient stream reaches. After emerging from the gravel, the small fish seek cool, slow moving stream reaches with quiet areas such as backwater pools, beaver ponds, and side channels. Juveniles generally spend one summer and a winter in these rearing areas before migrating towards the ocean as smolts in the spring, typically from late April until early June (NMFS, 2016c). Most adult coho salmon return to natal tributaries from September to November as 3-year-old fish, after spending two summers in the ocean. Coho salmon have been, and continue to be, threatened by habitat degradation, hydropower impacts including water diversions, harvest, and hatchery production.

Photo Credit: NMFS

Figure 3.7-7. Coho Salmon

The Central California Coast ESU was listed as threatened under the ESA in 1996, and critical habitat was designated in 1999. This ESU occurs on California's central coast which extends from Punta Gorda in southern coastal Humboldt County south to Aptos Creek in Santa Cruz County and includes the San Francisco Bay estuary and its tributaries (except for the Sacramento-San Joaquin Rivers) where coho salmon historically occurred, but are now extirpated (NMFS, 2012). The low survival of juveniles in fresh water, in combination with poor ocean conditions, has led to the precipitous declines of populations in this ESU. Human population growth and land use changes threaten California's salmon habitats. Many streams lack sufficient water or habitat complexity, and are dammed, channelized, or polluted, making it more difficult for salmonids to survive. Other factors such as ocean harvest, bycatch, and hatchery practices have also had adverse impacts to salmonid survival. The abundance of the Central California Coast ESU was estimated at 200,000 to 500,000 in 1940 but at 2,000 to 3,000 wild adults in 2011 (NMFS, 2012).

The Lower Columbia River ESU was listed as threatened under the ESA in 1999, and critical habitat was designated in 2016. This ESU includes all naturally spawned populations of coho salmon in the lower Columbia River and its tributaries, from the mouth of the Columbia upstream to and including the Hood River (in Oregon) and the White Salmon River (in Washington), and including the Willamette River up to Willamette Falls (NMFS, 2013). It also includes Coho salmon from 25 artificial propagation programs. Lower Columbia River coho salmon are typically categorized into early- and late-returning stocks. Early-returning adult coho salmon enter the Columbia River in mid-August and begin entering tributaries in early September, with peak spawning from mid-October to early November. Late-returning coho salmon pass through the lower Columbia from late September through December and enter tributaries from October through January. Most spawning occurs from November to January, but some occurs as late as March. Out of the 24 populations that make up this ESU, 21 are considered to have a very low probability of persisting for the next 100 years, and none is considered viable (NMFS, 2013).

The Oregon Coast ESU was listed as threatened under the ESA in 1998, and critical habitat was designated in 2008. This ESU includes the Pacific Ocean and the freshwater and estuarine habitat (rivers, streams, and lakes) along the Oregon Coast from the Necanicum River on the north to the Sixes River on the south (NMFS, 2016c). Rivers in the ESU flow from the mountains of the Coast Range, with the exception of the Umpqua River, which extends east through the Coast Range to drain the Cascade Mountains. Most of the rivers transition to estuaries before reaching the Pacific Ocean. In 1850, coho salmon were far more abundant than Chinook salmon in the majority of Oregon coastal watersheds. Runs of coho salmon to these coastal rivers and streams were likely only approached, or exceeded, by runs of chum salmon in rivers along the northern portion of the Oregon coast. Pre-development coho salmon runs to the Oregon Coast may have been in the range of 1 to 2 million fish or more during periods of favorable ocean conditions. Oregon Coast coho salmon were the most numerous species harvested in commercial and recreational fisheries off the Oregon coast during the 1950s and through the 1970s. All-time low returns occurred in the 1970s and 1990s – around 20,000 coho salmon spawners annually – which could be as low as one percent of some of the predevelopment run sizes. Since the mid-1990s, Oregon Coast coho spawner abundance levels have varied greatly (NMFS, 2016c).

The Southern Oregon/Northern California Coast ESU was listed as threatened under the ESA in 1997, and critical habitat was designated in 1999. This ESU includes all naturally spawned populations of coho salmon in coastal streams between Cape Blanco, Oregon and Punta Gorda, California, as well as coho salmon produced by three artificial propagation programs: Cole Rivers Hatchery, Trinity River Hatchery, and Iron Gate Hatchery (NMFS, 2014b). Currently, over three quarters of the coho salmon in 40 populations of this ESU are at high risk due to the combined effects of fish harvest, hatcheries, hydropower operations, and habitat alterations caused by land management that led to declines in these populations. The Rogue River is the only river in the ESU with data on coho abundance from the 1800s. Based on extrapolations from cannery pack data, up to 114,000 adult coho salmon returned to the Rogue River in the late 1800s even after heavy fishing pressure had occurred for years. The estimated number of adult coho salmon spawners that returned to the Rogue River from 1980 to 2010 ranged from less than 1,000 per year up to 25,000 per year (NMFS, 2014b).

3.7.1.4.8 Sockeye Salmon (Ozette Lake Evolutionarily Significant Unit, Snake River Evolutionarily Significant Unit)

Sockeye salmon are the second most abundant of the seven Pacific salmon species (NMFS, 2015b). Sockeye salmon are often referred to as red salmon. Sockeye salmon are generally anadromous, but distinct populations of non-anadromous sockeye also exist; these fish are commonly referred to as kokanee or silver trout. The vast majority of sockeye salmon populations spawn in or near lakes. Spawning can take place in lake tributaries, lake outlets, rivers between lakes, and on lake shorelines or beaches where suitable upwelling or intra-gravel flow is present. Spawn timing is often determined by water temperature. In spawning habitats with cooler water temperatures, sockeye salmon typically spawn earlier (August) than in warmer habitats (November). In North America, sockeye salmon spawn from the Columbia River north to the Noatak River in Alaska (NMFS, 2015b).

The Ozette Lake ESU was listed as threatened under the ESA in 1999, and critical habitat was designated in 2005. The listing was primarily attributed to concerns over abundance and effects of small population genetic and demographic variability. Ozette Lake ESU sockeye spawn in Ozette Lake or its tributaries on the Olympic Peninsula at the western edge of Washington State (NMFS, 2009). The lake, its perimeter shore, and most of the Ozette River, which forms the outlet of the lake to estuary and Pacific Ocean, are included in the 373,120-hectare (ha) (922,000-acre [ac]) Olympic National Park. The Ozette Lake ESU is made up of only one population, which currently contains five distinct spawning aggregations or subpopulations. The subpopulations can be grouped according to whether they spawn in tributaries (Umbrella Creek, Big River, and Crooked Creek) or near lake beaches (Olsen's Beach and Allen's Beach). Overall abundance of the Ozette Lake ESU is low, and degraded habitat conditions represent a limiting factor for this ESU. Between 1996 and 1999, the Ozette Lake ESU run size averaged 2,590 sockeye annually, while from 2000 to 2003 the run size averaged just over 4,600 sockeye. Within these two 4-year cycles, the average return increased by approximately 78 percent between the first and second period (NMFS, 2009).

The Snake River ESU was listed as endangered under the ESA in 1999, and critical habitat was designated in 1993. The last remaining Snake River sockeye salmon spawn in Sawtooth Valley lakes, high in the Salmon River drainage of central Idaho in the Snake River basin. While very few sockeye salmon there currently follow an anadromous life cycle, the small remnant run of the historical population migrates 1,450 km (900 mi) downstream from the Sawtooth Valley through the Salmon, Snake and Columbia Rivers to the ocean. After one to three years in the ocean, they return to the Sawtooth Valley as adults, passing once again through these mainstem rivers and through eight major federal dams, four on the Columbia River and four on the lower Snake River (NMFS, 2015b). Before the turn of the twentieth century, large runs of sockeye salmon returned annually to the Snake River basin. When Snake River ESU sockeye salmon were ESA-listed in 1991, all of the Snake River populations but one, the Redfish Lake population in the Sawtooth Valley, were gone, and that population had dwindled to fewer than 10 fish per year. Between 1999 and 2007, more than 355 adult Snake River sockeye salmon from captive broodstock releases returned to Redfish Lake from the ocean. These returns increased to 1,579 by 2014 (NMFS, 2015b). Threats still include overfishing, irrigation diversions, obstacles to migrating fish, and eradication through poisoning.

3.7.1.4.9 Steelhead

Steelhead trout (**Figure 3.7-8**) are a unique species in that individuals develop differently depending on their environment. They are closely related to Pacific salmon (i.e., in the same genus taxonomically). All steelhead trout hatch in gravel-bottomed, fast-flowing, well-oxygenated rivers and streams. Some stay in fresh water all their lives and are called rainbow trout (NMFS, No Date-a). Steelhead that migrate to the ocean typically grow larger than the ones that stay in fresh water; they then return to fresh water to spawn. Steelhead are vulnerable to many stressors and threats including blocked access to spawning grounds, habitat degradation caused by dams and culverts, loss of freshwater and estuarine habitat, and periodic poor ocean conditions.

Figure 3.7-8. Steelhead

Photo Credit: NMFS

Steelhead was listed under the ESA between 1998 and 2007, with one DPS listed as endangered and 10 DPS listed as threatened (see **Table 3.7-1**). Additionally, the Middle Columbia River non-essential experimental population is listed as threatened, the Northern California Summer Population is an ESA candidate, and the Klamath Mountains Province steelhead is under ESA review. All the listed steelhead populations have associated designated habitat. The following describes the final steelhead species determinations (71 FR 834, January 5, 2006), abundance, and critical habitat designations (70 FR 52488, September 2, 2005 and 70 FR 52630, September 2, 2005):

The Southern California DPS is the only DPS listed as endangered and includes all naturally spawned populations of steelhead in streams from the Santa Maria River south to the U.S. border with Mexico. The historical steelhead run for four of the major river systems within the range of this DPS is estimated to have been between 32,000 and 46,000 adults. Recent run size for the same four systems has been estimated to be fewer than 500 total adults. Of 65 river drainages where steelhead are known to have occurred historically, between 26 and 52 percent are still occupied. Approximately 1,132 km (708 mi) of stream habitat are designated as critical habitat within the geographical area presently occupied by the Southern California DPS.

The South-Central California Coast DPS includes all naturally spawned populations of steelhead in streams from the Pajaro River to, but not including, the Santa Maria River. There is a paucity of abundance information for this DPS. In general, these river systems are much degraded and are expected to have steelhead runs reduced in size from historical levels. Steelhead is present in approximately 86 to 95 percent of historically occupied streams. Approximately 2,000 km (1,249 mi) of stream habitat and 8 km^2 (3 mi^2) of estuarine habitat are designated as critical habitat within the geographical area presently occupied by the South-Central California Coast DPS.

The Central California Coast DPS includes all naturally spawned populations of steelhead in coastal streams from the Russian River to Aptos Creek, and the drainages of San Francisco, San Pablo, and Suisun

Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers; and tributary streams to Suisun Marsh exclusive of the Sacramento-San Joaquin River Basin of the California Central Valley. Two artificial propagation programs are also considered to be part of the DPS: the Don Clausen Fish Hatchery and Kingfisher Flat Hatchery/Scott Creek (Monterey Bay Salmon and Trout Project) steelhead hatchery. There are no population abundance data for the naturally spawning component of this DPS. The naturally spawning population in the largest river system in the DPS, the Russian River, is believed to have declined seven-fold since the mid-1960s. Steelhead are present in approximately 82 percent of historically occupied streams. Approximately 2,344 km (1,465 mi) of stream habitat and 386 mi^2 (996 km^2) of estuarine habitat are designated as critical habitat within the geographical area presently occupied by the Central California Coast DPS.

The California Central Valley DPS includes all naturally spawned populations of steelhead in the Sacramento and San Joaquin Rivers and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries. Two artificial propagation programs are considered to be part of the DPS: the Coleman NFH and Feather River Hatchery. It is estimated that on average during 1998–2000, approximately 181,000 juvenile steelhead were produced naturally each year in the Central Valley by approximately 3,600 spawning female steelhead. It is estimated that there were 1 to 2 million spawners in the Central Valley prior to 1850, and approximately 40,000 spawners in the 1960s. Although steelhead remain widely distributed in Sacramento River tributaries, the vast majority of historical spawning areas are currently above impassable dams. Approximately 3,693 km (2,308 mi) of stream habitat and 254 mi^2 (655 km^2) of estuarine habitat are designated as critical habitat within the geographical area presently occupied by the California Central Valley DPS.

The Northern California DPS includes all naturally spawned populations of steelhead in coastal river basins from Redwood Creek southward to, but not including, the Russian River. Two artificial propagation programs are considered part of the DPS: the Yager Creek Hatchery and North Fork Gualala River Hatchery. Abundance levels range from three to 418 adults, and exhibit downward short- and long-term trends. Despite low abundance and downward trends, steelhead appear to be still widely distributed throughout this DPS. Approximately 4,844 km (3,028 mi) of stream habitat and 65 km^2 (25 mi^2) of estuarine habitat are designated as critical habitat within the geographical area presently occupied by the Northern California DPS.

The Upper Willamette River DPS includes all naturally spawned populations of winter-run steelhead in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River in Oregon. Abundance for this DPS is approximately 5,800 adults, and individual populations remain at low abundance. Long-term trends in abundance are negative for all populations in the DPS; short-term trends, buoyed by recent strong returns, are positive. Approximately one-third of the DPS's historically accessible spawning habitat is now blocked, but the DPS continues to be spatially well distributed. Approximately 2,054 km (1,276 mi) of stream habitat and 5.2 km^2 (2 mi^2) of lake habitat are designated as critical habitat within the geographical area presently occupied by the Upper Willamette River DPS.

The Lower Columbia River DPS includes all naturally spawned populations of steelhead in streams and tributaries to the Columbia River between the Cowlitz and Wind Rivers, Washington, and the Willamette and Hood Rivers, Oregon. Ten artificial propagation programs are considered to be part of the DPS: the Cowlitz Trout Hatchery (in the Cispus, Upper Cowlitz, Lower Cowlitz, and Tilton Rivers), Kalama River Wild (winter- and summer-run), Clackamas Hatchery, Sandy Hatchery, and Hood River (winter- and summer-run). Population abundance levels are small with no population having greater than 750 spawners annually. Four historical populations have been extirpated or nearly extirpated, and only half of 23 historical populations currently exhibit appreciable natural production. Although approximately 35 percent of historical habitat has been lost within the range of this DPS due to the construction of dams or other impassable barriers, the DPS exhibits a broad spatial distribution in a variety of watersheds and habitat types. Approximately 3,740 km (2,324 mi) of stream habitat and 70 km^2 (27 mi^2) of lake habitat are designated as critical habitat within the geographical area presently occupied by the Lower Columbia River DPS.

The Middle Columbia River DPS includes all naturally spawned populations of steelhead in streams from above the Wind River, Washington, and the Hood River, Oregon, upstream to, and including, the Yakima River, Washington. Seven artificial propagation programs are considered part of the DPS: the Touchet River Endemic, Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River), Umatilla River, and the Deschutes River. The abundance of some natural populations in this DPS has increased substantially in recent years. Long-term trends for 11 of the 12 production areas within the range of the DPS were negative, but short-term trends in the 12 production areas were mostly positive from 1990 to 2001. Steelhead remain well distributed in the majority of sub-basins within the range of the DPS. Approximately 9,358 km (5,815 mi) of stream habitat are designated as critical habitat within the geographical area presently occupied by the Middle Columbia River DPS.

The Upper Columbia River DPS includes all naturally spawned populations of steelhead in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the U.S.-Canada border. Six artificial propagation programs are considered part of the DPS: the Wenatchee River, Wells Hatchery (in the Methow and Okanogan Rivers), Winthrop NFH, Omak Creek, and the Ringold hatchery program. The 1996–2001 average return through the Priest Rapids Dam fish ladder was approximately 12,900 total adults compared to 7,800 adults for 1992–1996, but predominantly composed of hatchery-spawners rather than naturally spawning fish. Approximately 2,031 km (1,262 mi) of stream habitat and 18 km^2 (7 mi^2) of lake habitat are designated as critical habitat within the geographical area presently occupied by the Upper Columbia River DPS.

The Snake River Basin DPS includes all naturally spawned populations of steelhead in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho. Six artificial propagation programs are considered part of the DPS: the Tucannon River, Dworshak NFH, Lolo Creek, North Fork Clearwater, East Fork Salmon River, and the Little Sheep Creek/Imnaha River Hatchery. The abundance of steelhead return has been generally improved, such as the return over Lower Granite Dam which was substantially higher in 2001 (14,768 natural returns) relative to the low levels in the 1990s. The DPS remains spatially well distributed in each of the six major geographic areas in Snake River Basin. Approximately 12,954 km (8,049 mi) of stream habitat and 10 km^2 (4 mi^2) of lake habitat are designated as critical habitat within the geographical area presently occupied by the Snake River Basin DPS.

The Puget Sound DPS includes naturally spawned populations of steelhead originating below natural and manmade impassable barriers from rivers flowing into Puget Sound from the Elwha River eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. Six artificial propagation programs are considered part of the DPS: the Green River, the White River, the Hood Canal (in the Dewatto, Skokomish, and Duckabush Rivers), and the Lower Elwha recovery program. Estimates of mean population growth rates are declining, typically three to ten percent annually. Approximately 3,269 km (2,031 mi) of stream habitat are designated as critical habitat within the geographical area presently occupied by the Puget Sound DPS.

3.7.1.4.10 Bull Trout

Bull trout are native to waters in western North America. In the U.S., bull trout range widely through the Columbia River and Snake River basins, extending east to headwater streams in Idaho and Montana, into Canada and southeast Alaska, and to the Puget Sound and Olympic Peninsula watersheds of western Washington and the Klamath River basin of south-central Oregon (USFWS, 2015). Historically bull trout also occurred in the Sacramento River basin in California.

Bull trout exhibit both resident and migratory life histories. Resident forms of bull trout complete their entire life cycle in the tributary streams in which they spawn and rear. Migratory bull trout spawn in tributary streams, where juvenile fish rear for one to four years before migrating to either a lake, river, or in certain coastal areas, to saltwater. Bull trout typically spawn from August to November during periods of decreasing water temperatures. Resident and migratory forms may be found together, and either form may give rise to offspring exhibiting either resident or migratory behavior (USFWS, 2015).

Currently, 109 occupied bull trout core areas exist. Complex core areas contain multiple local populations; they are typically situated in a larger patch of habitat, often occupied by bull trout of both the migratory life history form and the resident form, and include a diverse pattern of connected spawning and rearing habitats and foraging, migratory, and overwintering habitats (USFWS, 2015). Simple core areas contain a single local population; typically, they are situated in a smaller patch of habitat that may not include foraging, migratory, and overwintering stream habitat and sometimes include only the resident life history form or a very simple migratory pattern.

All populations of bull trout were listed as threatened under the ESA in 1999. Of the 121 core areas in which bull trout populations were evaluated, 23 exhibited population trends that were declining from slightly to severely, 18 were stable, 14 were increasing, and 66 were unknown (USFWS, 2015). Critical habitat was designated in 2004 and most recently revised in 2010. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species.

Of native salmonids in the Pacific Northwest, bull trout have the most specific habitat requirements. These requirements include cold water temperatures compared to other salmonids (often less than 12°C [54°F]); the cleanest stream substrates; complex stream habitat including deep pools, overhanging banks and large woody debris; and connectivity between spawning and rearing areas and downstream foraging, migratory, and overwintering habitats (USFWS, 2015). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors.

Bull trout are opportunistic feeders, with food habits primarily a function of size and life history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro-zooplankton, and small fish. Adult migratory bull trout feed primarily on a wide variety of resident and anadromous fish species. In coastal areas of western Washington, bull trout feed on forage fish species such as Pacific herring, Pacific sand lance, and surf smelt in near shore marine areas and the ocean (USFWS, 2015).

Designated critical habitat comprises 31,751 km (19,729 mi) of streams (which includes 1,213 km [754 mi]) of marine shoreline in the Olympic Peninsula and Puget Sound), and 197,589 hectares (488,252 acres) of reservoirs and lakes of bull trout habitat (75 FR 63898, October 18, 2010). These areas contain 32 critical habitat units which reflect single core areas or groups of core areas that are in close proximity geographically (USFWS, 2015). The PCEs (i.e., the specific elements of physical or biological features that provide for a species' life-history processes and are essential to the conservation of the species) upon which the critical habitat areas are designated are:

1) Space for individual and population growth and for normal behavior;
2) Food, water, air, light, minerals, or other nutritional or physiological requirements;
3) Cover or shelter;
4) Sites for breeding, reproduction, or rearing (or development) of offspring; and
5) Habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species.

3.7.1.4.11 Eulachon (Southern Distinct Population Segment)

Eulachon are a small, anadromous fish endemic to the Pacific Ocean and are found from northern California to southwest and south-central Alaska. Eulachon have many other names: smelt, hooligan, oolichan, and candlefish. Native people continue to fish for eulachon by traditional methods for use as an important subsistence food and medicine. Threats to the eulachon include climate change, habitat degradation, habitat impediments, fisheries interaction and bycatch, and water pollution (NMFS, 2017c).

The Southern DPS of eulachon is composed of fish that spawn in rivers south of the Nass River in British Columbia to, and including, the Mad River in California. This DPS was listed as threatened under the ESA in 2010, and critical habitat was designated in 2011. There are no reliable abundance estimates for eulachon. Spawning stock biomass estimations of eulachon in the Columbia River for the years 2000 through 2017 have ranged from a low of 783,400 fish in 2005 to a high of 185,965,200 fish in 2013, with an estimated 18,307,100 fish in 2017 (NMFS, 2017c). Spawning stock biomass estimations of eulachon in the Fraser River for the years 1995 through 2017 have ranged from a low of 109,129 to 146,606 fish in 2010 to a high of 41,709,035 to 56,033,332 fish in 1996, with an estimated 763,330 to 1,026,251 fish in 2017.

Eulachon commonly spawn at age three or four. They generally spawn once, although some individuals may spawn twice in a lifetime. Spawning appears to take place at night and can occur at various depths up to 7 m (25 ft) or more. Spawning substrates can range from silt, sand, or gravel to cobble and detritus. Spawning rivers may be turbid or clear, but all have spring freshets characteristic of rivers draining large snow packs or glaciers. In many rivers, the spawning reach is more or less limited to the part of the river that is influenced by tides. Entry into the spawning rivers appears to be related to water temperature and the occurrence of high tides. Eulachon typically spend several years in salt water before returning to fresh water as a run to spawn from late winter through early summer. Some eulachon runs are very reliable from year to year; others occur more sporadically (NMFS, 2017c).

Numerous populations of eulachon spawn in rivers from northern California to southwestern Alaska. In the portion of the species' range that lies south of the U.S.-Canada border, most eulachon production originates in the Columbia River Basin, including the Columbia River, the Cowlitz River the Grays River, the Kalama River, the Lewis River, and the Sandy River (NMFS, 2017c). Historically, the only other large river basins in the contiguous U.S. where large, consistent spawning runs of eulachon have been documented are the Klamath River in northern California and the Umpqua River in Oregon. In Alaska, at least 35 rivers have spawning runs of eulachon, including one in a glacial stream on Unimak Island, the first island in the Aleutian Island chain off the western end of the Alaska Peninsula.

Although they spend 95 to 98 percent of their lives at sea, little is known about the saltwater existence of eulachon. Once juvenile eulachon enter the ocean, they move from shallow nearshore areas to deeper areas over the continental shelf. Larvae and young juveniles become widely distributed in coastal waters, where they are typically found near the ocean bottom in waters 20 to 150 m (66 to 492 ft) deep (NMFS, 2017c).

The PCEs for the Southern DPS fall into three major categories reflecting key life history phases of eulachon (76 FR 65324, October 20, 2011): 1) freshwater spawning and incubation sites with water flow, quality and temperature conditions and substrate supporting spawning and incubation, and with migratory access for adults and juveniles; 2) freshwater and estuarine migration corridors associated with spawning and incubation sites that are free of obstruction and with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted; and 3) nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. Based on these features, 16 specific areas consisting of 539 km (335 mi) of riverine and estuarine habitat in California, Oregon, and Washington within the geographical area occupied by the southern DPS of eulachon were designated as critical habitat. No specific marine areas meet the definition of critical habitat, nor were any unoccupied areas identified that may be essential to the conservation of the Southern DPS.

3.7.1.4.12 Bocaccio and Yelloweye Rockfish (Puget Sound/Georgia Basin Distinct Population Segment)

Yelloweye rockfish (**Figure 3.7-9**) and bocaccio occupy the waters of the Pacific coast from California to Alaska. Yelloweye rockfish are among the longest lived of rockfishes, living up to 118 years. Rockfish are slow-growing, late to mature, and long-lived. Historical overfishing has been the primary cause of the decline of rockfishes in Puget Sound; additional threats include bycatch, degraded water quality and habitat, contaminants, and derelict fishing gear (NMFS, 2017d).

Figure 3.7-9.
Yelloweye Rockfish

Photo Credit: California Department of Fish and Wildlife

The Puget Sound/Georgia Basin DPS of yelloweye rockfish was listed as threatened and bocaccio was listed as endangered under the ESA in 2010. The DPSs include all yelloweye rockfish and bocaccio found in waters of Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of Victoria Sill in Washington. The yelloweye rockfish DPS extends further north than bocaccio into the waters of Johnstone Strait. Critical habitat was designated for both species in 2014. The best available data indicate that the total rockfish population in the Puget Sound region is estimated to have declined approximately three percent per year for the past several decades, corresponding to an approximate 70 percent decline from 1965 to 2007. The decline of yelloweye rockfish and bocaccio is estimated to be greater than the 70 percent observed in the total rockfish decline during that time period (NMFS, 2017d).

Rockfish are mid-level predators with diverse diets that include many species of marine invertebrates and fish (NMFS, 2017d). Larval and juvenile rockfish feed on very small organisms such as zooplankton, particularly copepods, phytoplankton, small crustaceans, invertebrate eggs, and krill. Rockfishes of all sizes are an important food resource for a variety of predators in Puget Sound including numerous fish species, birds, and several marine mammals.

Rockfish have multiple reproductive cycles during their lifetime and are typically long-lived. This trait allows the adult population to persist through many years of poor reproduction until a good recruitment year occurs, likely dictated by climatic or oceanic conditions. Rockfish are viviparous, meaning the eggs are fertilized internally, the embryonic fish develop within the mother, and the young are released as larvae. Larval rockfish are often observed under free-floating algae, seagrass, and detached kelp, and also occupy the full water column (NMFS, 2017d). Generally, juvenile rockfish move from the pelagic environment and associate with benthic environments when they reach approximately the age of three to six months. As they grow, juveniles gradually move to areas of rocky habitat in deeper waters. Juvenile yelloweye rockfish are not typically found in intertidal waters, but rather in habitats along the shallow range of adult habitats. Juvenile bocaccio occurs on shallow rocky reefs and nearshore areas.

As adults, rockfish generally inhabit relatively deep waters with rugged, steep, and complex bathymetry, though they may also occur over less complex habitat or in the water column in association with sheer walls (NMFS, 2017d). Rockfish commonly occupy reef habitats, though are also found on complex soft bottom or in association with subtidal vegetation. Adult yelloweye rockfish and bocaccio frequently occupy habitats within and adjacent to areas that are highly rugged, but yelloweye rockfish have also been documented in areas with mud and mud/cobble habitats, and bocaccio also occupy benthic areas with soft-bottomed habitats, particularly those adjacent to structure such as boulders and crevices. Adult yelloweye rockfish remain near the substrate and have relatively small home ranges, while some bocaccio have larger home ranges, move long distances, and spend time suspended in the water column. Adult yelloweye rockfish and bocaccio generally occupy habitats from approximately 30 to 425 m (90 to 1,394 ft).

The specific areas designated as critical habitat for bocaccio total approximately 1,617 km^2 (1,005 mi^2) of deepwater (>30 m [98 ft]) and nearshore (<30 m [98 ft]) marine habitat in Puget Sound. The specific areas designated for yelloweye rockfish include 666 km^2 (414 mi^2) of deepwater marine habitat in Puget Sound, all of which overlap with areas designated for bocaccio (NMFS, 2017d). The PCEs for yelloweye rockfish and bocaccio include sites deeper than 30 m (98 ft) that possess or are adjacent to areas of complex bathymetry, and juvenile settlement sites located in the nearshore with substrates such as sand, rock, and/or cobble compositions that also support kelp and eelgrass.

3.7.1.4.13 Giant Manta Ray

The giant manta ray (**Figure 3.7-10**) is the world's largest ray with a wingspan of up to 9 m (29 ft). Manta rays are filter feeders and eat large quantities of zooplankton. Giant manta rays are slow-growing, migratory animals with small, highly fragmented populations that are sparsely distributed across the world (NMFS, No Date-a). The main threat to the giant manta ray is commercial fishing, with the species both targeted and caught as bycatch in a number of global fisheries. Additionally, demand for the gills of manta rays has risen dramatically in Asian markets, leading to large harvests and declines in population of the species.

Figure 3.7-10. Giant Manta Ray

Photo Credit: George Schmahl

The giant manta ray was listed as threatened under the ESA in 2018. Information on the global distribution of giant manta rays and their population sizes is lacking. Regional population sizes are small, ranging from around 100 to 1,500 individuals (NMFS, No Date-a). In areas subject to fishing, giant manta ray populations have significantly declined. Ecuador is thought to be home to the largest population of giant manta ray, with large aggregation sites within the waters of the Machalilla National Park and the Galapagos Marine Reserve.

The giant manta ray is a migratory species seasonally found along productive coastlines with regular upwelling, in oceanic island groups, and near offshore pinnacles and seamounts. The timing when giant manta rays occur in these locations varies by region and seems to correspond with the movement of zooplankton, current circulation and tidal patterns, seasonal upwelling, seawater temperature, and possibly mating behavior (NMFS, No Date-a). Although the giant manta ray tends to be solitary, individuals aggregate to feed and mate. Manta rays primarily feed on planktonic organisms such as euphausiids, copepods, mysids, decapod larvae and shrimp, and moderately sized fish. Giant manta rays exhibit a high degree of plasticity in terms of their use of depths within their habitat. During feeding, giant manta rays may aggregate in shallow waters at depths less than 10 m (33 ft). However, they may also dive up to 200 to 450 m (656 to 1,476 ft) and are capable of diving to depths exceeding 1,000 m (3,281 ft). This diving behavior may be influenced by season and shifts in prey location associated with the thermocline.

The giant manta ray is found worldwide in tropical, subtropical, and temperate waters and is commonly found offshore, in oceanic waters, and near productive coastlines. Off the U.S. east coast, giant manta rays are commonly found in waters from 19 to 22°C (66 to 72°F) whereas those off the Yucatan peninsula and Indonesia are commonly found in waters between 25 to 30°C (77 to 86°F) (NMFS, No Date-a). The giant manta ray has also been observed in estuarine waters near oceanic inlets, with use of these waters as potential nursery grounds.

3.7.1.4.14 Scalloped Hammerhead Shark (Eastern Pacific Distinct Population Segment, Central and Southwest Atlantic Distinct Population Segment, and Indo-West Pacific Distinct Population Segment)

Scalloped hammerhead sharks are moderately large sharks with a global distribution. The most distinguishing characteristic of this shark is its hammer-shaped head. They are threatened by commercial fishing, mainly for the shark fin trade. Scalloped hammerhead sharks are both targeted and taken as bycatch in many global fisheries. They are targeted by semi-industrial, artisanal and recreational fisheries, and caught as bycatch in pelagic longline tuna and swordfish fisheries and purse seine fisheries (NMFS, 2014c). Since the scalloped hammerhead shark range is composed of open ocean environments occurring over broad geographic ranges, large-scale impacts such as global climate change that affect ocean temperatures, currents, and potentially food chain dynamics are most likely to pose the greatest threat to this species.

The Central and Southwest Atlantic DPS and the Indo-West Pacific DPS of scalloped hammerhead shark were listed as threatened and the Eastern Pacific DPS was listed as endangered under the ESA in 2014. Current population sizes are available for the scalloped hammerhead shark but are considered qualitative indicators rather than precise estimates. Population estimates vary from 142,000 to 169,000 in 1981 to 24,000 to 29,000 in 2005 (NMFS, 2014c). Data from multiple sources indicate that the Atlantic population experienced the most severe declines over the past few decades, with the northwestern Atlantic and Gulf of Mexico stocks depleted by approximately 83 percent since 1981.

The scalloped hammerhead shark lives in coastal warm temperate and tropical seas. It occurs over continental and insular shelves, as well as adjacent deep waters, but is seldom found in waters cooler than 22°C (72°F) (NMFS, 2014c). It ranges from the intertidal and surface to depths of up to 450-512 m (1,476-1,680 ft) with occasional dives to even deeper waters. It has also been documented entering enclosed bays and estuaries. Scalloped hammerhead sharks are highly mobile, partly migratory, and are likely the most abundant of the hammerhead species. These sharks make migrations along continental margins as well as between oceanic islands in tropical waters. Both juveniles and adult scalloped hammerhead sharks occur as solitary individuals, pairs, or in schools. The scalloped hammerhead shark is a high trophic level predator and opportunistic feeder with a diet that includes a wide variety of fish, cephalopods, crustaceans, and rays. The species is viviparous (i.e., give birth to live young) with a gestation period of 9 to 12 months. Females move inshore to birth, with litter sizes anywhere between one and 40 live pups (NMFS, 2014c).

The scalloped hammerhead shark can be found in coastal warm temperate and tropical seas worldwide. In the western Atlantic Ocean, the scalloped hammerhead range extends from the northeast coast of the U.S. (from New Jersey to Florida) to Brazil, including the Gulf of Mexico and Caribbean Sea. Distribution in the eastern Pacific Ocean extends from the coast of southern California, including the Gulf of California, to Ecuador and possibly Peru, and off waters of Hawai'i and Tahiti (NMFS, 2014c). The habitat of adult scalloped hammerheads consists of continental areas further offshore, with adult aggregations common over seamounts and near islands like the Galapagos, Malpelo, Cocos and Revillagigedo Islands, and within the Gulf of California. Many of these islands are considered hot spots for both juvenile and adult scalloped hammerhead sharks and are also designated as marine reserves.

3.7.1.4.15 Largetooth Sawfish and Smalltooth Sawfish

Although shark-like in appearance, sawfish are actually rays, as their gills and mouths are found on the underside of their bodies. Largetooth sawfish and smalltooth sawfish are the two species of sawfish that have historically inhabited U.S. waters in the Gulf of Mexico mainly along the Texas coast and east into

Florida waters, though largetooth sawfish have not been found in the U.S. in 50 years (NMFS, No Date-a). The largetooth sawfish has the largest historical range of all sawfish species, but its populations have dramatically declined worldwide due to habitat loss, entanglement in fishing gear, and low population growth. In the present day, largetooth sawfish are thought to primarily occur in freshwater habitats in Central and South America and Africa.

The largetooth sawfish was first listed as endangered under the ESA in 2011. Taxonomic changes to the sawfishes resulted in the largetooth sawfish known as *P. pristis* being revised to include the species formerly known as *P. microdon* and *P. perotetti* and being listed again in 2014. Though reported in the U.S., it appears that the largetooth sawfish was never abundant, with approximately 39 confirmed records (33 in Texas) from 1910 through 1961 and no confirmed sightings since then (NMFS, 2010).

Smalltooth sawfish look very similar to largetooth sawfish, and it can be hard to tell the two species apart. Smalltooth sawfish live in tropical seas and of the Atlantic Ocean in shallow, coastal waters and sometimes the lower reaches of freshwater river systems. Smalltooth sawfish populations have declined dramatically due to habitat loss associated with coastal development and accidental capture in fisheries. The smalltooth sawfish was the first marine fish to receive federal protection as an endangered species under the ESA in 2003. Under the ESA, it is illegal to catch, harm, harass, or kill an endangered sawfish; however, some fishermen catch sawfish as bycatch (NMFS, No Date-a).

Sawfish eat a variety of fish and invertebrates (e.g., shrimp and crabs). They use their rostra, the long flat snout edged with teeth, to slash through schools of fish, swinging it from side to side to impale and stun prey. Their rostra also contain electro-sensitive organs, which can sense the weak amount of electricity produced by other animals (NMFS, No Date-a). Sawfish are yolk-sac viviparous, meaning that their young are attached to yolk sacs that nourish the embryo inside the mother's body and emerge fully developed. They are born with their saw fully developed, but it is very flexible and sheathed in a thick gelatinous material to avoid injuring the mother at birth. Sawfish reach sexual maturity at around seven years and when they have grown to about 3 m (11 ft) long.

Largetooth sawfish are generally restricted to shallow (<10 m [33 ft]) coastal, estuarine, and fresh waters, although they have been found at depths of up to 122 m (400 ft) (NMFS, 2010). Largetooth sawfish are often found in brackish water near river mouths and large bays, preferring partially enclosed waters, lying in deeper holes and on bottoms of mud or muddy sand. This species, like the smalltooth sawfish, is highly mangrove-associated. While it is thought that they spend most of their time on the bottom, they are commonly observed swimming near the surface. Largetooth sawfish move across salinity gradients freely and appear to have more physiological tolerance of fresh water than smalltooth sawfish. Though their habitats once overlapped in the northern Gulf of Mexico, the largetooth sawfish historically had a more southerly range than the smalltooth sawfish, with what appears to be a narrower seasonal migration pattern.

Smalltooth sawfish were once found in the Gulf of Mexico from Texas to Florida and along the East Coast from Florida to North Carolina. Their distribution has decreased greatly in U.S. waters over the past century, and the species is only found now off the coast of Florida from about Charlotte Harbor through the Everglades region at the southern tip of the state (NMFS, No Date-a). Outside the U.S., smalltooth sawfish have been confirmed to live in the Bahamas and Sierra Leone (a single confirmed record). However, informal reports suggest they might also be found off the coasts of Honduras, Belize, Cuba, and Guinea Bissau.

Smalltooth sawfish use a variety of coastal habitats depending on life stage. During their first two years, juveniles live in estuaries and the smaller habitats within them, such as shallow portions of bays, lagoons, and rivers (NMFS, No Date-a). Once they reach 2 m (7 ft), they move out of the shallow estuaries into more coastal habitats. Larger juveniles and adults can be found in estuaries, off beaches, and along deep-water reefs. Generally, smalltooth sawfish live in waters warmer than 18°C (64°F).

3.7.1.4.16 Atlantic Sturgeon (New York Bight Distinct Population Segment, Carolina Distinct Population Segment, Chesapeake Bay Distinct Population Segment, South Atlantic Distinct Population Segment, Gulf of Maine Distinct Population Segment, and Gulf subspecies)

The anadromous Atlantic sturgeon (**Figure 3.7-11**) lives in rivers and coastal waters from Canada to Florida. Atlantic sturgeon are slow-growing, late-maturing, and long-lived and have been recorded to reach up to 4 m (14 ft) in length and up to 60 years of age (NMFS, No Date-a). Atlantic sturgeon were once found in great abundance, and their eggs were valued as high-quality caviar. During the late 1800s, the sturgeon fishery was known as the Black Gold Rush for its caviar. By the beginning of the 1900s, sturgeon populations had declined drastically. Close to 3,175,147 kg (7 million lbs) of sturgeon were reportedly caught in 1887, but by 1905 the catch declined to only 9,071 kg (20,000 lbs), and by 1989 only 181 kg (400 lbs) of sturgeon were recorded (NMFS, No Date-a). The primary threats currently facing Atlantic sturgeon are entanglement in fishing gear, habitat degradation, habitat impediments such as dams and other barriers, and vessel strikes.

All five U.S. Atlantic sturgeon DPSs were listed under the ESA in 2012. Atlantic sturgeon that hatch out in Gulf of Maine rivers are listed as threatened, and those that hatch out in other U.S. rivers are listed as endangered. Critical habitat for all five DPSs was designated in 2017. Additionally, the Gulf of Mexico subspecies (also known as the Gulf sturgeon) was listed as threatened in 1991, with critical habitat designated in 2003.

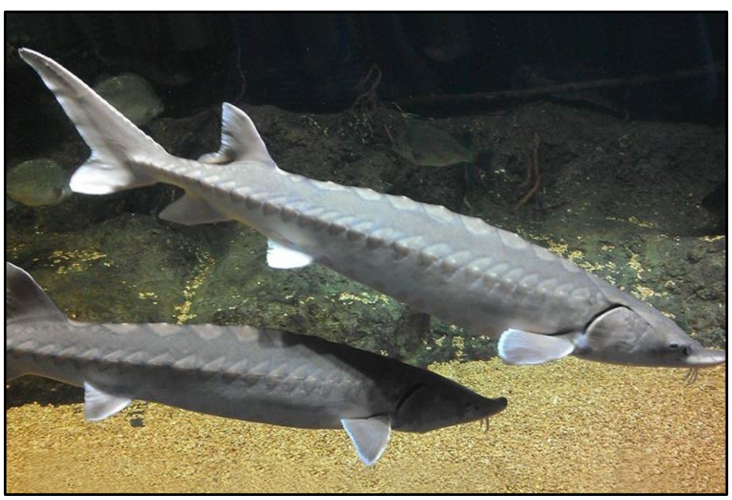


Figure 3.7-11. Atlantic Sturgeon

Photo Credit: NMFS

In rivers from Georgia to the Chesapeake Bay, adult sturgeon generally spawn during the late summer and fall. However, there are also spring-spawning males in the James River, VA (Balazik et al., 2017) and in the Edisto River, SC (Farrae et al., 2017), as well as spring and fall spawning in the Altamaha River, Georgia (Ingram and Peterson, 2016). In rivers from Delaware to Canada, adults spawn in the spring and early summer. Adult Atlantic sturgeon migrate along the coast when not spawning and preferentially use estuaries. Juvenile fish can leave their natal rivers as early as one year of age, and juvenile aggregations within a river may be composed of two or more different natal populations of fish. After spawning in northern rivers, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks after spawning. In southern rivers, males usually enter the river in late summer when temperatures can be as high as 32°C (90°F), spawn as river temperatures approach 21-24°C (70-75°F), with females leaving immediately after spawning and males leaving as temperatures drop below 18°F (65°F) (NMFS, No Date-a). Upon hatching, larvae hide along the bottom and drift downstream until they reach brackish waters where they may reside for one to five years before moving into nearshore coastal waters. Atlantic sturgeon are bottom feeders with a diet consisting of invertebrates such as crustaceans, worms, and mollusks, and bottom-dwelling fish.

Historically, Atlantic sturgeon ranged in major estuaries and river systems along the Canadian and U.S. Atlantic Coast from Labrador to Florida. While still found throughout their historical range, Atlantic sturgeon spawning is known to occur in only 22 of 38 historical spawning rivers from Maine to Georgia and in several more in Canada (NMFS, No Date-a). Atlantic sturgeon are anadromous fish born in fresh water, then migrating to the sea and back again to fresh water to spawn. Most juveniles remain in their river of birth for at least several months before migrating out to the ocean. Tagging data indicate that these immature Atlantic sturgeon travel widely up and down the East Coast, and as far as Iceland, when they are at sea.

In designating critical habitat for the Gulf of Maine, New York Bight, and Chesapeake Bay DPSs, a key conservation objective is to increase the abundance of each DPS by facilitating increased successful reproduction and recruitment to the marine environment and essential physical features: 1) hard bottom substrate; 2) aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate; 3) water of appropriate depth and absent physical barriers to passage; and 4) water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with appropriate temperature, salinity, and oxygen values (82 FR 39160, August 17, 2017). For the Carolina and South Atlantic DPSs of Atlantic sturgeon, the key conservation objectives are to increase the abundance of each DPS by facilitating increased survival of all life stages and facilitating adult reproduction and juvenile and subadult recruitment into the adult population, and essential physical features: 1) hard bottom substrates; 2) transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5– up to 30 ppt and soft substrate; 3) water of appropriate depth and absent physical barriers to passage; and 4) water quality conditions, especially in the bottom meter of the water column, between the river mouths and spawning sites with appropriate temperature and oxygen values (82 FR 39160, August 17, 2017). Specific occupied areas designated as critical habitat for these five DPSs is described in the Federal Register final rule notice (82 FR 39160, August 17, 2017).

The Gulf of Mexico subspecies inhabits coastal rivers from Louisiana to Florida during the warmer months and overwinters in estuaries, bays, and the Gulf of Mexico (68 FR 13370, March 19, 2003). Historically, the Gulf sturgeon occurred from the Mississippi River east to Tampa Bay. Its present range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi east to the Suwannee River in Florida. Sporadic occurrences have been recorded as far west as the Rio Grande River between Texas and Mexico, and as far east and south as Florida Bay. In fresh water, they are typically found on sandbars and sand shoals over rippled bottom and in shallow, relatively open, unstructured areas. Estuarine and marine habitat consists of unvegetated sandy shoreline, sandbars, or shoals, with water depths less than 3.5 m (11.5 ft) and deep holes near passes in intertidal and subtidal energy zones.

The PCEs essential for the conservation of the Gulf sturgeon upon which the critical habitat areas are designated are: 1) abundant food items; 2) riverine spawning sites with substrates suitable for egg deposition and development; 3) riverine aggregation areas, also referred to as resting, holding, and staging areas; 4) a flow regime necessary for normal behavior, growth, and survival of all life stages in the riverine environment; 5) water quality necessary for normal behavior, growth, and viability of all life stages; 6) sediment quality necessary for normal behavior, growth, and viability of all life stages; and 7) safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (68 FR 13370, March 19, 2003). The areas designated as critical habitat for the Gulf sturgeon provide one or more of these PCEs consisting of seven units of riverine habitat along 2,783 river km (1,730 river mi) and seven units of estuarine and marine habitat in 6,042 km^2 (2,333 mi^2).

3.7.1.4.17 Green Sturgeon (Southern Distinct Population Segment)

The green sturgeon is an anadromous, long-lived, slow-growing fish native to the Pacific Ocean. Spawning and juvenile rearing occurs in rivers, followed by migrating to saltwater to feed, grow, and mature before returning to fresh water to spawn. Green sturgeon are vulnerable to many stressors and threats including blocked access to spawning grounds caused by dams and culverts, habitat degradation, modification, and loss, fishing and bycatch (NMFS, No Date-a).

The green sturgeon Southern DPS, consisting of coastal and Central Valley populations south of the Eel River in California, was listed as threatened under the ESA in 2006. Data suggest that the spawning population of the Southern DPS is smaller than the Northern DPS, which is consistent with the threatened listing for the Southern, but not the Northern, DPS. The spawning population of the Southern DPS in the Sacramento River congregates in a limited area of the river compared to potentially available habitat. The reason for this is unknown, and it is concerning given that a catastrophic or targeted poaching event impacting just a few holding areas could affect a significant portion of the adult population. Critical habitat was designated for the Southern DPS of green sturgeon in 2009.

Green sturgeon range from the Bering Sea, Alaska, to Ensenada, Mexico, with abundance increasing north of Point Conception, CA. Green sturgeon occupy freshwater rivers from the Sacramento River up through British Columbia, but spawning has been confirmed in only three rivers, the Rogue River in Oregon and the Klamath and Sacramento rivers in California (74 FR 52300, October 9, 2009). Southern DPS green sturgeon typically spawn every 3-4 years, and spawning occurs primarily in the Sacramento River. Adult Southern DPS green sturgeon enter San Francisco Bay in late winter through early spring and spawn from April through early July, with peaks of activity influenced by factors including water flow and temperature. Spawning primarily occurs in cool sections of the upper mainstem Sacramento River in deep pools containing small to medium sized gravel, cobble or boulder substrate.

Subadult and adult green sturgeon spend most of their life in the coastal marine environment, typically in waters less than 100 m (328 ft) (Erickson and Hightower, 2007). Southern DPS green sturgeon are found in high concentrations in coastal bays and estuaries along the West Coast during the summer and autumn, particularly in Willapa Bay, Grays Harbor, and the Columbia River estuary (74 FR 52300, October 9, 2009). Southern DPS green sturgeon generally inhabit specific areas of coastal estuaries near or within deep channels or holes, moving into the upper reaches of the estuary, but rarely into fresh water. Green sturgeon in these estuaries may move into tidal flats areas, particularly at night, to feed. Prey species for juvenile, subadult, and adult green sturgeon within bays and estuaries primarily consist of benthic invertebrates and fishes, including crangonid shrimp, burrowing shrimp, amphipods, isopods, clams, annelid worms, crabs, sand lances, and anchovies.

The primary constituent elements for the Southern DPS upon which critical habitat is designated are food resources, substrate type and size, water flow, water quality, migratory corridor, sediment quality, and water depth applicable to freshwater riverine systems, estuarine areas, and coastal marine areas. Critical habitat is designated for approximately 515 km (320 mi) of riverine habitat and 2,323 km^2 (897 mi^2) of estuarine habitat in California, Oregon, and Washington, and 29,581 km^2 (11,421 mi^2) of coastal marine habitat off California, Oregon, and Washington within the geographical area presently occupied by the Southern DPS of green sturgeon. It is also designated on approximately 784 km (487 mi) of habitat in the Sacramento-San Joaquin Delta, and 350 km^2 (135 mi^2) of habitat within the Yolo and Sutter bypasses, adjacent to the Sacramento River, California (74 FR 52300, October 9, 2009).

3.7.1.4.18 Shortnose Sturgeon

Shortnose sturgeon live in rivers and coastal waters from Canada to Florida. Like other sturgeons, shortnose sturgeon are slow-growing and late-maturing, and they have been recorded to reach up to 1.3 m (4.5 ft) in length and live 30 years or more (NMFS, No Date-a). Unlike Atlantic sturgeon, they tend to spend relatively little time in the ocean. When they do enter marine waters, they generally stay close to shore. In the spring, adults move far upstream and away from saltwater to spawn. After spawning, the adults move rapidly back downstream to the estuaries, where they feed, rest, and spend most of their time. In the mid-1800s, Atlantic and shortnose sturgeon began to support a thriving and profitable fishery for caviar, smoked meat, and oil. By the late-1800s, sturgeon were being over-exploited; in 1890, over 3,175,147 kg (7 million lbs) of sturgeon were caught in one year alone. In 1920, only 10,433 kg (23,000 lbs) of sturgeon were caught (NMFS, No Date-a). Although shortnose sturgeon is no longer fished, threats remain that continue to affect recovery efforts. Bycatch in commercial fisheries and increased industrial uses (e.g., hydropower, nuclear power, treated sewage disposal) of the nation's large coastal rivers during the 20th century became the primary barriers to shortnose sturgeon recovery. Other threats to this species are habitat degradation, water pollution, dredging, water withdrawals, fisheries bycatch, and habitat impediments such as dams.

The shortnose sturgeon was first listed as endangered under the Endangered Species Preservation Act in 1967. No estimate of the historical population size of shortnose sturgeon is available. While shortnose sturgeon were rarely the target of a commercial fishery, they were often taken incidentally in the commercial fishery for Atlantic sturgeon. In the 1950s, sturgeon fisheries declined on the East Coast, which resulted in a lack of records of shortnose sturgeon. Currently, shortnose sturgeon are found in 41 rivers and bays along the east coast, spawning in 19 of those rivers and comprising three metapopulations, or reproductively isolated groups. These three metapopulations include the Carolinian Province (southern metapopulation), Virginian Province (mid-Atlantic metapopulation), and Acadian Province (northern metapopulation) (NMFS, No Date-a). Their distribution across this range is broken up, with a large gap of about 400 km (250 mi) separating the northern and mid-Atlantic metapopulations from the southern metapopulation.

Historically, shortnose sturgeon were found in the coastal rivers along the east coast of North America from the Saint John River in New Brunswick, Canada, to the St. Johns River in Florida, and perhaps as far south as the Indian River in Florida (NMFS, No Date-a). In the southern metapopulation, shortnose sturgeon are currently found in the Great Pee Dee, Waccamaw, Edisto, Cooper, Santee, Altamaha, Ogeechee, and Savannah rivers. They may also be found in the Black, Sampit, Ashley, Roanoke, and Cape Fear rivers, as well as Albemarle Sound and Pamlico Sound. Shortnose sturgeon used to be considered extinct in the Satilla, St. Marys, and the St. Johns rivers, but were recently found again in both the Satilla and St. Marys rivers (NMFS, No Date-a). In the northern and mid-Atlantic metapopulations, shortnose sturgeon are currently found in the Saint John (Canada), Penobscot, Kennebec, Androscoggin, Piscataqua, Merrimack, Connecticut, Hudson, Delaware, and Potomac rivers. They have also been frequently spotted opportunistically foraging and transiting in the St. George, Medomak, Damariscotta, Sheepscot, Saco, Deerfield, East, and Susquehanna rivers. On rare occasions, they have been seen in the Narraguagus, Presumpscot, Westfield, Housatonic, Schuylkill, Rappahannock, and James rivers (NMFS, No Date-a).

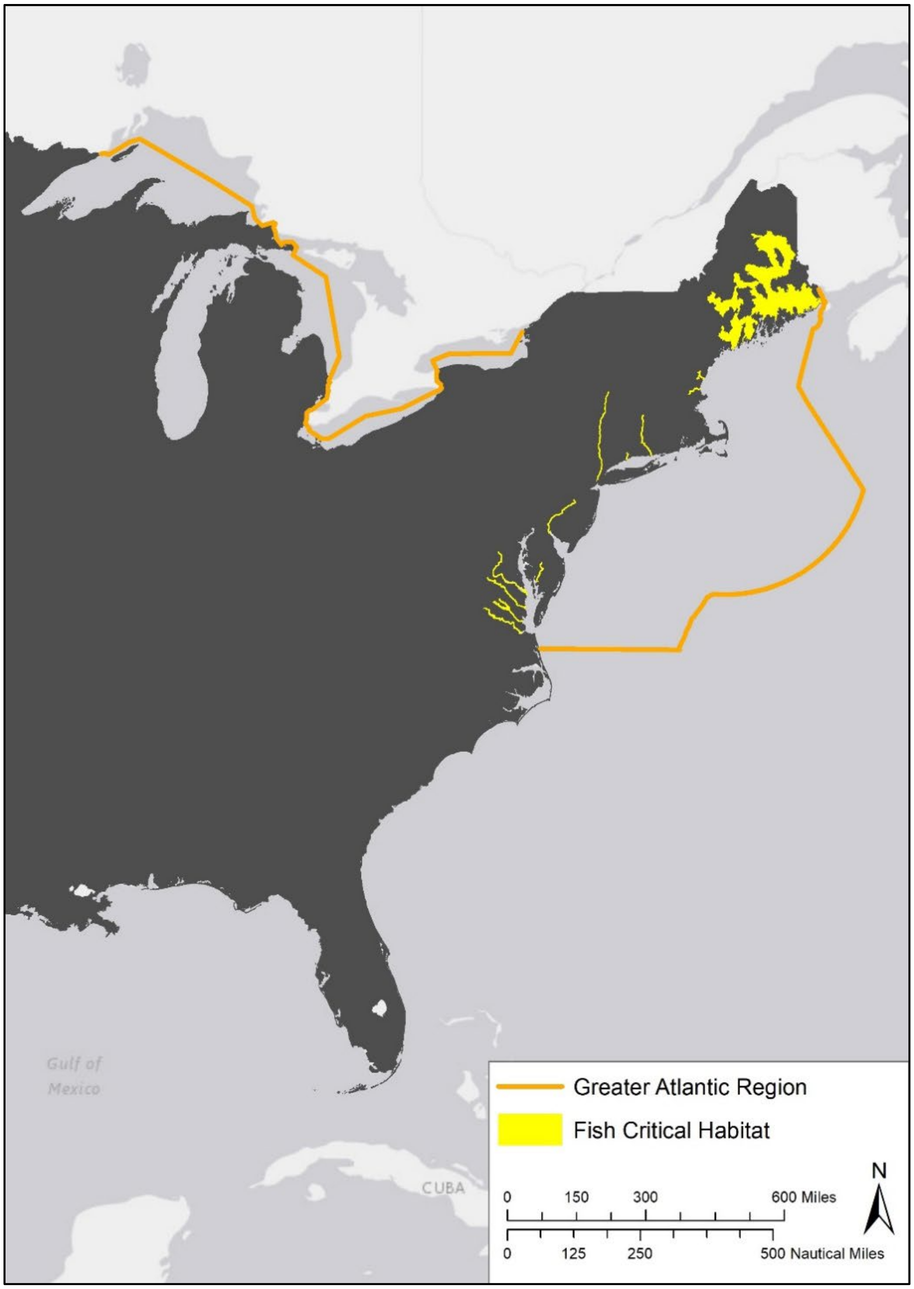
Spawning adults generally migrate upriver in spring, from January to April in the south, April to May in the Mid-Atlantic, and May to June in Canadian waters (NMFS, No Date-a). After spawning, the adults typically move quickly back downstream to the lower river and estuaries. Juveniles move downstream and live in brackish waters for a few months. Shortnose sturgeon search for food in the sandy, muddy bottom of rivers. They use a vacuum-like mouth to suck up this bottom-dwelling food, typically eating invertebrates such as insects, crustaceans, worms, and mollusks.

3.7.1.5 Regional Distribution

This section summarizes region-specific ESA-listed species and critical habitat. General fish assemblages are discussed in Section 3.7.1.1.

3.7.1.5.1 Greater Atlantic Region

Six ESA-listed fish species (Atlantic salmon, giant manta, Atlantic sturgeon – New York Bight DPS, Atlantic sturgeon – Chesapeake Bay DPS, Atlantic sturgeon – Gulf of Maine DPS, and shortnose sturgeon) occur in the Greater Atlantic Region, as indicated in **Table 3.7-1**. The Atlantic salmon and three DPSs of Atlantic sturgeon also have designated critical habitat in the region as shown in **Figure 3.7-12**, much of it occurring in inland rivers.

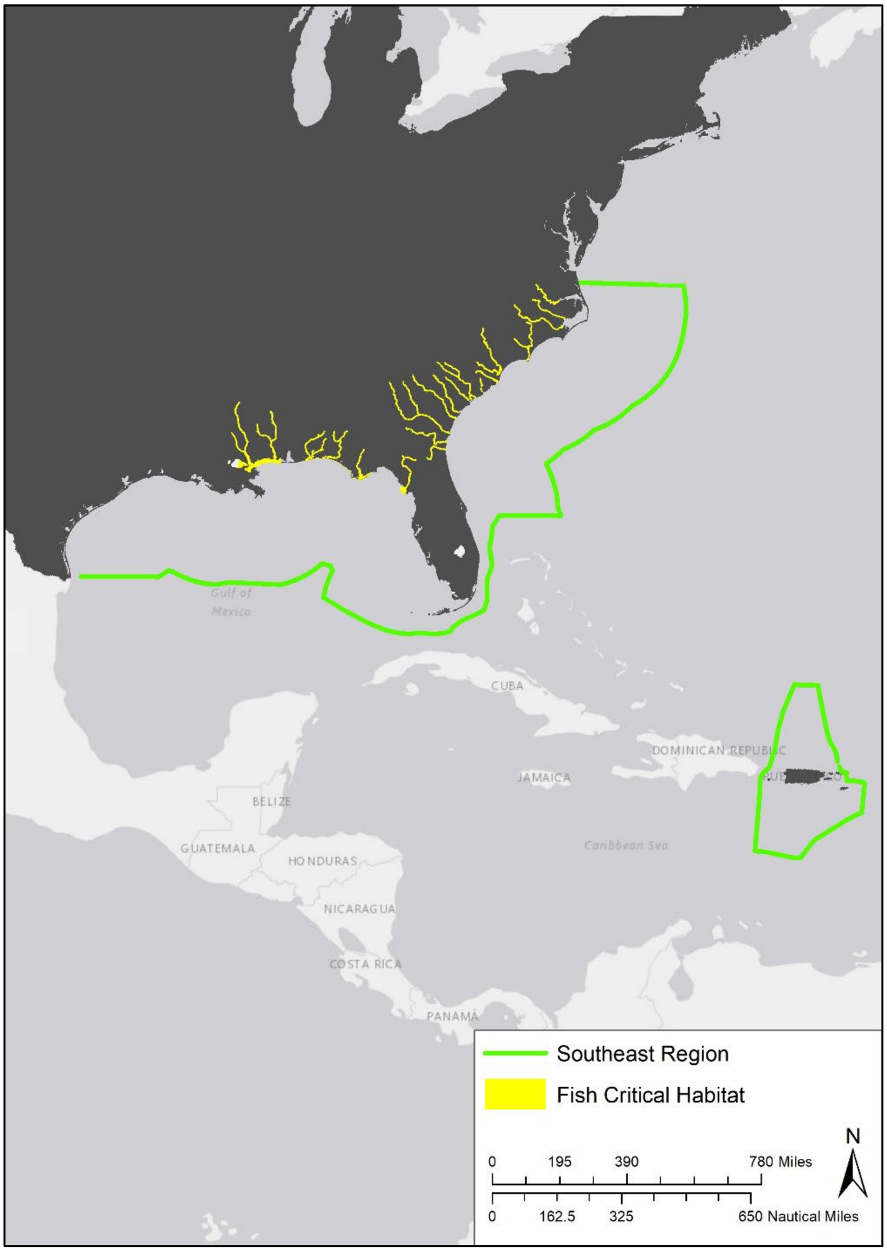


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-12. Designated Critical Habitat for Atlantic Sturgeon and Atlantic Salmon in the Greater Atlantic Region

3.7.1.5.2 Southeast Region

Nine ESA-listed fish (Nassau grouper, giant manta, scalloped hammerhead shark - Central and Southwest Atlantic DPS, largetooth sawfish, smalltooth sawfish, Atlantic sturgeon – Carolina DPS, Atlantic sturgeon – South Atlantic DPS, Atlantic sturgeon – Gulf or Mexico subspecies, and shortnose sturgeon) occur in the Southeast Region, as indicated in **Table 3.7-1**. The two DPSs of Atlantic sturgeon and the Atlantic sturgeon-Gulf of Mexico subspecies also have designated critical habitat in the region as shown in **Figure 3.7-13**, some of it occurring in inland rivers.

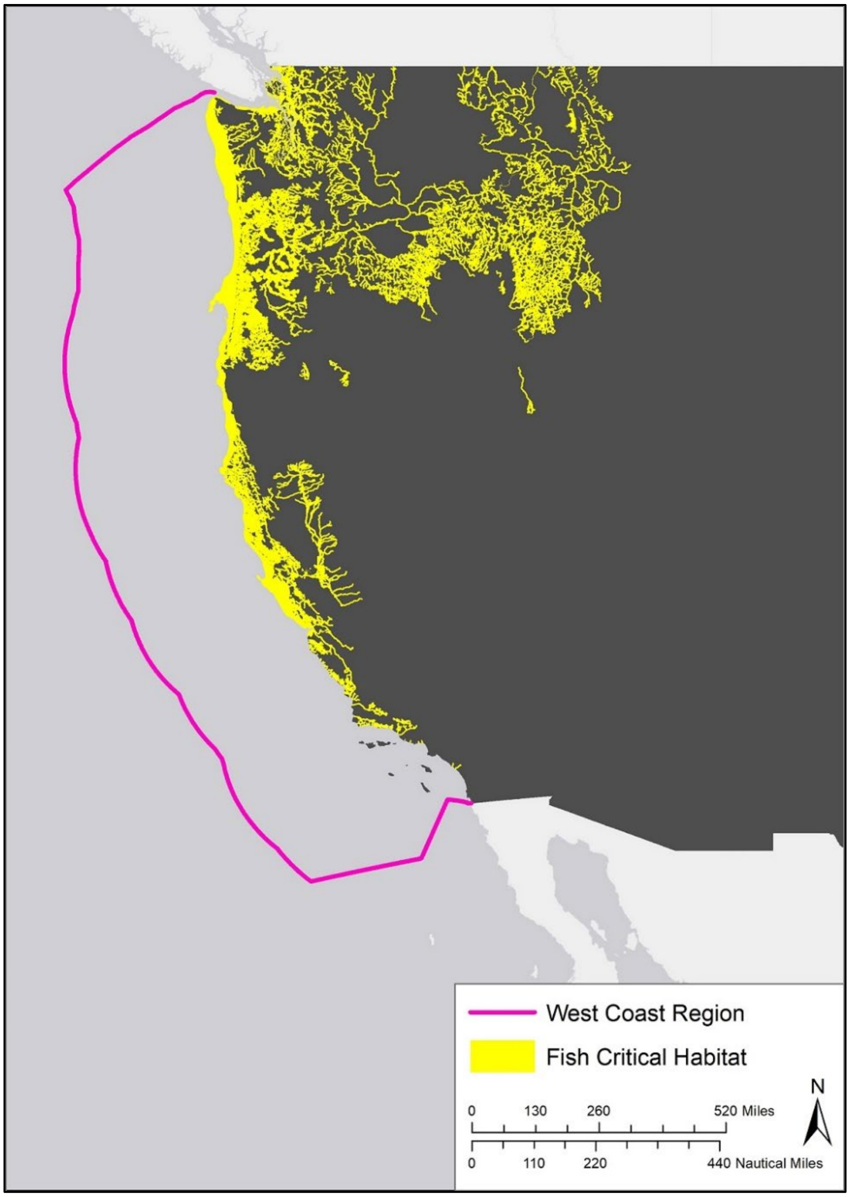


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-13. Designated Critical Habitat for Atlantic Sturgeon in the Southeast Region

3.7.1.5.3 West Coast Region

Thirty-six ESA-listed fish species, subspecies, ESU, or DPS occur in the West Coast Region, as indicated in **Table 3.7-1**. All nine ESUs of Chinook salmon, two ESUs of chum salmon, four ESUs of coho salmon, two ESUs of sockeye salmon, 11 DPSs of steelhead, tidewater goby, eulachon, yelloweye rockfish, bull trout, and green sturgeon have designated critical habitat in the region as shown in **Figure 3.7-14**, much of it occurring in inland rivers.



Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-14. Designated Critical Habitat for Ten Fish Species in the West Coast Region

3.7.1.5.4 Alaska Region

Three ESA-listed fish (eulachon, bocaccio, and yellow rockfish) occur in the Alaska Region, as indicated in **Table 3.7-1**. None of these species have designated critical habitat in the region.

3.7.1.5.5 Pacific Islands Region

Three ESA-listed fish (giant manta, scalloped hammerhead [Eastern Pacific DPS], and scalloped hammerhead [Indo-West Pacific DPS]) occur in the Pacific Islands Region, as indicated in **Table 3.7-1**. None of these species have designated critical habitat in the region.

3.7.2 Environmental Consequences for Fish

This section discusses potential impacts of proposed activities associated with Alternatives A, B, and C on fish. ESA-listed endangered and threatened species are included as part of the discussion along with non-listed species because the potential impact mechanisms are the same. However, any impacts on managed species are of particular concern since they could affect key populations of these species. Effects determinations for ESA-listed species are presented at the end of this section after the analysis of impacts.

Activities described in Sections 2.4.1 through 2.4.13 that occur on NOS projects and that could be expected to impact fish include operation of crewed sea-going surface vessels; operation of ROVs and autonomous vehicles; use of echo sounders, ADCPs, acoustic communication systems, and sound speed data collection equipment; anchoring; collection of bottom grab samples; operation of drop/towed cameras and video systems; installation, maintenance, and removal of tide gauges and GPS reference stations; and SCUBA operations.

3.7.2.1 Methodology

The factors from NOS activities that could impact fish include: (1) active underwater acoustic sources (e.g., echo sounders, ADCPs, and acoustic communication systems); (2) vessel sound (e.g., from surface vessels, ROVs, and autonomous vehicles); (3) vessel surface wake and underwater turbulence (e.g., from surface vessels; ROVs and autonomous vehicles; survey equipment; and anchors); (4) accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters (e.g., from vessel operations); (5) disturbance of the sea floor (e.g., from anchoring and bottom sampling); and (6) air emissions (e.g., from vessel smokestacks and outboard motors). These potential impact causing factors and their associated impacts on fish are discussed below for each alternative. Note that use of the term “sea floor” in the analysis below also includes lake and river bottoms where NOS activities could occur.

As discussed in Section 3.2.2, significance criteria were developed for each resource analyzed in this Final PEIS to provide a structured framework for assessing impacts from the alternatives and the significance of the impacts. The significance criteria for fish are shown in **Table 3.7-2**.

Table 3.7-2. Significance Criteria for the Analysis of Impacts to Fish

Impact Descriptor	Context and Intensity	Significance Conclusion
Negligible	Impacts to fish would be limited to temporary (lasting up to several hours) behavioral and stress-startle responses to individual fish or schools of fish found within the project area. Impacts on habitat would be temporary (e.g., placement of object on the sea floor which increases turbidity) with no lasting damage or alteration.	Insignificant
Minor	Impacts would be temporary or short-term (lasting several days to several weeks) but would not be outside the natural range of variability of species’ populations, their habitats, or the natural processes sustaining them. This could include temporary threshold shift of hearing or repeated, short-term stress responses without permanent physiological damage. Behavioral responses to disturbance by some individuals or a	

Impact Descriptor	Context and Intensity	Significance Conclusion
	school of fish could be expected, but only temporary disturbance of breeding, feeding, or other activities would occur, without any impacts on population levels. Displacement would be short-term and limited to the project area or its immediate surroundings. Impacts on habitat would be easily recoverable (e.g., short-term placement of objects on the sea floor which increases turbidity or causes loss of a small area of vegetation) with no long-term or permanent damage or alteration.	
Moderate	Impacts would be short-term or long-term (lasting several months or longer) and outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. This could include physiological injury to individuals in the form of temporary or permanent threshold shift, repeated stress responses, or mortality. Behavioral responses to disturbance by numerous individuals could be expected in the project area, its immediate surroundings, or beyond with some adverse impacts to breeding, feeding, growth, or other factors affecting population levels, including population-level mortality to, or extended displacement (up to a year) of large numbers (i.e., population-level) of fish but would not threaten the continued existence of a species. Habitat would be damaged or altered potentially over the long term but would continue to support the species reliant on it.	
Major	Impacts would be short-term or long-term and well outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Behavioral and stress responses would be repeated, and threshold shifts would be permanent. Actions would affect any stage of a species' life cycle (i.e., breeding, feeding, growth, and maturity), alter population structure, genetic diversity, or other demographic factors, and/or cause mortality beyond a small number of individuals, resulting in a decrease in population levels. Displacement and stress responses would be short- or long-term within and well beyond the project area. Habitat would be degraded over the long term or permanently so that it would no longer support a sustainable fishery and would cause the population of a managed species to become stressed, less productive, or unstable.	Significant

3.7.2.2 Alternative A: No Action - Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

Under Alternative A, NOS survey effort would cover a total of 2,647,958 nm (4,904,017 km) across all five regions over the five-year period. Although the survey effort under Alternative A would vary by year (see **Table 3.4-4**), over the five-year period for proposed projects that the greatest number of nautical miles surveyed would be in the Southeast Region (approximately 47 percent). The survey effort in each of the other four regions is approximately 10 percent over five years, and perhaps slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 18 percent). Additionally, survey effort in the Great Lakes would average 2,917 nm (5,402 km) annually, as compared to the annual average survey effort of 529,592 nm (980,803 km) for the remainder of the action area. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, hearing frequency of fish, and population densities of fish, that add nuance to this trend. Overall, NOS projects would be a very small part of all ocean activities as vessels used by NOS would represent a negligible proportion of all vessel traffic in the action area. Additionally, whenever possible, the location and timing of a given project would be purposefully coordinated to ensure that areas are not repeatedly surveyed. This ensures that the potential environmental impacts directly resulting from NOS projects and activities would not be exacerbated by repeated surveys within a given area.

3.7.2.2.1 Fish

The analysis of impacts on fish considers all of the impact causing factors introduced above, except for air emissions which are analyzed in Section 3.7.2.2.2. Potential impacts could occur in all of the geographic regions. All the regions include one or more ESA-listed species and designated critical habitat (with the exception that the Alaska Region and Pacific Islands Region do not have designated critical habitat). The West Coast Region contains the greatest number of ESA-listed species and the greatest amount of designated critical habitat (see **Table 3.7-1**).

In addition to the impacts on fish discussed in this section, fish may also be affected by alteration of habitat, such as degradation of water quality and disturbance of benthos, aquatic vegetation, and sediments. These impacts are discussed in Section 3.7.2.2.2 below.

3.7.2.2.1.1 Active Underwater Acoustic Sources

Effects of human-generated sound on fishes have been examined in numerous publications (Hastings and Popper, 2005; Hawkins et al., 2015; Mann, 2016; Neenan et al., 2016; Popper et al., 2003, 2007, 2014). Exposure of fish to sound from active underwater acoustic sources used in NOS projects, including echo sounders (0.5-900 kHz), ADCPs (35-1,200 kHz) and acoustic communication systems (10s of kHz), could affect pathological, physiological, and behavioral characteristics. As discussed in Section 3.7.1.3, the hearing frequency range of most fish is below approximately 1.5 kHz with the most sensitive range below 0.8 kHz. Thus, most fish may be able to hear low frequency sources that go down to 0.5 kHz, and which are used in deeper water, but remain outside of the primary energy band. The hearing range of pressure-sensing fish is typically extended to a few kHz (up to about 4 kHz). However, at least three species of herring-like fishes detect sounds above 20 kHz (Mann et al., 1997). Generally, underwater acoustic sources have not been known to cause direct injury or mortality to fish under conditions that would be found in the wild (Halvorsen et al., 2012; Kane et al., 2010; Popper et al., 2007). Potential direct injuries (e.g., barotrauma, hemorrhage or rupture of organs or tissue) from such sound sources are unlikely because of slow rise times (the amount of time for a signal to change from static pressure [the ambient pressure without the added sound] to high pressure), lack of strong shock waves, and relatively low peak pressures (Navy, 2018a).

Exposure to high-intensity sound can cause hearing loss, also known as a noise-induced threshold shift. TTS) is a temporary, recoverable loss of hearing sensitivity which may last several minutes to several weeks, and the duration may be related to the intensity of the sound source and the duration of the sound (including multiple exposures). PTS is non-recoverable, results from the destruction of tissues within the auditory system, permanent loss of hair cells, or damage to auditory nerve fibers (Liberman, 2016), and can occur over a small range of frequencies related to the sound exposure. However, the sensory hair cells of the inner ear in fishes are regularly replaced over time when they are damaged, unlike in mammals where sensory hair cells loss is permanent (Lombarte et al., 1993; Popper et al., 2014; Smith et al., 2006). As a consequence, PTS has not been known to occur in fish, and any hearing loss in fish may be temporary (i.e., for as long as required to repair or replace the damaged or destroyed cells) (Popper et al., 2005; Popper et al., 2014; Smith et al., 2006). For both TTS and PTS, the fish does not become deaf but requires a louder sound stimulus to detect a sound within the affected frequencies.

All fish detect and use particle motion, particularly at frequencies below several hundred Hz (Popper and Hawkins, 2019). Thus, the detection of particle motion is integral to hearing in all fishes (and invertebrates), and it is used to locate the direction of the source, even in those fishes that are also sensitive to sound pressure. Some fish species with a swim bladder that is involved in hearing may be more susceptible to TTS from high intensity sound sources, such as echo sounders, depending on the duration and frequency of the exposure (Popper et al., 2014). Fishes with a swim bladder involved in hearing and fishes with high-frequency hearing may exhibit TTS from exposure to low- and mid-frequency sonar. Fishes without a swim bladder and fishes with a swim bladder that is not involved in hearing would be unlikely to detect mid- or other higher frequency sonars and would likely require a much higher source level to exhibit the same effect from exposure to low-frequency active sonar. Adverse effects are possible for the small numbers of individual fish that could occur in close proximity (i.e., within several meters) to an active sound source. Generally, adverse effects on a species can be considered significant if they result in a reduction in the overall health and viability of a population. However, given the localized and transient spatial scale of no more than a few NOS projects occurring at any one time, relative to the generally large-scale distribution of fish populations and the considerably narrow beam characteristics of equipment such as echo sounders, no population level effects are expected on marine or freshwater fish.

Behavioral effects from active underwater acoustic sources include changes in the distribution, migration, and breeding of fish populations. Fish typically exhibit a sharp startle response at the onset of a sound, followed by habituation and a return to normal behavior after the sound ceases (Boeger et al., 2006; Wardle et al., 2001). The behavior and ecology of fish whose hearing does not overlap with the emitted sounds of active underwater acoustic sources would not, in most cases, be expected to be affected. A possible exception would be that those individuals within several meters of a sound source operating at high levels could be harmed by the energy of the sound, though the intensity of the impact is unknown. The frequencies of echo sounders, ADCPs, and acoustic communication systems do not overlap with the frequencies at which most marine and freshwater fish, including ESA-listed fish, are known to detect or produce sound (see above and Section 3.7.1.3). An exception to this is that some of the herring-like fishes (of the Clupeoid subfamily Alosinae: the anadromous shads, river herrings, and near-shore menhadens) can detect very high frequency (>20 kHz) signals (Mann et al., 2001). Non-alosine Clupeoids (sea herrings, sardines, and anchovies, among other marine fish species) do not hear above 4 or 5 kHz (Mann et al., 2001). For those fishes in the Alosine subfamily of herrings that can hear at frequencies above 20 kHz, exposures of most individual fish would be very brief. Therefore, NOS active underwater acoustic sources are very unlikely to result in population-level effects on these fish species.

Masking is the effect of an acoustic source interfering with the reception and detection of an acoustic signal of biological importance to a receiver (NSF and USGS, 2011). Any sound within an animal's hearing range can mask relevant sounds. Active underwater acoustic sources and vessel sound (see section below) could contribute to localized transitory masking of sound detection by some fish, at least those species mentioned above whose sound detection capacities are in the frequency range of the active sound sources. However, in general, the potential for masking effects would be limited given the brief, pulsed nature of the equipment and the transiting vessels used by NOS relative to individual fish. For alosine herrings, there could be some disturbance from underwater sound, such as changes in swim direction, speed, foraging patterns, and respiration patterns; however, the temporal and spatial scale of these effects would be short-term and localized to the area where the sound is being emitted. For most fish populations, including ESA-listed species, disturbance from active underwater acoustic sources would be limited to any relatively small portion of a population that may be located near the active sound source. Such effects would be considered insignificant at the population level.

NOS projects using active underwater acoustic sources would likely cross schools or aggregations of fish. Depending on water depth, these would include coastal pelagic, epipelagic, and demersal hard bottom species. If encountered, interactions with fish would be temporary because the vessel used by NOS would be constantly moving during project activities. Species exposed to sound might move away from the sound source; experience short-term TTS (hearing loss), masking of biologically relevant sounds, or increased levels of stress hormones; or may not show obvious effects (BOEM, 2014a). Mortality is very unlikely. Sound levels would return to ambient conditions once the sound source ceases. When exposure to sound ends, stress-related behavioral response by fishes would also be expected to end (McCauley et al., 2000b).

For fish species, the greatest potential for adverse impacts as a result of active underwater acoustic sources under Alternative A would be related to changes in behavior. Of primary importance is any change in behavior that would increase mortality or result in reduced survival or reproductive success. To be significantly adverse, such behavioral changes would need to cause an overall reduction in population abundance. Sound detection by the majority of marine and freshwater fishes, and hence behavioral disturbance and hearing impairment, is unlikely to occur due to the much higher frequencies of the NOS acoustic sources relative to fish hearing capabilities, although these sources could affect the behavior of shad, herrings and other fish that can hear these sounds. Active underwater acoustic sources would have the potential to disrupt spawning aggregations or schools of fishes, including those important as prey for other fishes and marine mammals. However, the mobile and temporary nature of the NOS projects, as well as the small area of the sea floor affected during the projects relative to the entire action area, and the potential for fish to temporarily move away from sound that is affecting them, would result in overall **adverse** and **minor** impacts. Impacts on fish, including ESA-listed species, would be **insignificant**.

3.7.2.2.1.2 Vessel Sound

All vessels produce underwater sound (in the 0.01 to 10 kHz frequency range) and are major contributors to overall background sound in the sea (see Appendix E). Source levels and frequency characteristics are roughly related to ship size and speed. The dominant sound source of vessels used by NOS is propeller cavitation, although propeller singing, propulsion machinery, and other sources (e.g., flow noise, wake bubbles) can also contribute to underwater sound. It is likely that fish occurring in locations where there is high vessel traffic have habituated to this sound. Sounds from vessels are generally below levels that can cause temporary hearing loss or injury in fish. Underwater vessel sound can disturb and displace nearby fish, interrupt feeding, cause other behavior modifications, and possibly mask biologically important signals; such impacts would vary among species as most fish cannot hear the higher frequencies emitted by vessel sound, except for perhaps shads, river herrings, and menhadens (see discussion in Sections 3.7.1.3 and 3.7.2.2.1.1). Impacts on fish behavior are expected to be temporary and localized to areas of vessel activity.

ROVs also generate engine sound, and impacts on fish would be similar to those from sound from surface vessels, but likely at a reduced severity as ROVs are smaller, thus producing less sound, and they would not be used as extensively as surface vessels (see **Table 2.6-1**).

In remote areas that are reached by boat for tide gauge installation, maintenance, and removal, impacts on fish could occur and would be similar to those from surface vessel operations. Likewise, installation of a shore-based GPS reference station would not have any effects on fish other than potentially from accessing the site via a surface vessel, in which case impacts on fish could occur and would be similar to those from surface vessel operations.

Vessels used by NOS would represent only a negligible proportion of total vessel traffic in the action area. Based on the proposed amount of vessel traffic associated with NOS projects in the action area under Alternative A, and the relatively low amounts of vessel sound produced as compared to sound from all other marine traffic in U.S. waters, the overall effects of vessel sound on fish, including ESA-listed species, would continue to be **adverse** and **negligible** as impacts would be limited to temporary behavioral and stress-startle responses to individual fish or schools of fish found within the project area. The severity of effects on shads, river herrings, and menhadens, species that can potentially hear the higher frequencies of vessel sound, could be somewhat higher but are not expected to be more than **minor**, as impacts under Alternative A would still continue to be temporary or short-term, may include some stress responses without permanent physiological damage, and may disturb breeding, feeding, or other activities but without any impacts on population levels. Any displacement of fish would continue to be short-term and limited to the NOS project area or its immediate surroundings. Thus, impacts under Alternative A would continue to be **insignificant**.

3.7.2.2.1.3 Vessel Wake and Underwater Turbulence

Water disturbance by surface vessel and ROV wakes and underwater turbulence could temporarily disturb and displace nearby fish in the project area or in a portion of the project area. The impact on fish would be minimal as the vessel would quickly pass by or stop moving. In any case, fish are expected to return to the area and resume normal activities once the vessel departs or the ROV is no longer present. The impact from ROVs would also be minimal; they would not create a wake or much underwater turbulence because they are slow-moving and relatively small.

Equipment used in NOS projects, such as echo sounders and ADCPs, are typically attached to a crewed vessel, ROV, or autonomous vehicles; thus, effects on fish due to water movement that is created would occur from the use of these carriers, rather than any disturbance from the equipment itself. An exception would be in the rare instances when echo sounders are placed directly on the sea floor or operated by divers, who would move through the water column, possibly disturbing fish temporarily.

Some equipment, such as sound speed data collection equipment, bottom grab samplers, and drop/towed cameras, is lowered and raised through the water column or falls through the water. This movement through the water could temporarily disturb and displace nearby fish, although fish would not be expected to move too far. These impacts would be temporary as fish are expected to return once water column turbulence ceases.

Under Alternative A, effects on fish, including ESA-listed species, from vessel wake and underwater turbulence would continue to be **adverse** and **negligible** as responses to disturbance by some individuals would be limited to temporary behavioral and stress-startle responses, but without interference to factors affecting population levels. Thus, impacts under Alternative A would continue to be **insignificant**.

3.7.2.2.1.4 Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in release of oil, fuel, or chemicals by a vessel used by NOS in a project area and its immediate surroundings. Adverse impacts on fish could also occur from pumping of oily bilge water overboard, discharged wastewater/graywater that may contain nutrients and fecal coliform bacteria, and accidental oil, fuel, and chemical spills. Most adult fish are mobile enough to avoid discrete, limited areas of higher concentrations of oil and other contaminants. Depending on the product, most oil would remain at or near the surface and typically would not impact fish in deeper water. Lighter substances can disperse into the water column or might dissolve in water, potentially impacting eggs, larvae, and juvenile fish which are more susceptible than adults since they are less mobile. Coastal pelagic and epipelagic species that forage at the surface would be most likely to encounter a spill (BOEM, 2014a).

Although the probability of accidental oil and chemical spills is very low, if exposed, fish can be affected directly either by ingestion of oil products or oiled prey, through uptake of dissolved petroleum compounds and through effects on fish eggs and larvae survival (Malins and Hodgins, 1981). Sublethal effects may cause stress and may be transient and only slightly debilitating, but fish may also be killed when coming into contact with oil and other contaminants. Repair and recovery require metabolic energy, and use of this energy may ultimately lead to increased vulnerability to disease or to decreased growth and reproductive success. The egg, early embryonic, and larval-to-juvenile stages of fish seem to be the most sensitive to oil products. The lethal effects may not be realized until the fish fails to hatch, dies upon hatching, or exhibits some abnormality as a larva, such as an inability to swim.

Fish can be affected indirectly by oil, spilled fuel, and chemicals through changes in the ecosystem that affect prey species and habitats. All fish rely on phytoplankton and zooplankton during their larval and juvenile stages. However, even if a large amount of plankton were affected, it can recover rapidly due to high reproductive rates, rapid replacement by cells from adjacent waters, widespread distribution, and exchange with tidal currents. Thus, the impact on a pelagic phytoplankton community, and on fish, would not be substantial.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. For example, on NOAA fleet vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the Commanding Officer takes appropriate action to minimize the effects of the spill. OMAO Procedure 0701-06 VRP/SOPEP provides policy and guidance to all NOAA vessels regarding oil pollution emergency planning and response, in accordance with MARPOL 73/78, Annex I. The plan contains all the information and instruction required for responding to shipboard oil spills, such as general spill mitigation and response, shipboard spill mitigation and response, reporting requirements, completing Corrective Action Assessments, trainings, drills, and exercises. This plan has been approved by the USCG, and complies with the Oil Pollution Act of 1990 and Federal Water Pollution Act of 1973.

Under Alternative A, the likelihood of an accidental spill from a vessel used by NOS would continue to be very low, thus impacts are expected to be **adverse** and **negligible**. All hazardous or regulated materials would be handled in accordance with applicable laws, crew members would be appropriately trained in materials storage and usage, and all MARPOL discharge protocols would be followed. In the event that an accidental spill does occur, the volume of oil, fuel, and/or chemicals would be fairly small given the amounts of fuel and other chemicals that vessels used by NOS typically carry for onboard consumption; thus, the impact on fish would continue to be **adverse** and **minor** as impacts would be temporary or short-term without any impacts on population levels. Displacement of fish that move away to avoid spilled substances would continue to be short-term and limited to the project area or its immediate surroundings. Impacts on fish, including ESA-listed species, would be considered **insignificant**.

3.7.2.2.1.5 Disturbance of the Sea Floor

Anchoring is an infrequent activity and would only occur in a small portion of a project area (see **Table 2.6-1**). Water disturbance by anchors and chains moving in the water and across the sea floor can temporarily disturb and displace nearby fish. This impact on fish would be negligible and cease with the anchoring system coming to rest or being taken out of the water. Any displaced fish are expected to return to the area and resume normal activities once water column turbulence ceases.

If anchor chains drag across the sea floor, they can create a circular scour hole (Limpinsel et al., 2017). Anchor scour has the potential to create localized turbidity that could reduce water clarity and increase sediment deposition. Increased turbidity and sedimentation can have minor impacts on juvenile and adult fish by reducing feeding efficiency, altering reproductive cycles, and reducing response to physical stimulus. In cases where organisms are exposed to excessive turbidity, the sediments can coat gills, thus limiting gas exchange and possibly leading to asphyxiation. However, adult fish are mobile and can avoid highly turbid areas and, under most conditions, can survive short exposure (minutes to hours) to elevated turbidity levels. Additionally, NOS would not drag anchor chains and would ensure that anchors are properly secured so as to minimize bottom disturbance.

More sensitive species and life stages (i.e., eggs, larvae, and fry) are impacted by longer exposure to suspended (or deposited) sediments than less sensitive species and older life stages. There could be delayed or reduced hatching of eggs, reduced larval growth or development, and abnormal larval development. There would not be any direct impacts on those fish that spawn in coral reefs as vessels would not anchor on coral reefs. Coral reef fish spawn in the water column, though, and release planktonic eggs which drift away with the currents, hatch to larvae, and develop in the water column; thus, there could be impacts from suspended sediments. However, suspended sediments are expected to settle quickly and long exposures are not likely to occur.

Collecting bottom samples could create localized turbidity and affect soft-bottomed seafloor habitat, potentially creating turbidity that could reduce water clarity temporarily. Such turbidity would likely be minimal as samplers are designed to close to contain the sediment and prevent sample washout. In some instances, equipment, such as echo sounders and XBTs, may be placed directly on the sea floor and could also cause minimal temporary localized turbidity. Fish in the vicinity could likely swim away and avoid any of these turbidity impacts. NOS would ensure that all instruments placed in contact with the sea floor are properly secured so as to minimize bottom disturbance. Additionally, equipment such as Autonomous Underwater Vehicles (AUVs) would be programmed and operated so as to avoid seafloor disturbance, SCUBA divers would avoid inadvertent disturbance to the sea floor, and stiffer line material would be used and kept taut during operations to reduce potential for entanglement with bottom features such as coral habitat.

Effects on fish from disturbance of the sea floor under Alternative A would continue to be **adverse** and **negligible** to **minor**. Impacts to fish would continue to be temporary behavioral responses to localized turbidity by some individuals, including potential disturbance of breeding, feeding, or other activities but without any impacts on population levels. Displacement would continue to be temporary and limited to the project area. Impacts on fish, including ESA-listed species, would continue to be **insignificant**.

3.7.2.2.2 Fish Habitat

The analysis of impacts on fish habitat, including designated critical habitat, does not consider active underwater acoustic sources or vessel and equipment sound as these impact causing factors would not affect habitat characteristics (other than on prey fish, which would have similar impacts as described above for fish in general).

3.7.2.2.2.1 Vessel Wake and Underwater Turbulence

Vessel wakes and turbulence can generate wave and surge effects on nearby shorelines and stir up bottom sediments in shallow locations of a project area and its immediate surroundings depending on the wake wave energy, the water depth, and the type of shoreline (Limpinsel et al., 2017). Vessel wakes can cause shoreline erosion, degrade wetland habitat, and increase water turbidity. Water column habitat gradients would be temporarily disrupted by wake action, including temperature, salinity, DO, turbidity, and nutrient supply. Stirring up lake sediment can re-suspend nutrients such as phosphorus, potentially contributing to harmful, DO-consuming algal blooms. Impacts would have greater effects in habitats where fish aggregate, such as spawning aggregation sites, feeding areas, hard bottom habitats, and artificial reefs, than in locations with few fish. Also, not only would these types of impacts occur in general fish habitat, but also such areas as nearshore marine critical habitat, for such species as bull trout and bocaccio, and estuarine critical habitat, for such species as Atlantic salmon, gulf sturgeon, and green sturgeon. To reduce these adverse effects of wake action which may occur in a project area and its immediate surroundings, vessels used by NOS would operate at sufficiently low speeds (up to 10 knots) to reduce wake energy when in shallow areas or close to shorelines. Additionally, all vessels in coastal waters would operate in a manner to minimize propeller wash, and transiting vessels should follow deep-water routes (e.g., marked channels), as practicable, to reduce disturbance to sturgeon and sawfish critical habitat.

The suspension of disturbed sediments from wake action and shoreline erosion could minimize the light intensity that reaches aquatic vegetation which depends on light for photosynthesis. High turbidity that causes a substantial reduction in light availability can lead to sublethal adverse effects or mortality of aquatic vegetation. Suspended material may also react with DO in the water and result in temporary or short-term oxygen depletion to aquatic resources, including vegetation and aquatic macroinvertebrates.

The movement of AUVs, equipment used in projects such as sound speed data collection equipment, bottom grab samplers, drop/towed cameras, and anchors and chains through the water column could temporarily cause turbulence and disturb nearby aquatic macroinvertebrates and other prey species, as well as potentially cause damage to submerged aquatic vegetation. These impacts would be temporary as benthos and prey species are expected to return once water column turbulence ceases.

Equipment such as echo sounders, ADCPs, and acoustic communication systems are typically attached to a crewed vessel, ROV, or autonomous vehicles, thus effects on habitat would occur from the use of these carriers, rather than any disturbance from the acoustic equipment itself. One exception would be in the rare instances when echo sounders are placed directly on the sea floor or operated by divers. In such cases, divers would move through the water column temporarily disturbing benthic communities and prey species. Lines connecting equipment to a vessel could also become entangled with, damage, or kill aquatic vegetation such as seagrass.

Underwater turbulence could occur during tide gauge installation even though it occurs primarily out of the water at existing piers, docks, bulkheads, and other such locales. All buoys would be attached to the sea floor using the best available mooring systems to reduce entanglement. Generally, no impact on habitat would occur except when tide gauge installation requires in-water work that could cause sediment disturbance. In remote areas which are reached by boat for installation, maintenance, and removal, impacts on habitat could occur and would be similar to those for surface vessel operations. Likewise, installation of a shore-based GPS reference station would not have any effects on habitat other than potentially from accessing the site via a surface vessel, in which case impacts on prey fish could occur and would be similar to those from surface vessel operations.

Effects on habitat, including designated critical habitat, from vessel wake and underwater turbulence under Alternative A would continue to be **adverse** and **minor** as habitat impacts would be easily recoverable with no long-term damage or alteration. Thus, impacts under Alternative A would continue to be **insignificant**.

3.7.2.2.2.2 Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in release of oil, fuel, or chemicals by a vessel used by NOS in a project area and its immediate surroundings. The accidental loss of a substantial amount of fuel or lubricating oil during projects could affect water quality, the water column, the sea floor, intertidal habitats, and associated biota (i.e., aquatic macroinvertebrates and submerged aquatic vegetation) resulting in their mortality or substantial injury, and in alteration of the existing quality of fish habitat. Habitat most at risk from a small spill would be pelagic Sargassum as it drifts at the surface in windrows or mats, and supports numerous fish and invertebrates (BOEM, 2014a).

Vessel bilge water discharges, engine operations, bottom paint sloughing, boat washdowns, and other vessel activities or wear can also deliver debris, nutrients, and contaminants to waterways which may degrade water quality, contaminate sediments, and alter benthic communities in fish habitat. Vessel wash, including gray water, deck runoff and cooling water can damage aquatic vegetation and disturb benthos and sediments, which may increase turbidity and suspend contaminants in habitat. Any liquid contaminants, however, are expected to be rapidly diluted throughout the water column.

Impacts from an accidental fuel spill and release of other contaminants would not only occur in general fish habitat, but also such areas as nearshore marine critical habitat, for such species as bull trout and bocaccio, deepwater critical habitat, for bocaccio and yelloweye rockfish, and estuarine critical habitat, for such species as Atlantic salmon, gulf sturgeon, and green sturgeon. It is also possible that impacts on critical habitat in rivers and streams for many species of salmon and steelhead could occur if vessels used by NOS are working in freshwater habitat.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. For example, on NOAA fleet vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the Commanding Officer takes appropriate action to minimize the effects of the spill. OMAO Procedure 0701-06 VRP/SOPEP provides policy and guidance to all NOAA vessels regarding oil pollution emergency planning and response, in accordance with MARPOL 73/78, Annex I. The plan contains all the information and instruction required for responding to shipboard oil spills, such as general spill mitigation and response, shipboard spill mitigation and response, reporting requirements, completing Corrective Action Assessments, trainings, drills, and exercises. This plan has been approved by the USCG, and complies with the Oil Pollution Act of 1990 and Federal Water Pollution Act of 1973.

All hazardous or regulated materials would be handled in accordance with applicable laws, all MARPOL discharge protocols would be followed, and crew members would be appropriately trained in materials storage and usage. The likelihood of occurrence of an accidental spill from a vessel used by NOS would be very low, although the release of other contaminants is a little more likely; thus, impacts are expected to be **adverse** and **negligible**. In the event that an accidental spill does occur, the volume of oil, fuel, and/or chemicals would be fairly small given the amounts of fuel and other chemicals that vessels used by NOS typically carry for onboard consumption; thus, the impact on habitat would be **adverse** and **minor** as habitat impacts would be easily recoverable with no long-term damage or alteration. Impacts on habitat, including designated critical habitat, would be considered **insignificant**.

3.7.2.2.2.3 Disturbance of the Sea Floor

Adverse impacts on fish habitat can occur when vessels anchor in shallow nearshore waters and the anchor chain drags across the sea floor, destroying submerged vegetation and creating a circular scour hole. Anchor scour has the potential to create localized turbidity and affect soft-bottomed seafloor habitat and/or rocky substrates, potentially creating turbidity that could reduce water clarity and increase sediment deposition. NOS would not drag anchor chains and would ensure that anchors are properly secured so as to minimize bottom disturbance.

Increased turbidity immediately following anchoring events could temporarily reduce foraging ability of prey due to decreased visibility in the water column; however, impacts to these conditions would be minor and of short duration and would soon return to baseline. Suspended material may also react with DO in the water and result in temporary oxygen depletion to aquatic resources.

Collecting bottom samples could create localized turbidity and affect soft-bottomed seafloor habitat, potentially creating turbidity that could reduce water clarity temporarily. Such turbidity would likely be minimal as samplers are designed to close to contain the sediment and prevent sample washout. Likewise, placement of echo sounders on the sea floor has the potential to create localized turbidity that could reduce water clarity temporarily, although this would be minor. NOS would not collect bottom samples on known coral reefs and would ensure that all instruments placed in contact with the sea floor are properly secured so as to minimize bottom disturbance. Additionally, equipment such as AUVs would be programmed and operated so as to avoid seafloor disturbance, SCUBA divers would avoid inadvertent disturbance to the sea floor; and stiffer line material would be used and kept taut during operations to reduce potential for entanglement with bottom features such as coral habitat.

Similar impacts from disturbance of ocean or river bottom could also occur in designated critical habitat if anchoring, collection or bottom samples, or placement of equipment occurs in such locations, including nearshore marine designated critical habitat of bull trout and bocaccio, estuarine critical habitat of Atlantic salmon, gulf sturgeon, and green sturgeon, and riverine critical habitat of species of salmon and steelhead. Additionally, all vessels in coastal waters would operate in a manner to minimize seafloor disturbance, and transiting vessels should follow deep-water routes (e.g., marked channels), as practicable, to reduce disturbance to sturgeon and sawfish critical habitat.

Effects from disturbance of the sea floor would be **adverse** and **negligible** to **minor** as habitat impacts would be easily recoverable with no long-term damage or alteration. Impacts on habitat, including designated critical habitat, would be **insignificant**.

3.7.2.2.2.4 Air Emissions

Since the pre-industrial era, increased emissions of anthropogenic GHGs (e.g., CO_2, CH_4, and N_2O) have resulted in higher atmospheric concentrations of these gases that influenced changes in oceanic conditions (as well as atmospheric and terrestrial conditions) (Limpinsel et al., 2017). Higher atmospheric CO_2 levels increase dissolved CO_2 and bicarbonate ions in seawater, which subsequently leads to a decrease in seawater pH and carbonate ions. In general, a decrease in pH corresponds to a simultaneous increase in acidity, termed "ocean acidification." Changes in seawater carbon chemistry, in particular interference with the formation of $CaCO_3$ in marine shells and skeletons, may adversely affect marine biota through a variety of biochemical, physiological, and physical processes and interactions.

Smokestack and two-stroke outboard motor emissions from vessels used by NOS would release air pollutants, which can be deposited on the water surface and contribute to adverse effects such as increasing water acidity in fish habitat, including designated critical habitat. In addition, two-stroke outboard motors can emit 25-30 percent of their unburned gas and oil mixture directly into the water, adding metals and chemicals directly to the water column. The amount of emissions from vessels used by NOS would be negligible compared to emissions from all other vessel activity in the oceans. Thus, impacts from air emissions are expected to be **adverse** and **minor** since air emissions could travel and be deposited within the project area. Air emissions could be deposited immediately outside of the project area but would dissipate fairly quickly. Impacts on habitat, including designated critical habitat, would be **insignificant**.

3.7.2.2.3 Conclusion

Under Alternative A, NOS would continue to operate a variety of equipment and technologies to gather data on the marine and coastal environments at the level of effort reflecting NOS fiscal year 2019 funding levels. Since the effects of impact causing factors on fish and fish habitat range from negligible to minor, the overall impact of Alternative A on fish, including ESA-listed species and designated critical habitat, would continue to be **adverse** and **minor**; thus, impacts of Alternative A would be **insignificant**.

3.7.2.3 Alternative B: Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations

The same impact causing factors for fish and fish habitat considered under Alternative A are considered under Alternative B. Under Alternative B, all of the activities and equipment operations proposed in Alternative A would continue but at a higher level of effort, although the percentage of nautical miles covered by project activities in each region would be the same as under Alternative A. Thus, the greatest level of effort would be in the Southeast Region (with approximately 47 percent of the survey effort); level of effort in the other four regions would be at similar levels (approximately 10 percent of the survey effort in each region), and perhaps slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 18 percent). The level of effort in the Great Lakes would remain much lower as compared to an annual total marine survey effort. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, hearing frequency of fish, and population densities of fish, that add nuance to this trend.

Projects under Alternative B would take place in the same geographic areas and timeframes as under Alternative A; however, Alternative B would include more projects and activities, and thus more nautical miles traveled, than Alternative A. Under Alternative B, NOS survey effort would cover a total of 2,912,753 nm (5,394,419 km) across all five regions over the five-year period. Overall, survey effort would cover an additional 264,796 nm (490,402 km) under Alternative B (see **Table 3.4-5**) as compared to Alternative A (2,647,958 nm [4,904,017 km] total) across all regions over the five-year period. The types and mechanisms of impacts would remain the same in Alternative B as discussed for Alternative A. Therefore, the difference between the two alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative B as compared to Alternative A.

For example, under Alternative B there would be projects using crewed vessel operations covering 577,000 nm (1,070,000 km), as compared to 518,000 nm (959,000 km) under Alternative A. Vessel operations could contribute to impacts on fish and fish habitat related to vessel sound, vessel wake and underwater turbulence, accidental spills, and air emissions. Although the amount of crewed vessel operations would be greater under Alternative B than under Alternative A, additional projects covering 59,000 nm (111,000 km) across five regions would result in greater impacts overall, but not so great that the magnitude of a particular impact causing factor would increase (e.g., from negligible to minor). The magnitude of impacts would likewise remain the same for other proposed activities contributing to potential impacts, such as underwater sound from echo sounders, ADCPs, and acoustic communication systems; and bottom disturbance from anchoring, bottom grab samples, and sound speed data collection.

Although NOS would add more widespread adoption of new techniques, protocols, and technologies to more efficiently perform surveying, mapping, charting, and related data gathering under Alternative B as compared to Alternative A, impacts on fish, including ESA-listed species, and fish habitat, including designated critical habitat, would be the same or slightly, but not appreciably, larger than those discussed above under Alternative A for each impact causing factor. Overall, impacts of Alternative B on fish would be **adverse, minor,** and **insignificant**.

3.7.2.4 Alternative C: Upgrades and Improvements with Greater Funding Support

The same impact causing factors for fish and fish habitat considered under Alternatives A and B are considered under Alternative C. Under Alternative C, all of the activities and equipment operation proposed in Alternative A would continue but at a higher level of effort, although the percentage of nautical miles in each region would be the same as under Alternatives A and B. In addition, there would be an overall funding increase of 20 percent relative to Alternative B, thus the level of project activity would increase further. Thus, the level of effort would be in the Southeast Region (with approximately 47 percent of the survey effort); level of effort in the other four regions would be at similar levels (approximately 10 percent of the survey effort in each region), and perhaps slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 18 percent). The level of effort in the Great Lakes would remain much lower as compared to an annual total marine survey effort. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, hearing frequency of fish, and population densities of fish, that add nuance to this trend.

Projects under Alternative C would take place in the same geographic areas and timeframes as under Alternatives A and B; however, Alternative C would include more projects and activities, and thus more nautical miles traveled, than Alternatives A and B. Under Alternative C, NOS survey effort would cover a total of 3,177,549 nm (5,884,821 km) across all five regions over the five-year period. Overall, there would be an additional 264,796 nm (490,402 km) covered by vessels used by NOS under Alternative C (see **Table 3.4-6**) as compared to Alternative B (2,912,753 nm [5,394,419 km] total), and an additional 529,592 nm (980,803 km) as compared to Alternative A (2,647,958 nm [4,904,017 km] total) across all regions over the five-year period. The types and mechanisms of impacts would remain the same in Alternative C as discussed for Alternatives A and B across all regions over the five-year period. Therefore, the difference between the alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative C as compared to Alternatives A and B. As discussed under Alternative B, the additional projects and nautical miles traveled under Alternative C across five regions would result in greater impacts on fish overall, but not so great that the magnitude of a particular impact causing factor would increase (e.g., from negligible to minor).

Alternative C would be similar to Alternative B, plus it would consist of NOS program implementation with an overall funding increase of 20 percent relative to Alternative B. However, impacts of Alternative C on fish, including ESA-listed species, and fish habitat, including designated critical habitat, would be the same or slightly, but not appreciably, larger than those discussed above under Alternatives A and B for each impact causing factor. Overall, impacts of Alternative C on fish would be **adverse, minor,** and **insignificant**.

3.7.2.5 Endangered Species Act Effects Determination

Federal agencies are required under the ESA to formally determine whether their actions may affect listed species or their designated critical habitat. Effects determinations divide potential effects into three categories: No Effect; May Affect, but Not Likely to Adversely Affect; and May Affect, and is Likely to Adversely Affect. Actions receiving a “No Effect” designation do not impact listed species or their designated critical habitat (hereafter listed resources) either positively or negatively, and this designation is typically only used in situations where no listed resources are present in the action area. Actions receiving a “May Affect, but Not Likely to Adversely Affect” designation have only beneficial, insignificant, or discountable effects to listed resources. Effects are considered insignificant if they are of low relative impact, undetectable, not measurable, or cannot be evaluated. Adverse effects are considered discountable if they are extremely unlikely to occur. Actions designated as “May Affect, and is Likely to Adversely Affect” will negatively impact any exposed listed resources.

ESA-listed fish species cannot hear the frequencies emitted by active underwater acoustic sources. Additionally, due to the mobile and temporary nature of the projects, the small area of the sea floor affected during the projects relative to the entire EEZ, and the possibility for fish to temporarily move away from sound that is affecting them, the response to sound exposure from active underwater acoustic sources included in the alternatives would be short term, limited to only a few individuals, and therefore, discountable (i.e., extremely unlikely to occur).

The proposed volume of sound from the use of vessels associated with project activities would be very small in comparison to sound from all the other non-project related vessel traffic in the EEZ. Impacts would be limited to temporary behavioral and stress-startle responses to individual fish or schools of fish. Because sound disturbance would be temporary or of short duration, limited to only a few individuals, and would occur infrequently in any given project area, the response by ESA-listed fish to sound from vessels used by NOS would be discountable (i.e., extremely unlikely to occur). Although water disturbance by surface vessel and ROV wakes and underwater turbulence could temporarily disturb and displace a few individual nearby fish, effects would be temporary and minimal and limited to the project area or its immediate surroundings; thus, the response by ESA-listed fish would be discountable.

The likelihood for an accidental spill is expected to be discountable (i.e., extremely unlikely to occur), and exposure of ESA-listed fish species and critical habitats to oil, fuel, and other contaminants is not expected. These accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the extreme unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. Thus, effects from chemical contamination on ESA-listed species are discountable (i.e., extremely unlikely to occur).

Given the minimal amount of potential turbidity and fine sediment created by disturbance of the sea floor, the effect on ESA-listed species would be discountable.

Thus, NOS concludes that the proposed project “May Affect, but Not Likely to Adversely Affect” any of the ESA-listed fish species occurring in the action area (**Table 3.7-3**). Additionally, these fish species serve as prey to marine mammals, and thus, effects on these fish would constitute indirect effects to marine mammals. Thus, the “May Affect, but Not Likely to Adversely Affect” determination for ESA-listed fish also applies indirectly to ESA-listed marine mammals.

Since projects may occur in some areas within or adjacent to designated critical habitats, there is the potential for impacts on critical habitat characteristics that support ESA-listed fish species. Critical habitat may be minimally disturbed but would remain functional to maintain viability of the species reliant on it. Due to the potential for effects that could be negligible or minor as discussed in the impact analysis above, the Proposed Action “May Affect, but Not Likely to Adversely Affect” the designated critical habitat occurring in the action area (**Table 3.7-3**).

Table 3.7-3. Summary of Effects Determinations for ESA-Listed Fish and Critical Habitat

ESA-Listed Fish	Species Determination	Critical Habitat Determination
Perch-likes (Perciformes)		
Nassau grouper	May Affect, Not Likely to Adversely Affect	N/A* (no critical habitat designated)
Tidewater goby	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Salmon, Smelts, etc. (Salmoniformes)		
Atlantic salmon (Gulf of Maine DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Chinook salmon (California Coastal ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect

ESA-Listed Fish	Species Determination	Critical Habitat Determination
Chinook salmon (Central Valley Spring-run ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Chinook salmon (Lower Columbia River ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Chinook salmon (Puget Sound ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Chinook salmon (Sacramento River Winter-run ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Chinook salmon (Snake River Fall-run ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Chinook salmon (Snake River Spring/Summer-run ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Chinook salmon (Upper Columbia River Spring-run ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Chinook salmon (Upper Willamette River ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Chinook salmon (Upper Klamath-Trinity River)	May Affect, Not Likely to Adversely Affect	NA (no critical habitat designated)
Chum salmon (Columbia River ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Chum salmon (Hood Canal Summer-run ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Coho salmon (Central California Coast ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Coho salmon (Lower Columbia River ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Coho salmon (Oregon Coast ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Coho salmon (Southern Oregon/Northern California Coast ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Sockeye salmon (Ozette Lake ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Sockeye salmon (Snake River ESU)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Steelhead (California Central Valley DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Steelhead (Central California Coast DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect

ESA-Listed Fish	Species Determination	Critical Habitat Determination
Steelhead (Lower Columbia River DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Steelhead (Middle Columbia River DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Steelhead (Northern California DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Steelhead (Puget Sound DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Steelhead (Snake River Basin DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Steelhead (South Central California Coast DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Steelhead (Southern California DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Steelhead (Upper Columbia River DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Steelhead (Upper Willamette River DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Bull trout (Coastal Recovery Unit)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Eulachon (Southern DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Scorpionfishes (Scorpaeniformes)		
Bocaccio (Puget Sound/Georgia Basin DPS)	May Affect, Not Likely to Adversely Affect	N/A (no critical habitat designated)
Yelloweye rockfish (Puget Sound/Georgia Basin DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Sharks, Skates, Rays, & Chimeras (Chondrichthyes)		
Giant manta ray	May Affect, Not Likely to Adversely Affect	N/A (no critical habitat designated)
Scalloped hammerhead shark (Eastern Pacific DPS)	May Affect, Not Likely to Adversely Affect	N/A (no critical habitat designated)
Scalloped hammerhead shark (Central and Southwest Atlantic DPS)	May Affect, Not Likely to Adversely Affect	N/A (no critical habitat designated)
Scalloped hammerhead shark (Indo-West Pacific DPS)	May Affect, Not Likely to Adversely Affect	N/A (no critical habitat designated)
Largetooth sawfish	May Affect, Not Likely to Adversely Affect	N/A (no critical habitat designated)

ESA-Listed Fish	Species Determination	Critical Habitat Determination
Smalltooth sawfish	May Affect, Not Likely to Adversely Affect	N/A (no critical habitat designated)
Sturgeons (Acipenseriformes)		
Atlantic sturgeon (New York Bight DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Atlantic sturgeon (Carolina DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Atlantic sturgeon (Chesapeake Bay DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Atlantic sturgeon (South Atlantic DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Atlantic sturgeon (Gulf of Maine DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Atlantic sturgeon (Gulf of Mexico subspecies)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Green sturgeon (Southern DPS)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Shortnose sturgeon	May Affect, Not Likely to Adversely Affect	N/A (no critical habitat designated)

*N/A = Not Applicable

3.8 Aquatic Macroinvertebrates

Invertebrates are animals without backbones and are the most diverse and numerous category of animals in the biosphere (New and Yen, 1995), comprising over 98 percent of the animal species on Earth classified to date by taxonomists (MarineBio, No Date). Aquatic macroinvertebrates are those aquatic invertebrates visible without the aid of a microscope. They evolved to live underwater in one or more stages of their life history, in both fresh water and salt water (marine) habitats. They are an extremely varied assortment of organisms that span a considerable number of taxonomic phyla.

3.8.1 Affected Environment

This section specifically covers aquatic macroinvertebrates that are found in the marine and freshwater environments included within the action area of this Final PEIS.

3.8.1.1 Marine Macroinvertebrates

Marine macroinvertebrates have been classified by taxonomists into more than 30 different phyla, a very large number representing considerable biological diversity. A phylum (plural phyla) is a major taxonomic category that ranks just above class and just below kingdom (as in plant, animal, and fungus kingdoms); it classifies organisms by their fundamental body plan.

Among the more prominent and better known and studied phyla of marine macroinvertebrates are the following (MarineBio, No Date):

- Annelids – segmented worms, including polychaetes (bristle worms);
- Arthropods – animals with exoskeletons, especially the crustaceans in marine habitats, including lobsters, crabs, shrimp, amphipods, barnacles, and copepods;
- Brachiopods – marine animals with hard “valves” or shells on their upper and lower surfaces;
- Bryozoans – moss animals or sea mats;
- Cnidaria – includes jellyfish, sea anemones, and corals (**Figure 3.8-1**);
- Echinoderms – includes sea stars, sea urchins, sea cucumbers, sand dollars, and crinoids;
- Mollusks – includes gastropods (e.g., sea snails, whelks, limpets, abalone), bivalves (clams, mussels, oysters, scallops), cephalopods (e.g., squid, octopus), and chitins;
- Porifera – sponges; and
- Tunicates – sea squirts or sea pork.

Figure 3.8-1. NOS Diver on Gray's Reef with Variety of Marine Macroinvertebrates

Photo Credit: Greg McFall, Gray's Reef NMS, NOS, NOAA

Arthropods have the largest number of species of the phyla listed above, with over 1 million described and classified. Mollusks are the next most abundant in the ocean.

Marine macroinvertebrates are very important ecologically (New and Yen, 1995). They constitute a vital food source for vertebrates such as diving sea birds, fish, sea turtles, and marine mammals in the marine food web. Jellyfish (**Figure 3.8-2**), for example, are the main food source of leatherback turtles, which also prey upon other marine invertebrates such as sea urchins, squid, crustaceans, and tunicates (NWF, No Date). Marine invertebrates in turn feed upon phytoplankton and zooplankton. Many cnidarians, mollusks, sponges, and crustaceans are filter feeders, playing a major role in ecosystem function (NAP, 2010; Burge et al., 2016; Sánchez et al., 2016). They help filter and clean estuaries and bays along the coast by removing suspended particles and reducing the turbidity of the water column.

Figure 3.8-2. Jellyfish in the Order Limnomedusae

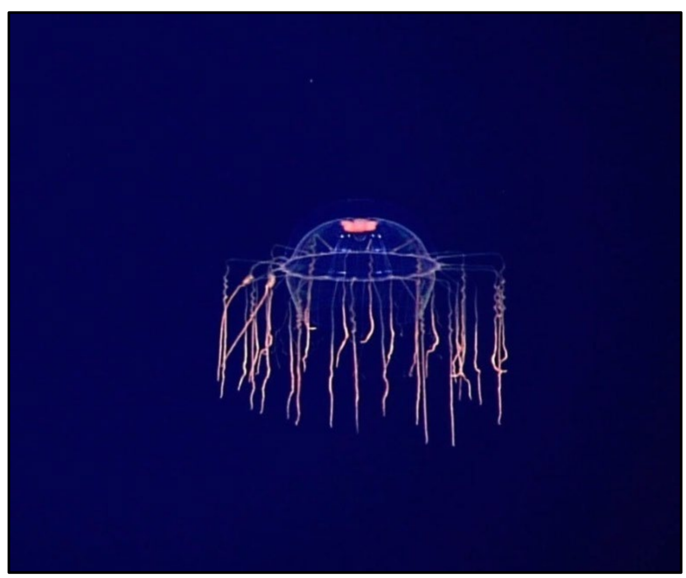


Photo Credit: NOAA Okeanos Explorer Program

The sessile, soft-bodied coral polyps attached to the sea floor secrete a hard, external skeleton of limestone (i.e., $CaCO_3$), constructing tropical coral reefs in the process. These reefs represent the largest structures of biological origin on the planet; the structure, complex three-dimensional geometry, and hard surfaces they provide are the basis for biologically diverse ecosystems (NOAA, No Date-c). Coral reefs are increasingly at risk around the world from increasing ocean temperatures and acidification related to increased atmospheric carbon dioxide levels and related global warming, as well as from more localized threats such as sedimentation, overfishing, dynamiting, and damage from anchors.

A number of marine macroinvertebrates support economically and socially important industries, both commercial and sport, along the nation's coasts and estuaries, especially crustaceans (e.g., lobster, crab, shrimp) and mollusks (e.g., clam, mussel, oyster, scallop, squid, octopus). In 2015 alone, total U.S. landings revenues were $618 million for lobster, $489 million for shrimp, and $439 million for sea scallop, in comparison to $509 million for walleye pollock and $461 million for Pacific salmon, the two most important fin fisheries (NMFS, 2017e). Harvest of these shellfish is regulated by the federal and state governments, and management of the harvest of cephalopods like the octopus has also begun (Conners et al., 2017; Conners and Conrath, No Date).

3.8.1.2 Freshwater Macroinvertebrates

The most important freshwater aquatic macroinvertebrates are bivalve mollusks (clams and mussels), crustaceans (crayfish), and arthropods (aquatic insects and their larvae). Clams and mussels are often so inconspicuous and immobile that they can be mistaken for cobblestones; they are found on the bottom of waterbodies and feed by filtering water for microscopic plant and animal food particles (plankton). Like marine macroinvertebrates, freshwater macroinvertebrates are very important both ecologically and economically (MDC, No Date). They are a vital food source for vertebrates, conveying nutrients from producers (plants and algae) to higher-order consumers in the aquatic food web. Many species of mammals, birds, reptiles, amphibians, and fish feed on aquatic macroinvertebrates in freshwater bodies. Some kinds of aquatic macroinvertebrates are indicators of water quality. Still others, notably mosquitoes whose larvae are aquatic, are disease vectors.

3.8.1.2.1 Freshwater Macroinvertebrate Stressors

North America has the highest freshwater mussel diversity in the world, but an estimated 70 percent of these are extinct or imperiled (Vollman, 2019). A number of species are listed as threatened or endangered because of changes to hydrology caused by dams, reservoirs, and channelization, and because of turbidity, sedimentation, and pollution (Platt, 2018) as well as invasive species (69 FR 42198, July 14, 2004). Aquatic macroinvertebrates are so sensitive to water quality and susceptible to water pollutants that certain kinds are frequently used as reliable indicators of freshwater quality in waterbodies (Gaufin and Tarzwell, 1952; USU, No Date). Some species of macroinvertebrates can survive degraded water quality, but others survive only under nearly pure or pristine conditions (NPS, 2020a).

Among the "indicator species" of water quality and pollution are the benthic (i.e., bottom-dwelling) macroinvertebrates: small, fully aquatic animals and the aquatic larval stages of insects (which may be non-aquatic as adults). They include snails, worms, beetles, and the larvae of dragonflies, mayflies, and stoneflies (**Figure 3.8-3**). Benthic macroinvertebrates are typically found attached to rocks, vegetation, sticks, and logs, or within burrows in bottom sand and sediments (EPA, 2022).

Figure 3.8-3. Variety of Freshwater Benthic Macroinvertebrates

Photo Credit: G. Carter via NOAA/GLERL

Non-native, invasive macroinvertebrates like the zebra mussel (*Dreissena polymorpha*) (**Figure 3.8-4**), a native to Eurasia introduced inadvertently into the Great Lakes ecosystem from ship ballast water (Vollman, 2019), have affected the aquatic ecology of entire lake and river systems (USGS, 2022a) including the Great Lakes, Mississippi River Basin, and other watersheds, where they have threatened native freshwater mussel species (USFWS, 2004). Since the early 1990s, more than 95 percent of the native clams once found in Lake Erie have disappeared because of the zebra mussel, which attaches itself to native clams in large numbers, impeding the ability of the clams to feed and burrow (Nichols and Wilcox, 2004). Zebra mussels have spread rapidly and now infest the entire Great Lakes ecosystem (Egan, 2019).

Figure 3.8-4. Zebra Mussel

Photo Credit: Amy Benson, USGS

In addition to its ecological impacts, the invasive zebra mussel has also become an extremely costly nuisance to industries and municipalities, such as water and electrical utilities, which withdraw water or discharge effluent, because of the mussel's tendency to completely clog water intake and effluent outfall pipes. Invasion of the zebra mussel has cost billions of dollars in the last three decades because of the need to invent, design, construct, and maintain water treatment systems that use chemicals, heat, and ultraviolet light to clear pipelines, intakes, and outfalls, and to keep water and effluent flowing through them (Egan, 2019).

The closely related quagga mussel (*Dreissena bugensis*), an invasive native to the Dnieper River basin in the Ukraine, was first discovered in Lake Erie in 1989 and has also spread very rapidly, proving even more ecologically destructive in the Great Lakes than the zebra mussel. Quaggas are such effective filter feeders that they remove substantial quantities of phytoplankton from the water column. By depleting phytoplankton, quaggas in turn reduce food for zooplankton, thereby co-opting and diverting energy flows at the base of the aquatic food pyramid into their own growth and biomass (IMC, 2018). The biomass of quagga mussels in Lake Michigan in one recent year was estimated to be about seven times greater than the entire biomass of the schools of prey fish upon which the lake's salmon and trout depend (Egan, 2019). Under favorable conditions, these mussels can now filter all of Lake Michigan's water in less than two weeks. Removal of suspended particles increases water clarity (decreasing turbidity) and reduces chlorophyll (phytoplankton) concentrations. In turn, increased light penetration leads to a proliferation of certain aquatic plants, altered species dominance, and changes in the entire aquatic ecosystem.

Pseudofeces (i.e., mucous-coated grit expelled by filter-feeding gastropod mollusks, distinct from actual feces) produced by quagga mussels from filtering water accumulate and foul the underwater environment (USGS, 2022b). As these waste particles decompose, DO is depleted and the water becomes very acidic; additionally, toxic byproducts are generated. Moreover, quagga mussels magnify organic pollutants within their tissues to concentrations 300,000 times greater than in the environment; these toxins can be passed up the food chain, increasing exposure of wildlife to organic pollutants (Snyder et al., 1997).

3.8.1.3 Sound Production and Hearing

The science of how aquatic macroinvertebrates, with their exceptional morphological and physiological diversity, use sound or are affected by anthropogenic sources of underwater sound is in its infancy (Mooney et al., 2010; Acoustical Society of America, 2017; Hawkins and Popper, 2012, 2017; NSF and USGS, 2011). Certain macroinvertebrates, such as cnidarians, annelids, arthropods, and mollusks, are known to have external sensory cilia (i.e., hair-like structures) and/or internal statocysts (i.e., sac-like organs with sensory cilia) to detect vibrations in the water (Navy, 2015).

Similar to the way that some fish sense sound, scientists believe that macroinvertebrates are able to sense vibrations and particle motion – rather than sound pressure, which is detected by and affects marine mammals (DOSITS, No Date-b; Nedelec et al., 2016; Edmonds et al., 2016). Because any acoustic sensory capabilities in aquatic macroinvertebrates, to the extent they exist at all, are limited to detecting particle motion, and this decreases rapidly with distance from the sound source, invertebrates are probably restricted to detecting sound sources in close proximity rather than sound caused by pressure waves from distant sources (Navy, 2015). Due to their commercial importance, most attention has focused on the acoustic capabilities and sensitivities of marine crustaceans (e.g., lobsters, shrimp, crabs). While crustaceans are known to detect, produce, and respond to sound, their sensitivity to sound is unknown (Edmonds et al., 2016).

The hearing range of macroinvertebrates is uncertain and likely varies from phylum to phylum. At present, no acoustic frequency or sound intensity thresholds exist above which there are known or observed impacts (Edmonds et al., 2016). All of the NOS underwater sound sources, such as echo sounders and ADCPs, associated with the project alternatives should be well above the hearing range of macroinvertebrates (Hawkins and Popper, 2012). However, certain macroinvertebrates can probably detect low-frequency sounds from ship movement (Mooney et al., 2010), though scientists still lack an understanding of what that means to them. To date, there are no studies indicating whether masking occurs in aquatic macroinvertebrates or suggesting that anthropogenic sounds would have any impact on invertebrate behavior (Hawkins and Popper, 2012).

3.8.1.4 Regional Distribution

Aquatic macroinvertebrates are found in all regions of the action area, though different phyla and taxa predominate in different regions and habitats. In the freshwater navigable rivers throughout the continental U.S., as well as the Great Lakes, mollusks, in particular mussels, are ecologically predominant. Native insect larva and crustaceans such as amphipods and crayfish (which are all arthropods), as well as annelids (segmented worms), are also present in these freshwater habitats. Brachiopods, bryozoans, Cnidaria (jellyfish and corals), echinoderms (sea stars, etc.), Porifera (sponges), and tunicates are some of the prominent macroinvertebrates not found to any extent or at all in freshwater environments.

It is in the marine environment that macroinvertebrate diversity and abundance reach their zenith, especially in warmer waters and the tropics. All five marine regions of the EEZ support abundant macroinvertebrate populations, biomass, and species diversity.

Tropical coral reefs of any significance, and the diverse animal assemblages and ecosystems they support, occur only in the Southeast Region and Pacific Islands Region. The economic value of particular commercially important macroinvertebrates varies substantially from region to region. Shrimp are particularly important in the Gulf states of the Southeast Region, while lobster support an important fishery in the Greater Atlantic Region. Oyster harvest in Chesapeake Bay (on the boundary between the Greater Atlantic Region and Southeast Region) used to support a major industry that is now much diminished, but crabs continue to be economically and culturally important. Crabs also support a large commercial fishery in the Alaska Region.

3.8.1.5 Threatened and Endangered Species

NMFS and the USFWS have listed a number of imperiled aquatic macroinvertebrates as either threatened or endangered under the ESA.

3.8.1.5.1 Marine Macroinvertebrates

A total of 17 ESA-listed or candidate species of marine macroinvertebrates, 15 coral species and two species of abalone (a marine gastropod mollusk), potentially occur in the action area (**Table 3.8-1**). The corals are all within the Southeast Region and the Pacific Islands Region, while the abalones are found in the West Coast Region. Two species of ESA-listed coral and one species of abalone have designated critical habitat.

Table 3.8-1. ESA-Listed Marine Macroinvertebrates Occurring in the Action Area

Common Name	Scientific Name	ESA Status	Lead Agency	Region*	Critical Habitat
Staghorn coral	*Acropora cervicornis*	Threatened	NMFS	SER	Yes
Coral: no common name	*Acropora globiceps*	Threatened	NMFS	PIR	No
Coral: no common name	*Acropora jacquelineae*	Threatened	NMFS	PIR	No

Common Name	Scientific Name	ESA Status	Lead Agency	Region*	Critical Habitat
Elkhorn coral	*Acropora palmata*	Threatened	NMFS	SER	Yes
Coral: no common name	*Acropora retusa*	Threatened	NMFS	PIR	No
Coral: no common name	*Acropora speciosa*	Threatened	NMFS	PIR	No
Pillar coral	*Dendrogyra cylindrus*	Threatened	NMFS	SER	No
Coral: no common name	*Euphyllia paradivisa*	Threatened	NMFS	PIR	No
Black abalone	*Haliotis cracherodii*	Endangered	NMFS	WCR	Yes
White abalone	*Haliotis sorenseni*	Endangered	NMFS	WCR	No
Coral: no common name	*Isopora crateriformis*	Threatened	NMFS	PIR	No
Rough cactus coral	*Mycetophyllia ferox*	Threatened	NMFS	SER	No
Lobed star coral	*Orbicella annularis*	Threatened	NMFS	SER	No
Mountainous star coral	*Orbicella faveolata*	Threatened	NMFS	SER	No
Boulder star coral	*Orbicella franksi*	Threatened	NMFS	SER	No
Coral: no common name	*Pocillopora meandrina*	Candidate	NMFS	PIR	--
Coral: no common name	*Seriatopora aculeata*	Threatened	NMFS	PIR	No

*SER = Southeast Region (includes Gulf of Mexico, the Caribbean, and the Atlantic seaboard from North Carolina to Florida); WCR = West Coast Region (includes Washington, Oregon, and California); PIR = Pacific Islands Region (includes the Hawaiian, Marianas, and American Samoa archipelagos, Wake Island, and the Remote Pacific Islands).

3.8.1.5.1.1 Acropora cervicornis (Staghorn Coral)

Staghorn coral (**Figure 3.8-5**) is considered one of the most important corals in the Caribbean Sea because it furnishes crucial habitat for other reef animals, especially fish. It lives in a number of coral reef habitats: spur and groove, bank reef, patch reef, transitional reef habitats, limestone ridges, terraces, and hard bottom. Along with elkhorn and star corals, staghorn coral gradually built Caribbean coral reefs across millennia. However, in the early 1980s, a severe epidemic of white band disease swept across its range, and now the surviving staghorn population is a tiny fraction (less than three percent) of its former abundance. Staghorn populations now comprise isolated colonies compared to the vast thickets that once predominated across its range. Thickets remain a prominent feature at just a few known locations. Staghorn coral populations have difficulty reproducing because of white band disease and other stressors (NMFS, No Date-a).

Photo Credit: NMFS

Figure 3.8-5. Staghorn Coral and Fish for Which They Furnish Habitat

The greatest single threat now facing staghorn coral is a warming ocean. This forces the corals to expel the photosynthetic algae (zooxanthellae) living in their tissue that provide them with food, causing "coral bleaching" and often leading to death. A related threat is ocean acidification, a decrease in water pH caused by increased carbon dioxide in the atmosphere, which dissolves in the surface water to form carbonic acid. This makes it harder for corals to build their skeletons. Other threats are unsustainable fishing practices, which deplete the herbivorous fish that clean the reef, and pollutants originating on adjacent lands such as sediments and nutrients (NMFS, No Date-a).

In 2014, staghorn coral was listed as ESA-threatened throughout its range, which includes the Bahamas, Caribbean, Florida, and Gulf of Mexico. NMFS has designated four critical habitat areas recognized as providing critical recruitment habitat for staghorn corals off the coast of Florida and off the islands of Puerto Rico and the U.S. Virgin Islands (NMFS, No Date-a).

3.8.1.5.1.2 Acropora globiceps

Within the action area, this species of coral, which lacks a common name, occurs in the central and western Pacific Ocean. Within the EEZ, it is found in Guam, the Commonwealth of the Northern Mariana Islands, American Samoa, and the Pacific Remote Island Area (NMFS, No Date-a).

A. globiceps coral has branches resembling fingers; their size and shape depend on the degree of wave action to which they are exposed. Colonies subject to strong wave action have pyramid-shaped branchlets. Colonies can range in color from uniform blue to cream, brown, or fluorescent green.

A. globiceps is susceptible to the three major threats identified for many corals, namely ocean warming, disease, and ocean acidification, as well as many of the other threats common to corals, such as unsustainable fishing, land-based pollution sources, small population size, and habitat degradation. Despite its widespread geographic distribution, this species occurs primarily in a limited depth range of 0 to 8 m (0-26 ft). Shallow reef areas like these can be complex and physically diverse but are often vulnerable to multiple stressors, both localized and global in nature.

The projected impact of climate change to coral reef ecosystems indicates that the shallow depth range that characterizes this species, in conjunction with other biological, demographic, and spatial elements, threaten it with extinction in the foreseeable future. In 2014, *A. globiceps* was listed as ESA-threatened throughout its range (NMFS, No Date-a).

3.8.1.5.1.3 Acropora jacquelineae

Within the action area, this species of coral, which lacks a common name, is found in the central and western Pacific Ocean. Within the EEZ, it is considered to be present in American Samoa. In addition, its current known geographic range is mostly confined to the Coral Triangle, a roughly triangular region of the tropical marine waters of Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands, and Timor-Leste. The Coral Triangle contains at least 500 species of reef-building corals and is considered a biodiversity hotspot (Allen, 2007). A number of ocean-warming events have already happened in recent years within the western equatorial Pacific, including the Coral Triangle, suggesting that future ocean warming events may be more severe than average in this part of the world.

Closely related to the previous species (*A. globiceps*), *A. jacquelineae* consists of gray-brown or pinkish flat plates up to 1 m (3 ft) in diameter (**Figure 3.8-6**). Its upper surface has many smooth-sided thin projections called corallites (NMFS, No Date-a). *A. jacquelineae* occurs in many subtidal reef slope and back-reef habitats, including lower reef slopes, walls and ledges, mid-slopes, and upper reef slopes protected from wave action. Its depth range is 10 to 35 m (33 to 115 ft). Like *A. globiceps*, *A. jacquelineae* is vulnerable to the three major threats facing corals, including ocean warming, disease, and ocean acidification. This combination of factors contributes to a risk of extinction within the foreseeable future for *A. jaquelineae.* Accordingly, in 2014 it was listed as ESA-threatened throughout its range (NMFS, No Date-a).

Figure 3.8-6. *Acropora jacquelineae*

Photo Credit: NMFS

3.8.1.5.1.4 Acropora palmata (Elkhorn Coral)

Elkhorn coral is in the same taxonomic genus as fellow Caribbean reef-builder staghorn coral (*Acropora*) and is threatened by the same factors. Elkhorn coral typically occurs in clear, shallow water 0.3 to 4 m (1 to 15 ft) deep on coral reefs throughout the Bahamas, Florida, and the Caribbean. It lives in high-energy zones with substantial wave action (NMFS, No Date-a).

Elkhorn coral colonies are golden tan or pale brown in color, with white tips. Like other corals, they derive their color from the symbiotic algae (zooxanthellae) that reside within their tissue and convert sunlight into food. Elkhorn corals have flattened frond-like branches, which typically angle upward from a central trunk. Individual elkhorn colonies can grow to at least 2 m (6 ft) in height and 4 m (12 ft) in diameter, as well as in dense stands with interlocking frameworks known as thickets. Due to their tree-like form, elkhorn corals furnish valuable, spatially complex habitat for fish and other coral reef organisms. In addition, dense thickets of elkhorn corals help prevent shoreline erosion from storm-generated waves (NMFS, No Date-a).

In 2014, elkhorn coral was listed as ESA-threatened throughout its range. NMFS has designated four critical habitat areas recognized as providing critical recruitment habitat for elkhorn corals off the coast of Florida and off the islands of Puerto Rico and the U.S. Virgin Islands.

3.8.1.5.1.5 Acropora retusa

A. retusa, which lacks a common name, is a species of coral found within the EEZ at Guam, American Samoa, and the Pacific Remote Island Area, occurring at relatively shallow depths ranging from 0 to 5 m (0 to 17 ft). Colonies of *A. retusa*, typically brown or green in color, are composed of flat plates with short, thick finger-like branches. These branches appear rough and spiky because their radial corallites vary in length. *A. retusa* is characterized as rare even where it is found. This species is vulnerable to the same global threats as other coral species, such as ocean warming, disease, and acidification.

Projections of climate change impacts to coral reef environments indicate that the shallow depth range of A. *retusa*, in combination with its other biological, demographic, and spatial factors, contributes to a risk of its extinction within the foreseeable future. Accordingly, in 2014 *A. retusa* was listed as ESA-threatened throughout its range (NMFS, No Date-a).

3.8.1.5.1.6 Acropora speciosa

This species of coral, which lacks a common name, is likely distributed from Indonesia to the Marshall Islands in the western and central Pacific. Within the EEZ, it might be found in the Pacific Remote Island area and American Samoa. Its colonies, which are cream or light brown in color with delicately colored branch tips, form thick cushions or bottlebrush branches (**Figure 3.8-7**). A*. speciosa* is found on lower reef slopes and walls, especially those with clear water and high *Acropora* diversity, at a depth ranging 12 to 40 m (40 to 132 ft) (NMFS, No Date-a).

This species is threatened by the same global factors as other coral species, such as ocean warming, disease, and acidification. Due to the widespread nature of these threats, any one threat event has the potential to adversely affect many coral colonies simultaneously. Thus, a species with a relatively small effective population size, like *A. speciosa*, may have a high proportion of genetically unique individuals harmed by threats at any given time within the foreseeable future. This, in combination with other biological, demographic, and spatial elements, contributes to a risk of extinction for this species within the foreseeable future. Accordingly, in 2014 A*. speciosa* was listed as ESA-threatened throughout its range (NMFS, No Date-a).

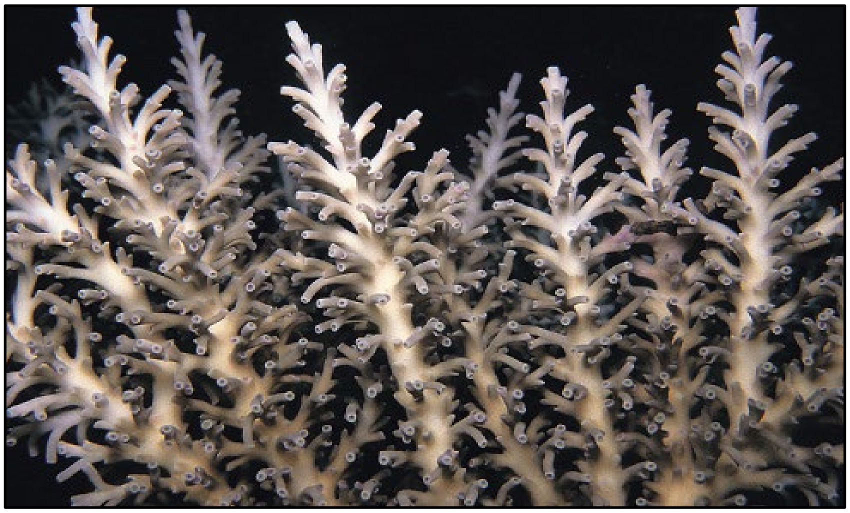


Figure 3.8-7. *Acropora speciosa*

Photo Credit: NMFS

3.8.1.5.1.7 Dendrogyra cylindrus (Pillar Coral)

Pillar coral (**Figure 3.8-8**) is a hard coral found in the western Atlantic Ocean and the Caribbean Sea. It often resembles a cluster of cigars or fingers protruding from the sea floor (NMFS, No Date-a). Pillar coral colonies occur on flat or gently sloping back reef and fore reef environments from 1 to 25 m (3 to 83 ft) in depth. Pillar coral colonies are resistant to heavy wave surge, but colonies will occasionally topple due to erosion at the bases. However, upper portions of the colonies generally survive, and they produce multiple new pillars which continue to grow upward.

Pillar coral is imperiled throughout its range by climate change, including ocean warming and ocean acidification. Diseases, land-based sources of pollution from residential and commercial development, overfishing, and habitat degradation are also threats (NMFS, No Date-a). In 2014, pillar coral was listed as ESA-threatened throughout its range.

Figure 3.8-8. Pillar Coral

Photo Credit: NMFS

3.8.1.5.1.8 *Euphyllia paradivisa*

This species of coral, which lacks a common name, is native to the Indo-Pacific islands, occurring mostly in the Coral Triangle area, but is also found in the waters around American Samoa. It favors underwater habitats sheltered from surface wave action on fringing reef crests, mid-slope terraces, and lagoons at depths ranging from 2-25 m (6-82 ft). Like *A. globiceps* and *A. jacquelineae* discussed above, *Euphyllia paradivisa* faces a variety of global and localized threats that in aggregate contribute to a risk of extinction for this species within the foreseeable future. In 2014, it was listed as ESA-threatened throughout its range (NMFS, No Date-a).

3.8.1.5.1.9 *Haliotis cracherodii (Black Abalone)*

The black abalone is an herbivorous marine snail that was once widespread and abundant along the California coast but is now endangered. For millennia before modern commercial fisheries appeared to exploit it, indigenous Californians harvested and ate abalone. Large piles of abalone shells called middens document human settlement dating back more than 7,000 years. Abalone shells were even traded by Native Americans along routes that began in southern California and extended east of the Mississippi River (NMFS, No Date-a).

The black abalone continues to survive in rocky intertidal pools and subtidal reefs along the California and Baja California coasts. Their oval-shaped shells protect them from predators, while their strong, muscular “foot” attaches to rocks and other hard substrates, from which they release eggs and sperm into the water by the millions when prompted by the right environmental conditions. Harvesting black abalone has been illegal in California since 1993, but the high price of abalone meat, considered a delicacy, maintains poaching pressure. This endangered species has declined significantly along the Southern California coast because of historical overharvest and poaching, and more recently, mass mortality has occurred from a disease known as withering syndrome. In 2009, black abalone was listed as ESA-endangered throughout its range (NMFS, No Date-a). Critical habitat was designated in 2011 to include approximately 360 km^2 of rocky intertidal and subtidal habitat within five segments of the California coast between the Del Mar Landing Ecological Reserve to the Palos Verdes Peninsula, as well as on the Farallon Islands, Año Nuevo Island, San Miguel Island, Santa Rosa Island, Santa Cruz Island, Anacapa Island, Santa Barbara Island, and Santa Catalina Island (76 FR 66806, October 27, 2011).

3.8.1.5.1.10 *Haliotis sorenseni (White Abalone)*

Closely related to the black abalone, in 2001 the white abalone (**Figure 3.8-9**) was listed as ESA-endangered throughout its range along the California coast because of overharvest and poaching. Although harvest of white abalone has been illegal in California since 1997, the high price of abalone meat on the black market makes them a continuing target of poachers. Surveys in southern California show a 99 percent decline in the white abalone stock since the 1970s. In 2001, NMFS determined that it would be imprudent to designate critical habitat because identification of such habitat might increase the threat of poaching for white abalone (NMFS, No Date-a).

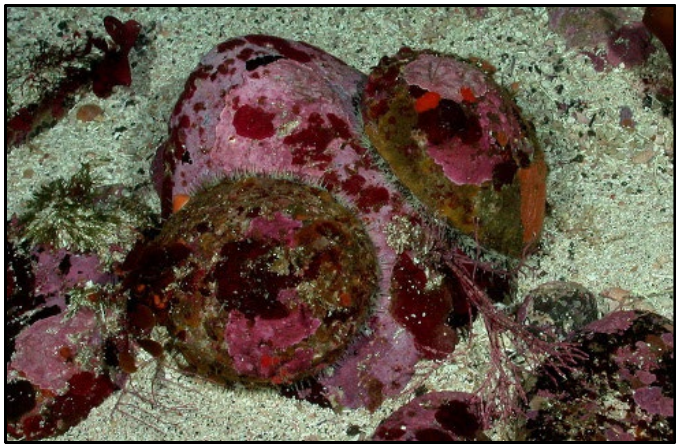


Figure 3.8-9. White Abalone

Photo Credit: NMFS

3.8.1.5.1.11 Isopora crateriformis

This coral, which lacks a common name, is believed to be distributed within the Coral Triangle, in addition to some of the western Pacific, including American Samoa and the Marshall Islands. It forms brown, fattened, solid encrusting plates which can reach over 1 m (3 ft) in diameter. When a colony grows on a slope, the lower edge is usually lifted as a plate. Its main habitats are shallow, high-wave-energy environments, including reef flats and lower crests, as well as upper reef slopes. It has been reported from low tide to at least 12 m (40 ft) deep. Its abundance is characterized as "rare" (NMFS, No Date-a).

I. crateriformis is threatened by the same global and localized factors as the other species in the Coral Triangle and western Pacific, including ocean warming, disease, and ocean acidification. Thus, in 2014 it was listed as ESA-threatened throughout its range (NMFS, No Date-a).

3.8.1.5.1.12 Mycetophyllia ferox (Rough Cactus Coral)

Rough cactus coral is distributed in the Caribbean, southern Gulf of Mexico, Florida, and the Bahamas. It usually exhibits shades of grey or brown, but may also be reddish or green (NMFS, No Date-a). This species is most abundant in fore reef environments from 5-30 m (17-100 ft), but it is also found at low abundance in certain deeper back reef habitats and deep lagoons (IUCN, 2022).

Rough cactus coral is threatened by many of the same factors that threaten other corals: residential and commercial development, transportation corridors, fishing and harvesting of aquatic resources, human intrusions and disturbance (e.g., recreational activities), invasive species, pollution, and climate change. In 2014, rough cactus coral was listed as ESA-threatened throughout its range (IUCN, 2022; NMFS, No Date-a).

3.8.1.5.1.13 Orbicella annularis (Lobed Star Coral)

This species is one of the dominant corals in the reefs of the Caribbean Sea and Gulf of Mexico, where it can form extremely large colonies. However, it is ESA-listed as threatened due to sharp population declines. The size of this species makes it an ecologically and structurally important component of coral reefs. It provides refuge for reef-dwelling fish and other animals and can alter marine microclimates to suit other coral species (EDGE, No Date).

Lobed star coral is threatened by residential and commercial development, shipping lanes, fishing and harvesting of aquatic resources, human intrusions and disturbance (e.g., recreational activities), invasive species, pollution, and climate change. In 2014, lobed star coral was listed as ESA-threatened throughout its range (NMFS, No Date-a).

3.8.1.5.1.14 Orbicella faveolata (Mountainous Star Coral)

Mountainous star coral (**Figure 3.8-10**) is found in the Caribbean Sea and Gulf of Mexico. It is usually pale brown but may be deep brown with fluorescent green highlights (NMFS, No Date-a). Befitting its name, colonies of mountainous star coral are massive, forming large rounded domes and becoming plate-like at the edges (Corals of the World, No Date). While this species is one of the most important reef-building corals in the Caribbean Sea, its populations have recently declined severely (Rippe et al., 2017).

Figure 3.8-10. Mountainous Star Coral

Photo Credit: NMFS

The mountainous star coral is threatened by a combination of climate change, including ocean warming and ocean acidification, diseases, land-based sources of pollution, and habitat degradation. Accordingly, in 2014 it was listed as ESA-threatened throughout its range (NMFS, No Date-a).

3.8.1.5.1.15 Orbicella franksi (Boulder Star Coral)

This coral species is native to shallow waters in the Caribbean, Gulf of Mexico, Bahamas, Bermuda, and Florida. Colonies of boulder star coral generally form very large clumps with uneven surfaces; they sometimes form plates. Boulder star coral is usually orange-brown, greenish-brown or greyish-brown. However, extremities of the lumps are frequently pale or white (NMFS, No Date-a).

The boulder star coral, like its close relative the mountainous star coral, is threatened by a combination of climate change, including ocean warming and ocean acidification, diseases, land-based sources of pollution, small population size, and habitat degradation. In 2014, it was listed as ESA-threatened throughout its range (NMFS, No Date-a).

3.8.1.5.1.16 Pocillopora meandrina (Cauliflower Coral)

This coral species, sometimes called cauliflower coral, occurs at depths of 1-27 m (3-89 ft) in shallow reefs exposed to strong wave action. It is distributed on coral reefs across the Pacific, with a range extending from the Seychelles Islands in the Indian Ocean to the west coast of Central America in the eastern Pacific. It is found in all U.S. Pacific Islands jurisdictions (NMFS, No Date-a).

Colonies of *P. meandrina* are usually cream colored but can also be green or pink; they resemble small upright bushes (**Figure 3.8-11**), with branches radiating outward from the initial point of growth. These branches are flattened and are covered by bumps called verrucae (NMFS, No Date-a).

P. meandrina is threatened by climate change, including ocean warming and ocean acidification, habitat degradation, diseases, and unsustainable fishing. It is an ESA-candidate species for listing through its entire range (NMFS, No Date-a).

Figure 3.8-11. *Pocillopora meandrina*

Photo Credit: NMFS

3.8.1.5.1.17 Seriatopora aculeata

This coral species, which lacks a common name, is likely distributed mostly within the Coral Triangle, as well as adjacent areas in the western Pacific Ocean including the Mariana Islands and Guam. Colonies of *S. aculeata* are pink or cream in color and have short, tapered branches, about the width of a pencil, usually in fused clumps (NMFS, No Date-a).

This species is found in a wide range of habitats, both on the reef slope and back reef. It occurs on upper reef slopes, mid-slope terraces, lower reef slopes, reef flats, and lagoons at a depth range of 3-40 m (10-132 ft).

S. aculeata is vulnerable to the three major, interrelated global threats documented for corals: ocean warming, disease, and ocean acidification. A number of ocean warming events have already taken place within the western equatorial Pacific, an indication that future ocean warming events in this part of the planet may be more severe than average. A substantial portion of its current known geographic range is located within the Coral Triangle, which over the 21st century, is predicted to experience the most rapid and severe impacts on the world's coral reefs both from global climate change and localized human actions. In aggregate, these stressors contribute to a risk of extinction within the foreseeable future for *S. aculeata.* In 2014, this coral was listed as ESA-threatened throughout its range (NMFS, No Date-a).

3.8.1.5.2 Freshwater Macroinvertebrates

A total of three ESA-listed species of aquatic macroinvertebrates, all mussels, have been documented in the Great Lakes (**Table 3.8-2**).

Table 3.8-2. ESA-Listed Aquatic Macroinvertebrates Occurring in the Great Lakes

Common Name	Scientific Name	ESA Status	Lead Agency	Critical Habitat
Northern Riffleshell	*Epioblasma torulosa rangiana*	Endangered	USFWS	No
Snuffbox	*Epioblasma triquetra*	Endangered	USFWS	No
Rayed Bean	*Villosa fabalis*	Endangered	USFWS	No

3.8.1.5.2.1 *Epioblasma torulosa rangiana* (Northern Riffleshell)

This mussel occurs in both small and large streams, as well as in Lake Erie, although it now survives in less than five percent of its former range in the upper Midwest. It buries into substrates of firmly packed sand or gravel, leaving its feeding siphons exposed. Like many mussels, it has a complex life history. Its reproduction requires undisturbed habitat and adequate numbers of host fish necessary for the mussel's larval development. After male mussels discharge sperm into the water, females siphon in the sperm to fertilize their eggs, which they store in their gill pouches until larvae hatch and are expelled. Those larvae that find a fish host to fasten onto by means of tiny clasping valves grow into juveniles with shells of their own. At that stage they detach from the host fish and settle into the stream or lakebed, ready to begin a long life (up to half a century) as an adult mussel (PNHP, No Date).

Dams and reservoirs have flooded most of the northern riffleshell’s habitat. Reservoirs act as barriers that isolate upstream populations from downstream ones. Erosion from strip mining, logging, farming, and grading introduces sediments to many waterbodies. Suspended and deposited sediments can clog mussels’ feeding siphons and smother them. Point-source and non-point-source pollution from agricultural runoff and industrial discharge is another threat. These toxins can accumulate and concentrate in the body tissues of filter-feeders like mussels, eventually poisoning them. In addition, the invasive zebra mussel poses a threat because they attach in great numbers to native mussels such as the northern riffleshell, suffocating and killing them. In 1993, this species was listed as ESA-endangered “wherever found” throughout its range (ECOS, No Date-a).

3.8.1.5.2.2 *Epioblasma triquetra* (Snuffbox)

The snuffbox is a small, triangular freshwater mussel with a yellow, green or brown shell that occurs in a number of states in the South and upper Midwest, as well as Pennsylvania and West Virginia. However, its range and numbers have decreased by at least 90 percent. It lives in small to medium-sized creeks with swift currents, although it also occurs in Lake Erie and some larger rivers (USFWS, 2012a). Males can grow up to 7.1 cm (2.8 in), with females reaching 4.6 cm (1.8 in). Adults often burrow deep in sandy, gravel, or cobble substrates, except when they are spawning or when the females are attempting to attract host fish. Snuffbox mussels are suspension feeders, feeding on algae, bacteria, detritus, microscopic animals, and dissolved organic material (USFWS, 2012a).

Adapted to living in currents, the snuffbox cannot survive in the lentic (still water) conditions created by dams. These mussels are also adversely affected by pollution, sedimentation, and invasive species like the zebra mussel. In 2012, the snuffbox mussel was listed as ESA-endangered “wherever found” throughout its range (ECOS, No Date-a).

3.8.1.5.2.3 Villosa fabalis (Rayed Bean)

The rayed bean (**Figure 3.8-12**) is a small freshwater mussel, typically less than 3.8 cm (1.5 in) long. Its shell is smooth-textured and green, yellowish-green, or brown with many dark-green wavy lines. It generally lives in smaller, headwater creeks, but is sometimes found in large rivers and wave-washed areas of glacial lakes, as well as Lake Erie. It prefers sand or gravel substrates, often in and around the roots of aquatic vegetation. Adult rayed beans spend their entire lives partially or completely submerged in the substrate, filtering water through their gills to feed upon algae, bacteria, detritus, microscopic animals, and dissolved organic material (USFWS, 2012b).

Figure 3.8-12. Rayed Bean Mussel

Photo Credit: Angela Boyer, USFWS

Historically, the rayed bean used to range across a wide area in the upper Midwest and eastern states, north to Ontario. Once found in at least 115 streams, canals, and lakes, it now occurs in only 31 streams and one lake, as well as Lake Erie. It has suffered a 73 percent reduction in the number of occupied streams and lakes. It has been extirpated entirely from three states but is still found in several others, as well as Ontario, Canada. After extirpation from Tennessee and West Virginia, reintroductions have restored the rayed bean to these states (USFWS, 2012b).

This mussel is endangered for the same reasons as the snuffbox mussel: dams and reservoirs, pollution, sedimentation, and invasive species. In 2012, the rayed bean mussel was listed as ESA-endangered "wherever found" throughout its range (ECOS, No Date-a).

3.8.1.5.2.4 Other ESA-Listed Freshwater Mussel Species

A number of other ESA-listed freshwater mussel species are found throughout navigable rivers of the U.S., particularly in the major tributaries of the Mississippi River System, including the Tennessee, Ohio, Illinois, Arkansas, and Red Rivers; these species are unlikely to be affected by NOS projects.

3.8.2 Environmental Consequences for Aquatic Macroinvertebrates

This section discusses the potential impacts of proposed activities associated with Alternatives A, B, and C on aquatic macroinvertebrates. ESA-listed endangered and threatened species are included as part of the discussion along with non-listed species because the potential impact mechanisms are the same. However, any impacts on managed species are of particular concern since they could affect commercially and recreationally important populations of these species. Effects determinations for ESA-listed species are presented in Section 3.8.2.5.

Activities described in Sections 2.1.1 through 2.1.13 that occur on NOS projects and that could be expected to impact aquatic macroinvertebrates include operation of crewed sea-going surface vessels; operation of ROVs and autonomous vehicles; use of echo sounders, ADCPs, acoustic communication systems, and sound speed data collection equipment; anchoring; collection of bottom grab samples; operation of drop/towed cameras and video systems; installation, maintenance, and removal of tide gauges and GPS reference stations; and SCUBA operations.

3.8.2.1 Methodology

The factors from NOS activities that could impact aquatic macroinvertebrates in the action area include: (1) active underwater acoustic sources (e.g., echo sounders, ADCPs, and acoustic communication systems); (2) vessel sound (e.g., from surface vessels, ROVs, and autonomous vehicles); (3) vessel surface wake and underwater turbulence (e.g., from surface vessels; ROVs and autonomous vehicles; survey equipment; and anchors); (4) accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters (e.g., from vessel operations); (5) disturbance of the sea floor (e.g., from anchoring and collection of bottom grab samples); and (6) air emissions (e.g., from smokestacks and outboard motors). These potential impact causing factors and their associated impacts on aquatic macroinvertebrates are discussed below for each alternative. Note that use of the term "sea floor" in the analysis below also includes lake and river bottoms where NOS activities could occur.

As discussed in Section 3.2.2, significance criteria were developed for each resource analyzed in this PEIS to provide a structured framework for assessing impacts from the alternatives and the significance of the impacts. The significance criteria for aquatic macroinvertebrates are shown in **Table 3.8-3**.

Table 3.8-3. Significance Criteria for the Analysis of Impacts to Aquatic Macroinvertebrates

Impact Descriptor	Context and Intensity	Significance Conclusion
Negligible	Impacts to aquatic macroinvertebrates would be limited to temporary (lasting up to several hours) behavioral and stress-startle responses to individual invertebrates found within the project area. Impacts on habitat would be temporary (e.g., temporary placement of an object on the sea floor or increased turbidity) with no lasting damage or alteration.	Insignificant
Minor	Impacts to aquatic macroinvertebrates would be temporary or short-term (lasting several days to several weeks) but would not be outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. This could include temporary or repeated short-term stress responses without permanent physiological damage. Behavioral responses to disturbance by some individuals, groups, populations, or colonies could be expected, but only temporary disturbance of breeding, feeding, or other activities would occur, without any impacts on population levels. Displacement would be short-term and limited to the project area or its immediate surroundings. Impacts on habitat (e.g., short-term placement of an object on the sea floor, increased	

Impact Descriptor	Context and Intensity	Significance Conclusion
	turbidity, or loss of a small area of vegetation) would be easily recoverable, with no long-term or permanent damage or alteration.	
Moderate	Impacts to aquatic macroinvertebrates would be short-term or long-term (lasting several months or longer) and outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. This could include physiological injury to individuals, repeated stress responses, or mortality. Behavioral responses to disturbance by numerous individuals could be expected in the project area, its immediate surroundings, or beyond. These could include negative impacts to breeding, feeding, growth, or other factors affecting population levels, including population-level mortality to or extended displacement (up to 1 year) of large numbers (e.g., population-level) of invertebrates. However, they would not threaten the continued existence of a stock, population, or species. Habitat would be potentially damaged or altered over the long term but would continue to support the species reliant on it.	
Major	Impacts to aquatic macroinvertebrates would be short-term or long-term and well outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Behavioral and stress responses would be repeated or permanent. Actions would affect any stage of a species' life cycle (i.e., breeding, feeding, growth, and maturity), alter population structure, genetic diversity, or other demographic factors, and/or cause mortality beyond a small number of individuals, resulting in a decrease in population levels. Displacement and stress responses would be short- or long-term within and well beyond the project area. Habitat would be degraded over the long term or permanently so that it would no longer support a sustainable fishery and/or would cause the population of a managed species to become stressed, less productive, or unstable.	Significant

3.8.2.2 Alternative A: No Action - Conduct Surveying and Mapping Projects for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

Under Alternative A, NOS survey effort would cover a total of 2,647,958 nm (4,904,017 km) across all five regions over the five-year period. Although the survey effort under Alternative A would vary by year (see **Table 3.4-4**), over the five-year period for proposed projects, the greatest number of nautical miles surveyed would be in the Southeast Region (approximately 47 percent). The survey effort in each of the other four regions is approximately 10 percent over five years, and perhaps slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 18 percent). Additionally, survey effort in the Great Lakes would average 2,917 nm (5,402 km) annually, as compared to an annual average survey effort of 529,592 nm (980,803 km) for the remainder of the action area. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, hearing frequency of aquatic macroinvertebrates, and population densities of aquatic macroinvertebrates, that add nuance to this trend.

Overall, vessel activity during NOS projects would comprise a negligible proportion of vessel traffic in the action area (not including recreational vessels as they are not generally included in the count). Additionally, whenever possible, the location and timing of a given project would be purposefully coordinated to ensure that areas are not repeatedly surveyed (although ONMS and IOOS surveys may occur multiple times in one year). This ensures that the potential environmental impacts directly resulting from NOS projects would not be exacerbated by repeated surveys within a given area.

3.8.2.2.1 Aquatic Macroinvertebrates

The analysis of impacts on aquatic macroinvertebrates considers all of the impact causing factors listed above, except for air emissions which are analyzed in Section 3.8.2.2.2. Potential impacts could occur in all of the geographic regions. Three of the regions (Southeast, West Coast, Pacific Islands) include one or more ESA-listed species, and two regions, the Southeast Region and the West Coast Region, include designated critical habitat for aquatic macroinvertebrates. The Pacific Islands Region contains the greatest number of ESA-listed species (all corals), closely followed by the Southeast Region (also corals). The only designated critical habitat is for staghorn and elkhorn coral in the Southeast Region and black abalone in the West Coast Region (see **Table 3.8-1**).

In addition to the impacts on aquatic macroinvertebrates discussed in this section, these organisms may also be indirectly affected by habitat modification, such as degradation of water quality and disturbance of benthos, aquatic vegetation, and sediments. These potential impacts are discussed in Section 3.8.2.2.2.

3.8.2.2.1.1 Active Underwater Acoustic Sources

As noted in Section 3.8.1.3, research into the effects of underwater sound waves on aquatic macroinvertebrates has barely begun and there are still many unknowns. While they lack ears and related structures associated with hearing, certain aquatic macroinvertebrates do possess morphological structures (external cilia sensory hairs, and internal statocysts), and at close range to a sound source, they are believed to be capable of detecting low-frequency vibrations and particle motion in water. However, unlike aquatic vertebrates, aquatic macroinvertebrates, lacking ears with which to hear, would not be vulnerable to potential hearing loss from loud underwater sounds. Furthermore, virtually all of the high-frequency underwater acoustic sources used during NOS projects should be above the detection range of aquatic macroinvertebrates.

Overall, active underwater acoustic sources including echo sounders and ADCPs, when considered with the mobile and temporary character of NOS projects, the limited low-frequency detection range of aquatic macroinvertebrates documented to date, as well as the small area of the water column and sea floor affected during the projects relative to the entire EEZ, would have **adverse, negligible** impacts on aquatic macroinvertebrates. Impacts on aquatic macroinvertebrates, both marine and fresh water (Great Lakes and major navigable rivers), including ESA-listed species, would continue to be **insignificant**.

3.8.2.2.1.2 Vessel Sound

As noted in earlier sections, all vessels generate low-frequency underwater sound in the 20 to 500 Hz range and are major contributors to the overall background sound in the sea, which has been increasing for decades. As indicated in Section 3.8.1.3, aquatic macroinvertebrates can probably detect low-frequency sound from ships, but scientists do not yet understand what, if anything, this sound at these levels means to them. It is likely that aquatic macroinvertebrates found in locations with high vessel traffic have already habituated to this background sound. Underwater vessel sound could potentially disturb certain nearby aquatic macroinvertebrates, interrupt feeding, cause other behavior modifications, and possibly mask biologically important signals; such impacts would vary among aquatic macroinvertebrate taxa. Impacts on invertebrate behavior are anticipated to be temporary and localized to areas of vessel activity.

ROVs also generate engine sound, and effects on aquatic macroinvertebrates would likely be similar to those from sound from surface vessels but likely at a reduced magnitude as ROVs are smaller, thus producing less sound, and they would not be used as extensively as surface vessels (see **Table 2.4-1**).

Given the proposed volume of vessel traffic associated with projects within the EEZ, the effects of sound from vessels used by NOS on aquatic macroinvertebrates, including ESA-listed species, would be **adverse** and **negligible**. Multiple activities in one area could lead to larger magnitudes and more widespread impacts, but they would still be considered **insignificant**.

3.8.2.2.1.3 Vessel Wake and Underwater Turbulence

Water disturbance by surface vessel and ROV wakes and underwater turbulence could temporarily disturb nearby invertebrates and displace mobile taxa. However, these impacts would be minimal as the vessel used by NOS would quickly pass by or stop moving. Impacts could increase if the frequency of disturbance becomes greater (i.e., repeated passes). In any event, mobile aquatic macroinvertebrates would be expected to return to the area and resume normal activities once the vessel used by NOS departs or the ROV is no longer present.

Equipment used in NOS projects, such as echo sounders and ADCPs, is typically attached to a crewed vessel, ROV, or an autonomous vehicle, thus effects on invertebrates due to water movement that is created would occur from the use of these carriers, rather than any disturbance from the equipment itself. An exception would be in the rare instances when echo sounders are placed directly on the sea floor or operated by divers, who would possibly disturb nearby invertebrates temporarily by moving through the water column.

Some equipment such as sound speed data collection equipment, bottom grab samplers, and drop/towed cameras is lowered and raised through the water column or falls through the water. This movement through the water could temporarily disturb and displace nearby aquatic macroinvertebrates such as crabs, shrimp, or lobsters, although it is not expected that most would move very far. These impacts would be temporary, as these organisms are expected to return once water column turbulence ceases.

Effects on aquatic macroinvertebrates, including ESA-listed species, from vessel wake and underwater turbulence would be **adverse** and **negligible**. Multiple activities in one area could lead to more widespread impacts of greater magnitude, but impacts would still be considered **insignificant**.

3.8.2.2.1.4 Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in release of fuel or diesel by a vessel used by NOS. Adverse impacts on aquatic macroinvertebrates could also occur from pumping of oily bilge water overboard, discharged wastewater/graywater that may contain nutrients and fecal coliform, and accidental oil, fuel, and chemical spills. Discharges other than accidental ones are regulated by the MARPOL 73/78 protocol, to which the U.S. is a signatory. Moreover, all hazardous or regulated materials would be handled in accordance with applicable laws and crew members would be appropriately trained in materials storage and usage.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. For example, on NOAA fleet vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the Commanding Officer takes appropriate action to minimize the effects of the spill. OMAO Procedure 0701-06 VRP/SOPEP provides policy and guidance to all NOAA vessels regarding oil pollution emergency planning and response, in accordance with MARPOL 73/78, Annex I. The plan contains all the information and instruction required for responding to shipboard oil spills, such as general spill mitigation and response, shipboard spill mitigation and response, reporting requirements, completing Corrective Action Assessments, trainings, drills, and exercises. This plan has been approved by the USCG, and complies with the Oil Pollution Act of 1990 and Federal Water Pollution Act of 1973.

Some aquatic macroinvertebrates (e.g., crustaceans) are mobile enough to avoid areas of higher concentrations of oil and other contaminants, while others such as corals, sea anemones, and sea urchins are sessile or immobile. Depending on the product, most oil would remain at or near the surface and typically would not impact aquatic macroinvertebrates in deeper water, where most are located. Lighter substances can disperse into the water column or might dissolve in water, potentially impacting sessile eggs and larvae, as well as more mobile juvenile aquatic macroinvertebrates and adult crustaceans.

Although the probability of an accidental oil or chemical spill from a vessel used by NOS is very low, if exposed, aquatic macroinvertebrates can be affected directly either by ingestion of oil or oiled prey, through uptake of dissolved petroleum compounds, and through effects on eggs and larvae survival. Sublethal effects may cause stress and could be transient and only slightly debilitating, but invertebrates may also be killed by coming into contact with oil and other contaminants. Recovery requires energy, and this could eventually lead to increased vulnerability to disease, diminished growth and reproductive success, and reduced fitness overall.

Aquatic macroinvertebrates can be affected indirectly by oil and chemicals via modifications of the ecosystem that affect their prey species and habitats. Many aquatic macroinvertebrates feed upon phytoplankton and zooplankton during various life stages. However, even if a large amount of plankton were affected, it can recover rapidly due to high reproductive rates, rapid replacement from adjacent waters, widespread distribution, and exchange with tidal currents. Moreover, the vessels used for NOS projects and the quantity of fuel and other chemicals they carry are extremely small compared to the extensive size of the action area. Thus, the impact on a pelagic phytoplankton community, and on aquatic macroinvertebrates, would not be substantial, widespread, or long-term.

The likelihood of an accidental spill from a vessel used for NOS projects would be very low, and thus impacts are expected to be **adverse** and **negligible** to **minor**. All hazardous or regulated materials would be handled in accordance with applicable laws, crew members would be appropriately trained in materials storage and usage, and all MARPOL discharge protocols would be followed. Impacts on aquatic macroinvertebrates, including ESA-listed species, would be considered **insignificant**. In the event that an accidental spill did occur, the volume of oil, fuel, and/or chemicals would be fairly small, so that the impact on aquatic macroinvertebrates would still be considered **insignificant**.

3.8.2.2.1.5 Disturbance of the Sea Floor

Water disturbance by anchors and chains moving in the water, and by collection of bottom grab samples, can temporarily disturb, displace, damage, or crush, injure, and kill nearby aquatic macroinvertebrates, both mobile (e.g., crustaceans) and immobile (e.g., corals, sea urchins, sea anemones, mollusks, sponges). Impacts would be minimal and extremely localized (BOEM, 2014b), and would cease with the removal of the grab sampler, with the anchoring system coming to rest, or with the equipment being taken out of the water. Any displaced benthic aquatic macroinvertebrates are expected to return to the area and resume normal activities as soon as water column turbulence ceases.

Dropping an anchor onto the seabed or lake/river bottom would disturb a very small area (1-2 m^2 [3-6 ft^2]). If anchor chains drag across the sea floor, they can create a circular scour hole. Anchor scour has the potential to create localized turbidity that could reduce water clarity and increase sediment deposition. Increased sedimentation can impact aquatic macroinvertebrates by reducing feeding efficiency, altering reproductive cycles, and reducing response to physical stimulus. In cases where organisms are exposed to excessive turbidity, the suspended sediments can potentially limit gas exchange and possibly lead to asphyxiation. However, suspended sediments are expected to settle quickly and long exposures are not likely to occur. Furthermore, NOS personnel would be careful not to drag anchor chains, would ensure that anchors are properly secured so as to minimize bottom disturbance, and would generally avoid anchoring on coral reefs.

Samples would not be collected on coral reefs, shipwrecks, obstructions, or hard bottom areas, further minimizing direct impacts to aquatic macroinvertebrates. Overall effects on aquatic macroinvertebrates from disturbance of the sea floor would be **adverse** and **negligible**. Impacts on aquatic macroinvertebrates, including ESA-listed species, would continue to be **insignificant**.

3.8.2.2.2 Habitat for Aquatic Macroinvertebrates

The analysis of impacts on habitat for aquatic macroinvertebrates does not consider active underwater acoustic sources or vessel and equipment sound, as these impact causing factors would not affect habitat characteristics.

3.8.2.2.2.1 Vessel Wake and Underwater Turbulence

Vessel wakes and turbulence can generate wave and surge effects on shorelines and stir up bottom sediments, increasing localized turbidity in shallow areas depending on the wake wave energy, the water depth, and the type of shoreline. Wakes can cause shoreline erosion, degrade wetland habitat, and increase water turbidity. Water column habitat gradients would be temporarily disrupted by wake action, including temperature, salinity, DO, turbidity, and nutrient supply. Stirring up lake sediment can re-suspend nutrients such as phosphorus, potentially contributing to harmful, DO-consuming algal blooms.

The suspension of disturbed sediments from wake action and shoreline erosion could minimize the light intensity that reaches aquatic vegetation which depends on light for photosynthesis. High turbidity that causes a substantial reduction in light availability can lead to sublethal adverse effects or mortality of aquatic vegetation. Suspended material may also react with DO in the water and result in short-term oxygen depletion to aquatic resources, including vegetation and aquatic macroinvertebrates.

The movement of ROVs, such as sound speed data collection equipment, bottom grab samplers, drop/towed cameras, and anchors and chains through the water column could temporarily cause localized turbulence and disturb nearby prey species, as well as potentially cause damage to submerged aquatic vegetation. These impacts would be temporary as prey species are expected to return once water column turbulence ceases.

Equipment such as echo sounders, ADCPs, and acoustic communication systems, are typically attached to a crewed vessel, ROV, or autonomous vehicle, thus effects on habitat would occur from the use of these carriers, rather than any disturbance from the equipment itself. The one exception would be in the rare instances when echo sounders are placed directly on the sea floor or operated by divers. In such cases, divers would move through the water column temporarily disturbing prey species.

Underwater turbulence could occur during tide gauge installation even though it occurs primarily out of the water at existing piers, docks, bulkheads, and other such locales. All buoys would be attached to the sea floor using the best available mooring systems to reduce entanglement. Generally, no impact on habitat would occur except when tide gauge installation requires in-water work that could cause sediment disturbance. In remote areas which are reached by boat for installation, maintenance, and removal, impacts on habitat could occur and would be similar to those for surface vessel operations. Likewise, installation of a shore-based GPS reference station would not have any effects on habitat other than potentially from accessing the site via a surface vessel, which would be similar to those from surface vessel operations.

Effects on habitat, designated critical habitat, and other aquatic macroinvertebrate habitat, from vessel wake and underwater turbulence would be **adverse** and **negligible** to **minor**. Multiple activities in one area could lead to greater magnitudes and extents of impacts, but impacts would still be considered **insignificant**.

3.8.2.2.2.2 Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in release of fuel or oil by a vessel used by NOS. The accidental loss of a substantial amount of fuel or oil during projects could affect water quality, the water column, the sea floor, intertidal habitats, and associated biota (i.e., submerged aquatic vegetation) resulting in their mortality or substantial injury, and in alteration of the existing quality of aquatic macroinvertebrate habitats. Cleaning and inspecting vessels prior to use would reduce the risk of accidental spills. In addition, implementation of a spill prevention and recovery plan and shipboard emergency plans that outline measures to reduce the potential for spills and isolate accidental spills should they occur would further reduce the potential for adverse impacts on habitat. In addition, onboard and supporting equipment and the procedures specified in the spill plan are expected to reduce the effects of accidentally discharged fuel and other petroleum products (e.g., oil, lubricants) by facilitating rapid response and cleanup operations.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. For example, on NOAA fleet vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the Commanding Officer takes appropriate action to minimize the effects of the spill. OMAO Procedure 0701-06 VRP/SOPEP provides policy and guidance to all NOAA vessels regarding oil pollution emergency planning and response, in accordance with MARPOL 73/78, Annex I. The plan contains all the information and instruction required for responding to shipboard oil spills, such as general spill mitigation and response, shipboard spill mitigation and response, reporting requirements, completing Corrective Action

Assessments, trainings, drills, and exercises. This plan has been approved by the USCG, and complies with the Oil Pollution Act of 1990 and Federal Water Pollution Act of 1973.

Vessel bilge water discharges, engine operations, bottom paint sloughing, boat washdowns, and other vessel activities or wear can also deliver debris, nutrients, and contaminants to waterways. This may degrade water quality, contaminate sediments, and alter benthic communities and other aquatic macroinvertebrate habitats. Vessel wash, including gray water, deck runoff and cooling water can damage aquatic vegetation and disturb benthos and sediments, which may increase turbidity and suspend contaminants. Any liquid contaminants are expected to be rapidly diluted.

The likelihood of occurrence of an accidental fuel or oil spill from a vessel used by NOS would be very low, although the release of other contaminants is a little more likely. All hazardous or regulated materials would be handled in accordance with applicable laws, crew members would be appropriately trained in materials storage and usage, and all MARPOL discharge protocols would be followed. Thus, impacts are expected to be **adverse** and **negligible** to **minor**. Impacts on habitat, as well as designated critical habitat, would continue to be **insignificant**.

3.8.2.2.2.3 Disturbance of the Sea Floor

Adverse impacts on aquatic macroinvertebrate habitat can occur when vessels used by NOS anchor in shallow nearshore waters and the anchor chain drags across the sea floor, destroying submerged vegetation and creating a circular scour hole. Anchor scour has the potential to create localized turbidity and affect soft-bottomed seafloor habitat and/or rocky substrates, potentially creating turbidity that could reduce water clarity and increase sediment deposition. NOS personnel would deploy anchors so as to minimize anchor drag, would ensure that anchors are properly secured so as to minimize bottom disturbance, and would not anchor on known coral reef areas.

Increased turbidity immediately following anchoring events could temporarily reduce foraging ability of prey due to decreased visibility in the water column; however, these conditions would be of short duration and would soon return to baseline. Suspended material may also react with DO in the water and result in short-term oxygen depletion to aquatic resources.

Collecting bottom samples could create localized turbidity and affect soft-bottomed seafloor habitat, potentially creating turbidity that could reduce water clarity temporarily. Such turbidity would likely be minimal as samplers are designed to close to contain the sediment and prevent sample washout. Samples would not be collected on coral reefs, shipwrecks, obstructions, or hard bottom areas, further minimizing impacts on aquatic macroinvertebrate habitat. Placement of equipment or moorings on the sea floor has the potential to create localized turbidity that could reduce water clarity temporarily, although this would be minimal. Additionally, equipment such as AUVs would be programmed and operated so as to avoid sea floor disturbance, SCUBA divers would avoid inadvertent disturbance to the sea floor, and stiffer line material would be used and kept taut during operations to reduce potential for entanglement with bottom features such as coral habitat.

Effects from disturbance of the sea floor would be **adverse** and **negligible** to **minor**. Impacts on habitats and designated critical habitat would be **insignificant**.

3.8.2.2.2.4 Air Emissions

Since the pre-industrial era, increased anthropogenic emissions of GHGs (CO_2, CH_4, and N_2O) have influenced changes in oceanic conditions (as well as atmospheric and terrestrial conditions) (Limpinsel et al., 2017). Higher atmospheric CO_2 levels increase dissolved CO_2 and bicarbonate ions in seawater, which subsequently leads to a decrease in carbonate ions and pH, termed "ocean acidification." Changes in seawater carbon chemistry may affect marine biota through a variety of biochemical, physiological, and physical processes.

Smokestack and two-stroke outboard motor emissions from vessels used by NOS would release air pollutants which can be deposited on the water surface and contribute to such adverse effects as increasing water acidity in aquatic macroinvertebrate habitat. Adverse impacts can be reduced by such measures as integrating new technologies, operational controls, replacing old engine systems, and switching to low sulfur fuels. Furthermore, the amount of emissions from vessels used by NOS would be a negligible fraction as compared to emissions from all other non-project related vessel activity.

Thus, impacts from air emissions are expected to be **adverse** and **negligible**. Impacts on habitat and designated critical habitat for aquatic macroinvertebrates would be **insignificant**.

3.8.2.2.3 Conclusion

Since the effects of impact causing factors on aquatic macroinvertebrates and their habitats range from negligible to minor, the overall impact of Alternative A on aquatic macroinvertebrates, including ESA-listed species, and designated critical habitat would be **adverse** and **minor**; thus, impacts of Alternative A would continue to be **insignificant**.

3.8.2.3 Alternative B: Conduct Surveying and Mapping Projects for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations

The same impact causing factors for aquatic macroinvertebrates and habitat considered under Alternative A are considered under Alternative B. Under Alternative B, all of the activities and equipment operations proposed in Alternative A would continue but at a higher level of effort, although the percentage of nautical miles covered by projects in each region would be the same as under Alternative A. The greatest level of effort would occur in the Southeast Region (with approximately 47 percent of the survey effort); level of effort in the other four regions would occur at similar levels (approximately 10 percent of the survey effort in each region), and perhaps slightly greater in the Alaska Region, where the survey effort would be somewhat higher overall (approximately 18 percent). The level of effort in the Great Lakes would remain much lower as compared to the annual total marine survey effort. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, hearing frequency of aquatic macroinvertebrates, and population densities of aquatic macroinvertebrates, that add nuance to this trend.

Survey activities under Alternative B would take place in the same geographic areas and timeframes as under Alternative A; however, Alternative B would include more projects and activities and thus more nautical miles traveled than Alternative A. Under Alternative B, NOS survey effort would cover a total of 2,912,753 nm (5,394,419 km) across all five regions over the five-year period. Overall, survey effort would cover an additional 264,796 nm (490,402 km) under Alternative B as compared to Alternative A (see **Table 3.4-5**). The types and mechanisms of impacts would remain the same in Alternative B as discussed for Alternative A. Therefore, the difference between the two alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative B as compared to Alternative A.

For example, under Alternative B there would be projects using crewed vessel operations covering 577,000 nm (1,070,000 km), as compared to 518,000 nm (959,000 km) under Alternative A. Vessel operations could contribute to impacts on aquatic macroinvertebrates and habitat related to vessel sound, vessel wake and underwater turbulence, accidental spills, and air emissions. Although the amount of crewed vessel operations would be greater under Alternative B than under Alternative A, additional projects covering 59,000 nm (111,000 km) across five regions would result in greater impacts overall, but not so great that the magnitude of a particular impact causing factor would increase (e.g., from negligible to minor). The magnitude of impacts would likewise remain the same for other proposed activities contributing to potential impacts, such as underwater sound from echo sounders, ADCPs, and acoustic communication systems; and bottom disturbance from anchoring, bottom grab samples, and sound speed data collection.

Although NOS would add more widespread adoption of new techniques, protocols, and technologies to more efficiently perform surveying, mapping, charting, and related data gathering under Alternative B as compared to Alternative A, impacts of Alternative B on aquatic macroinvertebrates, including ESA-listed species, and on habitat and designated critical habitat, would be the same or slightly, but not appreciably, larger than those discussed above under Alternative A for each impact causing factor. Overall, impacts on aquatic macroinvertebrates and habitat would be **adverse, minor,** and **insignificant**.

3.8.2.4 Alternative C: Upgrades and Improvements with Greater Funding Support

The same impact causing factors for aquatic macroinvertebrates and habitat considered under Alternative A are considered under Alternative C. Under Alternative C, all the activities and equipment operation proposed in Alternative A would continue but at a higher level of effort, although the percentage of nautical miles in each region would be the same as under Alternatives A and B. In addition, there would be an overall funding increase of 20 percent relative to Alternative B, thus the level of survey activity would increase. The greatest level of effort would occur in the Southeast Region (with approximately 47 percent of the survey effort); in the other four regions level of effort would occur at similar levels (approximately 10 percent of the survey effort in each region), and perhaps slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 18 percent). The level of effort in the Great Lakes would remain much lower as compared to the annual total marine survey effort. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, hearing frequency of aquatic macroinvertebrates, and population densities of aquatic macroinvertebrates, that add nuance to this trend.

Survey activities under Alternative C would take place in the same geographic areas and timeframes as under Alternatives A and B; however, Alternative C would include more projects and activities and thus more nautical miles traveled, than Alternatives A and B. Under Alternative C, NOS survey effort would cover a total of 3,177,549 nm (5,884,821 km) across all five regions over the five-year period. Overall, there would be an additional 264,796 nm (490,402 km) covered by vessels used by NOS under Alternative C (see **Table 3.4-6**) as compared to Alternative B, and an additional 529,592 nm (980,803 km) as compared to Alternative A. The types and mechanisms of impacts would remain the same in Alternative C as discussed for Alternatives A and B. Therefore, the difference between the alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative C as compared to Alternatives A and B. As discussed under Alternative B, the additional projects and nautical miles traveled under Alternative C across five regions would result in greater impacts on aquatic macroinvertebrates overall, but not so great that the magnitude of a particular impact causing factor would increase (e.g., from negligible to minor).

Alternative C would be similar to Alternative B, plus it would consist of NOS program implementation with an overall funding increase of 20 percent relative to Alternative B. Impacts of Alternative C on aquatic macroinvertebrates, including ESA-listed species, habitats, and designated critical habitat, would be the same or slightly, but not appreciably, larger than those discussed above under Alternatives A and B for each impact causing factor. Overall, impacts on aquatic macroinvertebrates and their habitats would be **adverse, minor,** and **insignificant**.

3.8.2.5 Endangered Species Act Effects Determination

Federal agencies are required under the ESA to determine whether their actions may affect ESA-listed species or their designated critical habitat. Effects determinations divide potential effects into three categories: No Effect; May Affect, but Not Likely to Adversely Affect; and May Affect, and is Likely to Adversely Affect. Actions receiving a “No Effect” designation do not impact listed species or their designated critical habitat (hereafter listed resources) either positively or negatively and is typically only used in situations where no listed resources are present in the action area. Actions receiving a “May Affect, but Not Likely to Adversely Affect” designation have only beneficial, insignificant, or discountable effects to listed resources. Insignificant effects under the ESA relate to the size of the impact and should never reach the scale where take occurs; they are of low relative impact, not measurable, or cannot be evaluated. Adverse effects are considered discountable if they are extremely unlikely to occur. Actions designated as “May Affect, and is Likely to Adversely Affect” will negatively impact any exposed listed resources in a manner that is not insignificant or discountable.

ESA-listed aquatic macroinvertebrate species – all of which are bottom-dwelling corals and mollusks (abalone and mussels) – are not believed to detect the mid-to-high frequencies emitted by active underwater acoustic sources. Additionally, due to the mobile and temporary nature of NOS projects and the small area of the sea floor affected during the projects relative to the entire EEZ, the response to underwater sound exposure from active underwater acoustic sources would be short term, limited to only a few individuals, and therefore, discountable (i.e., extremely unlikely to occur).

The proposed volume of sound from vessel traffic associated with NOS projects would be very small in comparison to sound from all the other non-project related vessel traffic within the EEZ. Additionally, there is no indication that ESA-listed corals and mollusks are susceptible to adverse effects from sound emitted by vessels. Because sound disturbance would be of temporary or short duration and would occur infrequently in any given area, the response by ESA-listed taxa to sound from vessels used by NOS would be short term, limited to only a few individuals, and therefore, discountable (i.e., extremely unlikely to occur).

Although water disturbance by surface vessel and ROV wakes and underwater turbulence could temporarily disturb and nearby corals and mollusks, effects would be temporary and minimal; thus, the response by ESA-listed aquatic macroinvertebrates would be short term, limited to only a few individuals, and therefore, discountable (i.e., extremely unlikely to occur).

The likelihood for an accidental spill is expected to be discountable (i.e., extremely unlikely to occur), and exposure of ESA-listed aquatic macroinvertebrate species and critical habitats to oil, fuel, and other contaminants is not expected. These accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. Thus, effects from chemical contamination on ESA-listed species are, therefore, discountable (i.e., extremely unlikely to occur).

Mitigation measures to reduce or avoid disturbance of the sea floor are included in Appendix D. Given the minimal amount of potential turbidity and fine sediment created by disturbance of the sea floor, the effect on ESA-listed species would be short term, limited to only a few individuals, and therefore, discountable (i.e., extremely unlikely to occur).

Thus, NOS concludes that the Proposed Action "May Affect, but [is] Not Likely to Adversely Affect" any of the ESA-listed aquatic macroinvertebrate species occurring in the action area (**Table 3.8-4**). Additionally, these aquatic macroinvertebrate species serve as prey to marine mammals, and thus, effects on them would constitute indirect effects to marine mammals. Thus, the "May Affect, but Not Likely to Adversely Affect" determination for ESA-listed aquatic macroinvertebrates also applies indirectly to ESA-listed marine mammals.

Since NOS projects may occur in some areas within or adjacent to designated critical habitats for elkhorn and staghorn coral in the Caribbean Sea, and for black abalone off the California coast, there is the potential for impacts on critical habitat characteristics that support these two ESA-listed species. Critical habitat may be minimally disturbed but would remain functional to maintain viability of the species reliant on it. Due to the potential for effects that could be negligible or minor, the Proposed Action "May Affect, but Not Likely to Adversely Affect" the designated critical habitat occurring in the action area (**Tables 3.8-4**).

Table 3.8-4. Summary of Effects Determinations for ESA-Listed Aquatic Macroinvertebrates and Critical Habitat

Common Name	Scientific Name	Species Determination	Critical Habitat Determination
Great Lakes			
Northern Riffleshell	*Epioblasma torulosa rangiana*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Snuffbox	*Epioblasma triquetra*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Rayed Bean	*Villosa fabalis*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Marine			
Staghorn coral	*Acropora cervicornis*	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Coral: no common name	*Acropora globiceps*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)

Common Name	Scientific Name	Species Determination	Critical Habitat Determination
Coral: no common name	*Acropora jacquelineae*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Elkhorn coral	*Acropora palmata*	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Coral: no common name	*Acropora retusa*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Coral: no common name	*Acropora speciosa*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Pillar coral	*Dendrogyra cylindrus*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Coral: no common name	*Euphyllia paradivisa*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Black abalone	*Haliotis cracherodii*	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
White abalone	*Haliotis sorenseni*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Coral: no common name	*Isopora crateriformis*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Rough cactus coral	*Mycetophyllia ferox*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Lobed star coral	*Orbicella annularis*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Mountainous star coral	*Orbicella faveolata*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Boulder star coral	*Orbicella franksi*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Coral: no common name	*Pocillopora meandrina*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Coral: no common name	*Seriatopora aculeata*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)

3.9 ESSENTIAL FISH HABITAT

This section discusses the affected environment and environmental consequences that would result under each alternative for EFH for fish and aquatic macroinvertebrates in the action area. EFH occurs in both the marine and freshwater environments, although none had been designated in the Great Lakes.

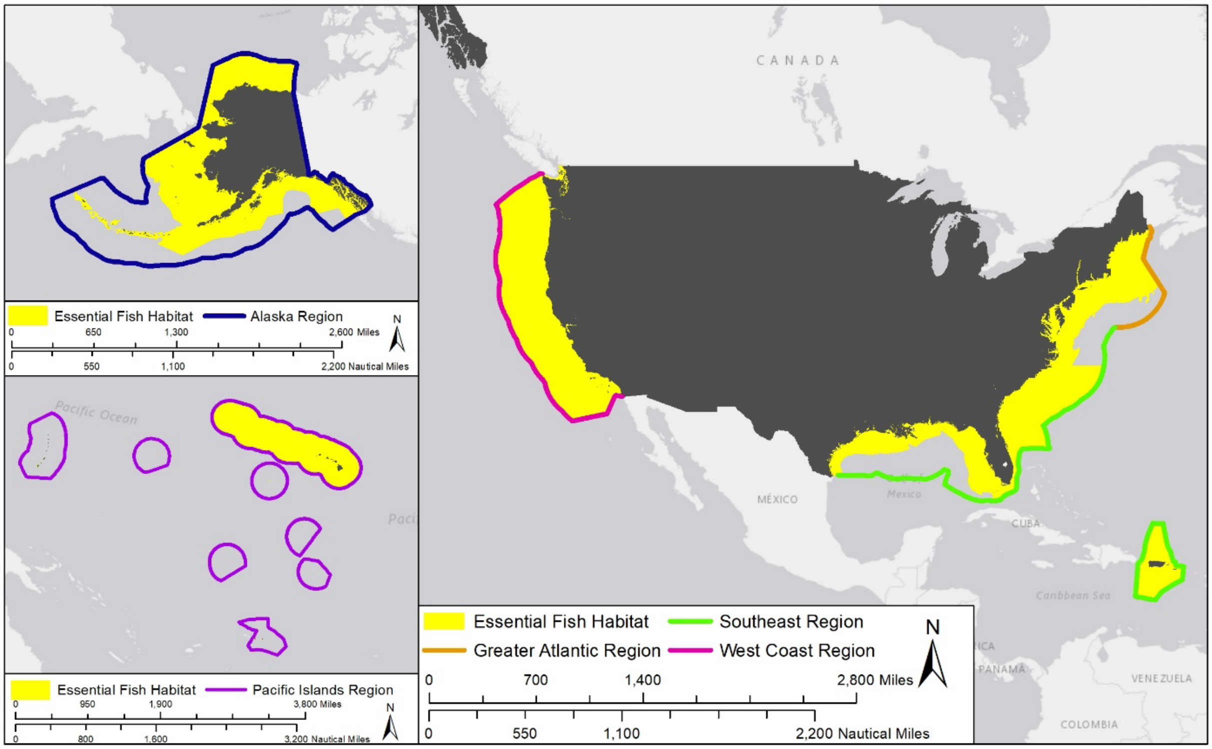
3.9.1 Affected Environment

As discussed in Section 3.3, Congress passed the MSA in 1976 and reauthorized it in 1996 as the Sustainable Fisheries Act. The MSA established eight regional Fishery Management Councils (FMCs) – North Pacific, Pacific, Western Pacific, Gulf of Mexico, Caribbean, South Atlantic, Mid-Atlantic, New England – and mandated that Fishery Management Plans (FMPs) be developed to responsibly manage fish and invertebrate species in waters within the U.S. EEZ. Under the reauthorization, NMFS was required to designate and conserve EFH for species managed under existing FMPs. This was intended to minimize, to the extent practicable, any adverse effects on habitat caused by human activities and to encourage the conservation and enhancement of such habitat (BOEM, 2014a).

EFH is defined as “those waters and substrate necessary for fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C §1801 [10]). The final rule summarizing EFH regulation (50 CFR Part 600) outlines additional interpretation of the EFH definition. Waters, as defined previously, include “aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate.” Substrate includes “sediment, hard bottom, structures underlying the waters, and associated biological communities.” “Necessary” is defined as “the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem.” Fish includes “finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds,” and “spawning, breeding, feeding or growth to maturity” covers the complete life cycle of those species of interest. Ecologically, EFH includes waters and substrate that include distribution and range zones such as migration corridors, spawning areas, and rocky reefs, as well as water characteristics such as turbidity zones and salinity gradients. EFH is not only a geographic area where a species occurs, but an all-encompassing habitat designation.

EFH regulations provide guidance to FMCs to identify and define EFH, clarify the intent of key terms, and require that federal agencies consult with NMFS when planning or authorizing activities that could affect EFH. NMFS works with the FMCs to designate EFH, which has been described for more than 1,000 managed species to date.

The area encompassed by the Proposed Action and alternatives extends from the shoreline to the seaward boundary of the U.S. EEZ. A large portion of these waters has been designated EFH for one or more species managed pursuant to the MSA. EFH also occurs in estuarine and freshwater habitat such as rivers, ponds, and wetlands. **Figure 3.9-1** shows the large extent of EFH as it covers most of the U.S. EEZ.



Source: NMFS, 2019a

Figure 3.9-1. EFH in the U.S. EEZ

EFH designations are based on interpretations of the best available scientific information on the general distribution of managed species within fisheries, and their habitat-related densities, growth, reproduction, or survival rates within habitats, and/or production rates by habitat (50 C.F.R. §600.815 (a)(1)(iii)). The available science is mostly limited to general distributions, and given that there are several life stages (eggs, larvae, juveniles and adults) and numerous representative species within all fisheries for which EFH has been designated, the EFH designations across regions are broad. Designations are primarily based on the species' position in the water column (e.g., demersal, pelagic), and include broad biogeographic and bathymetric areas (0-400 m [0-1,312 ft] depth in a region), and general habitat types. Fish habitat includes the substrate and benthic resources (e.g., submerged aquatic vegetation, shellfish beds, salt marsh wetlands), as well as the water column, and prey species. EFH includes all types of aquatic habitats such as wetlands, coral reefs, seagrass (**Figure 3.9-2**), muddy and rocky substrates in state and federal waters, and rivers where fish spawn, breed, feed, or grow to maturity.

Figure 3.9-2. Seagrass EFH

Photo Credit: NMFS

Within the EFH designations, Habitat Areas of Particular Concern (HAPCs) have been identified; these are high-priority areas for conservation, management, or research because they are rare, sensitive, stressed by development, or important to ecosystem function. HAPCs are discrete subsets of EFH and comprise specific sites or habitat types that meet one or more considerations including: being of particular ecological importance to the long-term sustainability of managed species; being of a rare type; and/or being especially susceptible to degradation or development (50 C.F.R. §600.815 (a)(8)). More than 100 HAPCs have been identified across all regions for enhanced EFH conservation. Several FMCs have designated discrete habitat areas as HAPC, while others have broadly designated all areas of a specific habitat type as HAPC.

EFH has been designated in the waters inside of the 320-km (200-mi) U.S. EEZ boundary in the eight FMC regions. Each EFH is described below by text and a map using the best scientific information available for each fish stock. Each of the FMCs has developed EFH descriptions in either separate documents or as amendments to existing FMPs. NMFS maintains an online EFH Mapper for viewing the spatial distributions of fish species, their life stages, and important habitats; it displays maps for EFH, HAPCs, and EFH areas protected from fishing (NMFS, 2019a).

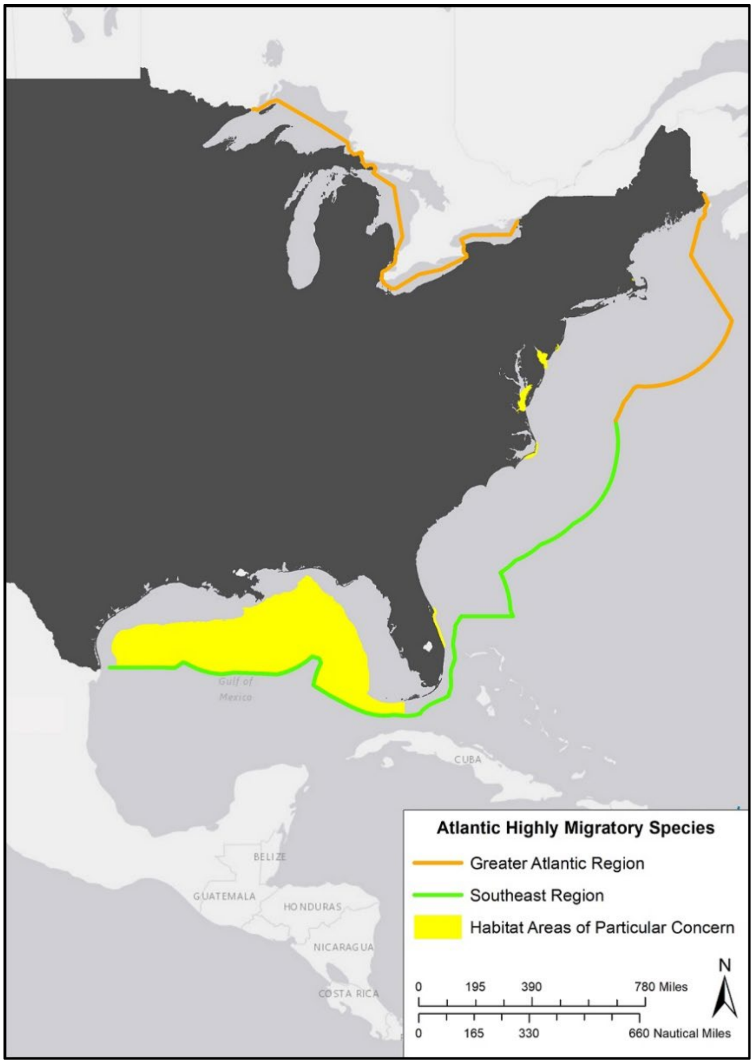
3.9.1.1 Regional Distribution

This section summarizes region-specific EFH and HAPCs for fish and marine macroinvertebrates. Most species found in federal waters are managed by FMCs through the development and implementation of an FMP. However, highly migratory species (HMS) such as Atlantic tunas, sharks, and billfish are different in that they are found throughout the Atlantic Ocean and in the Caribbean and must be managed both domestically and internationally. As a result, NMFS has primary authority for identifying and describing EFH in FMPs for HMS. NMFS has identified geographic areas, rather than specific habitat types as EFH for these fisheries (see **Table 3.9-1** and **Figure 3.9-3**). Detailed descriptions of EFH and HAPC designations for HMS are available in the Atlantic HMS FMP (NMFS, 2019b).

Table 3.9-1. EFH and HAPCs for Atlantic HMS

Fisheries	EFH	HAPC
Highly Migratory Species	Overall: waters of New England, Mid-Atlantic, South Atlantic, Gulf of Mexico, and the U.S. Caribbean.	For bluefin tuna: west of 86° west longitude and seaward of the 100-m (328-ft) isobath, extending from the 100-m (328-ft) isobath to the EEZ in the Gulf of Mexico. For sharks: waters off Chesapeake Bay, Virginia and Maryland; Plymouth-Duxbury-Kingston Bay in Massachusetts; Delaware Bay, Delaware; Great Bay, New Jersey; the Outer Banks off North Carolina; and Titusville to Jupiter off Florida coast.

Source: NMFS, 2019b



Source: NMFS, 2019a

Figure 3.9-3. HAPCs for Atlantic HMS

3.9.1.1.1 Greater Atlantic Region

Two FMCs occur in the Greater Atlantic Region: the New England FMC and the Mid-Atlantic FMC. EFH for various life stages of numerous fish species occurs in this region, including Atlantic salmon (*Salmo salar*), Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*), bluefish (*Pomatomus saltatrix*), monkfish (*Lophius piscatorius*), spiny dogfish (*Squalus acanthias*), and multiple species of groundfish and skates such as Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), red drum (*Sciaenops ocellatus*), pollock (*Pollachius* spp.), hake (Merlucciidae), and flounder (Pleuronectidae, Paralichthyidae, and Bothidae) (NEFMC, No Date; MAFMC, No Date). EFH for HMS occurring in the Greater Atlantic Region, including blue marlin, white marlin, and sailfish, are discussed above in Section 3.9.1.1 and shown in **Table 3.9-1**. For aquatic macroinvertebrates, EFH has been delineated for Atlantic surf clam (*Spisula solidissima*), deep-sea red crab (Chaceon quinquedens), two species of squid (*Doryteuthis pealeii* and *Illex illecebrosus*), and Atlantic sea scallop (*Placopecten magellanicus*) (NMFS, 2019a).

On January 3, 2018, NMFS approved all of the updated EFH and all of the recommended HAPC designations as part of the New England FMC's recommendations for the Omnibus EFH Amendment 2

(OHA2). OHA2 was initiated in 2004 to review and update the EFH components of all the New England FMC's FMPs.

A large proportion of the marine waters and habitats off the coasts of Maine and the states south of Maine to North Carolina, and marine waters within the full 200-mile Greater Atlantic Region EEZ have been designated as EFH for 15 different fisheries managed by the New England and Mid-Atlantic FMCs (see **Table 3.9-2**). EFH includes the coastal and offshore waters from the surface to the sea floor and various bottom substrate and habitat types in the Gulf of Maine, Georges Bank, southern New England, the middle Atlantic south to Cape Hatteras, North Carolina; waters over the continental shelf south of Cape Hatteras through Key West, Florida (some EFH designations extend into the Southeast Region); the Slope Sea and Gulf Stream between latitudes 29° north and 40° north; various bays and estuaries along the eastern coast; and all waters currently or historically accessible to Atlantic salmon within the streams, rivers, lakes, ponds, wetlands, and other water bodies of New England which are designated as EFH for the eggs, larvae, juveniles and/or adults for one or a combination of the managed species. Within these boundaries, one or more of the MSA-managed species are associated with certain water temperature regimes, oxygen saturation levels and salinities, and various seafloor substrates and habitat types.

HAPCs in New England and the Mid-Atlantic have been designated as discrete spatial areas and habitat types as listed in **Table 3.9-2** and shown in **Figure 3.9-4** and include all canyons HAPCs and seamounts HAPCs. In addition to the HAPCs listed in the table, the following areas have been designated for a variety of managed species as part of OHA2:

- The Cashes Ledge Habitat Closure Area was designated as the Cashes Ledge HAPC;
- The existing Western Gulf of Maine Habitat Closure Area was designated as the Jeffreys Ledge/Stellwagen Bank HAPC; and
- Eleven canyons or groupings of canyons south of Georges Bank and offshore of the Mid-Atlantic Bight were designated as HAPCs.

Detailed descriptions of EFH and HAPC designations in New England and the Mid-Atlantic are available in the New England and Mid-Atlantic FMCs' multiple FMPs (NEFMC, No Date; MAFMC, No Date).

Table 3.9-2. EFH and HAPCs for the Greater Atlantic Region

Fisheries	EFH	HAPC
New England		
Northeast Multispecies (Groundfish)	Overall: pelagic waters down to 1,250 m (4,101 ft) depth that meet certain temperature and salinity regimes, and bottom down to 700 m (2,297 ft) depth supporting aquatic vegetation; substrate of soft mud, clay, sand, or gravel; and rough or rocky bottom locations along slopes of the outer banks in Gulf of Maine, Georges Bank, southern New England, middle Atlantic south to Cape Hatteras,	Northern Edge Juvenile Cod HAPC: covers approximately 187 nm^2 on the northeastern edge of Georges Bank up to 120 m depth. Inshore Juvenile Cod HAPC: inshore areas of the Gulf of Maine and Southern New England between 0-20 m (0-66 ft) depth. Great South Channel Juvenile Cod HAPC: the area north of 41° north latitude, west of 69° west longitude,

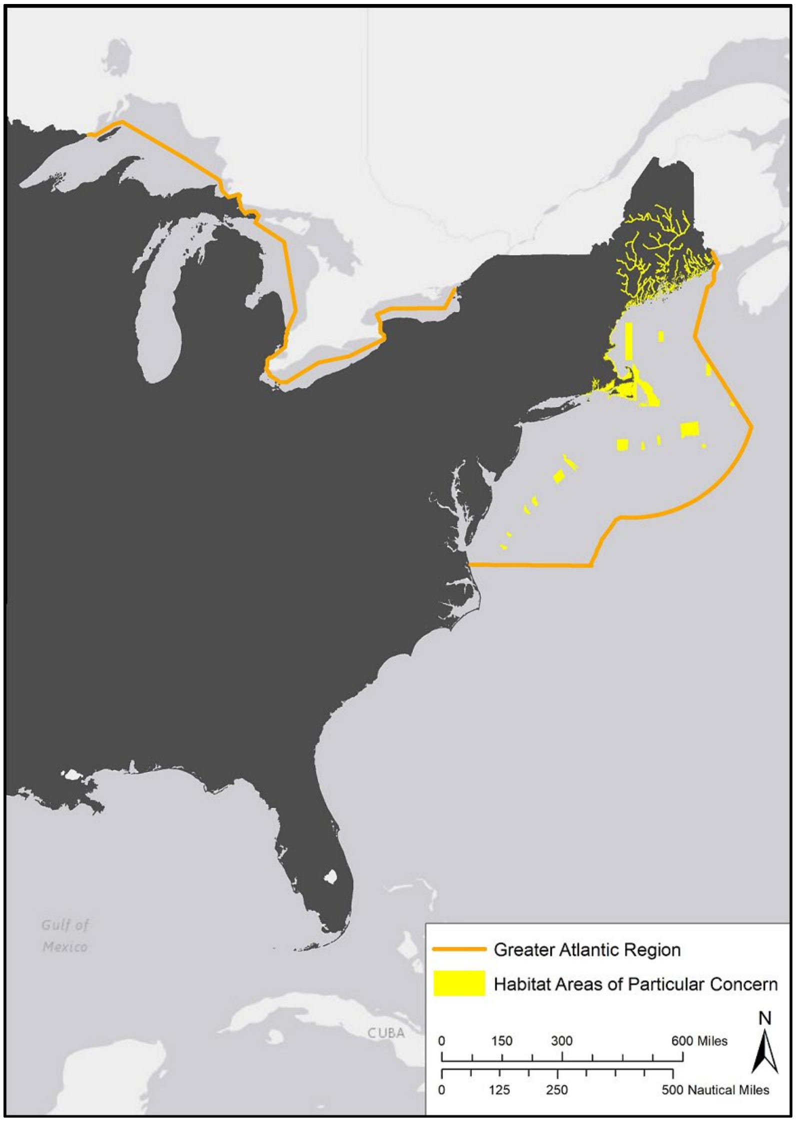
Fisheries	EFH	HAPC
	North Carolina; also a range of estuaries along the coasts.	south of 42° 15’ north latitude, and east of 70° west longitude; offshore habitats between 30 and 120 m (98 and 394 ft) depth.
Atlantic Sea Scallop	Overall: coastal and offshore waters to the EEZ limit that meet certain temperature and salinity regimes, and bottom supporting red algae, hydroids, amphipod tubes and bryozoans and/or substrate of gravelly sand, sand, shell fragments, and pebbles, cobble and silt in the Gulf of Maine, Georges Bank, southern New England, and the mid-Atlantic south to the Virginia-North Carolina border; also various bays and estuaries along the coasts.	None
Atlantic Herring	Overall: coastal and offshore waters to the EEZ limit that meet certain temperature and salinity regimes, and bottom supporting aquatic macrophytes and substrate of gravel, sand, cobble, and shell fragments in the Gulf of Maine and Georges Bank and southern New England.	None
Atlantic Deep-Sea Red Crab	Overall: water column from the surface to the sea floor that meets certain temperature, dissolved oxygen (DO), and salinity regimes along the entire depth range along the southern flank of the outer continental shelf and slope, including two seamounts, from Georges Bank, Maine south to Cape Hatteras, North Carolina; and bottom within the depths of 200 – 1,800 m (5,905 ft) of the continental slope with substrates of silts, clays, and all silt-clay-sand composites.	Bear and Retriever Seamounts HAPC: the tops of Bear and Retriever seamounts that overlap spatially with the proposed EFH designation are designated as a HAPC.
Skates	Overall: down to 750 m (2,461 ft) depth of soft substrate, including sand and mud bottoms, mud with echinoid and ophiuroid fragments, broken shells, and shell and pteropod ooze; and substrate of	None

Fisheries	EFH	HAPC
	gravel and pebbles on offshore banks of the Gulf of Maine, Georges Bank through the Mid-Atlantic Bight to Cape Hatteras, North Carolina.	
Atlantic Salmon	Overall: all waters currently or historically accessible to Atlantic salmon within the streams, rivers, lakes, ponds, wetlands, and other water bodies of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut that meet a set of conditions, and oceanic pelagic waters of the continental shelf off southern New England north throughout the Gulf of Maine.	Eleven rivers in Maine: Dennys, Machias, East Machias, Pleasant, Narraguagus, Ducktrap, Sheepscot, Kennebec, Penobscot, St. Croix, and Tunk Stream.
Small Mesh Multispecies (Whiting/Hake)	Overall: pelagic waters along the outer continental shelf of Georges Bank and southern New England south to Cape Hatteras, North Carolina; water depths less than 1,250 m (4,101 ft)	None
Mid-Atlantic		
Atlantic Mackerel, Squid, and Butterfish	Overall: inshore, offshore, and pelagic waters down to 1,829 m (6,000 ft) depth along the continental shelf from Maine through Cape Hatteras, North Carolina; also, a range of estuaries along the coasts.	None
Summer Flounder, Scup, and Black Sea Bass	Overall: water column down to 152 m (499 ft) depth including demersal waters and bottom that is rough, structured, muddy, sandy, or supporting shellfish and eelgrass beds along continental shelf from Gulf of Maine to Cape Hatteras, North Carolina; also, a range of estuaries along the coasts.	For summer flounder: HAPC consists of all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH on continental shelf and estuaries from Cape Cod, Massachusetts to Cape Canaveral, Florida*.
Atlantic Bluefish	Overall: pelagic waters over continental shelf from Nantucket Island, Massachusetts south to Cape Hatteras; and south of Cape Hatteras over continental shelf through Key West, Florida*, the Slope Sea and Gulf Stream between	None

Fisheries	EFH	HAPC
	latitudes 29° north and 40° north; also, a range of estuaries along the coasts.	
Tilefish	Overall: semi-lithified clay substrates within a preferred temperature range, which generally correspond to a depth contour of 100 to 300 m (328 to 984 ft); outer continental shelf and slope from U.S.-Canada boundary to the Virginia-North Carolina boundary.	Clay outcrop/pueblo six habitats within four canyon areas (Norfolk, Veatch, Lydonia, and Oceanographer canyons), within the same depth contour identified as EFH.
Atlantic Surf Clams and Ocean Quahogs	Overall: substrate to a depth of 245 m (804 ft) within the EEZ. Ocean quahog: continental shelf from southern New England and Georges Bank to Virginia. Surf clam: continental shelf from southwestern Gulf of Maine to Cape Hatteras, North Carolina.	None
Joint		
Monkfish	Overall: coastal and offshore waters to the EEZ limit that meet certain temperature and salinity ranges, and bottom of a sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud between 15 – 1,000 m (49 to 3,281 ft) depths in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras, North Carolina.	None
Spiny Dogfish	Overall: continental shelf waters between 10-450 m (33 to 1,476 ft) depth in the Gulf of Maine through Cape Hatteras, North Carolina; continental shelf waters south of Cape Hatteras through Florida*; also, a range of estuaries along the coasts.	None

Sources: NEFMC, 2016; NEFMC, 2018; NEFMC, No Date; MAFMC, No Date

*Note that some EFH and HAPC designations extend into the Southeast Region.

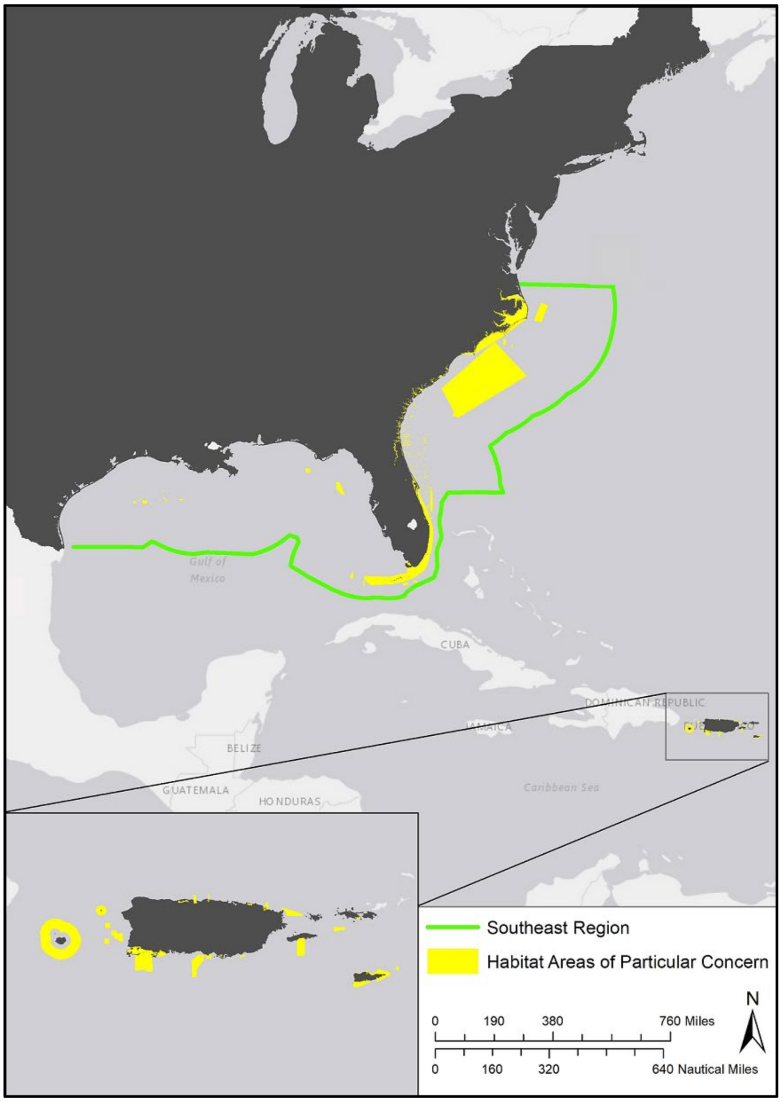


Source: NMFS, 2019a

Figure 3.9-4. HAPCs in the Greater Atlantic Region

3.9.1.1.2 Southeast Region

Three FMCs occur in the Southeast Region: the South Atlantic FMC, the Gulf of Mexico FMC, and the Caribbean FMC. EFH for various life stages of numerous fish species occurs in this region, including mackerel, cobia (*Rachycentron canadum*), wahoo (*Acanthocybium solandri*), snapper (*Lutjanus* spp.), grouper (Epinephelinae), and red drum (SAFMC, No Date; Gulf Council, No Date; CFMC, No Date). EFH for HMS occurring in the Southeast Region, including blue marlin, white marlin, and sailfish, are discussed above in Section 3.9.1.1 and shown in **Table 3.9-1**. For aquatic macroinvertebrates, EFH has been established in the Gulf of Mexico for corals (Anthozoa), shrimp, and spiny lobster (Palinuridae). In the South Atlantic and Caribbean, EFH has been established for corals, golden crab (*Chaceon fenneri*), spiny lobster, and queen conch (*Strombus gigas*). In addition, EFH for sargassum (Phaeophyceae), a seaweed found in free-floating offshore mats throughout the waters of the South Atlantic that is harvested for use in the feed supplement industry, occurs in this region. The sargassum mats provide crucial habitat for a wide variety of marine organisms in the open ocean, including pelagic species such as tuna, dolphin, wahoo, and billfish, as well as sea turtles and marine birds. EFH in the Southeast Region is discussed below for each FMC area: South Atlantic, Gulf of Mexico, and Caribbean. HAPCs in the Southeast Region are mapped in **Figure 3.9-5**.



Source: NMFS, 2019a

Figure 3.9-5. HAPCs in the Southeast Region

3.9.1.1.2.1 South Atlantic

A large proportion of the marine waters and habitat inside of the U.S. EEZ off the coasts of North Carolina and southward through to east Florida and Key West have been designated as EFH for eight fisheries managed by the South Atlantic FMC (see **Table 3.9-3**). EFH includes estuarine inshore habitats; various marine offshore habitats throughout the South Atlantic EEZ; the South- and Mid-Atlantic Bights; and the Gulf Stream in the South Atlantic Region EEZ. Estuarine inshore habitats consist of estuarine emergent vegetation, estuarine shrub/scrub, seagrass, oyster reefs and shell banks, intertidal flats, palustrine emergent and forested, and the estuarine water column. Marine offshore habitats include live/hard bottom, coral and coral reefs, artificial/manmade reefs, pelagic sargassum, and water column habitat.

HAPCs have been designated for all of the fisheries, many of which are identified for multiple managed species as listed in **Table 3.9-3**. HAPCs include: coastal inlets and Atlantic coast estuaries; pelagic and benthic sargassum; various discrete sites, bays, and sounds; marine protected areas and ridges; state-designated nursery habitats; various hardbottom areas; irregular bottom; mud-clay bottoms; and various habitat types such as coral reefs, *Phragmatopoma* reefs, manganese outcroppings, mangroves, seagrass, oyster/shell habitat, and sandy shoals.

Detailed descriptions of EFH and HAPC designations in the South Atlantic are available in the South Atlantic FMC's Habitat Plan, and the South Atlantic FMCs' multiple FMPs (SAFMC, No Date).

Table 3.9-3. EFH and HAPCs for the Southeast Region - South Atlantic

<table>
<tr><th>Fisheries</th><th>EFH</th><th>HAPC</th></tr>
<tr><td>Coral, Coral Reefs, and Live/Hard Bottom</td><td>Overall: hard substrate, mud, and silt bottoms in subtidal to outer shelf depths within a wide range of salinity and light penetration throughout the South Atlantic EEZ.</td><td rowspan="5">Big Rock; The Point; Hurl Rocks; Charleston Bump; Ten-Fathom Ledge; Georgetown Hole; The Point off Jupiter Inlet; The Hump off Islamorada; The Marathon Hump; The "Wall"; Hoyt Hills; Gray's Reef National Marine Sanctuary (NMS); eight deepwater Snapper Grouper Marine Protected Areas (MPAs); Oculina Banks; Biscayne Bay; Biscayne National Park; Florida Keys National Marine Sanctuary; Cape Lookout; Cape Fear; Stetson Reefs; Savannah and East Florida Lithoherms; Miami Terrace; Pourtals Terrace; Blake Ridge Diapir; Florida Bay; and Card Sound.

All coastal inlets and Atlantic coast estuaries with high numbers of Spanish mackerel and cobia.

All state-designated nursery habitats of particular importance to shrimp and snapper-grouper; state-identified overwintering areas; localities of known or likely periodic spawning aggregations.

Pelagic and benthic sargassum; all hermatypic coral habitats and reefs; Stetson-Miami Terrace deepwater coral; shrimp fishery access areas; golden crab fishery access areas;</td></tr>
<tr><td>Dolphin and Wahoo</td><td>Overall: Gulf Stream in the Atlantic EEZ; Charleston Gyre, Florida Current, and pelagic sargassum.</td></tr>
<tr><td>Golden Crab</td><td>Overall: seven habitat types (a flat foraminferan ooze habitat; distinct mounds, primarily of dead coral; ripple habitat; dunes; black pebble habitat; low outcrop; and soft-bioturbated habitat) throughout the U.S. continental shelf from Chesapeake Bay south through the Florida Straits and into the Gulf of Mexico and the Gulf Stream.</td></tr>
<tr><td>South Atlantic Shrimp</td><td>Overall: inshore estuarine nursery areas (including intertidal marshes, mangroves, and seagrass) and offshore marine habitats used for spawning and growth to maturity (including terrigenous and biogenic sand bottom and blue/black and white calcareous mud), and all interconnecting water bodies from North Carolina through the Florida Keys, shelf current systems near Cape Canaveral, and the Gulf Stream.</td></tr>
<tr><td>Snapper-Grouper</td><td>Overall: coral reefs, live/hard bottom, macroalgae, estuarine emergent vegetated wetlands</td></tr>
</table>

Fisheries	EFH	HAPC
	(saltmarshes, brackish marsh); tidal creeks; estuarine scrub/shrub; oyster reefs and shell banks; unconsolidated bottom; submerged aquatic vegetation, artificial reefs and outcroppings from shore up to 610 m (2,000 ft) depth where the annual water temperature range is sufficiently warm to maintain populations; spawning area in the water column above the adult habitat and the additional pelagic environment, including sargassum; and Gulf Stream.	various hardbottom areas from 0-30 m depth (0-98 ft); irregular bottom comprising troughs and terraces intermingled with sand, mud, or shell hash bottom; mud-clay bottoms in depths of 150-300 m (492-984 ft); irregular bottom habitats along the shelf edge in 45-65 m (148-213 ft) depth, shelf break; upper slope along the 150-225 m (492-738 ft) contour; *Phragmatopoma* reefs off central and central east coast Florida; manganese outcroppings on the Blake Plateau; mangrove habitat; seagrass habitat; oyster/shell habitat; sandy shoals of Cape Lookout, Cape Fear, and Cape Hatteras; various offshore pelagic areas and associated benthic habitats.
Pelagic Sargassum Habitat	Where it occurs in the South Atlantic EEZ and in the state waters off of North Carolina, South Carolina, Georgia, and the east coast of Florida, including the Gulf Stream.	
Coastal Migratory Pelagics (Mackerel and Cobia) – Managed jointly by the Gulf of Mexico and South Atlantic FMCs	Overall: all coastal inlets; all state-designated nursery habitats of particular importance to coastal migratory pelagics; high salinity bays, estuaries, and seagrass habitat; sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters and sargassum from the surf to the shelf break zones shoreward of the Gulf stream; the Gulf Stream; and the South Atlantic and Mid-Atlantic Bights.	
Atlantic Spiny Lobster – Managed jointly by the Gulf of Mexico and South Atlantic FMCs	Overall: nearshore shelf/oceanic waters; shallow subtidal bottom; seagrass habitat; unconsolidated bottom; coral and live/hard bottom habitat; sponges; algal communities; mangrove habitat; and the Gulf Stream.	

Source: SAFMC, No Date

3.9.1.1.2.2 Gulf of Mexico

A large proportion of the marine waters and habitat inside of the U.S. EEZ off the coasts of Texas and states east of Texas through to western Florida and Key West have been designated as EFH for the fisheries managed by the Gulf of Mexico FMC (see **Table 3.9-4**). EFH includes the waters and substrates from estuarine waters to depths of 100 fathoms (approximately 183 m [600 ft]) in the entire Gulf of Mexico and the total distribution of coral species and life stages throughout the Gulf of Mexico. EFH habitat types include: estuarine and marine water column; estuarine emergent wetlands; submerged aquatic vegetation; algal flats and non-vegetated bottoms; mangrove wetlands; live (hard) bottoms and mud, sand, shell, and rock substrates; and coral reefs.

HAPCs have been designated for one or more of the fisheries as 18 spatially discrete sites in waters off Florida, Texas, and Louisiana as listed in **Table 3.9-4**. These areas predominantly contain living coral reefs or hard bottom habitat with known coral colonies, and include various protected areas, ridges and reefs.

Detailed descriptions of EFH and HAPC designations in the Gulf of Mexico are available in the Gulf of Mexico FMCs' multiple FMPs (Gulf Council, No Date).

Table 3.9-4. EFH and HAPCs for the Southeast Region – Gulf of Mexico

Fisheries	EFH	HAPC
Coral and Coral Reefs	Overall: the total distribution of coral species and life stages throughout the Gulf of Mexico including the East and West Flower Garden Banks, Florida Middle Grounds, southwest tip of the Florida reef tract, and predominant patchy hard bottom offshore of Florida from approximately Crystal River south to the Keys and scattered along the pinnacles and banks from Texas to Mississippi at the shelf edge.	18 areas primarily for protecting coral and hard bottom as identified within Coral FMP: Off of Florida: Madison-Swanson Marine Reserve; Tortugas North; Tortugas South; Florida Middle Grounds; and Pulley Ridge. Topographic features (reefs and banks) off of Texas/Louisiana: West Flower Garden Banks; East Flower Garden Banks; Stetson Bank; 29 Fathom Bank; MacNeil Bank; Rezak Sidner Bank; Rankin Bright Bank; Geyer Bank; McGrail Bank; Bouma Bank; Sonnier Bank; Alderdice Bank and Jakkula Bank. Coral HAPCs for reefs and banks; Alabama Alps Reef, AT047, AT357, Florida Keys National Marine Sanctuary, Garden Banks 299, Garden Banks 535, Green Canyon 140 and 272, Green Canyon 234, Green Canyon 354, Green Canyon 852, Harte Bank, L&W Pinnacle and Scamp Reef, MacNeil, the Mississippi canyons (118, 751, and 885), Rough Tongue Bank, South Reed Site, Southern Bank, Steamboat Lumps,
Red Drum	Overall: all Gulf of Mexico estuaries; waters and substrates extending from Vermilion Bay, Louisiana to the eastern edge of Mobile Bay, Alabama out to depths of 25 fathoms (approximately 46 m [151 ft]); waters and substrates extending from Crystal River, Florida to Naples, Florida between depths of 5 and 10 fathoms (9-18 m [29-59 ft]); waters and substrates extending from Cape Sable, Florida to the boundary between the areas covered by the Gulf of Mexico FMC and the South Atlantic FMC between depths of 5 and 10 fathoms (9-18 m [29-59 ft]).	
Gulf of Mexico Shrimp	Overall: Gulf of Mexico waters and substrates extending from the U.S./Mexico border to Fort Walton Beach, Florida from estuarine waters	

Fisheries	EFH	HAPC
	out to depths of 100 fathoms (183 m [600 ft]); waters and substrates extending from Grand Isle, Louisiana to Pensacola Bay, Florida between depths of 100 and 325 fathoms (183-594 m [600-1,949 ft]); waters and substrates extending from Pensacola Bay, Florida to the boundary between the areas covered by the Gulf of Mexico FMC and the South Atlantic FMC out to depths of 35 fathoms (64 m [210 ft]), with the exception of waters extending from Crystal River, Florida to Naples, Florida between depths of 10 and 25 fathoms (18-46 m [59-151 ft]) and in Florida Bay between depths of 5 and 10 fathoms (9-18 m [29-59 ft]).	West Florida Wall, The Edges, and the Viosca Knolls (826 and 862/906).
Reef Fish	Overall: Gulf of Mexico waters and substrates extending from the U.S./Mexico border to the boundary between the areas covered by the Gulf of Mexico FMC and the South Atlantic FMC from estuarine waters out to depths of 100 fathoms (183 m [600 ft]).	
Stone Crab	Overall: all Gulf of Mexico estuaries; Gulf of Mexico waters and substrates extending from the U.S./Mexico border to Sanibel, Florida from estuarine waters out to depths of 10 fathoms (9-18 m [30-59 ft]); waters and substrates extending from Sanibel, Florida to the boundary between the areas covered by the Gulf of Mexico FMC and the South Atlantic FMC from estuarine waters out to depths of 15 fathoms (27 m [89 ft]).	
Coastal Migratory Pelagics (Mackerel and Cobia) – Managed jointly by the Gulf of Mexico and South Atlantic FMCs	Overall: Gulf of Mexico waters and substrates extending from the U.S./Mexico border to the boundary between the areas covered by the Gulf of Mexico FMC and the South Atlantic FMC from estuarine waters	

Fisheries	EFH	HAPC
	out to depths of 100 fathoms (183 m [600 ft]).	
Atlantic Spiny Lobster – Managed jointly by the Gulf of Mexico and South Atlantic FMCs	Overall: Gulf of Mexico waters and substrates extending from Tarpon Springs, Florida to Naples, Florida between depths of 5 and 10 fathoms (9-18 m); waters and substrates extending from Cape Sable, Florida to the boundary between the areas covered by the Gulf of Mexico FMC and the South Atlantic FMC out to depths of 15 fathoms (27 m [89 ft]).	

Source: Gulf Council, No Date

3.9.1.1.2.3 United States Caribbean

A large proportion of the marine waters and habitat inside of the U.S. EEZ off the coasts of Puerto Rico and the U.S. Virgin Islands have been designated as EFH for the five fisheries managed by the Caribbean FMC (see **Table 3.9-5**). All waters from mean high water to the outer boundary of the EEZ and all substrates from mean high water to 100 fathoms (183 m [600 ft]) depth are designated as EFH for the eggs, larvae, juveniles and/or adults for one or more of the managed species. The various habitat types included are: estuarine and marine water column, salt marshes, seagrass, intertidal flats, salt ponds, sandy beaches, rocky shores, mangrove wetlands, live (hard) bottoms, mud, sand, shell, and rock substrates, and corals and coral reefs.

HAPCs have been designated for two of the fisheries as listed in **Table 3.9-5**, with the intent that the HAPCs protect the life stages of all managed species. The HAPCs include: eight reef fish spawning locations in Puerto Rico, St. Croix and St. Thomas; and 37 Ecologically Important Habitat areas in Puerto Rico, St. Thomas, and St. Croix. The HAPC locations sometimes overlap with refuges, bays, and banks and include a variety of habitat types such as coral and coral reefs, mangrove lagoons, seagrass beds, and coastal wetlands.

Detailed descriptions of EFH and HAPC designations in the U.S. Caribbean are available in the Caribbean FMCs' multiple FMPs (CFMC, No Date).

Table 3.9-5. EFH and HAPCs for the Southeast Region – U.S. Caribbean

Fisheries	EFH	HAPC
Reef Fish	Overall: all waters from mean high water to the outer boundary of the EEZ and all substrates from mean high water to 100 fathoms (183 m [600 ft]) depth.	Eight reef fish spawning locations: four in Puerto Rico, two in St. Croix, and two in St. Thomas. 18 Ecologically Important Habitat areas: 11 in Puerto Rico, two in St. Thomas, and four in St. Croix.

Fisheries	EFH	HAPC
		Areas/sites/habitat types include refuges, reefs, seagrass beds, bays, banks, and mangrove lagoons.
Queen Conch	Overall: all waters from mean high water to the outer boundary of the EEZ and seagrass, benthic algae, coral, live/hard bottom and sand/shell substrates from mean high water to 100 fathoms (183 m [600 ft]) depth.	None – no HAPC has been designated for the queen conch fishery in this region.
Spiny Lobster	Overall: all waters from mean high water to the outer boundary of the EEZ and seagrass, benthic algae, mangrove, coral, and live/hard bottom substrates from mean high water to 100 fathoms (183 m [600 ft]) depth.	None – no HAPC has been designated for the spiny lobster fishery in this region.
Coral and Reef Associated Plants and Invertebrates	Overall: all waters from mean low water to the outer boundary of the EEZ and coral and hard bottom substrates from mean low water to 100 fathoms (183 m [600 ft]) depth.	19 Ecologically Important Habitat areas: 13 in Puerto Rico and six in St. Croix. Areas contain corals and are in some cases identified at a scale (e.g., state forest) that includes a variety of other habitat types such as mangroves, seagrass beds, and coastal wetlands.

Source: CFMC, No Date

3.9.1.1.3 West Coast Region

One FMC occurs in the West Coast Region: the Pacific FMC. EFH for various life stages of numerous fish species occur in this region, including over 90 species of groundfish such as rockfish (Sebastes), Pacific ocean perch (*Sebastes alutus*), Dover sole (*Solea solea*), arrowtooth flounder (*Atheresthes stomias*), lingcod (*Ophiodon elongatus*), sablefish (*Anoplopoma fimbria*), spiny dogfish, leopard shark (*Triakis semifasciata*), and California skate (*Raja inornata*); Pacific salmon (*Oncorhynchus* spp.); Pacific halibut (*Hippoglossus stenolepis*); HMS such as thresher sharks (*Alopias* spp.), shortfin mako shark (*Isurus oxyrinchus*), blue shark (*Prionace glauca*), tuna (*Thunnus* spp.), striped marlin (*Kajikia audax*), swordfish (*Xiphias gladius*), and mahimahi (*Coryphaena hippurus*); and coastal pelagic species such as Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), and anchovy (Engraulidae) (PFMC, No Date). Along the coast of California, EFH for aquatic macroinvertebrates has been designated for squid and several species of krill.

A large proportion of the waters in the EEZ off the coasts of Washington, Oregon, and California have been designated as EFH for the approximately 119 individual fish species within four fisheries as managed by the Pacific FMC (see **Table 3.9-6**). EFH includes all freshwater water bodies occupied by Council-managed salmon; substrate down to 3,500 m (11,483 ft) depth and estuarine and marine waters from the high tide line to the EEZ limit offshore of Washington, Oregon, and California; seamounts in depths greater than 3,500 m (11,483 ft). Areas designated as HAPCs not already identified as EFH are designated as EFH for the eggs, larvae, juveniles and/or adults for one or more of the salmon, groundfish, coastal pelagic, and/or HMS. Within these boundaries, one or more of the federally managed species are associated with water temperature regimes bounded by 13°C and 31°C; (55 and 88 °F) oxygen saturation levels greater than 60 percent; and different prey such as anchovies, squid, and herring.

HAPCs in the West Coast Region have been designated for two of the fisheries, defined primarily as habitat types as listed in **Table 3.9-6** and shown in **Figure 3.9-6**. For salmon, HAPCs include complex channels and floodplain habitats, thermal refugia, spawning habitat, estuaries, and marine and estuarine submerged aquatic vegetation. For groundfish, HAPCs include estuaries, canopy-forming kelp, seagrass, and rocky reefs plus several areas of interest which include all waters and sea bottom within the 3 nm (6 km) territorial boundary off Washington, several seamounts and banks off of Oregon and California, Monterey Canyon, and areas of the Channel Islands NMS offshore from each of the states.

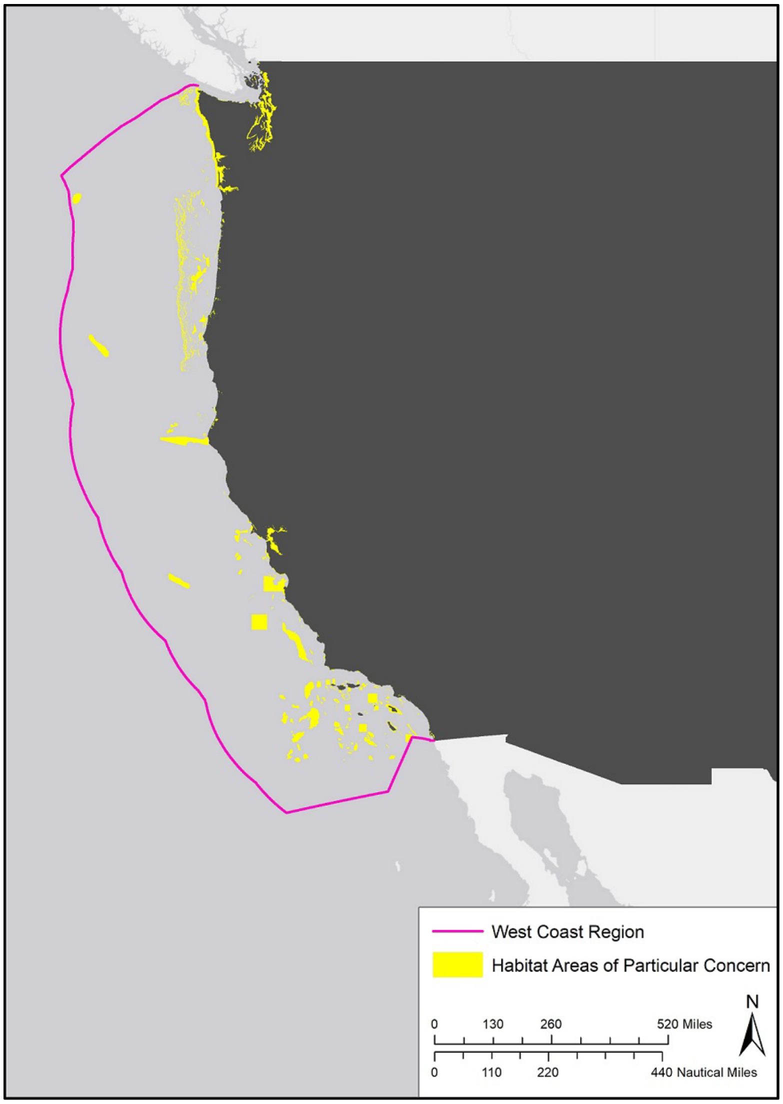
Detailed descriptions of EFH and HAPC designations in the West Coast Region are available in the Pacific FMC's four FMPs (PFMC, No Date).

Table 3.9-6. EFH and HAPCs for the West Coast Region

Fisheries	EFH	HAPC
Pacific Coast Salmon	Overall: all freshwater water bodies currently or historically occupied by Council-managed salmon within the USGS 4th field hydrologic units (HU), and estuarine and marine areas that extend from the extreme high tide line in nearshore and tidal submerged environments to the EEZ limit offshore of Washington, Oregon, and California north of Point Conception. Also, marine areas off Alaska designated as salmon EFH by the North Pacific FMC for stocks also managed by the North Pacific FMC.	Complex channels and floodplain habitats, thermal refugia, spawning habitat, estuaries, and marine and estuarine submerged aquatic vegetation. With the exception of estuaries, none of these HAPCs have been comprehensively mapped, and some may vary in location and extent over time.
Pacific Coast Groundfish	Overall: all waters and substrates down to 3,500 m (11,483 ft) depth from mean higher high water level (MHHW) on shoreline or the upriver extent of saltwater intrusion; seamounts in depths greater than 3,500 m (11,483 ft) as mapped in the EFH assessment GIS, and areas designated as HAPCs not already identified by the above criteria.	Estuaries, canopy-forming kelp, seagrass, and rocky reefs, plus several "areas of interest" which include: all waters and sea bottom from the MHHW out to the 3 nm (6 km) boundary off Washington, and several seamounts and banks off Oregon and California, Monterey Canyon, and areas of the Channel Islands National Marine Sanctuary.

Fisheries	EFH	HAPC
Coastal Pelagic Species	Overall: all marine and estuarine waters from the shoreline to the EEZ limit offshore of California, Oregon, and Washington, and above the thermocline where sea surface temperatures range between 10°C and 26°C (50 and 80 °F).	None – no HAPC has been designated for the coastal pelagic species fishery in this region.
West Coast HMS	Overall: coastal, epipelagic, mesopelagic, and oceanic waters extending beyond the 11 m (36 ft) isobath to the EEZ boundary offshore of California, Oregon, and Washington. Associated with water temperature regimes bounded by 10°C and 31°C (50 and 88 °F); and different prey such as anchovies, squid and herring.	None – no HAPC has been designated for West Coast HMS in this region.

Source: PFMC, No Date



Source: NMFS, 2019a

Figure 3.9-6. HAPCs in the West Coast Region

3.9.1.1.5 Alaska Region

One FMC occurs in the Alaska Region: the North Pacific FMC. EFH for various life stages of numerous fish species occurs in this region, including Alaskan stocks of Pacific salmon, halibut, Pacific herring (*Clupea pallasii*), and approximately 25 species of groundfish including walleye pollock (*Gadus chalcogrammus*), Greenland turbot (*Reinhardtius hippoglossoides*), sablefish, Atka mackerel (*Pleurogrammus monopterygius*), cods (*Gadus* spp.), sole, flounders (Pleuronectiformes), sculpins (Cottoidea), skates (Rajidae), and rockfish (NPFMC, No Date). In Alaskan waters of the Bering Sea and Aleutian Islands, EFH for aquatic macroinvertebrates have been established for octopus (Octopoda), weathervane scallop (*Patinopecten caurinus*), tanner crab (*Chionoecetes bairdi* and *C. opilio*), snow crab (*Chionoecetes opilio*), and red king crab (*Paralithodes camtschaticus*).

A large proportion of the waters and habitat in the EEZ off the coast of Alaska have been designated EFH for over 66 individual fish species within six fisheries as managed by the Alaska FMC (see **Table 3.9-7**). All marine waters above the entire continental shelf, slope, and deep basins off the coast of Alaska including the Gulf of Alaska (GOA), Bering Sea and Aleutian Islands (BSAI), Chukchi Sea, and Arctic Ocean from the mean higher tide line to the EEZ limit; bottom down to 100 m (328 ft) depth (inner and middle continental shelf) in Arctic waters south of Cape Lisburne, and bottom down to 200 m (656 ft) depth (inner, middle and deep shelf) in concentrated areas of the GOA and BSAI are designated as EFH for the eggs, larvae, juveniles and/or adults for one or more of the BSAI ground fish, GOA ground fish, BSAI crab, salmon, scallops and/or Arctic fisheries species. The various substrate types across the continental shelf, slope, and basins above which water column has been designated EFH include: sand, mud, rock, gravel, cobble, vegetated areas, crevices, overhangs, vertical walls, high-relief living habitats such as coral and larger sponges, and biogenic structures such as boltenia, bryozoans, ascidians, and shell hash.

HAPCs in the Alaska Region have been designated for one or more of the fisheries using a site-based approach as listed in **Table 3.9-7** and shown in **Figure 3.9-7**. These include Alaska Seamount Habitat Protection Areas, Bowers Ridge Habitat Conservation Zone, GOA Coral Habitat Protection Areas; Aleutian Islands Coral Habitat Protection Areas, GOA Slope Habitat Conservation Areas, and Skate Nursery Areas.

Detailed descriptions of EFH and HAPC designations in the Alaska Region are available in the North Pacific FMC's six FMPs (NPFMC, No Date).

Table 3.9-7. EFH and HAPCs for the Alaska Region

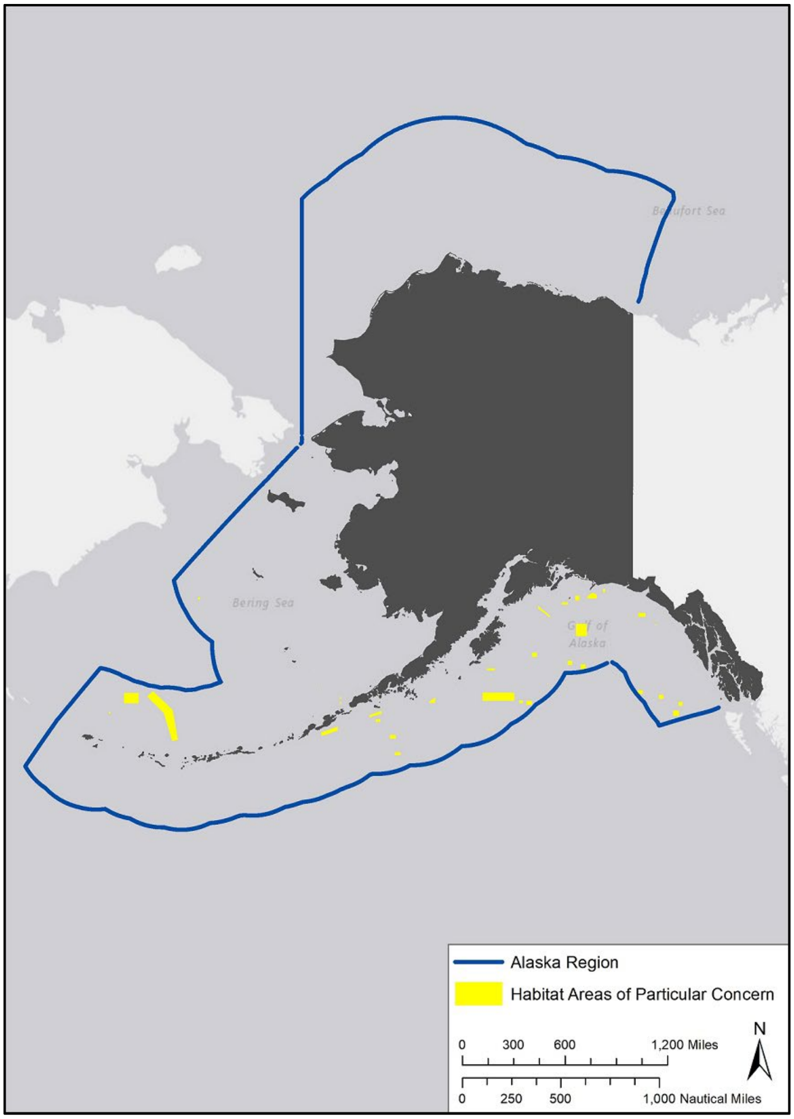
Fisheries	EFH	HAPC
Bering Sea and Aleutian Islands Groundfish	Overall: water column within bays and island passages, and along the entire shelf (0 to 200 m [0 to 656 ft]), upper, intermediate, and lower slope (200 to 3,000 m [656 to 9,843 ft) throughout the BSAI over various substrates such as sand, gravel, and cobble substrates of rock and in vegetated areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges.	Bowers Ridge Habitat Conservation Zone: Bowers Ridge and Ulm Plateau) Alaska Seamount Habitat Protection Area: Bowers Seamount
Gulf of Alaska Groundfish	Overall: water column within bays and island passages, and along the entire shelf (0 to 200 m [0 to 656 ft]), upper and intermediate slope (200 to 1,000 m [656 to 3,281 ft]) and deep shelf gulleys throughout the GOA over various substrate of rock, cobble, gravel, sands, and muds, and in vegetated areas of vertical relief, such as crevices, overhangs, vertical walls, coral, and larger sponges.	Alaska Seamount Habitat Protection Areas: Dickens, Denson, Brown, Welker, Dall, Quinn, Giacomini, Kodiak, Odyssey, Patton, Chirikof & Marchand, Sirius, Derickson, Unimak, and Bowers Seamounts. GOA Coral Habitat Protection Areas: Cape Ommaney, Fairweather Ground NW Area, and Fairweather Ground Southern Area
Bering Sea and Aleutian Islands Crab	Overall: bottom habitats along the along the entire shelf (0 to 200 m [0	Aleutian Islands Coral Habitat Protection Areas: Great Sitkin

Fisheries	EFH	HAPC
	to 656 ft]) and entire slope (200 to 3,000 m [656 to 9,843 ft]) and basins (more than 3,000 m [9,843 ft]) throughout the BSAI where there are substrates consisting of sand, mud, rock, cobble, gravel and biogenic structures such as boltenia, bryozoans, ascidians, and shell hash also coral, and vertical substrates, such as boulders, vertical walls, ledges, and deep water pinnacles.	Island, Cape Moffett Island, Adak Canyon, Bobrof Island, Ulak Island, and Semisopochnoi Island Aleutian Islands Habitat Conservation Area: the entire Aleutian Islands groundfish management subarea Alaska Seamount Habitat Protection Area: Bowers Seamount Bowers Ridge Habitat Conservation Zone: Bowers Ridge, Ulm Plateau
Alaska Scallops	Overall: the sea floor along the entire shelf (0 to 200 m [0 to 656 ft]) shelf in concentrated areas of the GOA and BSAI where there are substrates of clay, mud, sand, and gravel that are generally elongated in the direction of current flow.	Alaska Seamount Habitat Protection Areas: Dickens, Denson, Brown, Welker, Dall, Quinn, Giacomini, Kodiak, Odessey, Patton, Chirikof & Marchand, Sirius, Derickson, Unimak, and Bowers Seamounts. Bowers Ridge Habitat Conservation Zone: Bowers Ridge, Ulm Plateau GOA Coral Habitat Protection Areas: Cape Ommaney, Fairweather Ground NW Area, and Fairweather Ground Southern Area GOA Coral Habitat Protection Area Aleutian Islands Habitat Conservation Area: the entire Aleutian Islands groundfish management subarea Aleutian Islands Coral Habitat Protection Areas: Great Sitkin Island, Cape Moffett Island, Adak Canyon, Bobrof Island, Ulak Island, and Semisopochnoi Island

Fisheries	EFH	HAPC
		GOA Slope Habitat Conservation Area: Yakutat, Cape Suckling, Kayak Island, Middleton Island east, Middleton Island west, Cable, Albatross Bank, Shumagin Island, Sanak Island, Unalaska and Island.
Alaska Salmon	Overall: marine waters off the coast of Alaska from the mean higher tide line to the EEZ limit including the GOA, Eastern Bering Sea, Chukchi Sea, and Arctic Ocean along the entire shelf (0 to 200 m [0 to 656 ft]) and slope (200 to 3,000 m [656 to 9,843 ft]); estuarine areas; fresh waters identified in Alaska Department of Fish and Game's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes*, and specific gravel substrate spawning areas.	Aleutian Islands Coral Habitat Protection Areas Aleutian Islands Habitat Conservation Area: the entire Aleutian Islands groundfish management subarea GOA Slope Habitat Conservation Areas Alaska Seamount Habitat Protection Areas Bowers Ridge Habitat Conservation Zone Gulf of Alaska Coral Habitat Protection Areas Skate Nursery Areas: six areas in the eastern Bering Sea where relatively high concentrations of skate eggs occur for several skate species
Arctic Fishery	Overall: pelagic and epipelagic waters from the nearshore to offshore areas along the entire shelf (0 to 200 m [0 to 656 ft]) and upper slope (200 to 500 m [656 to 1,640 ft]) throughout Arctic Ocean (including waters often associated with ice floes in deeper water, under nearshore ice in sand and gravel substrates) and bottom habitats along the inner and middle (0 to 100 m [0 to 328 ft]) shelf in Arctic waters south of Cape Lisburne wherever	None – no HAPC has been designated for the arctic fishery in this region.

Fisheries	EFH	HAPC
	there are substrates consisting mainly of mud.	

Source: NPFMC, No Date



Source: NMFS, 2019a

Figure 3.9-7. HAPCs in the Alaska Region

3.9.1.1.6 Pacific Islands Region

One FMC occurs in the Pacific Islands Region: the Western Pacific FMC. EFH for various life stages of numerous fish species occurs in this region, including bottom fish such as snappers (Lutjanidae), jacks (Carangidae), and groupers; coral reef fish (**Figure 3.9-8**) such as goatfish (Mullidae), squirrelfish and soldierfish (Holocentridae), parrotfish (Scaridae), and surgeonfish (Acanthuridae); and pelagic fish such as albacore (*Thunnus alalunga*), yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), mahi (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*), blue marlin (*Makaira nigricans*), swordfish

(*Xiphias gladius*), and sharks (Selachimorpha) (WP Council, 2019a). EFH for aquatic macroinvertebrates has been delineated for several coral reef ecosystems.

A large proportion of the marine waters in the EEZ surrounding the Hawaiian Archipelago, the Mariana Islands, American Samoa, and the Pacific Remote Island Areas (PRIAs) have been designated as EFH for over one thousand representative species within five fisheries as managed by the Western Pacific Regional FMC (see **Table 3.9-8**). EFH include the entire marine water column from the 0 to 1,000 m (0 to 3,281 ft) depth from the shoreline out to the EEZ limit, and all bottom from the shoreline down to 700 m (2,297 ft) depth around each of the U.S. Pacific Islands are designated as EFH for the eggs, larvae, juveniles and/or adults of one or more of the coral reef ecosystem, bottomfishes, crustacean, precious coral, and/or pelagic fisheries species. The types of habitats types within these EFH designations include: mangrove, lagoon, estuarine, seagrass beds, soft substrate, coral reef/hard substrate, patch reefs, surge zone, deep-slope terraces, and pelagic/open ocean.

Figure 3.9-8. Coral Reef EFH in the Pacific Islands Region

Photo Credit: NMFS

The definitions for EFH in the Pacific Islands Region changed broadly in 2019. Certain bottomfish, coral reef ecosystem, precious coral, and crustacean management unit species were reclassified as ecosystem component species, and the scientific and local names of certain species were updated (84 FR 2767, February 8, 2019).

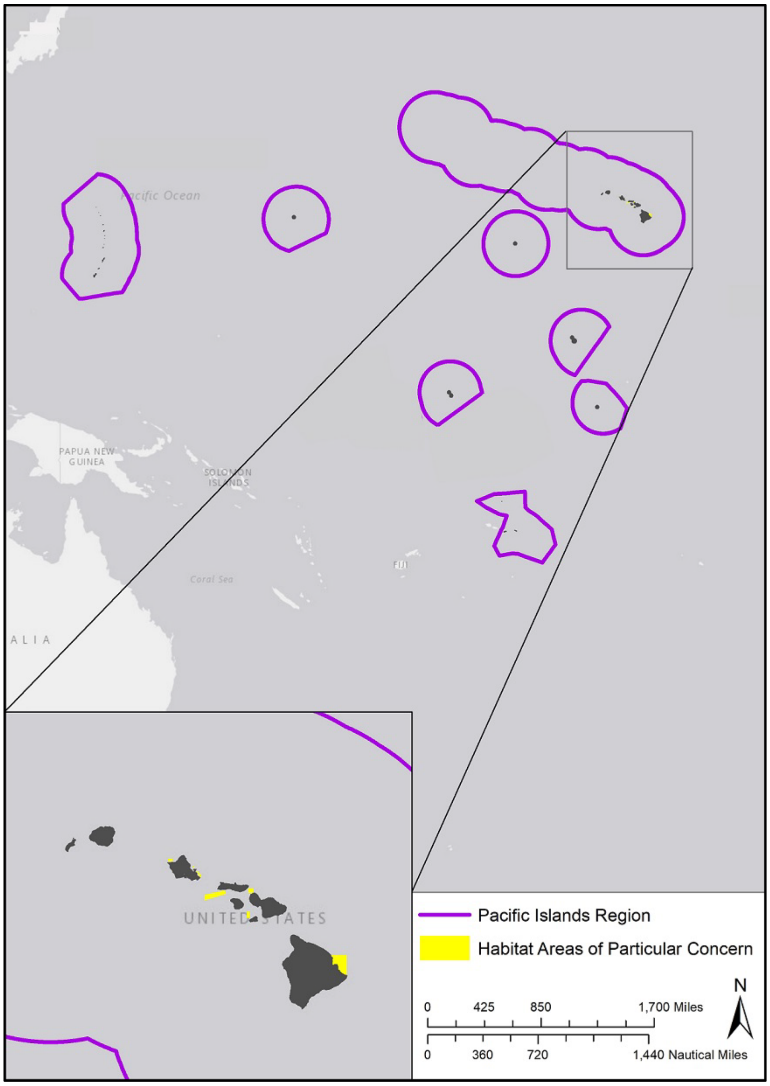
HAPCs have been designated for all fisheries primarily defined in terms of habitat types within defined depth contours as listed in **Table 3.9-8** and shown in **Figure 3.9-9**. HAPCs include the water column habitat, escarpments/slopes, banks with summits, MPAs, and research sites.

Detailed descriptions of EFH and HAPC designations in the U.S. Pacific Islands Region are available in the Western Pacific Regional FMC's five place-based Fishery Ecosystem Plans (FEPs) for the American Samoa Archipelago, Hawai'i Archipelago, Mariana Archipelago, Pacific Remote Island Areas, and Pacific Pelagic fisheries (WP Council, 2020). Updated and amended EFH and HAPC descriptions can be found in the most current Annual Stock Assessment and Fishery Evaluation Reports for each of these five place-based fisheries (WP Council, 2019b).

Table 3.9-8. EFH and HAPCs for the Pacific Islands Region

Fisheries	EFH	HAPC
Bottomfish and Seamount Groundfish: Hawai'i Archipelago, Marianas Archipelago, American Samoa Archipelago, and Pacific Remote Island Areas regions	Overall: the water column and all bottom habitat extending from the shoreline to the outer boundary of the EEZ to a depth of 200 fathoms (400 m [1,312 ft]); and all EEZ waters and bottom habitat bounded by latitude 29°–35° north and longitude 171° E–179° west between 100 and 300 fathoms (200 and 600 m [1,312 and 1,969 ft]).	All escarpments and slopes between 20-140 fathoms (40-280 m [131-918 ft]) throughout the Western Pacific Region; three known areas of juvenile opakapaka habitat (two off Oahu and one off Molokai).
Crustaceans: Hawai'i Archipelago, Marianas Archipelago, American Samoa Archipelago, and Pacific Remote Island Areas regions	Overall: water column from the shoreline to the outer limit of the EEZ down to a depth of 75 fathoms (150 m [492 ft]) throughout the Western Pacific Region; bottom habitat from the shoreline to a depth of 50 fathoms (100m [328 ft]); associated outer reef slopes at depths between 300-700 m (984-2,297 ft).	All banks with summits less than or equal to 30 m (15 fathoms) from the surface.
Precious Corals: Hawai'i Archipelago, Marianas Archipelago, American Samoa Archipelago, and Pacific Remote Island Areas regions	Six known beds of precious corals located off Keahole Point, Makapuu, Kaena Point, Wespac bed, Brooks Bank, and 180 Fathom Bank; three black coral beds between Milolii and South Point on Hawai'i, Auau Channel between Maui and Lanai, and the southern border of Kauai.	Makapuu bed, Wespac bed, Brooks Banks bed; for Black Corals, the Auau Channel.
Coral Reef Ecosystem: Pacific Remote Island Areas region	Overall: water column and all benthic substrate from the shoreline to the outer boundary of the EEZ to a depth of 50 fathoms (100 m [328 ft]).	All no-take MPAs identified in the Coral Reef Ecosystem FMP, all Pacific remote islands, as well as numerous existing MPAs, research sites, and coral reef habitats throughout the western Pacific.
Pelagics: Pacific Remote Island Areas and Pacific Pelagic regions	Overall: water column down to a depth of 500 fathoms (1,000 m [3,281 ft]) from the shoreline to the outer limit of the EEZ.	The water column from the surface down to a depth of 500 fathoms (1,000 m [3,281 ft]) above all seamounts and banks with summits shallower than 1,000 fathoms (2,000 m [6,562 ft]) within the EEZ.

Sources: WP Council, 2019a; WP Council, 2020



Source: NMFS, 2019a

Figure 3.9-9. HAPCs in the Pacific Islands Region

3.9.2 Environmental Consequences for Essential Fish Habitat

This section discusses potential impacts of NOS activities associated with Alternatives A, B, and C on EFH, including HAPCs. Impacts on the managed species, fish (Section 3.7.2) and aquatic macroinvertebrates (Section 3.8.2), for which EFH is designated are discussed separately in their respective sections. Activities described in Sections 2.4.1 through 2.4.13 that occur on NOS projects and that could be expected to impact EFH include operation of crewed sea-going surface vessels; operation of ROVs and autonomous vehicles; use of echo sounders, ADCPs, acoustic communication systems, and sound speed data collection equipment; anchoring; collection of bottom grab samples; operation of drop/towed cameras and video systems; installation, maintenance, and removal of tide gauges and GPS reference stations; and SCUBA operations.

3.9.2.1 Methodology

Adverse effects to EFH that could result from proposed NOS activities are discussed by the stressors that may occur. These stressors include: (1) physical impacts to bottom habitat (e.g., from anchoring, collection of bottom grab samples, tide gauge installation, operation of ROVs and autonomous vehicles, and SCUBA operations); (2) increase in sedimentation, turbidity, and/or chemical contaminants (e.g., from operation of crewed sea-going vessels, operation of ROVs and autonomous vehicles, anchoring, collection of bottom grab samples, installation of tide gauges and GPS reference stations, and SCUBA operations); (3) increase in ambient sound (e.g., from operation of crewed sea-going vessels, operation of ROVs and autonomous vehicles, use of echo sounders, ADCPs, and acoustic communication systems); (4) impacts to the water column (e.g., from operation of crewed sea-going vessels, operation of ROVs and autonomous vehicles, anchoring, use of sound speed data collection equipment and bottom grab samplers, operation of drop/towed cameras and video systems, and SCUBA operations); and (5) dispersal of invasive species (e.g. from ballast water discharged during crewed vessel operation or organisms attached to hulls, equipment, and anchors). Note that use of the term “sea floor” in the analysis below also includes lake and river bottoms where NOS activities could occur.

As discussed in Section 3.2.2, significance criteria were developed for each resource analyzed in this PEIS to provide a structured framework for assessing impacts from the alternatives and the significance of the impacts. The significance criteria for EFH are shown in **Table 3.9-9**.

Table 3.9-9. Significance Criteria for the Analysis of Impacts to EFH

Impact Descriptor	Context and Intensity	Significance Conclusion
Negligible	Impacts on EFH would be temporary and minimal (e.g., placement of an object on the sea floor which increases turbidity) with no lasting damage or alteration.	Insignificant
Minor	Impacts on EFH would be easily recoverable (e.g., short-term placement of an object on the sea floor which increases turbidity or causes loss of small area of vegetation) with no long-term or permanent damage or alteration. Effects on EFH would be temporary and minimal.	
Moderate	EFH would be damaged or altered potentially over the long term but would continue to support the species reliant on it. Effects on EFH would be not temporary and not minimal.	
Major	EFH would be degraded over the long term or permanently so that it would no longer support a sustainable fishery and would cause the population of a managed species to become stressed, less productive, or unstable. Effects on EFH would be not temporary and substantial.	Significant

3.9.2.2 Alternative A: No Action - Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

Under Alternative A, excluding survey effort in the Great Lakes, NOS projects are estimated to cover a total of 2,633,374 nm (4,877,009 km) across all five regions over the five-year period. Although the survey effort under Alternative A would vary by year (see **Table 3.5-6**), over the five-year period for proposed projects the greatest number of nautical miles surveyed would be in the Southeast Region (approximately 47 percent). The survey effort in each of the other four regions is approximately 10 percent over five years, and slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 18 percent). In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location of surveys, physical contact with bottom habitat, and population density of prey, that add nuance to this trend.

Impacts of Alternative A on EFH and HAPCs are discussed below for each of the stressors introduced above. Potential impacts could occur in all of the geographic regions as EFH is extensive and covers a large majority of the EEZ. By region, there are 108 HAPC sites in the Southeast Region, 93 sites in the Greater Atlantic Region, 38 sites in the Alaska Region, 34 sites in the West Coast Region, and one site in the Pacific Islands Region. This indicates that by far the greatest number of projects, along with associated potential impacts, could occur in HAPC areas in the Southeast Region and Greater Atlantic Region, and the fewest by far could occur in the Pacific Islands Region.

3.9.2.2.1 Physical Impacts to Bottom Habitat

Activities that could result in physical disturbances or damage to the sea floor and bottom substrate consist of anchoring, collection of bottom grab samples, installation of tide gauges and remote GPS reference systems, operation of ROVs and autonomous vehicles, and SCUBA operations.

Anchoring of vessels and installation of equipment on the sea floor can cause damage to EFH/HAPCs consisting of corals and vegetated bottom, potentially reducing available structure, cover, and nutrient/food availability for dependent species. Anchor chains, or their attached chains/lines, could drag across the sea floor, potentially destroying submerged vegetation and seafloor structure, and creating a circular scour hole; the anchor itself would create a hole or divot in the bottom habitat. This alteration of underwater structure would reduce the availability of shelter and cover necessary for the survival or offspring development of many aquatic taxa. This would particularly affect those organisms at lower levels of the aquatic food chain and could potentially reduce the overall aquatic biodiversity of the area through cascading trophic impacts (i.e., reduced prey availability reduces the abundance of higher-level predators).

Anchoring of vessels used by NOS, however, would not be a common practice. Only large vessels would typically anchor within or near project areas, while the small boats and survey launches used during NOS projects generally return to port or to the ship each day. Most vessels used by NOS would not anchor, except in an emergency, such as to avoid adverse weather conditions or in the unlikely event of an engine malfunction. Vessels would not anchor on coral reefs and would avoid anchoring in hard bottom areas in abalone critical habitat and seagrass whenever possible; thus, these sensitive habitats and their dependent species would be minimally impacted, if at all. Additionally, NOS would not drag anchor chains and would ensure that anchors are properly secured so as to minimize bottom disturbance. However, it is possible that when a vessel is not collecting data, it may anchor either within the project area or nearby; there are approximately 55 projects with a planned anchoring component annually.

Installation of equipment on the sea floor, such as new moorings for tide buoys, would cause relatively small footprints of bottom substrate disturbance (approximately 1 square meter (3 ft), see Section 2.4.12). The disturbance could potentially create holes in the bottom sediment and damage or destruction of submerged vegetation/macroalgae and bottom structure. Additionally, infauna may be disturbed, removed, or destroyed in the immediate area where the buoy is installed. A decrease of underwater structure could reduce the availability of shelter and cover necessary for the survival or offspring development of many aquatic taxa. This could particularly affect those organisms at lower levels of the aquatic food chain and could potentially reduce the overall aquatic biodiversity of the area through cascading trophic impacts (i.e., reduced prey availability reduces the abundance of higher-level predators). During all buoy deployment and retrieval operations, buoys should be lowered and raised slowly to minimize risk to ESA-listed species and benthic habitat. NOS would ensure that all instruments placed in contact with the sea floor (including anchors or moorings) are properly secured to avoid the dragging of moorings or lines across the bottom. NOS would undertake approximately 32 projects that include tide gauge installations annually, but only a portion of these would involve installation of new moorings. Given the low number of equipment installations, the relatively small area of bottom substrate disturbance, and the large geographic separation between installations, the physical impact on bottom habitat from equipment installation is expected to be small.

Bottom sediment sample collection involves targeted removal of sediment cores in approximately 54 projects annually across the entire action area. Bottom grab samples inherently damage bottom substrate and could potentially reduce or damage existing underwater structure. This could result in reducing the availability of cover and shelter necessary for prey species or immature marine organisms to avoid predation. NOS would not collect bottom samples for sediment verification on coral reefs or hard bottom areas. Sediment sampling activities would not target substrates such as coral reefs, seagrass beds, or hard bottom areas. Bottom sampling may adversely affect EFH through the temporary suspension of sediment and the potential removal or disturbance of infauna. Given that the sampling activities would be infrequent and geographically widespread across the action area, that the area of bottom habitat sampled would be very small (e.g., 15 x 15 cm [6 x 6 in] area and 5 cm [2 in] deep), and that physical contact with sensitive habitat would be avoided, the physical disturbance to bottom habitat associated with bottom grab sampling is expected to be minimal. Additionally, stiffer line materials would be used for instrument deployment and kept taut during operations to reduce the potential for entanglement in bottom features such as coral habitats.

ROVs and autonomous vehicles would be operated by NOS to maintain a slow speed and height above the sea floor. The use of AUVs may adversely affect EFH through unplanned contact with bottom habitats, which may cause physical damage or through the localized and temporary resuspension of bottom sediments if height above the sea floor cannot be maintained. Such adverse effects would occur accidentally and are expected to be rare.

Operations involving SCUBA divers may inadvertently disturb bottom substrates in EFH/HAPCs. NOS SCUBA operations would include approximately 248 benthic and fish monitoring projects conducted on hard bottom and coral reef habitats annually; these areas would contain shallow marine habitat characteristics necessary for many marine invertebrate and vertebrate species and are particularly sensitive to disturbances. Although SCUBA operations represent a very small component of NOS projects (mainly related to tide gauge installation/maintenance/removal projects), SCUBA divers in these areas could potentially reduce or damage existing underwater structure, reducing the availability of cover and shelter necessary for prey species or immature marine organisms to avoid predation, and potentially inducing cascading impacts throughout the food chain. NOS divers are trained to hover over the sea floor to avoid inadvertent disturbance of sediments and to place or handle equipment such that impacts to bottom habitat are avoided. Given the low risk of contact with the sea floor during diver operations and large geographic separation of diving projects throughout the action area, physical disturbances to bottom substrate from SCUBA operations are expected to be minimal.

Any damage to bottom habitat would not have lasting effects on EFH as unvegetated softbottom habitat would shift and reform and coral reefs, seagrass beds, abalone habitat, and hard bottom habitat would be avoided. In general, physical damage to the sea floor recovers within 1.5 years through water currents and natural sedimentation (Stevenson et al., 2004). Overall, activities under Alternative A that would involve physical disturbance of the sea floor and bottom habitat would continue to have **adverse** and **negligible** to **minor** impacts as the effects on EFH would be recoverable with no long-term damage or alteration. Impacts of Alternative A on EFH, including HAPCs, would be **insignificant**.

3.9.2.2.2 Increase in Sedimentation/Turbidity, and/or Chemical Contaminants

Activities that could result in an increase in sedimentation, turbidity, or chemical contamination consist of crewed vessel operations, operation of ROVs and autonomous vehicles, anchoring, collection of bottom grab samples, tide gauge and GPS reference station installation or maintenance/removal, and SCUBA operations.

Crewed vessel, ROV, and autonomous vehicle operations, in conjunction with all activities which physically contact bottom substrate, would increase sedimentation and turbidity in disturbed areas from bottom sediments loosened through displaced water from transiting vessels or physical contact with bottom substrate. Increased sedimentation and turbidity can potentially cause respiratory damage to aquatic species (e.g., damage to fish gills) and block sunlight necessary for photosynthesis by aquatic plants, macroalgae, and phytoplankton. These impacts could potentially lower the overall nutrient availability of affected EFH areas and could reduce the cover and structure available to dependent species from submerged vegetation or macroalgae. Furthermore, increases in suspended sediments and turbidity reduce the depth to which sunlight can penetrate, which changes the wavelengths of light reaching fish and benthic species. Divers would not stand or rest on live corals/coral reefs, and bottom contact would only be in unconsolidated areas or non-living hard bottom. NOS would ensure that all instruments placed in contact with the sea floor are properly secured to minimize bottom disturbance.

Photosynthetic marine species are dependent on sunlight and often have a narrow band of wavelengths of light that they are able to use. Increased sedimentation and turbidity could inhibit photosynthesis in oceanic habitat areas, thus reducing nutrient cycling by marine phytoplankton and reducing shelter and cover provided by submerged plants and macroalgae. Suspended material may also react with DO in the water and result in temporary or short-term oxygen depletion to aquatic resources (e.g., vegetation and aquatic macroinvertebrates) and could further exacerbate impacts to EFH from reduced nutrient and cover availability. Since most fish can avoid highly turbid areas, they may temporarily relocate to undisturbed areas until suspended sediments settle. Given the low frequency, large degree of geographic separation, and small affected area of activities physically impacting bottom substrate, the resulting increases in sedimentation/turbidity would be very small and would likely settle back to the sea floor or dissipate with prevailing currents and winds relatively quickly (within seconds or minutes).

An increase in chemical contaminants can reduce fitness and cause mortality of exposed organisms. Often, contaminants entering the marine environment are lighter than water, and thus float on the surface where most of them evaporate within a few days (Neff et al., 2000). However, this property of some contaminants may lead to greater exposure of seagrass ecosystems which could cause extensive mortality of the seabed, with the associated loss of juvenile fish and invertebrates due to the loss of habitat (Zieman et al., 1984). Seagrass mortality would reduce the available cover and shelter that many marine species require to avoid predation, reproduce, and rear or develop offspring in addition to reducing food availability for seagrass foragers, including prey species such as aquatic macroinvertebrates and fish.

For those chemical contaminants that sink, the effects on coral colonies may include mortality, tissue death, reduced growth, impaired reproduction, bleaching, and reduced photosynthetic rates (Cook and Knap, 1983; Burns and Knap, 1989; Ballou et al., 1987). The effects of chemical contaminants and sedimentation/turbidity would range from superficial exposure of fish and aquatic macroinvertebrates to ingestion, sub-lethal effects and reduced fitness (due to adverse effects on sensory systems, growth, behavior, and/or bio-accumulation), and fatality. Reduction of corals would reduce the food, structure, and shelter necessary for prey species and would likely reduce the overall biodiversity of the area through cascading impacts throughout the food chain. Chemical contaminants could also cling or adhere to submerged structural features in all EFH areas, which could serve as an additional exposure vector to fish and aquatic macroinvertebrates and result in changes in growth rates or behavior, injuries, and death of exposed individuals. Bioaccumulation of some toxic chemicals could disproportionately impact higher-level predators which consume contaminated prey items, which could ultimately reduce top-down ecosystem regulation and degrade the nutrient availability of affected habitat areas. To minimize impacts, all hazardous or regulated materials would be handled in accordance with applicable laws, and crew members would be appropriately trained in materials storage and usage.

Mortality of phytoplankton and zooplankton from oil and fuel spills could indirectly affect marine mammals which feed on them. However, even if a large amount of plankton were affected, it can recover rapidly due to high reproductive rates, rapid replacement by cells from adjacent waters, widespread distribution, and exchange with tidal currents. Thus, the impact of changes in water quality, including an accidental spill on a pelagic phytoplankton community would not be substantial.

Operation of crewed vessels and of ROVs and autonomous vehicles may result in discharge (mostly unintentional) of harmful substances including bilge water, debris, fuel, oil, and miscellaneous chemicals. NOS would undertake projects covering 518,000 nm (959,000 km) of crewed vessel operations annually and 28,600 nm (53,000 km) of ROV and autonomous vehicles movement annually. In shallow waters, propellers from boats can cause increased turbidity and contamination by resuspending bottom materials. Equipment such as AUVs would be programmed and operated so as to avoid seafloor disturbance. The context and intensity of these impacts are contingent on the size, location, and chemical composition of the source discharge or spill. Small spills rarely occur during NOS activities, and large spills are unlikely given the size of vessels used during NOS projects. Given that operators of vessels used by NOS would strictly adhere to applicable laws and regulations pursuant to MARPOL 73/78 that restrict onboard hazardous material use and the discharge of contaminants into the marine environment, and that the probability of accidental fuel spills is very low, increases in sedimentation, turbidity, and chemical contamination would be relatively small, especially when compared to similar disturbance and discharges from the much greater number of all other vessels occurring in the EEZ, lakes, and rivers.

Installation and removal of tide gauges on land along the shoreline could also increase the turbidity, sedimentation, and chemical contamination of the water column through run-off of any soil disturbed during installation/removal on land and disturbance of bottom sediments from new buoy moorings in the water. The installation of buoys may have adverse impacts on EFH through direct contact with the sea floor or nearby habitat. During the installation process, temporary increases in sedimentation and turbidity may occur through the suspension of bottom sediments or drill cuttings (i.e., particles of rock/hard bottom). Increased sedimentation and turbidity could potentially lower the overall nutrient availability of affected coastal wetland and shallow marine habitat areas due to reduced photosynthesis by phytoplankton. Photosynthetic inhibition in these areas could also reduce the availability of cover and shelter created by submerged vegetation and macroalgae necessary for many species to avoid predation and develop offspring. Soil runoff also often includes chemical contaminants such as fertilizers or detergents with high levels of nitrates and phosphates. Influxes of nutrients or chemicals in shallow marine, estuarine, and coastal wetland habitat areas could potentially trigger algal blooms. Algal blooms are toxic for many marine species and they reduce DO concentrations, thus reducing the overall habitat quality of the affected area. However, when a tide gauge is installed on land, it would be located beyond the mean high tide line so any disturbed sediments from installation would not reach the water. NOS would undertake approximately 32 projects that include tide gauge installations annually, and 30 projects that include tide gauge removal annually. Given that the activities would be conducted infrequently and geographically widespread across the action area, that the footprints of disturbance would be small, and that installation and removal procedures would be applied to control sediment runoff, increases in turbidity and sedimentation are expected to be minimal.

Anchoring (in approximately 55 projects annually), bottom grab sampling (approximately 54 projects annually), and other physical contact with bottom habitat may stir up sediments resulting in increased turbidity and sedimentation. The footprints of impact on bottom sediments would be relatively small and the sediment stirred up limited in quantity. NOS would ensure that anchors are properly secured so as to minimize bottom disturbance. Any sediments that are re-suspended would likely settle back to the sea floor relatively quickly (within seconds or minutes in the immediate area) following disturbance; fine sediments, however, may drift and disperse. Given that bottom sediments would be stirred up infrequently and activities would be dispersed across the widespread action area, increases in turbidity and sedimentation are expected to be minimal.

Changes in water quality from increased sedimentation, turbidity, and chemical contamination due to these activities would include short-term reductions in water clarity and light availability that would subside shortly after activities cease. Any discharges released during vessel operation would be minimized through adherence to MARPOL laws and regulations. Overall, the likelihood of occurrence of an accidental fuel spill from a vessel used by NOS would continue to be very low. Along with the activities under Alternative A that would increase sedimentation, turbidity, and/or chemical discharges in EFH, this scenario would continue to have **adverse** and **negligible** impacts as water quality in EFH would be able to recover with no long-term damage or alteration. In the event that an accidental spill does occur, the volume of oil, fuel, and/or chemical contaminants would be fairly small given the amounts of fuel and other chemicals that vessels used by NOS typically carry for onboard consumption, and along with handling hazardous and regulated materials in accordance with applicable laws, and having crew members appropriately trained in materials storage and usage, the impact on EFH would be **adverse** and **minor**. Impacts of Alternative A on EFH, including HAPCs, would continue to be **insignificant**.

3.9.2.2.3 Increase in Ambient Sound

Activities that could result in an increase in underwater sound consist of operation of crewed vessels, operation of ROVs and autonomous vehicles, and use of underwater acoustic equipment including echo sounders, ADCPs, and acoustic communication systems. Increases in underwater sound may adversely affect different life stages of fish and aquatic macroinvertebrate prey species (prey is a potential habitat characteristic of EFH). See Section 3.7 Fish and Section 3.8 Aquatic Macroinvertebrates for full discussions of the hearing capabilities of fish and aquatic macroinvertebrates and the potential impacts on these species from vessel sound and underwater acoustic sources. Increasing the ambient sound level could potentially degrade the habitat value of affected areas which would be manifested through impacts such as behavioral disruption or injury to biological resources. Underwater sound adversely affects aquatic taxa variably, with effects differing considerably based on the frequency and intensity of the sound and the hearing sensitivity of the affected organism.

Operation of crewed vessels (approximately 518,000 nm [959,000 km] annually) and of ROV and autonomous vehicles (approximately 28,600 nm [53,000 km] annually) would generate underwater sound and vibrations at low- to mid-frequencies that overlap with the hearing ranges of aquatic prey species. Underwater sound would not adversely affect structural EFH but may affect mobile fish that are prey species by temporarily altering behavior. Behavioral changes can result in animals leaving feeding or breeding grounds (Slabbekoorn et al., 2010) or becoming more susceptible to mortality through decrease predator-avoidance responses (Simpson et al., 2016). Noise can also mask biologically important sounds and alter the natural soundscape, cause hearing loss, and/or have an adverse effect on an organism's stress levels and immune system (NOAA, 2016). Reduction of prey species would reduce food and nutrient availability for top-level predators in aquatic habitat areas and could potentially result in cascading impacts throughout the local aquatic food chain and reduce biodiversity. However, the exposure of prey species to vessel sound would be limited for aquatic macroinvertebrates (see Section 3.8), somewhat greater for fish but still with negligible to minor impacts (see Section 3.7), and the responses temporary in nature as activities would be infrequent in any given area and geographically widespread across the entire action area. Furthermore, the potential effects of sounds associated with vessel operations, which would be infrequent in any given area and at the most represent only a negligible proportion of total vessel traffic in the action area (Section 2.4.1), would be minimal as compared to the effects from sound generated by all other ship traffic in the EEZ. The overall contribution to background sound in the ocean from vessels used by NOS would be negligible. Exposure to vessel sounds would only persist for the duration of vessel transit through the habitat area. As such, prey species would only be temporarily exposed to vessel sound and likely would not change their behavior or habitat occupancy in the long-term. It would be unlikely that the exposure of prey species to these sounds would exceed the levels and lengths of time that would result in more than minimal adverse effects.

Use of active underwater acoustic sources would involve relatively high frequency, directional, and short duration repeated signals which could increase the ambient sound environment of EFH areas. These instruments produce acoustic signals perceptible to several marine prey species; exposure of these marine prey species to this sound could result in the same adverse impacts to EFH as those discussed in the preceding paragraph. NOS would annually undertake projects covering 479,000 nm (887,000 km) of single beam, multibeam, and side scan sonar use; approximately 3,210 nm (5,940 km) of sub-bottom profiler use; approximately 5,890 nm (10,900 km) using ADCPs; and approximately 24 projects using acoustic communication systems. As with vessels, sound from underwater acoustic sources would not adversely affect structural EFH but may temporarily alter the behavior of mobile fish that are prey species. All of these instruments involve the production of an acoustic signal, but they are usually only operated while a ship is in motion, so any area would be exposed to acoustic energy for a very short duration. Furthermore, many of the associated sounds would be intermittent in use and highly directional in nature, and the energy of the signal would drop off rapidly with distance from the source (as opposed to the low frequency sounds emitted by vessels which can travel farther in water). Thus, any potential impacts on prey species would be limited to temporary behavioral and stress-startle responses. Also, more importantly, adverse impacts are unlikely to occur due to the much higher frequencies of these instruments relative to the hearing capabilities of most prey species, except for a few species of shad and herring (as discussed in Section 3.7 Fish).

Vessel operations, which would generate sounds in the mid- and low-level frequencies, are within the hearing range of most prey species but would be infrequent, geographically widely distributed, and likely to elicit a minimal or temporary response. A majority of the sounds generated by underwater acoustic sources are well above the hearing frequencies of the most prey species, thus unlikely to cause behavioral disturbance and hearing impairment. Thus, activities under Alternative A that would create underwater sound would continue to have **adverse** and **negligible** to **minor** impacts on EFH. Impacts of Alternative A on EFH, including HAPCs, would continue to be **insignificant**.

3.9.2.2.4 Impacts to Water Column

Impacts to the water column could be caused by vessels or equipment moving through the water column in activities including operation of crewed sea-going vessels, operation of ROVs and autonomous vehicles, anchoring, use of sound speed data collection equipment and bottom grab samplers, operation of drop/towed cameras and video systems, and SCUBA operations.

NOS would undertake projects covering 518,000 nm (959,000 km) annually with operation of crewed vessels and projects covering 28,600 nm (53,000 km) annually with ROVs and autonomous vehicles. Wakes from crewed sea-going vessels and from ROVs and autonomous vehicles would create turbulence and generate wave and surge effects in the water column where habitat gradients would be temporarily disrupted, including temperature, salinity, DO, turbidity, and nutrient supply. Propellers from vessels could also cause water column destratification and elevated water temperatures. Vessel movement through the water column may disrupt benthic communities in shallow areas and other prey species and cause mortality to floating eggs and larvae by physically damaging them with the hull or other ship parts, including the propulsion system. These disruptions would likely reduce the availability of space, shelter, and nutrients for dependent species within EFH. Disruptions could also potentially affect food chains and ultimately reduce the overall biodiversity of affected areas. However, the vast majority of impacts to EFH would be temporary as disturbance would be limited to the immediate vicinity of vessels and would only persist for the duration of transits or projects within the affected area. Also, all vessels in coastal waters would operate in a manner to minimize propeller wash and seafloor disturbance, and transiting vessels would follow deep-water routes (e.g., marked channels), as practicable.

Instruments and gear that interact with the water column, including sound speed data collection equipment, bottom grab samplers, drop/towed cameras, and anchors and chains, and SCUBA divers could temporarily cause turbulence and disturb or displace nearby benthic communities and other prey species. Reduction of prey species would reduce food and nutrient availability for top-level predators in EFH. This could potentially result in cascading impacts throughout the local aquatic food chain and reduce biodiversity. Lines connecting equipment to a vessel could also become entangled with, damage, or kill submerged aquatic vegetation such as seagrass and corals. Reduction of underwater structure would likely reduce the space, shelter, and cover necessary for the avoidance of predators by prey species and the rearing or development of offspring. Additionally, divers in SCUBA operations that would be conducted as part of various projects, but mainly as a component of tide gauge installation/maintenance/removal, would move through the water column, temporarily disturbing both vertebrate and invertebrate prey species. The vast majority of impacts to EFH would be temporary as disturbance would be limited to the immediate vicinity of instruments, gear, or personnel and would only persist for the duration of the activity. Mobile prey species would likely only be minimally displaced from project areas as they would not likely move too far away and are expected to return once water column turbulence ceases; they would not experience long-term changes in the availability of space, structure, shelter, or nutrients outside the range of natural variability.

Impacts to the water column from vessels and equipment under Alternative A would continue to be **adverse** and **negligible** as effects on EFH would be easily recoverable with no long-term damage or alteration. Impacts of Alternative A on EFH, including HAPCs, would continue to be **insignificant**.

3.9.2.2.5 Dispersal of Invasive Species

Dispersal of invasive species could be caused by ballast water discharged during crewed vessel operation, or organisms attached to hulls, equipment, and anchors. The use of the same physical equipment and instruments in geographically disparate regions could potentially facilitate the dispersal and establishment of invasive species in new areas.

Invasive species can outcompete, displace native species, and alter biodiversity and ecosystem function. Invasive species such as zebra mussels (*Dreissena polymorpha*) and lionfish (*Petrois* spp.) have large numbers of offspring and limited or no natural threats or predators outside of their native habitat, allowing them to outcompete locally native species for space and nutrients (TISI, 2014). Invasive seagrass can displace native species of seagrass, affect fish species assemblage, and decrease fish abundance through associated changes in habitat complexity (Becking et al., 2014). Additionally, invasive algae can overgrow and kill coral through smothering and shading, resulting in the reduction in biodiversity and coral cover (RRN, 2022). Over time, the propagation of invasive species can result in cascading impacts to the local food chain through the extirpation of local predators and prey due to reduced nutrient cycling and availability. These impacts typically reduce the habitat value of affected areas in the long-term or permanently after the establishment of invasive species. These species and their resulting impacts persist until all invasive organisms are removed from a given area through aggressive trapping, harvesting, or use of pesticides.

NOS would undertake projects covering 518,000 nm (959,000 km) of crewed vessel operations annually and 28,600 nm (53,000 km) of ROV and autonomous vehicles movement annually. NOS projects would occur in all regions of the action area and can potentially involve transit and surveying across large swaths of the action area using the same physical equipment and instrumentation. These longer voyages or projects could potentially inadvertently transport invasive macroinvertebrate larvae, vertebrate eggs or animals, plant seeds, or algae propagules in ballast water or on equipment surfaces to novel areas, thereby facilitating their dispersal and establishment (Gregory, 2009).

While NOS vessel operations may unintentionally introduce or spread invasive species, the most common pathways for the introduction of invasive species in marine systems is shipping (i.e., ballast water and hull biofouling), aquaculture, canal construction, aquarium trade, and the live seafood trade (Molnar et al., 2008). The impact of NOS activities would be miniscule in comparison, and it is unlikely that NOS activities would involve the release of ballast water discharge. Vessel operations could also contribute to the spread of invasive and nuisance species through hull fouling and anchoring. Anchoring may dislodge non-native or nuisance algae or seagrass, facilitating its spread; however, anchoring would be conducted infrequently. NOS equipment and instruments used in consecutive projects in disparate geographically areas could also potentially serve as transmission vectors for invasive species. However, the majority of NOS projects would not transit to multiple areas consecutively, and NOS project crews would implement mandatory invasive species control procedures to limit or avoid hull fouling, use anti-fouling coatings, and clean hulls, thus limiting the potential impact to EFH in the action area.

All NOS projects, however, would include mandatory invasive species prevention procedures including, but not limited to, vessel and equipment washdown, cleaning, and de-ballasting (exchange of ballast water in open ocean waters for those vessels used by NOS that have ballast tanks). Proper implementation of these procedures would prevent most NOS equipment from serving as exchange vectors for invasive species; however, the possibility for the transmission of some invasive species would likely still exist. NOS project vessels, however, compose only a very small proportion of vessel traffic in the action area and would likely contribute marginally to the overall transmission of invasive species.

Given the relatively low likelihood of occurrence, the adverse impact on EFH, including HAPCs, of invasive species dispersal facilitated by NOS activities under Alternative A would continue to be **adverse** and **negligible** to **minor**, and therefore **insignificant**.

3.9.2.2.6 Conclusion

Under Alternative A, NOS would continue to operate a variety of equipment and technologies to gather data on the marine and coastal environments at the level of effort reflecting NOS fiscal year 2019 funding levels. Since the effects of impact causing factors on EFH range from negligible to minor, the overall impact of Alternative A on EFH, including HAPCs, would be **adverse** and **minor**; thus, impacts of Alternative A would be **insignificant**.

3.9.2.3 Alternative B: Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations

The same stressors on EFH considered under Alternative A are considered under Alternative B. Under Alternative B, all of the projects and equipment operations proposed in Alternative A would continue but at a higher level of effort, although the percentage of nautical miles covered by projects in each region would be the same as under Alternative A. Thus, the greatest level of effort would be in the Southeast Region (with over 50 percent of the survey effort); level of effort in the other four regions would be at similar levels (approximately 10 percent of the survey effort in each region), and perhaps slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 16 percent). In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location of surveys, physical contact with bottom habitat, and population density of prey, that add nuance to this trend.

Projects under Alternative B would take place in the same geographic areas and timeframes as under Alternative A; however, Alternative B would include more projects and activities, and thus more nautical miles traveled, than Alternative A. Under Alternative B, excluding survey effort in the Great Lakes, NOS projects would cover a total of 2,896,712 nm (5,364,710 km) across all five regions over the five-year period. Overall, vessels used by NOS would cover an additional 263,337 nm (487,701 km) under Alternative B (see **Table 3.5-14**) as compared to Alternative A (2,633,374 nm [4,877,009 km] total) across all regions over the five-year period. The types and mechanisms of impacts would remain the same in Alternative B as discussed for Alternative A. Therefore, the difference between the two alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative B as compared to Alternative A.

For example, under Alternative B there would be projects using crewed vessel operations covering 577,000 nm (1,070,000 km), as compared to 518,000 nm (959,000 km) under Alternative A. Vessel operations could contribute to impacts on EFH related to increases in sedimentation/turbidity, and/or chemical contamination, increases in sound, and impacts to the water column. Although the amount of crewed vessel operations would be greater under Alternative B than under Alternative A, additional crewed vessel operations projects covering 59,000 nm (111,000 km) across five regions would result in greater impacts overall, but not so great that the magnitude of a particular impact-causing factor would increase (e.g., from negligible to minor). This would also be the case for other proposed activities contributing to potential impacts, such as underwater acoustic sound from echo sounders, ADCPs, and acoustic communication systems; and bottom disturbance from anchoring, collection of bottom grab samples, tide gauge installation, and SCUBA operations.

Although NOS would add more widespread adoption of new techniques, protocols, and technologies to more efficiently perform surveying, mapping, charting, and related data gathering under Alternative B as compared to Alternative A, impacts of Alternative B on EFH and HAPCs would be the same or slightly, but not appreciably, larger than those discussed above under Alternative A for each stressor. Overall, impacts of Alternative B on EFH would be **adverse, minor,** and **insignificant**.

3.9.2.4 Alternative C: Upgrades and Improvements with Greater Funding Support

The same stressors of EFH considered under Alternatives A and B are considered under Alternative C. Under Alternative C, all of the projects and equipment operation proposed in Alternatives A and B would continue but at a higher level of effort, although the percentage of nautical miles in each region would be the same as under Alternatives A and B. In addition, there would be an overall funding increase of 20 percent relative to Alternative B, thus the level of project activity would increase further. The greatest level of effort would be in the Southeast Region (with over 50 percent of the survey effort); the other four regions would be at similar levels of effort (approximately 10 percent of the survey effort in each region), and perhaps slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 16 percent). In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location of surveys, physical contact with bottom habitat, and population density of prey, that add nuance to this trend.

Projects under Alternative C would take place in the same geographic areas and timeframes as under Alternatives A and B; however, Alternative C would include more projects, and thus more nautical miles traveled, than Alternatives A and B. Under Alternative C, excluding survey effort in the Great Lakes, NOS projects would cover a total of 3,160,049 nm (5,852,411 km) across all five regions over the five-year period. Overall, there would be an additional survey effort of 263,337 nm (487,701 km) covered by vessels used by NOS under Alternative C (see **Table 3.5-21**) as compared to Alternative B (2,896,712 nm [5,364,710 km] total), and an additional 526,675 nm (975,402 km) as compared to Alternative A (2,633,374 nm [4,877,009 km] total) across all regions over the five-year period. The types and mechanisms of impacts would remain the same in Alternative C as discussed for Alternatives A and B across all regions over the five-year period. Therefore, the difference between the alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative C as compared to Alternatives A and B. As discussed under Alternative B, the additional projects and nautical miles traveled under Alternative C across all five regions would result in greater impacts on EFH overall, but not so great that the magnitude of a particular stressor would increase (e.g., from negligible to minor).

Alternative C would be similar to Alternative B, plus it would consist of NOS program implementation with an overall funding increase of 20 percent relative to Alternative B. However, impacts of Alternative C on EFH and HAPCs would be the same or slightly, but not appreciably, larger than those discussed above under Alternatives A and B for each stressor. Overall, impacts of Alternative C on EFH would be **adverse, minor,** and **insignificant**.

3.9.2.5 Conclusion

Proposed NOS projects in the action area across all five regions would be associated with physical impacts to bottom habitat, increases in sedimentation, turbidity, and/or chemical contamination, increases in underwater sound, impacts to the water column, and dispersal of invasive species.

A subset of NOS projects would involve physical contact with the sea floor. Where this results in physical disturbance to bottom habitat, the disturbance is expected to be temporary and negligible to minor in nature. The adverse effects from physical disturbance on EFH are expected to be temporary and minimal.

The NOS projects with a potential to increase sedimentation, turbidity, and chemical contamination in EFH would be geographically widespread and expected to result in only temporary to short-term, localized, and negligible to minor reductions to water quality. Additionally, the likelihood of occurrence of an accidental spill from a vessel used by NOS would be very low. Thus, the adverse effects from an increase in sedimentation, turbidity, and chemical contamination in EFH would be temporary and minimal.

Sound generated by proposed NOS underwater acoustic sources would be well above the hearing frequencies of the majority of prey species and managed species. The active sources in the mid-frequencies would be within hearing of a few species, such as Atlantic herring, and the passive and incidental sources that generate sounds in the low-level frequencies would be within the hearing range of most prey and managed species. However, these sound sources would be infrequent, geographically widely distributed, and the sound emitted would be miniscule compared to all other vessel sound in the EEZ. The sounds that are audible to prey and managed species, most of which would be associated with vessel operations, would likely elicit negligible to minor responses as many of the sounds would be temporary in duration and not likely detectable at an appreciable distance from vessels used by NOS. Thus, the adverse effects from increased sound on EFH would be temporary and minimal.

Impacts to the water column would temporarily cause destratification and turbulence, could disturb or displace nearby benthic communities and other prey species, and could damage or kill submerged aquatic vegetation. However, NOS projects would be geographically widespread and expected to result in only temporary, localized, negligible impacts on the water column. Thus, adverse effects on EFH would be temporary and minimal.

Dispersal of invasive species could cause displacement of native species and altered biodiversity and ecosystem function in EFH. However, it is unlikely that NOS activities would involve the release of ballast water discharge, anchoring would be conducted infrequently, and NOS project crews would implement mandatory invasive species control procedures to limit or avoid hull fouling. Given the low likelihood of occurrence, the adverse effects from invasive species dispersal in EFH would be minimal.

3.10 Seabirds, Shorebirds and Coastal Birds, and Waterfowl

This section discusses the affected environment and environmental consequences that would result under each alternative for seabirds, shorebirds, coastal birds, and waterfowl in the action area.

3.10.1 Affected Environment

There are roughly 10,000 species of birds in the world (Barrowclough et al., 2016), 1,000 species of birds in the U.S., and 100 ESA-listed species of birds in states and territories adjoining the water bodies of the action area (ECOS, No Date-a). The groups of birds most relevant to the Proposed Action include seabirds, shorebirds, coastal birds, and waterfowl (from now on collectively referred to as "birds"), and ESA-listed species within these groups. Many of the birds found in the project area are also migratory and are protected under the MBTA) (see Section 3.3.4 for discussion of the MBTA). This section presents an overview of these functional groups, a discussion of avian acoustical capabilities, and a description of the distribution of bird species within the action area. It also identifies those bird species that are listed as threatened or endangered under the ESA.

3.10.1.1 Overview of Taxonomic and Functional Groups

Seabirds feed in marine environments where they plunge or dive under the surface to catch prey. They may spend much of their lives at sea foraging over pelagic habitat (open sea), often thousands of kilometers from their nesting grounds. Coastal birds are distinguished by their preference for coastal habitat and vary considerably in foraging and nesting behaviors. Shorebirds, a distinct taxonomic subset of coastal birds, use marine and/or freshwater edge habitat for feeding, breeding, and/or nesting. They largely forage from water's edge through neritic zones (areas where sunlight reaches the sea floor), although specific foraging behaviors vary by species. Waterfowl are found in fresh water and salt water environments and spend much of their lives on the water's surface and dive below to feed. Nearly all species covered in this evaluation are migratory, though their ranges from nesting to foraging sites vary from hundreds to thousands of kilometers. Ecological characteristics of these groups are summarized in **Table 3.10-1**. Birds are found in all regions of the action area, though different bird groups and species predominate in different regions and habitats.

Table 3.10-1. Ecological Characteristics of Functional and Taxonomic Bird Groups

Taxonomic Group	Common Species	Primary Habitat	Feeding Behavior	Common Forage / Prey	Nesting Behavior	Migratory Behavior
Seabirds	Albatross, petrel, booby, gulls, terns, pelicans	Pelagic	Surface feeding, pursuit diving, plunge diving	Baitfish, krill, squid	Large colonies, often on cliffs, small islands, or headlands	Migratory
Shorebirds	Avocet, plover, sandpipers, snipe, oystercatcher, whimbrel, whippet	Coastal	Shallow wading	Small aquatic and terrestrial invertebrates	Solitary, shallow scrapes near bodies of water	Migratory
Waterfowl	Bufflehead, eider,	Coastal / Freshwater	Diving and dabbling	Invertebrates, aquatic	Solitary, ground-	Migratory

Taxonomic Group	Common Species	Primary Habitat	Feeding Behavior	Common Forage / Prey	Nesting Behavior	Migratory Behavior
	harlequin, merganser, scoter		(specialized surface feeding)	insects, small fish, aquatic plants	nesting near bodies of water	

3.10.1.2 Sound Production and Hearing

The mechanics of avian hearing are similar to those of reptiles and mammals, though the audible frequency range for any given species of bird is generally narrower than that of a given mammal. Birds are not as sensitive to the ends of their hearing range as mammals are. Mid-frequency bird hearing generally spans 1 to 5 kHz in air with highest sensitivity at about 2 to 3 kHz. Birds generally cannot perceive sound above 15 kHz (NSF and USGS, 2011).

Hearing ability and sensitivity of birds in underwater conditions is not well known. It is thought that avian hearing is generally adapted to in-air environments, though seabirds may be able to hear underwater. Underwater sound emitters have been documented to deter diving seabirds from gill nets when set to operate at 1.5 kHz (±1 kHz) at 120 dB re 1 µPa (NSF and USGS, 2011).

Based on available data, this Final PEIS assumes that all birds have similar in-air hearing ranges (unless specifically noted otherwise in the literature) and that the birds’ ears are primarily used and adapted to above-water conditions, with limited hearing underwater.

3.10.1.3 Threatened and Endangered Species

The USFWS has listed a number of imperiled bird species, sub-species, and populations as either threatened or endangered under the federal ESA. A total of 22 ESA-listed bird species and one bird species (bald eagle - *Haliaeetus leucocephalus*) protected under the Bald and Golden Eagle Protection Act potentially occur in the action area (**Table 3.10-2**). Descriptions of each along with summaries of their habitat, diet, and status are presented following the table.

Table 3.10-2. Federally Protected Seabirds, Shorebirds and Coastal Birds, and Waterfowl Occurring in the Action Area

Common Name	Scientific Name	ESA Status	Lead Agency	Region*	Critical Habitat
Seabirds					
Marbled murrelet	*Brachyramphus marmoratus*	Threatened	USFWS	WCR	Yes
Band-rumped storm-petrel	*Oceanodroma castro*	Endangered	USFWS	PIR	No
Short-tailed albatross	*Phoebastria albatrus*	Endangered	USFWS	AR, PIR, WCR	No
Hawaiian petrel	*Pterodroma sandwichensis*	Endangered	USFWS	PIR	No
Newell's shearwater	*Puffinus auricularis newelli*	Threatened	USFWS	PIR	No
California least tern	*Sternula antillarum browni*	Endangered	USFWS	WCR	No
Roseate tern	*Sterna dougallii*	Threatened	USFWS	GAR	No

Common Name	Scientific Name	ESA Status	Lead Agency	Region*	Critical Habitat
Shorebirds and Coastal Birds					
Red knot	*Calidris canutus rufa*	Threatened	USFWS	GAR, SER	No
Piping Plover	*Charadrius melodus*	Threatened	USFWS	GAR, SER	Yes
Western snowy plover	*Charadrius nivosus*	Threatened	USFWS	WCR	Yes
Hawaiian coot	*Fulica americana alai*	Endangered	USFWS	PIR	No
Whooping crane	*Grus americana*	Endangered	USFWS	GAR, SER	Yes
Bald eagle	*Haliaeetus leucocephalus*	Least Concern	USFWS	All	No
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered	USFWS	PIR	No
Wood stork	*Mycteria americana*	Threatened	USFWS	SER	No
Eskimo curlew	*Numenius borealis*	Endangered	USFWS	AR	No
Light-footed clapper rail	*Rallus longirostris levipes*	Endangered	USFWS	WCR	No
California clapper rail	*Rallus longirostris obsoletus*	Endangered	USFWS	WCR	No
Waterfowl					
Laysan duck	*Anas laysanensis*	Endangered	USFWS	PIR	No
Hawaiian duck	*Anas wyvilliana*	Endangered	USFWS	PIR	No
Steller's eider	*Polysticta stelleri*	Threatened	USFWS	AR	Yes
Spectacled eider	*Somateria fischeri*	Threatened	USFWS	AR	Yes

*SER = Southeast Region (includes Gulf of Mexico, the Caribbean, and the Atlantic seaboard from North Carolina to Florida); WCR = West Coast Region (includes Washington, Oregon, and California); PIR = Pacific Islands Region (includes the Hawaiian, Marianas, and American Samoa archipelagos, Wake Island, and the Remote Pacific Islands).

3.10.1.3.1 Seabirds

3.10.1.3.1.1 Marbled Murrelet

The marbled murrelet (**Figure 3.10-1**) is a small seabird that forages for small fish and invertebrates in near-shore marine environments of the Pacific coast from California through Alaska. They prefer to nest in old growth forest interiors with little edge habitat and low fragmentation for breeding (USFWS, 2019). Egg-laying and incubation typically occur from March to August, and nestlings are reared from their emergence through the September fledging period – the period of time in which hatchlings become physically capable of flight (Nelson and Hamer, 1995).

Figure 3.10-1. Marbled Murrelet

Photo credit: USFWS

In 1992, the USFWS listed the marbled murrelet as threatened in California, Oregon, and Washington (ECOS, No Date-a). In 1996, critical habitat was designated in these three states, though the initial 16,000 km^2 designated (3.9 million ac) was revised slightly downward to 15,000 km^2 (3.7 million ac) in 2011. Nesting habitat loss and fragmentation continue to threaten marbled murrelets, along with depredation (the killing of adult birds and offspring by natural predators), harmful algal blooms, oil spills, and reduction of prey species quality and quantity. There were approximately 23,260 marbled murrelets in California, Oregon, and Washington as of 2016 (USFWS, 2019).

3.10.1.3.1.2 Band-rumped Storm-petrel

Band-rumped storm-petrels are small seabirds about the size of a robin. Breeding populations in the eastern Atlantic are regular visitors to marine habitats as close as 50 km (31 mi) from the Gulf and Atlantic coasts of the U.S. Breeding populations in Japan and the Galapagos are also known to range in the Pacific. The Hawai'i DPS is the only current breeding population in the U.S. (Slotterback, 2002). The birds seem to prefer steep cliff crevices and lava flows for mating and nesting and spend the remainder of their time at sea (American Bird Conservancy, No Date). Their primary prey are fish and squid caught at or just below the ocean surface (Slotterback, 2002). This DPS typically lays eggs between May and June and nestlings fledge in October (Hawaii DLNR, 2015a)

Hawaiian band-rumpled storm-petrel populations were reduced primarily by depredation by introduced species. Collisions with manmade structures, particularly associated with light pollution leading to disorientation, were also recognized as threats to the population (75 FR 69222, November 10, 2010). In 2016, the Hawai'i DPS of the band-rumped storm-petrel was listed as endangered in Hawai'i. No critical habitat has been designated for the species (ECOS, No Date-a).

3.10.1.3.1.3 Short-tailed Albatross

The short-tailed albatross (**Figure 3.10-2**) is found in Hawai'i, Alaska, California, Washington, and Oregon. The bird is known to breed only on two remote islands of Japan and they stay close to this area during nesting, breeding, and rearing young; nesting occurs from late-October to mid-June. During the non-breeding seasons, these birds range across the temperate and subarctic Pacific and use areas of upwellings and high productivity and, less frequently, use waters between 3,000 and 6,000 m (10,000 – 20,000 ft) in depth not near upwellings. There is little information on the diet of the short-tailed albatross, though squids, crustaceans, and fishes all seem to be important prey. The birds are also known to follow commercial fishing vessels for feeding purposes (USFWS, 2009a).

Figure 3.10-2. Male Short-tailed Albatross Shelters a Chick

Photo credit: USFWS

In 1970, the short-tailed albatross was listed as an endangered foreign species (an endangered species without primary habitat within the U.S.), though this listing was revised in 2000 to endangered throughout its range. As of 2014, the status of the short-tailed albatross appeared to be improving, though limited breeding distribution continues to be a risk for the species (USFWS, 2014f). No critical habitat has been designated for the species (ECOS, No Date-a).

3.10.1.3.1.4 Hawaiian Petrel

The Hawaiian petrel, also known as the dark-rumped petrel, is a gadfly petrel that nests only in Hawai'i. It nests in burrows in high and difficult terrain with good vegetative cover (USFWS, 1983). Hawaiian petrels typically lay eggs in May/June, and most hatchlings fledge by December (Hawaii DLNR, 2015b). The marine range of the Hawaiian petrel is thought to extend from approximately 10° south to 20° north, expanding to 25° north in spring and up to 50° north in the southern Gulf of Alaska in July and August. This range overlaps with that of the Galapagos petrel and the two species are indistinguishable from each other when observed at sea. The Hawaiian petrel ranges east to areas off the coast of the western continental U.S. and Mexico, and has been observed west as far as the Philippines and Japan, though these sightings are very rare. When encountered at sea and not feeding, the Hawaiian petrel is generally solitary, though they join flocks comprising a mix of species when feeding. The bodies of gadfly petrels are less suited to diving than other petrels, and they are thought to feed on the water surface by seizing prey and by scavenging. Diet studies on Maui indicated that the Hawaiian petrel feeds primarily on squid, but also on fish and crustaceans (Simons and Hodges, 1998).

Following severe population declines attributed to predation and habitat degradation by introduced species, the Hawaiian petrel was listed as endangered in 1967 (USFWS, 1983). These pressures continue to threaten the species and, as of 2017, the population on Kauai was estimated to have decreased by 78 percent since the 1990s (USFWS, 2017b). No critical habitat has been designated for the species (ECOS, No Date-a).

3.10.1.3.1.5 Newell's Shearwater

The Newell's shearwater (previously known as the Newell's Manx shearwater) is a threatened species native to Hawai'i. They breed and nest only on the main Islands of Hawai'i, with 30 to 40 known breeding sites. Additional breeding sites are also expected to exist based on the population size of Newell's shearwater, but the location and number of these additional sites are not currently known. Newell's shearwaters burrow into the ground or nest in rocky crevices at high elevations or on coastal cliffs. In April, they gather at breeding colonies and lay eggs in May and June, with chicks generally fledging in October. During non-breeding nesting periods, the Newell's shearwater is highly pelagic, using tropical and subtropical waters of depths greater than 2,000 m (6,500 ft). They range from the Hawaiian Islands eastward to about 120° west latitude, and from the equator to about 22° north longitude. The birds feed on fish and squid by pursuit-plunging to depths up to 50 m (164 ft) (Ainley et al., 2019).

In 1975, the Newell's shearwater was listed as threatened wherever found. No critical habitat has been designated for the species (ECOS, No Date-a). Depredation by introduced species, collisions with powerlines, light pollution leading to collision deaths among juveniles, and changes to breeding habitats by invasive plants continue to threaten the species. Populations at sea have been estimated to range from 18,000 to 37,000 individuals (USFWS, 2016b).

3.10.1.3.1.6 California Least Tern

The California least tern, previously classified in the genus *Sterna*, is a migratory bird that is native to California and Mexico, ranging from San Francisco in the north through Baja California in the south, though generally concentrated in Los Angeles County, Orange County, and San Diego County. They generally nest from April through August on open beaches in colonies of about 25 pairs. California least terns migrate south along the Pacific coast to wintering locations in Mexico, Costa Rica, and Panama. They forage mainly in near-shore ocean waters and shallow estuaries and lagoons (USFWS, 2006a). The California least tern's diet likely consists of small fish (Thompson et al., 1997).

In 1970, the California least tern was listed as endangered wherever found. No critical habitat has been designated for the species (ECOS, No Date-a). Populations as of 2005 were estimated to be 7,100 breeding pairs. The pressures on nesting habitat that led to the California least tern's decline were still present but somewhat managed by 2006 (USFWS, 2006a).

3.10.1.3.1.7 Roseate Tern

The roseate tern is an exclusively marine, primarily plunge-feeding seabird distributed around the tropics and subtropics of the Indian Ocean, Pacific Ocean, Caribbean Sea, and temperate latitudes of the North Atlantic. The Caribbean roseate tern (**Figure 3.10-3**) population is listed as threatened and the Northeast roseate tern population, sometimes called the North Atlantic roseate tern, is listed as endangered. It should be noted that 'northeast' in this sense refers to the northeast of the continent, not the northeast of the Atlantic Ocean. Discussion of the roseate tern's ecology will focus on these populations.

Figure 3.10-3. Caribbean Roseate Tern

Photo credit: USFWS

The roseate tern forages for small, schooling fish over reefs and sandbars or in pelagic habitats in association with marine predators that bring fish to the surface. The Northeast population prefers sand lance, and the Caribbean population prefers dwarf herring and anchovies. The Northeast population breeds in colonies from New York through Nova Scotia, nesting with common terns on nearshore islands, barrier islands, and rarely on salt marsh islands from May to early-September (ECOS, No Date-a). They prefer nesting habitat with dense cover. The Caribbean population on the other hand, nests in more open areas on rocky to sandy substrates on islands and islets around Cuba, the Florida Keys, the Bahamas, Puerto Rico, the Virgin Islands, and the Lesser Antilles beginning in early-May and extending through July. Roseate terns from these populations are generally confined to South America during the winter. Both populations migrate offshore (Nisbet et al., 2014).

In 1987, the roseate tern was listed as threatened in the western hemisphere and adjacent oceans where not listed as endangered, and endangered in the U.S. on the Atlantic coast from North Carolina northward. No critical habitat has been designated for the species (ECOS, No Date-a). Degradation of habitat is the most urgent threat to the Northeast population, where populations had declined from about 4,000 nesting pairs in 2000 to around 3,000 nesting pairs as of 2010. Depredation, disease, and human disturbances are the most substantial threats to the Caribbean population (ECOS, No Date-a), which were estimated to a maximum of about 7,000 pairs in 2012 (Nisbet et al., 2014).

3.10.1.3.2 Shorebirds and Coastal Birds

3.10.1.3.2.1 Red Knot

The rufa red knot (**Figure 3.10-4**) is a sandpiper shorebird and one of three subspecies of red knots (Baker et al., 2013). Rufa red knots can be found along the Atlantic, Gulf, Caribbean, and Great Lakes coasts of the action area (ECOS, No Date-a). The birds breed in the Arctic beginning in late-May, and the highly precocial (hatchlings requiring lower levels of parental care, e.g., ducklings or goslings) fledge during July (Niles et al., 2008). Red knots overwinter in South America, the Caribbean, and the Gulf coasts of the U.S. and Mexico (USFWS, No Date-a). During migration, knots generally prefer sandy coastal habitats near tidal inlets at the mouths of bays and estuaries. They also use sandy beaches, rocky beaches, mudflats, mangroves, salt marshes, and intertidal rocky areas, particularly those with high availability of bivalves and crustaceans (Baker et al., 2013). Rufa red knots eat a variety of invertebrates such as bivalves, snails, crustaceans, marine worms, and horseshoe crab eggs (USFWS, No Date-a).

Figure 3.10-4. Red Knot with Leg Tag

Photo credit: USFWS

Prior to the early 20th century, red knot populations were heavily and primarily impacted by hunting. After removal of hunting pressures with the passage of the MBTA in 1918, accelerated coastal development and reduction of horseshoe crab populations continued to impact red knot populations. This has resulted in drastic population reductions such as those in the Delaware Bay, where populations fell by 75 percent from the 1980s to 2000s (USFWS, No Date-a). In 2015, the red knot was listed as threatened wherever found. No critical habitat rules have been published (ECOS, No Date-a). USFWS identifies current threats to the rufa red knot as: “sea level rise; coastal development; shoreline stabilization; dredging; reduced food availability at stopover areas; disturbance by vehicles, people, dogs, aircraft, and boats; and climate change” (USFWS, No Date-a).

3.10.1.3.2.2 Piping Plover

The piping plover (**Figure 3.10-5**) is a shorebird that breeds and spends the summer months along the Atlantic coast from North Carolina through Newfoundland and much of the Great Lakes. During this part of the year, these plovers generally inhabit and nest on wide, sandy-to-gravelly beaches with little vegetation on barrier islands, ocean fronts, bays, sand bars, spoil islands, tidal creeks, and tidal marshes. In freshwater systems they can be found along the shores of lakes, rivers, ponds, and artificial water bodies, and often nest in or near colonies of terns.

Figure 3.10-5. Piping Plover

Photo credit: USFWS

During migration piping plovers prefer beaches and alkali flats (dried lake beds adjacent to coasts containing high salt concentrations). During non-breeding winter months, piping plovers can be found at beaches, mudflats, and sandflats along the Atlantic Coast from North Carolina to Florida, along the Gulf Coast from Florida through the Yucatan peninsula, as well as on the Caribbean coast of the Yucatan. They frequently use bays, lagoons, and inlets. The birds generally prefer feeding at sand flats, algal flats and mudflats, within 15 m (50 ft) of the shoreline, and mainly within 5 m (16 ft) of the edge of water. They feed on marine worms, various life-stages of insects, terrestrial invertebrates, marine and freshwater benthic invertebrates, crustaceans, and mollusks (Elliott-Smith and Haig, 2004).

In 1985, the piping plover was listed as threatened wherever found, except where listed as endangered in the Great Lakes-Big Rivers region, that is the Great Lakes and their watersheds. Critical habitat was designated in 2001 for the Great Lakes Breeding Population, followed by multiple additional designations and revisions for other populations over subsequent years. Most recently critical habitat for wintering populations in Texas were revised in 2009. Designated areas of critical habitat relevant to the action area include some shorelines along the Great Lakes, Gulf coast, and Atlantic coast from Florida through North Carolina (ECOS, No Date-a). Coast and shore habitat loss and competition from recreational uses represent the greatest threats to the species (USFWS, 2009b).

3.10.1.3.2.3 Western Snowy Plover

Western snowy plovers (**Figure 3.10-6**) can be found residing year-round and migrating along the west coast of the continental U.S. and Mexico. They inhabit and nest on the ground of unvegetated and sparsely vegetated beaches and shores of alkali lakes; the nesting season occurs from March to September (Center for Biological Diversity, No Date). Western snowy plovers feed on terrestrial and aquatic invertebrates in freshwater, marine, and brackish environments. They feed on the sand surface and up to 2 cm (1 in) below surface, normally foraging around the mean high-water line (Page et al., 2009).

Photo credit: USFWS

Figure 3.10-6. Western Snowy Plover

In 1993, the Pacific population of the western snowy plover was listed as threatened in California, Oregon, Washington, and areas of Mexico within 80 km (50 mi) of the Pacific coast. Critical habitat was designated in 1995 and revised as recently as 2012. There are currently multiple, discrete areas of designated critical habitat along the coasts of California, Oregon, and Washington (ECOS, No Date-a). Current threats to the western snowy plover include habitat loss and fragmentation and human-caused disturbance, injury, and kills (USFWS, 2006b).

3.10.1.3.2.4 Hawaiian Coot

Hawaiian coots are wetland birds endemic to the Hawaiian Islands. Although they are generally found in freshwater habitats, coots can also be found on estuaries and calm seas within reefs. Hawaiian coots are believed to maintain similar diets to American coots, that is, plants, algae, aquatic invertebrates, and small aquatic vertebrates in generally freshwater environments, but sometimes in saline environments. The Hawaiian coot is non-migratory and breeds and nests year-round (Pratt and Brisbin, 2002).

In 1970, the Hawaiian coot was listed as endangered wherever found. No critical habitat has been designated for the species (ECOS, No Date-a). The Hawaiian coot continues to face pressure from the same forces that led to its decline: depredation by introduced species and loss and degradation of wetland habitat. Beyond direct impacts from human use, the coastal wetlands used by the coots are vulnerable to sea level rise (USFWS, 2010a).

3.10.1.3.2.5 Whooping Crane

Whooping cranes (**Figure 3.10-7**) can be found in the action area along portions of the Great Lakes, Gulf coast, and a small area of the Florida Atlantic coast (ECOS, No Date-a). There are only four populations of whooping cranes, one of them naturally occurring and the remainder introduced. Whooping cranes generally feed in croplands and roost in wetlands during migration and use estuarine marshes, shallow bays, and tidal flats while overwintering in the Gulf. Some populations winter in wetlands, riverine systems, and flooded agricultural land. Prior to the decline of the species, whooping crane were known to winter along the east coast from New Jersey south. Whooping cranes return to Canadian nesting grounds from April to September to lay/incubate eggs and rear hatchlings (USFWS, No Date-b). When feeding in saltwater environments, whooping cranes primarily consume crabs and clams at depths up to 20 cm (8 in). When feeding in freshwater environments, the cranes generally feed on the margins of wetlands, agricultural fields, pastures, or savannah at the same depth as in saltwater environments (Urbanek and Lewis, 2015).

Figure 3.10-7. Whooping Crane with Chick

Photo credit: USFWS

In 1967, the whooping crane was listed as endangered wherever found, except for reintroduced populations listed as "experimental population, non-essential". Critical habitat was designated for the whooping crane in 1978, including a small area along the Gulf coast northeast of Corpus Christi, Texas (ECOS, No Date-a). Pressures that led to the decline of whooping crane, such as settlement and conversion of habitat in prairie pothole regions, wetlands, and coastal wetland wintering grounds, continue to threaten the species. Threats from sea level rise, temperature changes affecting feed species, and potential salinity changes are also anticipated at the coastal wetland wintering areas. Despite these pressures, populations were reported as growing steadily as of 2012 (USFWS, 2012c).

3.10.1.3.2.6 Bald Eagle

Bald eagles are large, predominantly coastal raptors endemic to North America and range throughout the entire continental U.S. They live near rivers, lakes, marshes, estuaries, and coastlines where they feed primarily on fish, but also waterfowl, rabbits, turtles, snakes, and other small animals. Bald eagles nest in the tops of trees and build nests reaching up to 3 m (10 ft) wide and weighing half a ton (USFWS, 2021b). Nesting season is dependent on the location of the individual but ranges approximately 5 months from initial nest building to fledging. Individual birds can be migratory depending on their location, but often return to breed within 160 km (100 mi) of where they were originally raised.

When the U.S. adopted the bald eagle as a national symbol in 1782, the country was thought to contain at least 100,000 bald eagle nests (USFWS, 2021b). By 1940, bald eagle populations had plummeted due to declines in fish and waterfowl stocks and targeted shooting by landowners fearing livestock losses. In response, Congress passed the Bald Eagle Protection Act – which prohibits the take, possession, sale, purchase, barter, offer to sell, purchase or barter, transport, export or import, of any bald eagle or bald eagle part, alive or dead (16 U.S.C. 668(a); 50 CFR 22) – in order to preserve the culturally significant birds, which was later amended to include golden eagles. Bald eagle populations continued to decline over the next 20 years due to the widespread use of the pesticide dichlorodiphenyltrichloroethane (DDT), which thinned bald eagle eggshells and drastically reduced nesting success. By 1963, only 417 nesting pairs of bald eagles remained in the lower 48 states. Bald eagles were federally listed as endangered in 1967 and only began to recover after the 1972 ban of DDT. By 1995, the species was upgraded to threatened status in the lower 48 states and in 2006 bald eagles were removed from the endangered species list. Today, bald eagles are considered a species of least concern and receive protections only under the Bald and Golden Eagle Protection Act.

3.10.1.3.2.7 Hawaiian Stilt

Hawaiian stilts are wading birds endemic to Hawai'i and are a subspecies of the North American stilt (ECOS, No Date-a). They can be found on six of the eight main islands, occupying lowland coastal wetlands and making seasonal movements among islands. Hawaiian stilts select nest sites on exposed mudflats between March and August (Hawaii DLNR, 2015c). They typically feed on invertebrates and fish in fresh and brackish or saline water up to about 13 cm (5 in) deep, using pecking, snatching, sweeping, and plunging methods (Robinson et al., 1999).

Hunting pressure, wetland habitat loss, and depredation by introduced species reduced Hawaiian stilt populations to a low of about 200 birds in the 1940s (Robinson et al., 1999). In 1970, the Hawaiian stilt was listed as endangered wherever found. No critical habitat has been designated for the species (ECOS, No Date-a). The Hawaiian stilt continues to face pressure from depredation by introduced species and loss and degradation of wetland habitat. Beyond direct impacts from human use, the coastal wetlands used by the stilts are vulnerable to sea level rise (USFWS, 2010b).

3.10.1.3.2.8 Wood Stork

Wood storks (**Figure 3.10-8**) are wading birds inhabiting the southeast of the U.S., including areas of the Gulf and Atlantic coasts (ECOS, No Date-a). Wood storks generally feed in freshwater wetlands of less than 50 cm (20 in) in depth. In coastal Georgia estuaries, the storks sometimes feed in tidal creeks and, less often, tidal pools. In Florida, the storks sometimes feed in estuarine forested swamps. Wood storks roost in trees over water. In their overwintering range, they use freshwater and saltwater wetlands. Wood storks nest in large colonies between October and June, depending on location (FWC, No Date). The birds are generally quiet, apart from some courtship and mating sounds and begging by nestlings, which can become loud enough in colonies to be heard from a distance (Coulter et al., 1999).

Figure 3.10-8. A Lone Wood Stork Wades at Water's Edge

Photo credit: USFWS

Because the storks rely on a specialized feeding strategy requiring wetlands that go through seasonal low-water periods, they are very susceptible to habitat loss. It is estimated that there was a 75 percent reduction in wood stork populations from the 1930s to the 1970s, primarily because of impacts to such habitat. In 1984, the wood stork duck was listed as threatened in Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina. No critical habitat has been designated for the species (ECOS, No Date-a).

3.10.1.3.2.9 Eskimo Curlew

The Eskimo curlew (**Figure 3.10-9**) is a shorebird that is extremely rare or extinct, with an estimated population size of less than 50 individuals (USFWS, 2016c). The Eskimo curlew's historical range was from Alaska to Chile, with southward migration intersecting the action area over the northwest Atlantic coast and potentially Great Lakes and northward migration over the Gulf coast. Southward movements would be made from July through October, and northward movements from March through April. The Eskimo curlew's diet is thought to include insects, marine invertebrates, and berries of particular shrubs such as blueberries, crowberry, and bearberry (Gill et al., 1998).

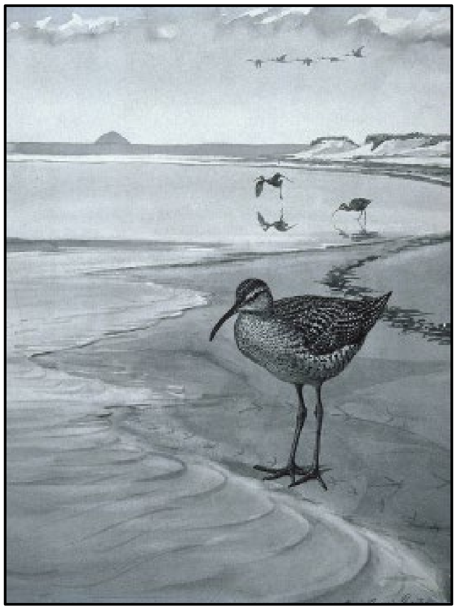


Figure 3.10-9. Painting of an Eskimo Curlew by Louis Agassiz Fuertes (1874-1927)

Photo credit: USFWS

Hunting, destruction of spring migration habitat, and extinction of at least one important insect prey species are thought to have led to the decline of the Eskimo curlew. In 1967, the Eskimo curlew was listed as endangered wherever found. No critical habitat has been designated for the species (ECOS, No Date-a).

3.10.1.3.2.10 Light-footed Clapper Rail

The light-footed clapper rail is a marsh bird endemic to California that now lives from Santa Barbara southward in coastal marshes, lagoons, and their maritime surroundings. The birds forage with the movement of tides in mudflats and shallow water adjacent to vegetated cover. They maintain an omnivorous diet that relies heavily on invertebrates such as insects, snails, crabs, crayfish, isopods, and decapods. Nests are located in dense vegetation such as cordgrass or pickleweed just above tidal inundation. Individuals generally remain in the vicinity of their home marshes (USFWS, 2009c). Nesting usually begins in March, and late nests hatch by August (USFWS, 2009c).

In 1970, the light-footed clapper rail was listed as endangered wherever found. No critical habitat has been designated for the species (ECOS, No Date-a). As of 2007, there were 443 known nesting pairs, though this number declined the following year (USFWS, 2009c).

3.10.1.3.2.11 California Clapper Rail

The California clapper rail is a marsh bird endemic to California that currently inhabits only the tidal salt and brackish marshes around San Francisco Bay. Historically it may have ranged from Morro Bay in the south to Humboldt Bay in the north. California clapper rails are omnivorous, feeding on mussels, spiders, clams, crabs, worms, and even rodents and small birds. They nest from mid-March to August in woven platforms above high tide levels in areas with sufficient invertebrate prey abundance and escape routes from predators (USFWS, 2013).

In 1970, the California clapper rail was listed as endangered wherever found. No critical habitat has been designated for the species (ECOS, No Date-a). As of 2008, California rails were estimated to number at least 1,425 birds. Lack of habitat continues to limit the species' recovery (USFWS, 2013).

3.10.1.3.3 Waterfowl

3.10.1.3.3.1 Laysan Duck

The Laysan duck is endemic to Laysan Island, Hawaii. Laysan Island is approximately 3 km by 1.5 km (2 mi by 1 mi) with a maximum elevation of approximately 12 m (40 f) above sea level. A defining feature of the island is a central saltwater lake that measures approximately 1.6 km by 0.5 km (1 mi by 0.3 mi) and a depth of no more than 10 m (33 ft). Laysan ducks feed on macroinvertebrates in shallow waters along the shores of the lake and in the surrounding sands and undergrowth (Moulton and Marshall, 1996). The birds nest around 350 m (1148 ft) upland of the lake from April through July, but the exact timing of nesting and reproduction is flexible in response to local habitat conditions (USFWS, No Date-c).

In 1967, the Laysan duck was listed as endangered wherever found. No critical habitat has been designated for the species (ECOS, No Date-a).

3.10.1.3.3.2 Hawaiian Duck

The Hawaiian duck is known locally as “koloa” and is a close relative of the mallard. Dependent on freshwater wetland habitat, the ducks were historically distributed on most of the main Hawaiian Islands except the drier islands of Lana’i and Kaho’olawe. Destruction of wetland habitat led to a decline of Hawaiian duck populations. Coastal brackish water, estuaries, and saline habitat are not frequently used by the ducks, apart from populations on Kaua’i observed using freshwater upwellings in coastal brackish marshes (Engilis et al., 2002). The species’ nesting biology is poorly known, but most pairs tend to nest in the upper Alaka’I swamp on Kau’ai. Nesting can occur year-round, but most nesting activity occurs between January and May (Hawaii DLNR, 2015d).

In 1967, the species was listed as endangered wherever found. No critical habitat has been designated (ECOS, No Date-a). The species currently faces threats from hybridization with non-native mallard populations (Engilis et al., 2002).

3.10.1.3.3.3 Steller’s Eider

Steller’s eider (**Figure 3.10-10**) is the smallest of the four species of eider. Its range is in northern latitudes only. The birds nest near freshwater ponds as the spring sea ice begins to break, but return to shallow marine habitats after breeding. While in marine habitats, Steller’s eiders prefer to feed by diving for mollusks and crustaceans, but also eat worms, echinoderms, small fish, gastropods and brachiopods (Fredrickson, 2001).

Figure 3.10-10. Steller's Eider Male and Female

Photo credit: USFWS

The Alaska breeding population of the Steller's Eider was listed as threatened in 1997, and in 2001 critical habitat was designated (ECOS, No Date-a). The five designated units were located at Yukon-Kuskokwim Delta, Kuskokwim Shoals, Seal Islands, Izembek Lagoon, and Nelson Lagoon, which includes Port Moller and Herendeen Bay. Marine environments of greater than 9 m (30 ft) in depth were specifically excluded from the critical habitat regardless of published boundaries (66 FR 8850, February 2, 2001).

3.10.1.3.3.4 Spectacled Eider

Similar to Steller's eider, distribution of the spectacled eider (**Figure 3.10-11**) is limited to Alaska and Russia and the birds inhabit marine environments apart from breeding and nesting activities near tundra ponds. Nesting occurs in the spring season, and breeding females remain with their young on the nesting grounds until early September (ECOS, No Date-a). Spectacled eiders feed mainly on clams and benthic invertebrates in marine habitat and insects and plant materials in freshwater habitat (Peterson et al., 2000).

Figure 3.10-11. Spectacled Eider

Photo credit: USFWS

Populations of spectacled eiders fell by 96 percent from the 1970s to 1992. In 1993, they were listed as threatened wherever found. In 2001, critical habitat for the spectacled eider was designated on the Yukon-Kuskokwim Delta, in Norton Sound, Ledyard Bay, and the Bering Sea between St. Lawrence and St. Matthew Islands (66 FR 9146, February 6, 2001).

3.10.1.4 Regional Distribution

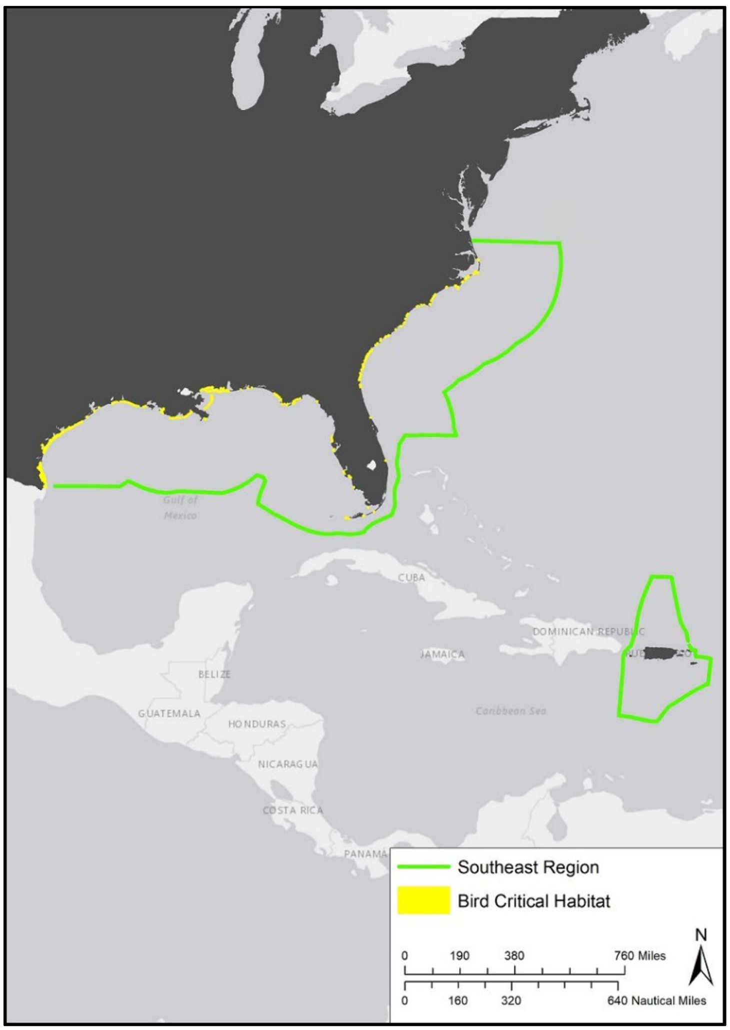
General bird assemblages are discussed in Section 3.10.1.1. This section summarizes region-specific ESA-listed species and critical habitat. It is important to note that not all ESA-listed bird species have designated critical habitat. The majority of critical habitat for birds is located within the Alaska and West Coast Regions.

3.10.1.4.1 Greater Atlantic Region

Four ESA-listed bird species (roseate tern, red knot, piping plover, and whooping crane) occur in the Greater Atlantic Region, as indicated in **Table 3.10-2**. There is no designated critical habitat for these species in this region.

3.10.1.4.2 Southeast Region

Four ESA-listed birds (red knot, whooping crane, wood stork, and piping plover) occur in the Southeast Region, as indicated in **Table 3.10-2**. Whooping cranes and piping plovers also have designated critical habitat in the region as shown in **Figure 3.10-12**.

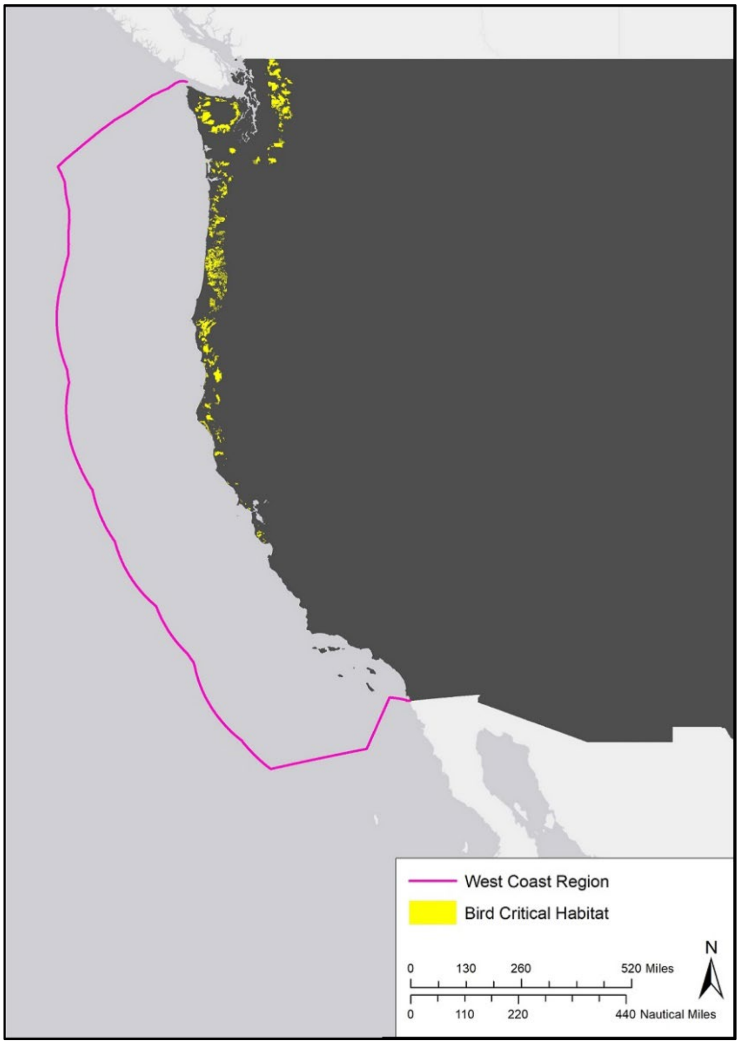


Sources: NMFS, No Date-a; ECOS, No Date-b

Figure 3.10-12. Designated Critical Habitat in the Southeast Region

3.10.1.4.3 West Coast Region

Six ESA-listed bird species (marbled murrelet, short-tailed albatross, California least tern, western snowy plover, light-footed clapper rail, and California clapper rail) occur in the West Coast Region, as indicated in **Table 3.10-2**. Marbled murrelet and western snowy plover have designated critical habitat in the region as shown in **Figure 3.10-13.**

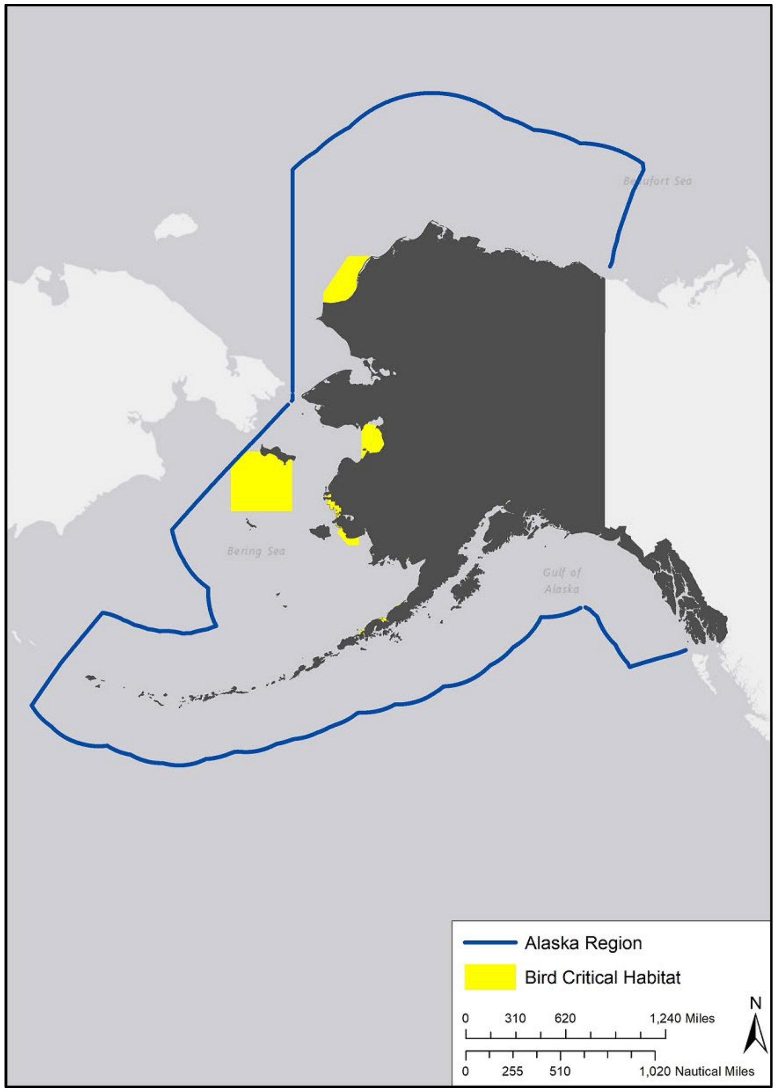


Sources: NMFS, No Date-a; ECOS, No Date-b

Figure 3.10-13. Designated Critical Habitat in the West Coast Region

3.10.1.4.4 Alaska Region

Four ESA-listed birds (short-tailed albatross, Eskimo curlew, Steller's eider, and spectacled eider) occur in the Alaska Region, as indicated in **Table 3.10-2**. Steller's eider and spectacled eider have designated critical habitat in the region, as shown in **Figure 3.10-14**.



Sources: NMFS, No Date-a; ECOS, No Date-b

Figure 3.10-14. Designated Critical Habitat in the Alaska Region

3.10.1.4.5 Pacific Islands Region

Eight ESA-listed birds (band-rumped storm petrel, short-tailed albatross, Hawaiian petrel, Newell's shearwater, Hawaiian coot, Hawaiian Stilt, Laysan duck, and Hawaiian duck) occur in the Pacific Islands Region, as indicated in **Table 3.10-2**. None of these species have designated critical habitat in the region.

3.10.2 Environmental Consequences for Seabirds, Shorebirds and Coastal Birds, and Waterfowl

This section discusses potential impacts to seabirds, shorebirds and coastal birds, and waterfowl and their associated habitat, including designated critical habitat, from NOS activities associated with Alternatives A, B, and C. Activities described in Sections 2.4.1 through 2.4.13 that occur on NOS projects and that could be expected to impact birds and their habitat in the action area include crewed vessel operations, anchoring, ROV and autonomous vehicle operations, use of echo sounders, use of ADCPs, use of acoustic communication systems, use of sound speed data collection equipment, operation of drop/towed cameras and video systems, collection of bottom grab samples, tide gauge installation, maintenance, and removal, GPS reference station installation, and SCUBA operations.

Given the ecological concordance between bird groups, impacts that would affect all groups are hereafter referred to as impacts on birds. Specific impacts based on behavior or habitat of an individual group or species are explicitly stated. Potential impacts could occur in all of the geographic regions described in Section 2.3.1. ESA-listed endangered and threatened species are included in the discussion along with non-listed species because the potential impact mechanisms are the same.

3.10.2.1 Methodology

The factors from NOS activities that could impact birds and their habitat, including ESA-listed species and designated critical habitat, in the action area include: (1) active underwater acoustic sources (e.g., echo sounders, ADCPs, and acoustic communication systems); (2) vessel and equipment sound (e.g., from crewed vessels, ROVs, and autonomous vehicles); (3) aircraft sound (e.g., from installing, maintaining, and removing remote tide gauges and GPS reference stations), (4) water column disruption and underwater activities (e.g., from ROVs and autonomous vehicles; project equipment; anchors; and SCUBA divers); (5) vessel presence and movement (e.g., from crewed vessels, ROVs, and autonomous vehicles); (6) accidental leakage or spillage of oil, fuel, chemicals, or waste into surrounding waters (e.g., from vessel operations); and (7) onshore activities (e.g., installation, maintenance, and removal of tide gauges and GPS reference stations). These potential impact causing factors and their associated impacts on birds and their habitat are discussed below. Note that use of the term “sea floor” in the analysis below also includes lake and river bottoms where NOS activities could occur.

As discussed in Section 3.2.2, significance criteria were developed for each resource analyzed to provide a structured framework for assessing impacts from the alternatives and the significance of the impacts. The significance criteria for birds and bird habitat are shown in **Table 3.10-3**.

Table 3.10-3. Significance Criteria for the Analysis of Impacts to Seabirds, Shorebirds and Coastal Birds, and Waterfowl

Impact Descriptor	Context and Intensity	Significance Conclusion
Negligible	Impacts to birds would be limited to temporary (lasting several hours) behavioral disturbances to individuals located within the project area. No mortality or debilitating injury to any individual bird would occur. There would be no displacement of birds from preferred breeding and feeding areas, nest sites, nursery grounds, or migratory routes. Impacts on bird habitat would be temporary (e.g., temporary displacement of finfish prey) with no lasting damage or alteration.	Insignificant
Minor	Impacts to birds would be temporary or short-term (lasting several days to several weeks) and within the natural range of variability of species’ populations, habitats, and the natural processes sustaining them. This could include non-life-threatening injury to individual birds and small disruptions of time-sensitive behaviors such as breeding. Displacement of birds from preferred breeding and feeding areas, nursery grounds, or migratory routes would be short-term and limited to the project	

Impact Descriptor	Context and Intensity	Significance Conclusion
	area. Any resulting increased competition, additional energy expenditure, or loss of young would not affect overall bird population numbers or demographic structure. Impacts on habitat (e.g., short-term displacement of finfish prey, increased turbidity, trampled vegetation) would be easily recoverable with no long-term or permanent damage or alteration.	
Moderate	Impacts to birds would be short-term or long-term (lasting several months or longer) and outside the natural range of variability of species' populations, habitats, and the natural processes sustaining them. This could include debilitating injury or mortality and disruptions of time-sensitive behaviors such as breeding. Behavioral responses and displacement would be expected from individuals within the project area, its immediate surroundings, or beyond. Long-term displacement of individuals from preferred breeding and feeding areas, nursery grounds, or migratory routes would occur. Resulting increased competition and energy expenditure would cause losses of breeding or egg-bearing adults and chicks at large enough scales to negatively impact overall bird population numbers or demographic structure but would not threaten the continued existence of any species. Habitat would be damaged or altered potentially over the long term but would continue to support dependent species.	
Major	Impacts to birds would be short-term or long-term and well outside the natural range of variability of species' populations, habitats, or the natural processes sustaining them. This could include extensive (i.e., affecting a large proportion of the local population), life-threatening, or debilitating injury and mortality and substantial disruption of time-sensitive behaviors such as breeding. Displacement of birds from preferred breeding or feeding areas, nursery grounds, or migratory routes would occur within project areas, their immediate surroundings, and beyond. Behavioral disruptions and displacement would result in the loss of breeding and egg-bearing adults and chicks due to increased competition or energy expenditure at scales large enough to affect overall bird population numbers or demographic structure. Impacts would also be considered major if they threatened the continued existence of any bird species. Full recovery of bird populations would not be expected to occur in a reasonable time. Habitat would be degraded over the long-term or permanently such that it would no longer be able to support dependent populations of birds.	Significant

3.10.2.2 Alternative A: No Action - Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

Impacts of Alternative A are discussed below by impact causing factors for seabirds, shorebirds and coastal birds, waterfowl, and their associated habitat. Under Alternative A, NOS survey effort would continue to cover a total of 2,647,958 nm (4,904,017 km) across all five regions over the five-year period. Although the survey effort under Alternative A would vary by year (see **Table 3.4-4**), approximately 47 percent of the total nautical miles surveyed over the five-year period would continue to be in the Southeast Region. The survey effort in each of the other four regions would continue to be approximately 10 percent of the total survey effort. Slightly greater impacts may continue to occur in the Alaska Region, which contains approximately 18 percent of the total survey effort. Additionally, survey effort in the Great Lakes would average 2,917 nm (5,402 km), as compared to the annual average survey effort of 529,592 nm (980,803 km) for the remainder of the action area. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location of surveys, sound production and hearing frequency of birds, and population density of birds, that add nuance to this trend.

The analysis of impacts on birds considers all of the impact causing factors introduced above and their impacts on birds and bird habitat. All regions in the action area include several ESA-listed species, and all regions, other than Pacific Islands Region, include designated critical habitat. The Pacific Islands Region contains the greatest number of ESA-listed species and the Alaska and West Coast Regions contain the most designated critical habitat (see **Table 3.10-2**).

3.10.2.2.1 Active Underwater Acoustic Sources

Active acoustic sources used in underwater surveying, including echo sounders, ADCPs, and acoustic communication systems, are a cause of potential impact on birds due to their propagation of underwater sound. The acoustic signals used in NOS active surveying range from 0.5 to 1200 kHz; specific characteristics of each activity are detailed in Section 2.4. Birds have a documented hearing range of around 100 Hz to 10 kHz in air (Dooling and Popper, 2000), but it is unclear whether this range is comparable underwater. The limited data available suggest that the range of bird hearing may shift to lower frequencies in water (Dooling and Therrien, 2012), which may allow birds to hear low and mid-frequency underwater acoustic sources (Navy, 2017b). However, bird hearing is adapted for airborne sound, and there is no evidence that underwater sound is used by birds ecologically.

Surface-diving birds (e.g., cormorants, murres, murrelets, puffins, auklets, guillemots) and plunge-diving birds (e.g., brown pelicans, terns, boobies, gannets) – including ESA-listed marbled murrelets, band-rumped storm petrels, short-tailed albatrosses, Hawaiian petrels, Newell’s shearwaters, California least terns, roseate terns, Steller’s eiders, and spectacled eiders – may be more susceptible to temporary underwater acoustic disturbance than other bird species due to their foraging behavior. Many diving bird species stay underwater for up to several minutes while foraging and reach depths of 15–168 m (50–550 ft) (Alderfer, 2003; Durant et al., 2003; Jones, 2001; Lin, 2002; Ronconi, 2001). While underwater, sound from echo sounders, ADCPs, and acoustic communication systems could temporarily disrupt foraging activity of diving birds in their immediate vicinity. However, diving birds have adaptations to protect the middle ear and tympanum from pressure changes during diving, and they have other structural protective hearing adaptations for in-air sound that may also serve to protect underwater hearing (Dooling and Therrien, 2012; Hetherington, 2008). Because of these adaptations and the relatively short time period diving birds spend underwater, the likelihood of a diving bird experiencing an underwater exposure from sound emitted by echo sounder, ADCPs, and acoustic communication systems that could result in an impact on hearing is considered low. Diving birds would also be able to surface shortly after exposure to sounds from underwater acoustic sources, limiting their exposure time and potential impacts. Furthermore, only diving birds within several meters of underwater acoustic sources would be temporarily exposed to active acoustic sources. Any increased foraging effort, competition, or energy expenditure resulting from displacement during project operations is not expected to substantially affect individuals or the population of birds as a whole. Non-diving birds would not be affected by underwater active acoustic sources.

Active acoustic sources could affect bird habitat, including designated critical habitat, by displacing finfish prey species from the project area during project operations. As discussed in Section 3.7, active acoustic sources could elicit pathological and behavioral effects on fish and could displace them from the immediate project area during NOS activities. However, given the relatively small project area and short duration of acoustic surveys, finfish prey are not expected to change their long-term behavior or habitat use in response to active underwater acoustic surveying. Consequently, any increased foraging effort, competition, or energy expenditure resulting from displacement of prey species is not expected to harm diving birds or surface feeding birds.

Birds likely cannot hear the majority of active acoustic underwater sound sources; thus, any resulting impacts would be limited to diving birds within meters of the source and would persist only for the duration of the activity. Birds and their prey are expected to return to project areas after the completion of NOS activities and are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure. Any resulting impacts from active acoustic underwater sources under Alternative A to birds and bird habitat, including ESA-listed species, designated critical habitat, and species protected by the MBTA, would continue to be potentially **adverse,** but **negligible** and therefore **insignificant**.

3.10.2.2.2 Vessel and Equipment Sound

Vessel and equipment sound (hereafter vessel sound) make up the majority of the ambient ocean auditory environment and are becoming more prominent with increasing human marine activity. Underwater vessel sound is a combination of tonal sound (sounds with discrete frequencies) and broadband sound (sounds with a combination of many frequencies) (Richardson et al., 1995) and typically ranges in frequency from 0.01 to 10 kHz. Underwater vessel sound is generated predominantly through the propeller operation – including cavitation, singing, and propulsion – of crewed vessels and autonomous vehicles. The intensity of this sound is dependent on the size and speed of the vessel in question, and sound levels attenuate quickly underwater with increasing distance from their source. Birds have a documented hearing range of around 100 Hz to 10 kHz in air (Dooling and Popper, 2000), but it is unclear whether this range is comparable underwater. The limited data available suggest that the range of bird hearing may shift to lower frequencies in water (Dooling and Therrien, 2012), which may allow birds to hear low and mid-frequency vessel and equipment sound. As such, sounds emitted by vessels and equipment used by NOS could potentially contribute to hearing threshold shifts and acoustic masking in exposed birds, but this is unlikely given that diving birds have protective structural hearing adaptations, and there is no evidence of ecological use of underwater sound by birds. Furthermore, only diving birds, including the ESA-listed species described in Section 3.10.2.2.1, within several meters of underwater acoustic sources would be temporarily exposed to active acoustic sources. Given the attenuation of vessel sound towards the surface, it is likely that only diving birds in the immediate vicinity of the vessel would be displaced by vessel sound as long as the vessel remains in the area. This temporary disturbance is not likely to cause any long-term behavioral changes or displacement of affected individuals. Non-diving birds would not be affected by vessel and equipment sound at all.

Vessel sound would affect bird habitat, including designated critical habitat, primarily through the displacement of finfish prey. As with active underwater acoustic sources, vessel sound could elicit pathological and behavioral effects on fish and likely would disturb or displace them from project areas during vessel operation (see Section 3.7 Fish). Fish are expected to return to project areas immediately following vessel activity, and any increased foraging effort, competition, or energy expenditure resulting from the displacement of prey species is not expected to considerably affect diving or surface feeding birds.

Vessel sound would displace birds, including ESA-listed species, and their prey within the immediate vicinity of vessels used by NOS and would not cause any mortality or direct injury. Birds and their prey are expected to return to project areas after the completion of NOS activities and are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure. Sound is a common byproduct of oceanic vessel activity, and the impacts created by sound from vessels used by NOS would be indistinguishable from those produced by all other vessels. As such, the impacts to birds and bird habitat, including ESA-listed species, designated critical habitat, and species protected by the MBTA, from vessel and equipment sound generated during NOS activities under Alternative A would continue to be **adverse**, **negligible**, and therefore **insignificant**.

3.10.2.2.3 Aircraft Sound

NOS projects would use low-flying aircraft, typically helicopters, to access some remote GPS reference stations and tide gauges in Alaska; the resulting aircraft sound could adversely affect birds, including ESA-listed species, in the project area. Fixed-wing aircraft and helicopters generate sound typically below 500 Hz (0.5 kHz) from their engines, airframe, and propellers (Richardson et al., 1995). Birds have a documented hearing range of around 100 Hz to 10 kHz in air (Dooling and Popper, 2000) and would be able to perceive the majority of sound generated by aircraft. Aircraft sound can cause temporary disturbance and displacement of birds up to 1 km (0.6 mi) away from an aircraft (Efroymson et al., 2000). Repeated, more intensive disturbance around sensitive coastal nesting areas, could lead to nest site abandonment and egg or nestling mortality via temperature stress, inadequate feeding of nestlings by parents, or predation. These impacts would also be magnified if coastal nesting ESA-listed bird species, including all species described in Sections 3.10.1.3.1 and 3.10.1.3.2, were exposed to repeated aircraft-induced stress. However, aircraft are not frequently used during NOS activities, and the resulting sound would likely only temporarily displace affected individuals in the Alaska region in a project area. Any disturbance from aircraft sound is unlikely to cause any long-term bird behavioral changes or displacement and would only continue to temporarily disturb existing bird habitat, including designated critical habitat.

Low-flying aircraft are only used very infrequently by NOS and their resulting sound would only displace birds, including ESA-listed species, and their prey within the immediate vicinity of aircraft and would not cause any mortality or direct injury. Birds and their prey are expected to return to project areas after the completion of NOS aircraft activities and are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure. Sound is also a common byproduct of aircraft activity and the impacts created by NOS aircraft sound would be indistinguishable from those produced by all other aircraft. As such, the impacts to birds and bird habitat, including ESA-listed species, designated critical habitat, and species protected by the MBTA, from aircraft sound generated during NOS activities under Alternative A would continue to be **adverse**, **negligible** to **minor**, and therefore **insignificant**.

3.10.2.2.4 Vessel Movement and Presence

Although many NOS projects involve vessel operations and activity, they represent only a very small proportion of the total vessel traffic within the action area (Section 2.4.1). As such, the resulting impacts of vessel operations on birds would only marginally contribute to the overall impact of vessel presence and movement within a given area as compared to that from all other vessels in the EEZ. Nevertheless, vessel presence and movement as a result of NOS projects could cause bird–vessel interactions including visual disturbance, vessel strikes, underwater turbulence from vessel wakes, and reduction or displacement of avian prey.

Much like vessel sound, vessel presence and movement as a result of NOS activities could potentially disrupt normal bird behavior and displace individuals from project areas through visual disturbance. The visual perception of vessels used by NOS would likely induce evasive maneuvers such as changes in flying direction or speed in nearby birds. As a result, some birds would likely be temporarily displaced from project areas while vessels are present. These behavioral changes and displacements would last only for the duration of vessel activity within a given area and would not induce any long-term or permanent changes in bird habitat use, prey availability, or competition. As such, increased evasive behavior and additional energy expenditure as a result of vessel presence and movement are not expected to harm individual birds or affect bird population numbers and demographic structure.

Vessel presence and movement during NOS projects could impact birds by direct collision, resulting in injury or death of the affected individual. Birds' responses to vessel presence and movement vary widely by species, physiological and reproductive status of the individual, distance from the vessel, and the type, intensity, and duration of the disturbance. While it is important to note that no component of the Proposed Action involves any intentional attraction of birds, a number of bird families (e.g., Procellariidae, Pelicanoididae, Laridae, and Alcidae), including all ESA-listed seabirds described in Section 3.10.1.3.1, are attracted to offshore vessels due to light attraction (Wiese et al., 2001) or as a foraging strategy to collect prey brought to the surface by propeller wakes (Hyrenbach, 2002). Accidental collisions occasionally occur, particularly at night, with alcids and petrels being the most frequently affected species (Black, 2005). Additionally, an increase in recent vessel strikes in 2020 and 2021 of Steller's and spectacled eiders, both of which are ESA-listed as threatened, have occurred in the Bering Strait and in the Aleutian Islands in Alaska (USFWS, 2021c). Taking into account the total number of eiders that have been injured or killed by vessel strikes in Alaska in recent years, NOS would expect that any interactions between vessels used by NOS and eiders would be appreciably lower than it has been in the past. Vessels used by NOS typically travel at speeds less than 10 knots during project operations, allowing birds to recognize and avoid vessels. Vessels used by NOS that operate at night, although uncommon, would use the appropriate lighting to comply with navigation rules and best safety practices, limiting the exposure of birds to onboard lighting. All project areas would be continually monitored for protected species by posted crewmembers during vessel operations, further reducing the risk of collision with birds. Given their low likelihood of occurrence, vessel collisions with birds are not expected to affect overall bird populations in terms of its demographic structure or abundance.

Activity from ships and boats being placed in and taken out of the water and traveling at sea or in close proximity to shore could also cause temporary disturbance and changes in behavior of some species of nearby birds (Turnpenny and Nedwell, 1994). The level of disturbance is contingent upon the habituation of the affected birds to human activity; sound and activity-based disturbance would be less pronounced at and near existing marinas, boat docks, heavily trafficked shipping lanes, and popular boating or recreation areas than at isolated island breeding colonies in the Pacific Ocean. Disturbances would be limited to the immediate vicinity of the activity and would not continue to persist after the conclusion of the activity. If repeated, intensive disturbance could eventually lead to nest site abandonment and egg or nestling mortality via temperature stress, inadequate feeding of nestlings by parents, or predation. Frequent, low-level vessel sound could also result in chronic stress responses that harm birds, especially during sensitive life stages such as molting. These impacts would be magnified if coastal nesting ESA-listed bird species, including all species described in Sections 3.10.1.3.1 and 3.10.1.3.2, were exposed to repeated vessel-induced stress. However, vessels used by NOS would operate transiently and only remain within a given area for the duration of activities before moving to new areas. As such, vessels used for NOS projects would not continue to repeatedly disturb birds or contribute to the creation of chronic stress responses.

Vessel presence and movement could affect bird habitat, including designated critical habitat, through the displacement and reduction of prey. As with active underwater acoustic sources, vessel sound could elicit pathological and behavioral effects on prey species (e.g., fish and aquatic macroinvertebrates) and would likely displace them from project areas during vessel operation. Prey are expected to return to project areas immediately following vessel activity, and any increased foraging effort, competition, or energy expenditure resulting from displacement of prey species is not expected to harm individual birds or the bird population. Prey species could also be exposed to waste and debris generated by NOS projects and serve as an additional source of waste ingestion for birds, particularly of bioaccumulated (concentrated in tissue through repeated exposure and ingestion) waste materials. Assuming proper waste disposal regulations are implemented, prey species would only continue to very rarely be exposed to trash and debris from NOS projects, and prey population numbers or habitat would not substantially change. As such, diving and surface-feeding birds would not be affected by increased foraging effort, competition, or energy expenditure resulting from displacement and reduction of prey populations by vessel presence and movement.

Any injury or death to ESA-listed birds would constitute a **moderate** or greater impact, depending on the species, given the protection status afforded to them by the ESA, NMFS, and USFWS. These impacts are particularly relevant to Steller's eiders, spectacled eiders, marbled murrelets, short-tailed albatross, band-rumped storm-petrel, Hawaiian petrel, Newell's shearwater, California least tern, and roseate terns due to the attraction of these species to vessels. Night operations are especially high risk to these species due to their inability to recognize and avoid vessels in low light conditions. However, the duration of NOS projects would be relatively short, on the order of hours, days, or weeks, although a small number of projects may last several months spread across multiple years (See Section 2.3), and there is only a very low likelihood of vessel strike occurrence. Vessels used by NOS operating at night would use the appropriate lighting necessary to comply with safety and navigation rules and best safety practices. Vessels used by NOS would also comprise only a negligible portion of overall vessel traffic, and any impacts produced from their movement would be indistinguishable from those produced by all other vessel traffic. Any displacement of birds and their prey by vessel presence or wakes would be limited to the immediate project vicinity. As such, any resulting impacts to individual birds or to overall bird populations, bird prey, and their respective habitat availability would be well within the natural range of variability. Overall, the effects of vessel presence and movement under Alternative A on birds and their habitat, including ESA-listed species, designated critical habitat, and species protected by the MBTA, would continue to be **adverse**, **negligible** to **minor**, and therefore **insignificant**.

3.10.2.2.5 Accidental Leakage or Spillage of Oil, Fuel, Chemicals or Waste

Accidental oil, fuel, and chemical discharges as a result of NOS projects could affect birds through various pathways including direct contact, inhalation of the oil, fuel, or volatile components, and ingestion directly or indirectly through the consumption of fouled prey species. Although large spills of volatile materials would not result from NOS activities, small accidental or routine discharges may occur during normal vessel operations. Globally, small discharges from all oceangoing vessels account for at least twice the volume of oil released into marine environments globally than that from large accidental spills due to their higher frequency of occurrence (GESAMP, 2007). Spilled fuel is less dense than water and floats to the surface of the water column where seabirds and shorebirds are susceptible to exposure. The location and size of the spill would determine the magnitude and duration of the impact to bird species in the area. Although the majority of spills typically dissipate in 24 hours, any direct fuel exposure can cause tissue and organ damage in birds in addition to interfering with essential behaviors such as prey detection, predator avoidance, and navigation along migratory routes. Large spills would contaminate areas beyond the immediate project area and increase the likelihood of bird exposure to volatile chemicals and resulting injury or mortality.

All crewed vessels produce some waste through normal operations, and vessels used by NOS could accidentally lose or discard debris, a major form of marine pollution (Laist, 1997). Vessels used by NOS would generate some waste in the form of metal, wood, glass, paper, and plastic, primarily through galley and food service operations on larger vessels. Birds commonly mistake improperly discharged marine waste for forage items and the continued ingestion of waste over time can substantially degrade avian health (Pierce et al., 2004). However, vessels used by NOS would comply with all USCG and EPA waste disposal regulations, and all MARPOL discharge protocols would be followed, which prohibit the illegal discharge of waste, require the development and implementation of onboard waste management plans, require marine debris education for crew members, and require the use of marine sanitation devices to treat and discharge sewage (33 U.S.C. § 1905-1915, 33 U.S.C. § 1952-1953, 33 C.F.R. § 159.7). Adherence to these regulations should prevent discharged waste from vessels used by NOS from harming birds. Furthermore, the vast majority of vessels used by NOS would be small and would not generate substantial amounts of waste, especially because they would not have food service or galley operations.

Accidental discharge of oil, fuel, chemicals, or waste could affect bird habitat, including designated critical habitat, through the disruption of prey sources and nest sites. In the event of a discharge, birds' vertebrate (finfish) and invertebrate (e.g., insects, larvae, polychaete worms, amphipod crustaceans) prey could become exposed and bioaccumulate spilled substances. These prey species would then serve as an additional source of exposure and ingestion of volatile chemicals for foraging birds. Breeding and nesting habitat, including that of ground-nesting ESA-listed piping plovers, roseate terns, red knots, western snowy plovers, California least terns, and Hawaiian stilts in all regions of the EEZ except the Alaska region, along coastlines adjacent to large spills could also be degraded as spilled substances are washed onshore, which could potentially cause birds to abandon important nesting and breeding areas.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. For example, on NOAA fleet vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the Commanding Officer takes appropriate action to minimize the effects of the spill. OMAO Procedure 0701-06 VRP/SOPEP provides policy and guidance to all NOAA vessels regarding oil pollution emergency planning and response, in accordance with MARPOL 73/78, Annex I. The plan contains all the information and instruction required for responding to shipboard oil spills, such as general spill mitigation and response, shipboard spill mitigation and response, reporting requirements, completing Corrective Action

Assessments, trainings, drills, and exercises. This plan has been approved by the USCG, and complies with the Oil Pollution Act of 1990 and Federal Water Pollution Act of 1973.

Although the likelihood of spill occurrence is low with proper adherence to existing regulations, coastal ground-nesting ESA-listed species are particularly susceptible to oiling within nesting habitat near high water lines. As such, adverse impacts to any ESA-listed species would be considered **moderate** or greater due to the vulnerable status of these birds. However, given the low likelihood of occurrence and short-term duration of most fuel spills, adverse impacts to birds, including ESA-listed species, designated critical habitat, and species protected by the MBTA, from accidental leakage or spillage of oil, fuel, or chemicals under Alternative A would continue to be **adverse**, **minor** to **moderate** depending on the spill size and location, and **insignificant**.

3.10.2.2.6 Underwater Activities

As with many human activities on or in the water, the vast majority of NOS projects would cause some temporary disturbance to the water column, potentially producing some adverse impacts to diving birds. Anchoring, camera and video systems, SCUBA diving, and CTD instruments could all cause temporary disturbance and displacement of nearby birds. Sound speed data collection equipment is not likely to affect birds as it would be used away from shore on stationary or moving vessels, and any sound or visual disturbance would come predominantly from operation of the crewed vessel rather than from use of equipment per se. Underwater disturbances would likely elicit avoidance behavior from nearby diving birds, but any increased energy expenditure is not expected to substantially affect any individuals or population.

A number of NOS activities involve trailing equipment with lines or wire behind and beneath vessels, which poses a risk of entangling nearby birds. From 2001–2005, entanglement rates ranged from 0.2 percent to 1.2 percent for all seabirds observed by beach monitoring programs in California, Oregon, and Washington (NOAA, 2014b). While the vast majority of entanglements involved fishing gear (e.g., monofilament line and hooks), approximately 8.3 percent of the entanglements were from non-fishery-related items such as plastics and other synthetic materials that birds may gather for making nests (NOAA, 2014b). However, NOS equipment is only submerged for periods of time ranging from minutes to hours (see Section 2.4.7) and is heavier and more conspicuous than discarded monofilament fishing line. All buoys would be attached to the sea floor using the best available mooring systems to reduce entanglement risks. Nearby birds would likely be able to recognize and avoid trailing equipment, thus the likelihood of bird-equipment interactions would be low. Furthermore, trailed equipment would stay within meters of the towing vessel and would only potentially impact birds within its immediate vicinity. Birds within the immediate vicinity of vessels would also likely be displaced by the visual disturbance and sound of the vessel itself (Section 3.10.2.2.4) before they would interact with trailed equipment, further lowering the likelihood of entanglement. Given its low likelihood of occurrence, entanglement of birds under Alternative A is not expected to affect the abundance or demographic structure of any bird populations.

Underwater activities would affect bird habitat, including designated critical habitat, predominantly through the operation of the crewed vessels that are used to carry associated equipment (see Section 3.10.2.2.4) and would not be expected to contribute to any long-term changes in habitat occupancy or behavior of finfish prey. Some underwater activities including anchoring, bottom sampling, use of drop cameras, and mobile ADCPs can also disturb the sea floor, increasing sedimentation and potentially displacing marine macroinvertebrate prey. However, underwater activities would only degrade very small proportions of bird habitat, and any resulting disturbance or degradation would be temporary and limited to the immediate project area.

Underwater activities would likely only displace birds, including ESA-listed species, and bird prey within the immediate vicinity of vessels used by NOS or divers and would not cause any mortality or direct injury. Birds and their prey are expected to return to project areas after the completion of NOS underwater activities and are not expected to experience any long-term changes in habitat availability or use, including that of designated habitat, or energy expenditure outside of the natural range of variation. As such, the impacts to birds and bird habitat, including ESA-listed species, designated critical habitat, and species protected by the MBTA, from underwater activities under Alternative A would continue to be **adverse**, **negligible** to **minor**, and therefore **insignificant**.

3.10.2.2.7 Onshore Activities

NOS onshore projects, such as the installation, maintenance, and removal of shore-based GPS reference stations and tide gauges, could potentially disturb birds from sensitive nesting, roosting, and breeding areas. Sound and activity from both the access of remote locations and on-shore installation of tide gauges and GPS reference stations could cause temporary disturbance and behavioral changes in nearby birds. Crews may also visit monitoring sites periodically for maintenance, during which sound and activity would disturb nearby birds temporarily. All disturbances would be limited to the immediate vicinity of the project area and would not persist beyond the conclusion of activity in the area. These responses would be well within the normal range of bird behavior; onshore activities are not expected to contribute to any long-term changes in habitat occupancy, avoidance behavior, or energy expenditure in birds.

Onshore activities could degrade and reduce sensitive breeding, roosting, and nesting habitat, including critical habitat. The installation of semi-permanent monitoring equipment such as GPS reference systems and tide gauges could potentially reduce the quantity and quality of shoreline and coastal bird habitat. The majority of birds affected by NOS projects and activities, including all ESA-listed species described in Sections 3.10.1.3.1 and 3.10.1.3.2, breed, nest, and roost along the coast. These behaviors are time-sensitive in nature and disturbances within associated areas would carry a higher potential cost to both individual birds and the overall bird population. During onshore activities, vegetation in and adjacent to the project area could be trampled by foot traffic, damaged, or cleared, but would likely recover post-installation. However, NOS would take all necessary precautions to avoid wounding birds or disturbing nests during onshore activities. Onshore installations would only occupy very small proportions of available habitat, and no long-term changes in bird habitat availability, quality, or use are expected as a result of onshore activities.

Onshore activity would likely only displace birds and prey within the immediate vicinity of the project area and would not cause any mortality or direct injury. Onshore installations would only occupy very small portions of available habitat and birds and their prey are expected to return to project areas after the completion of NOS onshore activities. As such, birds are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure outside of the natural range of variation. Given the relatively low level of onshore activity anticipated, along with the short duration of exposure to sound and visual disturbance, the impacts to birds and bird habitat, including ESA-listed species, designated critical habitat, and species protected by the MBTA, from NOS onshore activities under Alternative A would continue to be **adverse**, **negligible** to **minor**, and therefore **insignificant**.

3.10.2.2.8 Air Emissions from Vessel Operations

Air emissions from NOS activities would adversely impact birds through direct inhalation pathways. It is important to note that vessels used by NOS make up only a small proportion of the total amount of vessel operation (Section 2.4.1) and would only marginally contribute to the overall level of emissions within the action area. However, any emissions of anthropogenic GHGs (CO_2, CH_4, N_2O, and ozone (O_3) by NOS would primarily contribute to ongoing changes in atmospheric and terrestrial conditions. Smokestack and two-stroke outboard motor emissions from vessels used by NOS would release pollutants into the atmosphere of the project area and immediately surrounding areas. Birds are particularly sensitive to air quality due to their high breathing rate and long periods of time spent in open air (Sanderfoot and Holloway, 2017). Prolonged exposure to high amounts of pollutants can result in respiratory stress, physiological changes, and reduced immunocompetency (ability to respond to illness) in birds (Sanderfoot and Holloway, 2017). ESA-listed short-tailed albatrosses, band-rumped storm petrels, and Hawaiian petrels are particularly susceptible to air pollution because they spend large proportions of their time travelling between foraging and nesting habitat. However, NOS activities are not expected to substantially increase air emissions in the oceans and the resulting bird exposure is not expected to substantially affect individual birds or the overall population of any species.

Air emissions could also potentially degrade seabird habitat, including designated critical habitat, by contributing to the acidification of the ocean. Higher atmospheric CO_2 levels increase dissolved CO_2 and bicarbonate ions in seawater, which subsequently leads to a decrease in seawater pH and carbonate ions. In general, a decrease in pH corresponds to a simultaneous increase in acidity, termed "ocean acidification." Changes in seawater carbon chemistry may adversely affect marine biota through a variety of biochemical, physiological, and physical processes and interactions. Although ocean acidification resulting from air emissions is within the range of bird tolerance and is not expected to cause any direct harm to individuals and the population, ocean acidification could potentially reduce the availability of macroinvertebrate prey species that are particularly sensitive to pH levels during their larval life stages. However, as stated previously, NOS activities are not expected to substantially increase air emissions in the oceans and any increased bird competition, foraging effort, or energy expenditure as a result of reduced prey availability from ocean acidification is not expected to substantially affect individuals or the overall population of any bird species.

Air emissions could potentially cause some direct injury to birds, including ESA-listed species. Injury or mortality resulting from air emissions to any ESA-listed species could be considered a large impact due to the vulnerable status of these birds. However, the amount of emissions from vessels used by NOS would be negligible when compared to emissions from all other vessel activity in the oceans. The minimal direct impact on birds species under Alternative A would be confined to the immediate project area for only the duration of activity. Macroinvertebrate prey populations could also potentially be affected by ocean acidification, but any changes in prey population size would be well within the natural range of variability. As such, birds are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure from air emissions outside of the range of natural variation. Thus, impacts to birds and bird habitat, including ESA-listed species, designated critical habitat, and species protected by the MBTA, from NOS air emissions under Alternative A would continue to be **adverse**, **negligible** to **minor** due to air emissions dispersing beyond the immediate project area, and therefore **insignificant**.

3.10.2.2.9 Conclusion

Although the effects of impact causing factors on birds and their associated habitat range from negligible to moderate, moderate impacts are only expected in the extremely unlikely occurrence of a large spill of oil, fuel, or chemicals. Since all other impacts range from negligible to minor, the overall impact of Alternative A on birds, including ESA-listed species, designated critical habitat, and species protected by the MBTA, would continue to be **adverse** and **minor**; therefore, impacts of Alternative A would be **insignificant**.

3.10.2.3 Alternative B: Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations

Projects under Alternative B would take place in the same geographic areas and timeframes as under Alternative A; however, Alternative B would include more projects, activities, and nautical miles traveled than Alternative A. Under Alternative B, NOS survey effort would cover a total of 2,912,753 nm (5,394,419 km) across all five regions over the five-year period. Overall, survey effort would cover an additional 264,796 nm (490,402 km) under Alternative B (see **Table 3.4-5**), an approximately 10 percent increase over Alternative A (2,647,958 nm [4,904,017 km] total) across all regions over the five-year period. Thus, the greatest number of nautical miles surveyed each year would be in the Southeast Region (with approximately 47 percent of the survey effort); the level of effort in the other four regions would be at similar levels (approximately 10 percent of the survey effort in each region), and perhaps slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 18 percent). The level of effort in the Great Lakes would remain much lower as compared to an annual total marine survey effort. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location of surveys, sound production and hearing frequency of birds, and population density of birds, that add nuance to this trend.

Under Alternative B crewed vessel operations would cover 577,000 nm (1,070,000 km), as compared to 518,000 nm (959,000 km) under Alternative A. Vessel operations are among the most disruptive NOS activities to bird populations and could contribute to impacts on bird and bird habitat through visual disturbance, direct collision, vessel sound, vessel wake and underwater turbulence, trailing equipment that could cause entanglement, accidental spills or waste disposal, and air emissions. Although the amount of crewed vessel operations would be greater under Alternative B than under Alternative A, the additional 59,000 nm (109,000 km) would be distributed across the five regions of the EEZ. While these additional operations would result in greater impacts overall, the associated impact-causing factors would not be concentrated enough in any given area to substantially increase the magnitude of impact (e.g., from negligible to minor). This relationship is consistent for all other impact-causing factors from proposed activities, such as onshore disturbance from the installation, maintenance, and removal of tide gauges and installation GPS reference stations; and entanglement risk from anchoring, bottom sample collection, and trailing video equipment.

Impacts of Alternative B on birds and bird habitat, including ESA-listed species, designated critical habitat, and species protected by the MBTA, would be the same or slightly, but not appreciably, larger than those discussed above under Alternative A for each impact causing factor. Overall, impacts on birds and bird habitat, including ESA-listed species and designated critical habitat, would be **adverse**, **minor** and therefore **insignificant**.

3.10.2.4 Alternative C: Upgrades and Improvements with Greater Funding Support

Projects under Alternative C would take place in the same geographic areas and timeframes as under Alternatives A and B; however, Alternative C would include more projects, activities, and nautical miles traveled than Alternative A. Under Alternative C, NOS survey effort would cover a total of 3,177,549 nm (5,884,821 km) across all five regions over the five-year period. Overall, NOS survey effort would cover an additional 264,796 nm (490,402 km) under Alternative C (see **Table 3.4-6**), an approximate nine percent increase over Alternative B (2,912,753 nm [5,394,419 km] total); and an additional 529,592 nm (980,803 km), an approximate 20 percent increase over Alternative A (2,647,958 nm [4,904,017 km] total) across all regions over the five-year period. Thus, the greatest number of nautical miles surveyed each year would be in the Southeast Region (with approximately percent of the survey effort); the level of effort in the other four regions would be at similar levels (approximately 10 percent of the survey effort in each region), and perhaps slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 18 percent). The level of effort in the Great Lakes would remain much lower as compared to an annual total marine survey effort. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location of surveys, sound production and hearing frequency of birds, and population density of birds, that add nuance to this trend.

Under Alternative C, crewed vessel operations would cover 637,000 nm (1,180,000 km), as compared to 577,000 nm (1,070,000 km) under Alternative B and 518,000 nm (959,000 km) under Alternative A. Vessel operations are among the most disruptive NOS activities to bird populations and could contribute to impacts on bird and bird habitat through visual disturbance, direct collision, vessel sound, vessel wake and underwater turbulence, trailing equipment that could cause entanglement, accidental spills or waste disposal, and air emissions. Although the amount of crewed vessel operations would be greater under Alternative C than under Alternatives A and B, the additional 119,000 nm (220,388 km) as compared to Alternative A and the additional 60,000 nm (111,000 km) as compared to Alternative B would be distributed across the five regions of the EEZ. While these additional operations would result in greater impacts overall, the associated impact-causing factors would not be concentrated enough in any given area to substantially increase the magnitude of impact (e.g., from negligible to minor). This relationship is consistent for all other proposed activities contributing potential impacts, such as onshore disturbance from the installation, maintenance, and removal of tide gauges and installation GPS reference stations; and entanglement risk from anchoring, bottom sample collection, and trailing video equipment.

Impacts of Alternative C on birds and bird habitat, including ESA-listed species, designated critical habitat, and species protected by the MBTA, would be the same or somewhat, but not appreciably, larger than those discussed above under Alternative A for each impact causing factor. Overall, impacts on birds and bird habitat, including ESA-listed species and designated critical habitat, would be **adverse**, **minor**, and therefore **insignificant**.

3.10.2.5 Endangered Species Act Effects Determination

Twenty-two species of birds occurring within the action area are listed under the ESA (see **Table 3.10-2**), and federal agencies are required under the ESA to formally determine whether their actions may affect listed birds or their designated critical habitat. Effects determinations divide potential effects into three categories: No Effect; May Affect, but Not Likely to Adversely Affect; and May Affect, and is Likely to Adversely Affect. Actions receiving a “No Effect” designation do not impact listed species or their designated critical habitat (hereafter listed resources) either positively or negatively. This designation is typically used only in situations where no listed resources are present in the action area. Actions receiving a “May Affect, but Not Likely to Adversely Affect” designation have only beneficial, insignificant, or discountable effects to listed resources. Effects are considered insignificant if they are of low relative impact, undetectable, not measurable, or cannot be evaluated. Adverse effects are considered discountable if they are extremely unlikely to occur. Actions designated as “May Affect, and is Likely to Adversely Affect” will negatively impact any exposed listed resources.

Although ESA-listed bird species can likely hear the frequencies emitted by active underwater acoustic sources, bird hearing is adapted for airborne sound. Diving birds could potentially be exposed to active underwater acoustic sources but this exposure would be limited to the short time periods in which these birds are foraging. Furthermore, underwater sound is not thought to be an important ecological factor for bird behavior. Due to the mobile and temporary nature of the projects, the small area of the seas affected during the projects relative to the entire EEZ, and the possibility of birds and their prey to temporarily move away from sound, the response to sound exposure from active underwater acoustic sources would be limited to only a few individuals and, therefore, insignificant (i.e., so small they cannot be meaningfully measured, detected, or evaluated).

The proposed amount of vessel presence and movement associated with activities would be very small in comparison to all other non-project related vessel presence and movement in the EEZ. Given the frequency and duration of vessel operations and the rarity of ESA-listed species, the likelihood of collision is very small. Vessels used by NOS that operate at night, although uncommon, adhere to mitigation measures including the use of appropriate lighting to comply with navigation rules and best safety practices, and all project areas would be continually monitored for protected species by posted crew members during vessel operations, thus limiting the exposure of birds to onboard lighting and further reducing the likelihood of collisions with ESA-listed species. Disturbances from increased vessel presence and movement, including sound, water column disruption, and accidental waste discharge, would be temporary to short-term and would likely only temporarily affect ESA-listed birds. Because disturbance would occur infrequently in any given area and would only temporarily affect ESA-listed birds, the response by ESA-listed birds to vessel presence and movement would be limited to only a few individuals, and therefore, insignificant (i.e., so small they cannot be meaningfully measured, detected, or evaluated) for most ESA-listed bird species. However, because of historical vessel strike occurrences of the Steller's eider and spectacled eider in Alaska, and although impacts of the Proposed Action would be negligible to minor, with moderate impacts only in the very low likelihood of a vessel strike (see Section 3.10.2.2.4), under the ESA this adverse potential impact cannot be considered insignificant (i.e., so small they cannot be meaningfully measured, detected, or evaluated), or discountable (i.e., extremely unlikely to occur).

The likelihood for an accidental spill is expected to be discountable (i.e., extremely unlikely to occur), and exposure of ESA-listed bird species and critical habitats to oil, fuel, and other contaminants is not expected. These accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be a very low likelihood for contaminants to make contact with the water because vessel operations personnel are required to respond immediately using established spill response procedures. Therefore, effects from chemical contamination on ESA-listed species are discountable (i.e., extremely unlikely to occur).

Onshore and above-water activities, such as the installation of onshore equipment and use of low-flying aircraft, could potentially disturb and displace nearby ESA-listed species for the duration of activity. No permanent changes in behavioral or habitat use are expected to result from these disturbances. Given the temporary nature of the disturbance and small proportion of total bird habitat affected, the response of ESA-listed birds to onshore activities would be discountable (i.e., extremely unlikely to occur).

Although underwater disturbance by crewed vessels, ROVs, ADCPs, and SCUBA divers could temporarily disturb and displace nearby diving birds, their effects would be temporary and minimal limited to only a few individuals; thus, the response by ESA-listed birds would be discountable (i.e., extremely unlikely to occur).

NOS concludes that the Proposed Action "May Affect, but is Not Likely to Adversely Affect" 20 of the ESA-listed bird species occurring in the action area and "May Affect, Likely to Adversely Affect" two ESA-listed bird species occurring in the action area (**Table 3.10-4**).

Since activities may occur in some areas within or adjacent to designated critical habitats, there is the potential for impacts on critical habitat that support ESA-listed bird species. Critical habitat may be minimally disturbed but would remain functional to maintain viability of the species dependent on it. The Proposed Action "May Affect, but Not Likely to Adversely Affect" the designated critical habitat occurring in the action area (**Table 3.10-4**).

Table 3.10-4. Summary of Effects Determinations for ESA-Listed Seabirds, Shorebirds and Coastal Birds, and Waterfowl and Critical Habitat

Common Name	Scientific Name	Species Determination	Critical Habitat Determination
Seabirds			
Marbled murrelet	*Brachyramphus marmoratus*	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Band-rumped storm-petrel	*Oceanodroma castro*	May Affect, but Not Likely to Adversely Affect	N/A* (no critical habitat designated)
Short-tailed albatross	*Phoebastria albatrus*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Hawaiian petrel	*Pterodroma sandwichensis*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Newell's shearwater	*Puffinus auricularis newelli*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
California least tern	*Sternula antillarum browni*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Roseate tern	*Sterna dougallii*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Shorebirds and Coastal Birds			
Red knot	*Calidris canutus rufa*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Piping Plover	*Charadrius melodus*	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Western snowy plover	*Charadrius nivosus*	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Hawaiian coot	*Fulica americana alai*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Whooping crane	*Grus americana*	May Affect, but Not Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Bald eagle	*Haliaeetus leucocephalus*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)

Common Name	Scientific Name	Species Determination	Critical Habitat Determination
Hawaiian stilt	*Himantopus mexicanus knudseni*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Wood stork	*Mycteria americana*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Eskimo curlew	*Numenius borealis*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Light-footed clapper rail	*Rallus longirostris levipes*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
California clapper rail	*Rallus longirostris obsoletus*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Waterfowl			
Laysan duck	*Anas laysanensis*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Hawaiian duck	*Anas wyvilliana*	May Affect, but Not Likely to Adversely Affect	N/A (no critical habitat designated)
Steller's eider	*Polysticta stelleri*	May Affect, Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect
Spectacled eider	*Somateria fischeri*	May Affect, Likely to Adversely Affect	May Affect, but Not Likely to Adversely Affect

*N/A = Not applicable

3.11 Cultural and Historic Resources

This section discusses cultural and historic resources associated with the underwater marine and freshwater areas and coastal areas included in the action area for the Proposed Action. The Advisory Council on Historic Preservation regulations at 36 CFR 800.16(l)(1) define the term 'historic property' (or historic resource) as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (NRHP) maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties and also includes properties of traditional religious and cultural importance to an Indian tribe or Alaska Native or Native Hawaiian Organization and that meet the National Register criteria. As described in Section 3.3, Regulatory Background, federal agencies are directed by the NHPA and NMSA to manage and maintain historic properties in ways that consider the preservation of their historic, archeological, architectural, and cultural values before undertaking a project. National marine sanctuaries were established, among other conservation purposes, to protect shipwrecks, downed aircraft, and other cultural and historic resources such as lighthouses, archaeological sites, and the cultural history of native communities. National marine sanctuaries are designated under the NMSA, as discussed in Section 3.3. Through site-specific legislation and regulations, national marine sanctuaries are afforded varying levels of protection from activities that would be potentially harmful to the natural and cultural resources they contain.

Section 3.3 also discusses the role of SHPOs and THPOs in the Section 106 process. SHPOs are responsible for reviewing undertakings for their impact on historic properties and evaluating and nominating historic buildings, sites, structures, and objects to the National Register. In accordance with the NHPA, a THPO is the designated tribal preservation official of a federally-recognized Indian tribe. A THPO is responsible for the administration of any or all of the functions of a SHPO with respect to tribal land, which refers to all lands within the exterior boundaries of any Indian reservation and all dependent Indian communities.

3.11.1 Affected Environment

The types of cultural and historic resources that could be present in locations where NOS's Proposed Action is conducted include:

1) Submerged cultural and historic resources (such as shipwrecks);
2) Areas where traditional or tribal fishing rights are held and subsistence fishing and hunting are practiced, including Traditional Cultural Places (TCPs);
3) Historic coastal infrastructure such as piers; and
4) Viewsheds of nearshore historic properties.

These resources are discussed below.

3.11.1.1 Submerged Cultural and Historic Resources

Submerged cultural and historic resources are objects found on the sea floor, lake beds, or river beds with historic, pre-historic, or culturally significant values (NPS, 2000). Archaeological sites present within the action area may include submerged isolated artifacts (e.g., fragments of tools, arrow points, stone bowls) from prehistoric or historic voyages, resources submerged as a result of sea level rise, downed aircraft, and historic shipwrecks. Based on research of federal and state agency sites, historical databases, and other informational sources, there are myriad inundated cultural and historic resources present throughout the extensive action area. Although these resources would be too numerous to list in this Final

PEIS, this subsection provides an overview of the types of submerged archaeological resources present throughout the action area.

The Office of Coast Survey's Public Wrecks and Obstructions database (also known as the Automated Wreck and Obstruction Information System, or AWOIS) contains information on identified submerged wrecks within the maritime boundaries of the U.S. Information within the database includes the position of each feature (latitude and longitude) along with a brief description. However, AWOIS records have not been updated since 2014 and are not comprehensive. A United Nations Educational, Scientific, and Cultural Organization (UNESCO) webpage includes information on numerous databases and maps of underwater cultural heritage sites maintained by external institutions worldwide (UNESCO, 2017). Although these and many other such databases, including the NRHP, provide valuable information on the nature and location of submerged historic and cultural resources, there is no one clearinghouse for the coordinates of the locations of all known wrecks.

3.11.1.1.1 Greater Atlantic Region

In the Greater Atlantic Region, prehistoric archaeological sites may be present in or on the continental shelf. At the beginning of the Early Archaic period 10,000 years ago, the relative sea level was approximately 25-26 m (81-85 ft) lower than at present. Prehistoric archaeological deposits could potentially exist if landforms beneath the sea floor are well preserved. There is also the potential for historic archaeological resources to be present. For example, data sources maintained by the recreational SCUBA diving community in the New Jersey area estimate between 4,000 and 7,000 shipwreck sites off the coast of New Jersey. The majority of these wrecks are located along the coastline (NSF and USGS, 2011). Between Truro and Wellfleet, Massachusetts, for example, more than 1,000 wrecks have occurred (NPS, 2020b).

Stellwagen Bank National Marine Sanctuary, established in 1992, encompasses the historic shipping routes and fishing grounds for numerous ports around Massachusetts. These ports have been centers of maritime activity in New England for hundreds of years. Historic use of the national marine sanctuary is evidenced by the remains of several historic shipwrecks on the sea floor (ONMS, No Date-a).

There are 7,290 km (4,530 mi) of coastline along the five Great Lakes. The Great Lakes region contains one national marine sanctuary (Thunder Bay in Lake Huron in northeastern Michigan) and two proposed national marine sanctuaries (Wisconsin-Lake Michigan and Lake Ontario). To date, nearly 100 shipwrecks have been discovered within the 11,137-km^2 (4,300-mi^2) Thunder Bay National Marine Sanctuary. The waters of Thunder Bay contain evidence of human use dating back thousands of years. Geological and archaeological evidence suggests a high probability of prehistoric archaeological sites that have yet to be discovered (ONMS, 2017). Northeastern Michigan's maritime landscape includes hundreds of shipwrecks located on the bottomlands of Lake Huron. It also encompasses all of the cultural and natural features related to maritime heritage, such as lighthouses, commercial fishing camps, and working ports.

The proposed 2,784-km^2 (1,075-mi^2) Wisconsin–Lake Michigan National Marine Sanctuary would protect 37 shipwrecks and related underwater cultural resources with historic, archaeological, and recreational value (ONMS, No Date-b). The area in eastern Lake Ontario being considered for designation as a national marine sanctuary includes approximately 4,403 km^2 (1,700 mi^2) of lake waters and bottomlands in the state of New York. These waters and bottomlands contain 21 known shipwrecks and one military aircraft. Based on historical records, an additional 47 shipwrecks and two aircraft are also likely located there. The area being considered for designation also includes a separate area surrounding the HMS *Ontario*, which is both the oldest confirmed shipwreck (1780) and the only fully intact British warship discovered in the Great Lakes (ONMS, 2020).

3.11.1.1.2 Southeast Region

Florida has one of the longest continuous coastlines in the country and, as a result, the range of underwater archaeological sites is broad and covers thousands of years. Florida's Bureau of Archaeological Research within the Department of State examines and interprets underwater sites. They have conducted surveys and excavations on both prehistoric and historic sites located offshore and in rivers and sinkholes - from submerged Native American middens and habitation sites to the remains of sunken steamboats and schooners. In 1987, Florida began to develop a statewide system of underwater parks featuring shipwrecks and other historic sites. Currently, there are 12 shipwrecks designated as underwater reserves (Florida DOS, No Date). Thousands more shipwrecks and offshore cultural and historic resources are likely to be present off of the Florida coast; there are over 1,000 shipwrecks along the Florida Keys National Marine Sanctuary alone **(Figure 3.11-1)** (NOAA, No Date-d).

Figure 3.11-1. City of Washington Shipwreck, Florida Keys National Marine Sanctuary

Off the coast of North Carolina, Monitor National Marine Sanctuary protects the wreck of the Civil War ironclad *USS Monitor*.

Though rare, prehistoric human remains have been discovered offshore in the Southeast Region. In 2016, a 0.3-ha (0.75-acre) prehistoric Native American ancestral burial site was discovered off the shore of Manasota Key in Florida (NatGeo, 2018). Other prehistoric and historic remains have been discovered within shipwrecks and underwater cave systems.

Puerto Rico has a maritime heritage reaching back over at least 500 years. Based on archival research conducted by the National Park Service (NPS) and other agencies and groups, there are more than 200 shipwrecks in Puerto Rico waters. One of the oldest of these shipwrecks is a 17th century merchantman off the coast of Rincon, a small municipality on Puerto Rico’s western coast. Artifacts recovered from the find include pins, scissors, ordnance, pewter ware, woodworking tools, myriad concretions, and a nautical astrolabe (NPS, 2022).

The U.S. Virgin Islands include the three main islands of St. Croix, St. Thomas, and St. John, plus Water Island off of St. Thomas, and about 50 islets and cays. St. Thomas was a maritime trading and mercantile exchange and along with St. Croix, the Danish center for the slave trade beginning in 1685. The importation of slaves was abolished in the early 1800s and St. Thomas became one of the first “free ports”. In the early 1700s, St. Thomas was a well-known haven for pirates. It later became a coaling station for international steamships moving between Europe and South and North America until 1935, when the U.S. Navy and U.S. Marine Corps began administering the islands. Based on archival research conducted by NPS, several hundred shipwrecks are thought to be in the waters surrounding the U.S. Virgin Islands (NPS, 2022b).

3.11.1.1.3 West Coast Region

In 2011, BOEM conducted a study to identify the locations of known and reported submerged cultural resources, potential inundated prehistoric sites, coastal properties that are listed or eligible for listing on the NRHP, and TCPs on the west coast of the U.S., including California, Oregon, and Washington. The study area for this effort stretched from the U.S./Canadian border to the U.S./Mexican border and extended 322 km (200 mi) west of the U.S. EEZ. The study discovered archaeological resources such as shell middens (an archaeological feature consisting mainly of mollusk shells that contain debris associated with human activity), lithic sites, rock art, burial grounds, and caves/rock shelters, and located records on hundreds of shipwrecks in the Pacific OCS area (BOEM, 2013).

The remains of prehistoric seafaring trading expeditions along the Pacific Coast (including travel to the Channel Islands) has resulted in artifacts such as soapstone bowls recovered and preserved from the offshore areas; at least 25 individual sites have been reported between Ventura Beach and Point Conception in California alone (Foster, No Date). Known historic archaeological resources in the southern California area consist of submerged shipwrecks and submerged aircraft. The most common causes of the wrecks were burning, collision, or stranding (NSF and USGS, 2011). Approximately 100 shipwrecks have been documented in the Channel Islands National Park in California (NPS, 2016).

3.11.1.1.4 Alaska Region

According to Geographic Information System (GIS) data, Alaska has 71,000 km (44,117 mi) of coastline and comprises almost half the total U.S. coastline. The numbers of both identified and potential submerged cultural resources in this area is vast. The U.S. Department of the Interior Minerals Management Service (MMS, now BOEM) estimated the presence of more than 4,000 shipwrecks off the coast of Alaska. In addition to marine vessels, Alaska waters contain numerous historic aircraft, many of which were associated with World War II military activities, battles, and campaigns (McMahan, 2007).

MMS maps indicate that known shipwrecks are scattered throughout the Western Gulf of Alaska, with the heaviest concentration in Chignik Bay (NSF and USGS, 2011). At Point Belcher near Wainwright, Alaska, 30 ships were frozen in the ice in September 1871; 13 others were lost in other incidents off Icy Cape and Point Franklin. Another seven wrecks are known to have occurred off Cape Lisburne and Point Hope. From 1865 to 1876, 76 whaling vessels were lost due to ice and battleship raids, which also caused the loss of 21 whaling ships near the Bering Strait during the Civil War (OCM, 2021).

3.11.1.1.5 Pacific Islands Region

NOAA’s Pacific Islands Region includes Hawai’i, Guam, Northern Mariana Islands, and American Samoa. The high-energy marine surf environment of Hawai’i is capable of breaking apart wooden vessels and eventually destroying even iron and steel-constructed boats and ships. The volcanic shorelines and exposed coasts of the islands do not feature many naturally protected bays or harbors. These conditions, combined with the fringing or barrier reefs and sharp submerged lava rocks in nearshore waters, have led to a great number of shipwrecks in Hawai’i. An initial examination by BOEM of the reported positions of shipwrecks reveals clusters around the locations of historic landings (BOEM, 2017a). In the Hawaiian Archipelago alone, there are over 80 submerged U.S. Navy ships and submarines, and over 1,500 Navy aircraft. Many of these sites are war graves associated with major historic events that shaped the region (ONMS, 2017).

Several maritime archaeology projects have been conducted on coastal fishing and aquaculture sites in the Hawaiian Islands, as part of a course offered by the University of Hawai’i. One resulted in the mapping of an accumulation of hundreds of fishing lures (artificial fishing bait designed to attract a fish's attention) surrounding specific topographical reef features offshore from Waikiki beach on Oahu. The distribution of lost lures suggests hundreds of years of fishing activity at this specific location and submerged reef feature (BOEM, 2017a).

In June 2007, NOAA's ONMS completed an initial maritime heritage resource document inventory for American Samoa. Known maritime heritage resources in American Samoa include historic shipwrecks, World War II naval aircraft and fortifications, gun emplacements, and coastal pillboxes; archaeological sites associated with the ancient past; and marine/coastal natural resources associated with the legends and folklore of American Samoa. Ten historic shipwrecks are known to exist in American Samoan waters, the earliest dating to 1828; 43 naval aircraft are known to have been ditched or crashed into American Samoan waters between 1942 and 1944; and countless marine archaeological resources such as whet stones (used to sharpen the edge of steel tools), petroglyphs (prehistoric rock carvings), and grinding holes/bait cups (small depressions ground into bedrock) are known to exist in American Samoan waters (ONMS, 2007).

In Guam, due to the region's substantial number of historic military activities, there are various underwater sites associated with World War II occupation and combat. From historical records and discovery, there are many known aircraft, ships, construction equipment, cargo, and supplies submerged throughout Micronesia. World War II-affiliated sites within and south of Guam's Apra Harbor include areas where the U.S. military dumped equipment or supplies; Japanese boats sank; or remnants of Japanese aircraft exist. One of Guam's most popular fishing sites, Ritidian, includes the remains of an ancient fish camp, where indigenous people gathered to process and cook fish (Auyong, 2016).

More than four dozen documented shipwrecks have occurred in the waters of the Northern Mariana Islands. Two of the earliest known losses are the Santa Margarita in 1601 and the Nuestra Senora de la Concepción in 1635. Six other ships are reported to have been lost during the Spanish colonial period. The majority of shipwrecks are from World War II. Due to their location between Hawai'i and the Philippines, the Northern Mariana Islands played an important role in several World War II battles. As a result, the waters of the Northern Mariana Islands contain sunken warships, auxiliaries, airplanes, tanks, and other military related debris (NPS, 2022c).

3.11.1.2 Subsistence Hunting and Fishing Areas, Including Traditional Cultural Places

State and federal laws define subsistence as the customary and traditional uses of wild resources for food, clothing, fuel, transportation, construction, art, crafts, sharing, and customary trade. Subsistence fishing, hunting, trapping, and gathering are important sources of employment and nutrition in many rural coastal communities and have cultural importance. In general, these rights are based on the legal foundations of tribal sovereignty, treaty provisions, and the "reserved rights" doctrine, which holds that Native Americans retain all rights not explicitly revoked in treaties or other legislation (NCAI, No Date).

From 1778 to 1871, the federal government's relations with Indian tribes were conducted largely through the treaty-making process. These treaties recognized the sovereignty of Indian tribes and established rights, benefits, and conditions for the treaty-making tribes that agreed to cede millions of acres of their land to the U.S. in return for recognition of property rights and federal protections. These rights are also known as "reserved rights." Treaties with Indian tribes cover reserved rights such as the right to hunt, fish, and gather both on land ceded by tribes and on land retained by tribes. Although treaty-making ended in 1871, federal treaties with Indian tribes ratified by Congress remain the law, though treaties have been supplemented by federal legislation such as land claims settlement acts and EOs (ACHP, 2018). Under the U.S. Constitution, treaties carry the same legal weight as federal statutes and bind both the federal government and the signing Indian tribe or tribes. This means that federal agencies must ensure that their actions do not conflict with tribal treaty rights (ACHP, 2018). Though not all federally-recognized tribes are located along the coastline, unless specifically revoked by the U.S., tribes have rights to fish at all "usual and accustomed places", which are not typically specifically defined regions (JRank, No Date).

Subsistence harvest practices have been documented in many studies over the last several decades. A wide array of natural resources is harvested throughout the year in a regular cycle of seasonal efforts timed for availability, access, and condition of the resources. The composition of subsistence harvests includes many species of fish, land mammals, marine mammals, and invertebrates, terrestrial invertebrates, waterfowl, berries, roots, and fuel gathering. Communities express and reproduce their unique identities based on the enduring connections between current residents, those who used harvest areas in the past, and the wild resources of the land (MMS, 2010). The role of subsistence hunting and fishing and traditional fishing rights in each region are described below. Relevant laws, treaties, and organizations are noted throughout the next sections.

3.11.1.2.1 Greater Atlantic Region

The Greater Atlantic Region includes the east coast states of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, and Maryland, and the states surrounding the Great Lakes (Indiana, Michigan, Minnesota, and Wisconsin). There are 17 federally-recognized tribes within the east coast states (four in Maine, two in Massachusetts, one in Rhode Island, two in Connecticut, and eight in New York) and 31 federally-recognized tribes in the states surrounding the Great Lakes (one in Indiana/Michigan, 11 in Michigan, eight in Minnesota, and 11 in Wisconsin).

The Maine Department for Inland Fisheries and Wildlife recognizes Maine Native American traditional fishing rights and issues a set number of trapping and fishing licenses for individuals belonging to the four federally-recognized tribes in Maine: the Passamaquoddy Tribe, Penobscot Nation, Houlton Band of Maliseet Indians, and Aroostook Band of Micmacs or Aroostook Micmac Council. Two tribal organizations, the Great Lakes Indian Fish and Wildlife Commission and the Chippewa Ottawa Resources Authority, manage traditional fishing rights and resources in the Great Lakes. The Great Lakes Indian and Wildlife Commission is an agency of 11 Ojibwe nations in Minnesota, Wisconsin, and Michigan that manages traditional fishing rights in Lake Superior for individuals belonging to these nations (GLIFWC, No Date). The Chippewa Ottawa Resource Authority manages fishing rights for five different tribal organizations under 1836 Treaties (CORA, No Date).

3.11.1.2.2 Southeast Region

The Southeast Region includes the states of Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas. It also includes Puerto Rico and the U.S. Virgin Islands. There are 23 federally-recognized tribes across all of these states (seven in Virginia, four in North Carolina, one in South Carolina, zero in Georgia, two in Florida, one in Alabama, one in Mississippi, four in Louisiana, and three in Texas); tribes in Puerto Rico and the U.S. Virgin Islands are not federally-recognized.

Fishing is an important component of the culture and livelihood of many individuals on the U.S. Caribbean islands, whether commercial, recreational, or subsistence, and is tied directly and indirectly to many of the island's residents and businesses. Fisheries are woven into the cultural fabric of local communities and make an important contribution to attainment of food and nutrition security. A significant portion of fishermen in these areas retain a portion of their landings for their own or their family's consumption, and, as such, engage in subsistence fishing. In the U.S. Virgin Islands, for example, approximately 11 percent of fishermen reported that they did not sell any of their catch in 2011. (NOAA, 2014a).

3.11.1.2.3 West Coast Region

There are more than 40 federally-recognized tribes with treaties and tribal fishing rights in place in NOAA's Northwest Region, which includes Washington, Oregon, California, and Idaho (NMFS, No Date-e). The Northwest Indian Fisheries Commission helps support natural resources management for 20 treaty Indian tribes in coastal Washington (NWIFC, No Date). The Olympic Coast National Marine Sanctuary on the coast of Washington is entirely encompassed by the traditional harvest areas of the Hoh, Makah, and Quileute tribes, and the Quinault Indian Nation. Along with the state of Washington and the Olympic Coast National Marine Sanctuary, these tribes created the Olympic Coast Intergovernmental Policy Council in January 2007, which provides a regional forum for the collective management of resources within the Olympic Coast National Marine Sanctuary (NOAA, No Date-e).

3.11.1.2.4 Alaska Region

The MMPA and the ESA acknowledge, and have exemptions for, pre-existing rights for Alaska Native groups to hunt and fish specific protected species. Under the MMPA (16 U.S.C. § 1371(b)) and the ESA (16 U.S.C. § 1539(e)), for example, Alaska Natives are allowed to harvest marine mammals as subsistence resources (OCM, 2021). Subsistence hunting of marine mammals, including seals, sea lions, walruses, and whales, occurs throughout Alaska all year long and is critical to the nutrition, food security, and economic stability of Alaska Natives. The Alaska Region includes subsistence use areas of traditional cultural significance to Alaska Peninsula Native people, who are ancestors of the maritime hunting cultures of Pacific and Yupi'k Eskimos and Aleuts. Their primary subsistence activity is fishing all five species of Pacific salmon, halibut, cod, and other fish species. (NSF and USGS, 2011). Section 3.13, Environmental Justice includes a description of Alaska Native populations that hunt marine mammals and fish for subsistence use, including the cultural, nutritional, and spiritual importance of each marine animal as well as where, when, and how it is hunted or fished for subsistence use.

The subsistence heritage of rural Alaskans is the basis for Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA), which states that continuation of the subsistence way of life by rural Alaskans is essential to their physical, economic, traditional, cultural, and social existence. This applies not only to Indians, Eskimos, and Aleuts, but to non-Native rural residents as well (USFS, 2010). The federal subsistence priority means that subsistence uses by rural residents of Alaska are given priority over non-subsistence uses (commercial or sport). On October 1, 1999, the Secretaries of the Interior and Agriculture published regulations (36 CFR 242 and 50 CFR 100) to provide for federal management of subsistence fisheries on Alaska rivers and lakes and limited marine waters within and adjacent to federal public lands. The USFWS is the lead agency for federal subsistence management. The ADF&G regulations continue to apply statewide to all commercial, sport, personal use, and subsistence fisheries, unless otherwise superseded by federal regulations. Federal subsistence fisheries often occur in the same area as state of Alaska fisheries. Federal regulations apply only on federal public lands and waters (USFWS, No Date-d). The Federal Subsistence Board oversees the Federal Subsistence Management Program. The Board members include the agency heads for Alaska of the USFWS, NPS, Bureau of Land Management, Bureau of Indian Affairs, and U.S. Forest Service. There are also three public members appointed by the Secretaries of the Interior and Agriculture: the Chair of the Federal Subsistence Board and two public members who possess personal knowledge of and direct experience with subsistence uses in rural Alaska (USFWS, No Date-d).

3.11.1.2.5 Pacific Islands Region

Fishing continues to contribute to the cultural integrity and social cohesion of Pacific island communities and support island economies (WPRFMC, 2016). In Hawai'i, a substantial portion of the local population participates in recreational and subsistence fishing. Fishing in Guam and the Mariana Islands is important not only in terms of contributing to the subsistence needs of the Chamorro people but also in preserving their history and identity. Fishing perpetuates traditional knowledge of marine resources and maritime heritage of the ancient Chamorro culture (Ka'ai'ai, 2016). In American Samoa, fish brought to shore continue to be distributed within Samoan villages according to age-old ceremonial traditions. Similar traditions are still practiced in Hawai'i, the Northern Mariana Islands, and Guam. These sociocultural attributes of fishing are at least as important as the contributions made to the nutritional or economic wellbeing of island residents (WPRFMC, 2016).

3.11.1.2.6 Traditional Cultural Places

The NHPA defines the word 'culture' as the traditions, beliefs, practices, lifeways, arts, crafts, and social institutions of any community, be it an Indian tribe, a local ethnic group, or the people of the nation as a whole. One kind of cultural significance a property or place may possess, and that may make it eligible for inclusion in the Register, is traditional cultural significance. "Traditional" in this context refers to beliefs, customs, and practices that have been passed down through generations of people, usually orally or through practice. Thus, TCPs, also referred to as "Traditional Cultural Properties," are historic properties that derive their cultural significance from the role the property plays in a community's historically rooted beliefs, customs, and practices (NPS, No Date-a).

TCPs may include locations of historic events, locations where sacred or ceremonial rituals, practices, or activities are or were performed, locations associated with the traditional beliefs or history of a cultural group, traditional hunting or gathering areas of economic and cultural importance, and sources of raw materials used to produce tools or sacred objects. The community may consider these properties significant to the cultural values, identity, and persistence of their traditional culture (NPS, 2012a). Cultural resources usually consist of tangible man-made properties, such as buildings, archeological sites, structures, objects, or historic districts. Although these same types of cultural resources may also be TCPs when cultural groups identify them as an important part of their community's history or as important to maintaining the cultural identity of their community, generally, the major differences in property types between cultural resources and TCPs are that the latter may be natural areas with no evidence of human activity or intervention.

Offshore TCPs may include subsistence hunting and fishing areas of cultural groups, and locations where American Indians or Alaska Natives performed ceremonial activities. For example, Chelhtenem (also known as Lily Point), located in Puget Sound, Washington (**Figure 3.11-2**), was added to the NRHP in 1994 for its cultural importance as a fishing site. Lily Point was the most important Native reef net fishery and one of the most significant salmon fisheries of the Central Coast Salish Tribe. Chelhtenem was a center of traditional salmon culture for hundreds of years and a place of spiritual importance for native peoples. The First Salmon Ceremony honored the returning salmon and directed them into the reef nets. The bones of the first fish "were carefully returned to the sea where the fish regained its form and told other salmon how well it had been treated, thus allowing the capture of other fish and insuring a return the following year." (Whatcom Land Trust, No Date). In the late 19th century, non-Indian fish traps replaced traditional reef nets. Alaska Packers purchased a cannery at Lily Point in 1884. The cannery was closed in 1917, leaving pilings and debris still visible today.

Figure 3.11-2. Lily Point TCP, Washington

Another example of a TCP is Nantucket Sound, Massachusetts, which was determined eligible for the NRHP in 2010 (**Figure 3.11-3**). Nantucket Sound is a culturally significant landscape associated with the history and traditional cultural practices of two Wampanoag tribes. It has yielded and has the potential to yield important information about the Native American exploration and settlement of Cape Cod and the Islands. Although the exact boundary is not precisely defined, the Sound is eligible as an integral, contributing feature of a larger historic district (BOEM, 2019a).

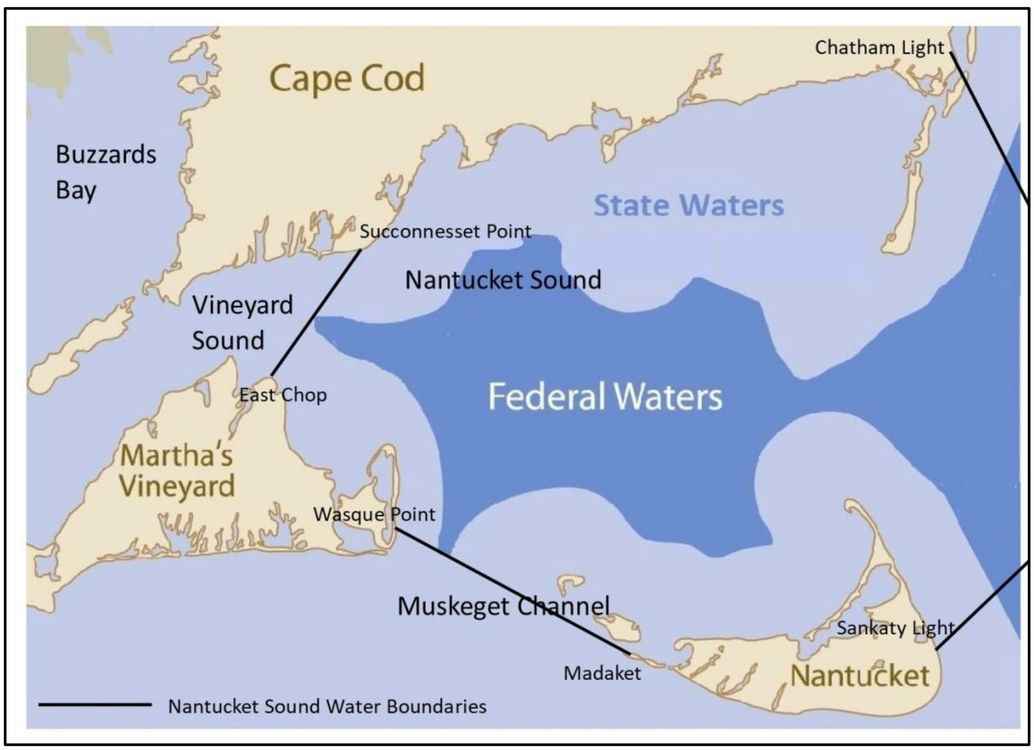


Figure 3.11-3. Nantucket Sound Traditional Cultural Place Boundary

3.11.1.3 Coastal Infrastructure and Communities and Nearshore Historic Properties

Coastal infrastructure refers to structures, systems, and facilities built along the coastline. This includes harbors, marinas, piers, and other types of development.

A pier (**Figure 3.11-4**) is a raised structure in a body of water, typically supported by piles or pillars. Piers may support bridges, buildings, and walkways. Their open structure allows waves, tides, and currents to flow relatively unhindered. Piers can be categorized according to their principal purpose and include working piers, pleasure piers, and fishing piers.

Figure 3.11-4. Tide Gauge on a Pier

There are many piers listed or eligible for listing on the NRHP throughout the U.S. as either individual resources or as contributing elements of an historic district. Hanalei Pier in Hawai'i, for example, is a typical finger pier constructed in the 1920s. The structure was used seasonally, primarily to transport rice from Hanalei to Honolulu. It is one of approximately a dozen remaining structures of this type in the state and is listed on the NRHP for its historical significance as one of the last remaining vestiges of the rice industry in Hanalei (NPS, 1979).

Other cultural and historic resources located along the coastline include fishing communities, whaling villages, and Native American settlements. A fishing community is a social or economic group whose members reside in a specific location and share a common dependence on commercial, recreational, or subsistence fishing or on directly related fisheries dependent services and industries (for example, boatyards, ice suppliers, tackle shops) (50 CFR 600.345).

Point Hope, Alaska, is one of the oldest continuously inhabited settlements in North America. Its whaling traditions extend back thousands of years, and Tikigaq – its Inupiaq name – is considered to be one of the most traditional villages in Alaska. The people hunt caribou, moose, seals, walrus, birds, fish, beluga whales, and polar bear, but the bowhead whale remains the focus of the annual subsistence cycle (AEWC, No Date).

In addition to the cultural and historic resources described above, there are many historic properties located near the shoreline that are listed or eligible for listing on the NRHP. Countless archaeological sites and cultural remains are also present along the coastline that provide evidence of the prehistory and history of coastal communities. These sites often contain lithic assemblages comprised of materials such as shell and midden refuse, fire cracked rock, quartz and basalt flakes, and chert points.

3.11.1.4 Visual Resources Associated with Historic Properties

Under Section 106 of the NHPA, the potential visual impacts from a proposed project or activity are considered with respect to the integrity of setting, feeling, and/or association of historic properties.

Setting is the physical environment of a historic property and can include natural or human-made elements, such as topographic features, vegetation, paths, or fences, and, importantly, the relationships between buildings and other features or open space. Feeling is a property's expression of the aesthetic or historic sense of a particular period of time. It results from the presence of physical features that convey the property's historic character. Association is the direct link between an important historic event or person and a historic property. A property retains association if it is the place where the event or activity occurred and is sufficiently intact to convey that relationship to an observer (Sullivan et. al, 2018).

Some historic properties are or include "designed cultural landscapes" that may include purposefully designed views or vistas. In a designed cultural landscape, the view itself is a significant characteristic of the historic property. Therefore, changes to these designed views, vistas, or view corridors may adversely affect the integrity of the property's design, not simply causing visual effects on integrity of setting, feeling, or association (NPS, No Date-b).

Many coastal resources listed on the NRHP derive all or part of their significance from their historic maritime setting. These resources include TCPs, coastal fortifications, parks and seashores, residential estates, lighthouses, life-saving stations, breakwaters, marinas, fishing and resort communities, and shore lodgings of all kinds, including hotels, motels, inns, seasonal cottages, and permanent residences. Some TCPs, for example, derive their importance from unobstructed views toward the rising sun (Klein et al., 2012).

In 2012, BOEM directed the preparation of a GIS database of known cultural resources and historic properties that could be impacted by the introduction of off-shore energy facilities along the entire east coast of the U.S. Based on existing data, each resource was assessed with respect to its maritime setting and view to the sea. In total, 9,175 resources were considered to have a historically significant maritime setting and 1,108 were considered to have a historically significant view toward the open sea (Klein et al., 2012).

3.11.2 Environmental Consequences for Cultural and Historic Resources

This discussion includes analysis of potential impacts to submerged cultural and historic resources; areas where traditional or tribal fishing rights are held and subsistence fishing and hunting are practiced, including TCPs; and coastal infrastructure listed or eligible for listing on the NRHP. Activities described in Sections 2.3.1 through 2.3.13 that occur on NOS projects and that could be expected to impact cultural and historic resources include: (1) anchoring; (2) bottom sampling; (3) installation, maintenance, and removal of tide gauges and buoys; and (4) installation of GPS reference stations.

NOS has prepared this Final PEIS to inform the NHPA Section 106 consultation when implementing the Proposed Action. NOS will initiate project-specific consultations under Section 106 of the NHPA before commencing any activity with the potential to affect cultural or historic resources. Also, NOS intends to notify individual federally recognized tribes and Alaska Native corporations consistent with EO 13175 (Consultation and Coordination with Indian Tribal Governments) before conducting any project that may have tribal implications. Federally recognized tribes and Alaska Native corporations may request formal government-to-government consultation pursuant to EO 13175 at any time.

Note that this Final PEIS considers the impacts to historic and cultural resources from NOS data collection. NOS acknowledges the potential for adverse effects resulting from the release of collected data. NOAA, like other federal agencies, is required to comply with Section 304 of the NHPA, which protects certain sensitive information about historic properties from disclosure to the public when such disclosure could result in a significant invasion of privacy, damage to the historic property, or impede the use of a traditional religious site by practitioners. NOS would comply with Section 304 of the NHPA in the course of creating public data products. Effects from the release of collected data are not assessed further in the PEIS.

3.11.2.1 Methodology

The factors from NOS activities that could impact the cultural and historic environment include: (1) placement or dragging of equipment directly on or along the sea floor; (2) the presence of vessels operated by NOS within areas with activity restrictions, such as subsistence hunting and fishing areas, TCPs, and national marine sanctuaries; (3) placement of equipment on historic nearshore properties; (4) the discovery of archaeological resources during the installation of tide gauges, buoys, and GPS reference stations. These potential impact causing factors and their associated impacts on cultural resources are discussed below.

As discussed in Section 3.2.2, significance criteria were developed for each resource to provide a structured framework for assessing impacts from the Proposed Action and the significance of the impacts. The significance criteria for cultural resources are shown in **Table 3.11-1**.

Table 3.11-1. Significance Criteria for the Analysis of Impacts to Cultural Resources

Impact Descriptor	Context, Intensity, and Likelihood	Significance Conclusion
Negligible	The action would disturb a submerged archaeological resource or the sediment surrounding a submerged cultural or historic resource but would not have a measurable or perceptible impact. The action may occur in traditional subsistence hunting or fishing areas but would not disturb these practices.	Insignificant
Minor	The action would have a measurable or perceptible impact on a submerged cultural resource or historic resource’s location, design, setting, materials, feeling, or association, but would not cause the loss of diagnostic features or research potential. The action would cause a temporary (lasting a few days) interference with traditional subsistence hunting and fishing practices.	
Moderate	The action would diminish the integrity of a submerged cultural or historic resource or a historic property's location, design, setting, materials, workmanship, feeling, or association, resulting in the loss of diagnostic features or research potential. The action would temporarily interfere with traditional subsistence hunting and fishing practices during peak seasons or times.	
Major	The action would permanently damage or destroy a submerged cultural or historic resource or historic property, resulting in the unrecoverable loss of the	Significant

Impact Descriptor	Context, Intensity, and Likelihood	Significance Conclusion
	resource or property's historic value, diagnostic features, research potential, or integrity. The action would result in a prolonged disturbance of traditional subsistence hunting and fishing practices during peak seasons or times.	

3.11.2.1.1 Projects with No Potential to Cause Effects to Historic Properties

On December 20, 2017, following guidance from the Advisory Council on Historic Preservation (ACHP), NOS prepared a Statement on Surveying and Mapping Activities with No Potential to Cause Effects to Historic Properties ("Statement") (NOS, 2017). This Statement identifies NOS projects that have no potential to cause effects to historic properties, assuming such historic properties were present, per 36 CFR 800.3(a)(1). These projects, listed below, do not require consultation under Section 106 of the NHPA. The sections of this Final PEIS in which these activities are described in detail are also included below in parentheses. The full Statement includes justification for each NOS determination based on the potential for each method or technology to interact with the sea floor, where cultural and historic resources might be present. Actions that were determined to have no potential to cause effects to historic properties include:

- Operation of manned vessels (Section 2.4.1);
- Operation of remotely operated vehicles and unmanned/autonomous systems (Section 2.4.3);
- Use of echo sounders (Section 2.4.4);
- Use of acoustic doppler current profilers (Section 2.4.5);
- Use of acoustic communication systems (Section 2.4.6);
- Use of sound speed data collection equipment (Section 2.4.7);
- Operation of drop/towed cameras and video systems (Section 2.4.8); and
- Use of passive listening systems (Section 2.4.10).

However, other activities performed under the Proposed Action (such as anchoring and bottom sampling) are not included in the Statement and could potentially damage cultural resources. These substrate-disturbing activities and their potential impacts are discussed in the following sections.

3.11.2.2 Alternative A: No Action - Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

Although the survey effort under Alternative A would vary by year (see **Table 3.4-4**), the greatest number of nautical miles surveyed over the five-year period would be in the Southeast Region (over 50 percent). The survey effort in each of the other four regions would be of a similar order of magnitude, approximately 10 percent in each region over five years, although slightly greater in the Alaska Region, where the survey effort would be approximately 16 percent over five years. Survey effort in the Great Lakes would be less than one percent of the total survey effort. In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, that add nuance to this trend. Overall, NOS projects would comprise a very small part of all ocean activities as vessels used by NOS would represent a very small proportion of all vessel traffic in the action area (as discussed in Section 2.4.1). Additionally, whenever possible, the location and timing of a given project would be purposefully coordinated to ensure that areas are not repeatedly surveyed. This ensures that the potential environmental impacts directly resulting from proposed NOS activities would not be exacerbated by repeated surveys within a given area.

3.11.2.2.1 Anchoring

Approximately 20 percent of NOS crewed vessel projects involve anchoring, so under Alternative A, NOS would undertake or fund approximately 55 projects with a planned anchoring component annually. Anchoring is described in Section 2.4.2.

When a vessel is not collecting data, it may anchor either within the project area or nearby. While smaller boats used by NOS would not typically anchor except in an emergency, larger vessels conducting multi-day efforts may anchor within or near the project area to reduce the transit time to the project area and to save fuel.

Although anchoring has the potential to impact submerged isolated artifacts (e.g., fragments of tools, arrow points, stone bowls) from prehistoric or historic voyages, resources submerged as a result of sea level rise, or undocumented downed aircraft or shipwrecks, the likelihood of an anchor landing on a historic resource is low. Vessel operators would select the anchor location based on depth, protection from seas and wind, and bottom type. Preferred bottom types are sticky mud or sand, as those characteristics allow the flukes of the anchor to dig into the bottom and hold the chain in place. When working in an un-surveyed area or in an area that has not been surveyed in many years, the ship would try to anchor in bays where data have already been collected, providing the ship with better information on where to drop the anchor. These practices would continue to minimize the potential for adverse impacts to submerged cultural or historic resources. Thus, adverse impacts would be unlikely, given that the submerged cultural or historic resources likely to be present in any one area compared to the enormous extent of the action area, continued adherence to NOS protocols, and the relatively small number of projects planned that would involve anchoring.

However, in the event anchoring results in the discovery of a cultural or historic property, the coordinates of the discovery would be noted and provided to the appropriate SHPO along with any information collected.

Impacts to cultural resources from anchoring under Alternative A would continue to be **adverse** and permanent and would range from **negligible** to **moderate**, depending upon the extent of damage the anchor caused to the resource and the cultural significance of the resource damaged. Anchoring could diminish the integrity of a submerged cultural or historic resource, resulting in the loss of diagnostic features or research potential. Impacts in general would be unlikely; impacts that would be moderate or higher would be very unlikely. It is far more likely that impacts would continue to be **insignificant**.

3.11.2.2.2 Bottom Sampling

Under Alternative A, NOS would undertake or fund approximately 54 projects that require collection of bottom samples, annually. Bottom sampling is described in detail in Section 2.4.9.

NOS would continue to use previously surveyed areas when available if anchoring were required for collection of the bottom sample. This would help to ensure that bottom samples are not collected near any documented or potential historic properties. When sampling the sea floor, crews would typically use a 6” by 6” clamshell bottom snapper or similar type of grab sampler or sediment corer to obtain samples. Samples would be obtained from only the top few inches of sediment. This is unlikely to disturb any objects that may be present, as it is likely that there is a thick layer of sediment over long-buried objects. At most, a few cups of sediment would be collected during each bottom sampling activity. Samples would not be collected in waters deeper than 80 m (263 ft). In areas surveyed within the last 30 years, samples may not need to be collected at all. In keeping with NOS protocol, samples would not be collected on coral reefs, shipwrecks, obstructions, or hard bottom areas. These practices would continue to minimize the potential for adverse impacts to archaeological resources.

However, if collection of a sample results in the discovery of an object that may be eligible for listing in the NRHP, the coordinates of the discovery would be noted and provided to the appropriate SHPO along with photographs of the sample and, if practicable, the recovered object itself.

In the event of inadvertent resource discovery, effects from bottom sampling under Alternative A could be **adverse** or **beneficial**. Adverse impacts would occur if the resource were damaged or destroyed during sample collection and would range from **negligible** to **minor** (less than those that could result from anchoring activities due to the nature and smaller size of the grab sampler) and would be permanent. Beneficial impacts would occur if a resource were discovered that led to the identification of a culturally-significant artifact, group of artifacts, or previously undocumented historic site. Impacts in general would be unlikely; impacts that could be moderate or higher would be very unlikely. It is far more likely that impacts would continue to be **insignificant**.

3.11.2.2.3 Installation, Maintenance, and Removal of Tide Gauges, Buoys, and GPS Reference Stations

Tide gauge stations consist of a sensor, data collection platform, solar panels, and satellite transmitter. Tide gauge installation would continue to occur primarily out of the water at existing piers, docks, bulkheads, and similar locations. Images of tide gauge stations are included in Section 2.4.12. Under Alternative A, NOS would undertake or fund approximately 32 projects that include tide gauge installations and 305 projects that include tide gauge maintenance visits, annually. NOS would undertake or fund approximately 12 projects that include GPS reference system installation annually.

As related to the Proposed Action, in accordance with 36 CFR 800.5, potential adverse effects from the installation of tide gauges on historic properties could include, but are not limited to:

i. Physical destruction of or damage to all or part of the property;

ii. Alteration of a property, including restoration, rehabilitation, repair, and maintenance…that is not consistent with the Secretary's standards for the treatment of historic properties (36 CFR part 68) and applicable guidelines;

iii. Removal of the property from its historic location;

iv. Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance; and

v. Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features.

Impacts to coastal structures could occur if the installation of tide gauges and GPS reference stations affected the view of or from the coastal structure that would affect the integrity of the structure’s location, design, setting, materials, workmanship, feeling, or association, as described in Section 3.11.1.4. Installation of tide gauges and GPS reference stations also have the potential to damage the historic structures on which they are being placed. Pier-mounted acoustic sensors, pressure-sensor tide gauge stations, microwave sensors and instruments, shore-based GPS reference stations, and, to a lesser extent, GPS tide buoys installed within the viewshed of a nearshore historic property or designed cultural landscape have the potential to impact cultural and historic resources. Changes to these designed views, vistas, or view corridors could impact the integrity of the property's design, not simply cause visual effects on the integrity of a historic property's setting or other historic characteristics.

If a sensor or station were proposed for installation on any coastal structure or would be anticipated to cause ground disturbance, NOS would continue to confer with the appropriate SHPO prior to installation. Adherence to this protocol would continue to minimize or avoid potential impacts to coastal structures listed or eligible for listing on the NRHP.

Since NOS would continue to confer with the SHPO prior to the installation of tide gauges or GPS reference stations on properties listed or eligible for listing on the NRHP, adverse impacts to historic piers and viewsheds would be very unlikely, given the enormous extent of the action area compared to the small number of tide gauge and GPS reference station installations planned annually and the likely avoidance of historic sites during the site selection process or avoidance of impacts to historic coastal structures following communication with the SHPO.

Impacts would be very unlikely; however, if a historic resource were inadvertently damaged during installation of tide gauges or GPS reference stations, impacts would continue to be **adverse**, short-term or long-term (depending on whether the installation is temporary or more permanent), would occur only to the historic resource or the viewshed of the historic resource, and would continue to range from **negligible** to **minor**. Impacts would therefore be **insignificant**.

3.11.2.2.4 Impacts on Subsistence Hunting and Fishing Areas, Including TCPs

Where relevant, the THPO assumes oversight of the Section 106 process from the state, providing the tribe with review authority over federal undertakings (NPS, 2012b). E.O. 13175, Consultation and Coordination with Indian Tribal Governments (November 6, 2000), requires each federal agency to establish procedures for meaningful consultation and coordination with tribal officials in the development of federal policies that have tribal implications.

The procedures outlined in the NOAA Procedures for Government-to-Government Consultation with Federally Recognized Indian Tribes and Alaska Natives (NOAA Tribal Consultation Handbook) provide guidance to NOAA to support a consistent, effective, and proactive approach to communicating with tribes. Examples of actions with the potential to trigger communication with tribes include but are not limited to:

- An action that would have effects within a reservation or Alaska Native village.
- An action that may impact tribal trust resources or the rights of a federally-recognized Tribe.
- An action affecting a facility or entity owned or operated by a tribal government.
- An action that affects Tribes, tribal governments, or a tribe's traditional way of life.
- An action that affects TCPs or Traditional Use Areas.

EO 13175 and the NOAA Tribal Consultation Handbook provide required procedures for consultation in recognition of the sovereignty of federally-recognized tribes and the federal government's trust responsibility to those tribes. NOS must invite any tribe to consult on a proposed policy, regulation, or action that might have tribal implications. NOS also consults with Alaska Native corporations on the same basis as federally recognized tribes under EO 13175. NOAA also communicates with many non-recognized tribes and tribal coalition groups who have interests regarding NOAA's activities.

In recent years in Alaska, the potential for NOS work to interfere with subsistence hunting has been the primary issue of concern identified by tribes during meetings. In the Pacific Northwest, the primary issues of concern from tribes have been the potential for NOS activities to affect ecotourism and to contribute to commercial vessel traffic. Concerns about the potential for NOS work to damage or alter historically or culturally significant sites have not been routinely identified in either location by tribal representatives.

NOS would continue to attempt to coordinate projects that would occur in traditional hunting and fishing areas in Alaska and the Pacific Northwest to avoid peak hunting and fishing seasons (e.g., whale, seal, and salmon seasons) or times of year to the extent possible, based on information obtained from the tribes. The effects of NOS's projects on subsistence hunting and fishing practices of Alaska Natives and indigenous tribes are discussed in further detail in Section 3.13.2. Any impacts to subsistence hunting or fishing that might occur if traditional hunting and fishing areas cannot be avoided during peak seasons are also described in Section 3.13.2.

Activities planned to occur in any NRHP-listed TCP would continue to comply with federal regulations related to the protection of these culturally significant places. The Section 106 review process is mandated for any federal projects that might affect a TCP; consultation with the affected traditional community may also be required (NPS, No Date-a). With the legal protection afforded to listed TCPs by the Section 106 review process, the effects of NOS activities in these areas under Alternative A are expected to be **adverse**, short-term (lasting only the duration of the activity), **negligible** to **minor**, and **insignificant**.

NOS would continue to facilitate tribal involvement related to planned projects throughout the action area. For example, regional Coast Survey representatives ("Navigation Managers") for Alaska and the Pacific Northwest would continue to discuss survey plans for the upcoming year during meetings open to the public. It is anticipated that these meetings would continue to be attended by tribal leadership or members. Meetings in the Pacific Northwest (Harbor Safety Committee meetings) would continue to take place approximately once every two months. In Alaska, meetings would continue to occur six to eight times per year. Following meetings, meeting minutes would continue to be developed and posted online.

Although NOS projects under Alternative A could temporarily interfere with traditional subsistence hunting and fishing practices during peak seasons or times, with ongoing communication between NOS and THPOs and attempted avoidance of these areas during peak times to the extent practicable, impacts under Alternative A of projects on subsistence hunting and fishing areas, including TCPs, would continue to be **adverse**, short-term (lasting only the duration of the activity), **negligible** to **moderate**, and **insignificant**.

3.11.2.2.5 Conclusion

The effects of impact causing factors on cultural resources range from negligible to moderate**;** thus, the overall impact of Alternative A on cultural resources, including impacts to submerged cultural or historic resources; coastal infrastructure; viewsheds of nearshore historic properties and designed cultural landscapes; and subsistence hunting and fishing areas, including TCPs, would continue to be **adverse** and **moderate.** Therefore, impacts of Alternative A to cultural and historic resources would continue to be **insignificant**.

3.11.2.3 Alternative B: Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations

The same impact causing factors on cultural resources considered under Alternative A are considered under Alternative B. Under Alternative B, all of the activities and equipment operations proposed in Alternative A would continue but at a higher level of effort, although the percentage of nautical miles covered by projects in each region would be the same as under Alternative A. Total survey effort for Alternative B in each region for the five-year timeframe is shown in **Table 3.4-5**. The greatest number of nautical miles surveyed over the five-year period would be in the Southeast Region (over 50 percent). The survey effort in each of the other four regions is of a similar order of magnitude (approximately 10 percent in each region over the five-year period), although slightly greater in the Alaska Region (approximately 16 percent). Survey effort in the Great Lakes over the five-year period would represent less than one percent of the overall survey effort. As described under Alternative A, it is generally expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, that add nuance to this trend.

Survey activities under Alternative B would take place in the same geographic areas and timeframes as under Alternative A; however, Alternative B would include more projects and activities and thus more nautical miles traveled than Alternative A. Overall, there would be an additional 264,796 nm (490,402 km) of survey effort under Alternative B as compared to Alternative A. The types and mechanisms of impacts would remain the same in Alternative B as discussed for Alternative A. Therefore, the difference between the two alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in the potential for effects under Alternative B as compared to Alternative A.

Impacts of Alternative B on cultural resources, including submerged cultural or historic resources; coastal infrastructure; viewsheds of nearshore historic properties and designed cultural landscapes; and subsistence hunting and fishing areas, including TCPs, would be the same or slightly, but not appreciably, larger than those discussed above under Alternative A for each impact causing factor. Overall, impacts on cultural resources under Alternative B would be **adverse**, **moderate**, and **insignificant**.

3.11.2.4 Alternative C: Upgrades and Improvements with Greater Funding Support

The same impact causing factors for cultural resources considered under Alternatives A and B are considered under Alternative C. Under Alternative C, all of the activities and equipment operation proposed in Alternatives A and B would continue but at an even greater level of effort than Alternative B, given the overall funding increase of 20 percent relative to Alternative B. However, the percentage of linear nautical miles of survey effort in each region would be the same as under Alternatives A and B. Total survey effort for Alternative C in each region for the five-year timeframe is shown in **Table 3.4-6.** The greatest number of nautical miles surveyed over the five-year period would be in the Southeast Region (over 50 percent). The survey effort in each of the other four regions would be of a similar order of magnitude (approximately 10 percent in each region over five years), although slightly greater in the Alaska Region (approximately 16 percent over five years). Survey effort in the Great Lakes over the five-year period would be less than one percent of the overall survey effort. As described under Alternatives A and B, it is generally expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as location and depth of surveys, that add nuance to this trend.

Survey activities under Alternative C would take place in the same geographic areas and timeframes as under Alternatives A and B; however, Alternative C would include more projects and activities and thus more nautical miles traveled than Alternatives A and B. Overall, there would be an additional 264,796 nm (490,402 km) of survey effort under Alternative C as compared to Alternative B, and an additional 529,592 nm (980,803 km) as compared to Alternative A. The types and mechanisms of impacts would remain the same in Alternative C as discussed for Alternatives A and B. Therefore, the difference between the alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative C as compared to Alternatives A and B.

The potential for impacts to cultural resources from Alternative C, including impacts to submerged cultural or historic resources; coastal infrastructure; viewsheds of nearshore historic properties and designed cultural landscapes; and subsistence hunting and fishing areas, including TCPs, would be the same or somewhat, but not appreciably, greater than those discussed above under Alternative A for each impact causing factor. Overall, impacts on cultural resources under Alternative C would be **adverse**, **moderate**, and **insignificant.**

3.12 Socioeconomic Resources

This section identifies those aspects of the social and economic environment in the action area that may be affected by the Proposed Action. The Proposed Action is essential to the coastal economy because it ensures safe navigation for coastal-dependent industries and provides data for local communities to plan for coastal resiliency in response to climate change. Potential socioeconomic impacts with the greatest magnitude, duration, and extent would occur in U.S. coastal communities and the U.S. Ocean and Great Lakes economies (referred to as the "ocean economy" from here on). U.S. coastal communities and the ocean economy are the focus for the analysis of direct socioeconomic impacts.

There are over 120 million people living in U.S coastal counties (OCM, 2021). Although some NOS projects would occur in coastal areas, they would not substantially affect social values, aesthetics, or demographic composition of the action area and likely would not have a substantial direct or indirect social impact. The Proposed Action would not require hiring at a scale which would substantially alter any local economies or stimulate migrations of populations. Furthermore, all of NOS's activities except for the installation, maintenance, and removal of tide gauges would occur offshore, so sound and visual intrusions from all other activities would not be experienced by the general public. In addition, due to the expansive geographic scope of the action area and the programmatic nature of this Final PEIS, any social impact to demographic composition, aesthetics, or social values of communities would be difficult to quantify.

A discussion of coastal minority and low-income communities that rely on subsistence hunting and fishing is presented in detail in Section 3.13, Environmental Justice.

The coronavirus disease 2019 (COVID-19) pandemic has caused many changes in the ocean economy. Widespread reductions in consumer behaviors and demand have drastically disrupted the maritime shipping, tourism, and commercial fishing sectors. Given the unprecedented nature of the situation, it is currently unclear how the ocean economy will continue to adapt and change moving into the future. Long-term ocean economic trends will be contingent upon many highly unpredictable variables, including the impacts of the COVID-19 virus on the global population level, international trade policy, consumer attitudes/behavior, and demand for tourism. Considering the uncertainty of the situation, any current projections of future economic activity based on the small quantity of available pandemic economic data would be highly speculative and may not accurately represent future economic conditions. Therefore, the analysis of socioeconomic impacts does not attempt to account for the effects of the COVID-19 pandemic and instead uses the best available pre-pandemic data. Although the magnitude and extent of impacts described by these data may be inflated compared to current economic conditions, the trends suggested by these analyses should remain constant.

The data supporting this analysis were collected and derived from standard sources, including federal agencies such as NOAA, the U.S. Census Bureau (USCB), Bureau of Labor Statistics (BLS), and Bureau of Economic Analysis (BEA). All of the tables in this section present data from the NOAA Economics: National Ocean Watch (ENOW) dataset, which is developed by NOAA's Office for Coastal Management in partnership with the BEA, BLS, and USCB. National and regional economic data presented in this section focus on the ocean economy and its supporting sectors.

3.12.1 Affected Environment

The ocean economy consists of six sectors: marine construction; living resources; offshore mineral extraction; ship and boat building; tourism and recreation; and marine transportation. Marine construction includes dredging navigation channels, beach renourishment, and pier building.

In 2016, the ocean economy's 154,000 business establishments employed about 3.3 million people, paid $129 billion in wages, and produced $304 billion in goods and services (OCM, 2022). As described in the 2019 NOAA Report on the U.S. Ocean and Great Lakes Economy, this accounted for 2.3 percent of the nation's employment and 1.6 percent of its gross domestic product (GDP) in 2016. Employment in the ocean economy rose 2.7 percent (adding 85,000 jobs) from 2015 to 2016 – faster than the national average employment growth of 1.7 percent. To put this in perspective, the ocean economy generated a larger share of the U.S. economy in 2016 than many better-known economic activities such as crop production, telecommunications, and building construction. In 2016, the ocean economy employed more people than these three sectors combined (OCM, 2022b).

National data by industry sector for the ocean economy in 2016 are shown in **Table 3.12-1**. The tourism and recreation sector was the largest in terms of establishments, employment, wages, and contribution to GDP.

Table 3.12-1. U.S. Ocean and Great Lakes National Economy by Sector (2016)

Industry Sector	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
Tourism and Recreation	125,972	2,367,746	58,727,878	124,232,520
Marine Transportation	10,191	467,453	32,726,192	64,313,381
Offshore Mineral Extraction	4,960	132,007	20,241,667	80,130,037
Living Resources	8,517	87,869	3,941,825	11,292,923
Marine Construction	3,053	45,092	3,267,443	6,397,310
Ship and Boat Building	1,751	157,912	10,521,187	17,498,842
Total	154,492	3,258,081	129,426,193	303,865,013

Source: OCM, 2022a[10]

National data by region for the ocean economy in 2016 are shown in **Table 3.12-2**. The Mid-Atlantic Region had the most establishments (41,407) and employees (787,652) compared to the other regions; but the Gulf of Mexico paid the most in wages (about $33.6 billion) and produced the most in goods and services (about $104 billion).

[10] The values used to quantify the contribution of living resources to GDP were published by OCM in the NOAA Report on the U.S. Marine Economy which uses Economics: ENOW data. There may be discrepancies between state collected data and data collected by NOAA. This may be the result of the contribution of self-employed workers which are a large part of the living resources sector; however, the ENOW data cited in this section looks exclusively at the component of the data that focuses on businesses with employees. The purpose of this analysis was to review the economic impact of this programmatic action over the entire action area and the OCM data was the best available data for the entire action area.

Table 3.12-2. U.S. Ocean and Great Lakes National Economy by Region (2016)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
Mid-Atlantic	41,407	787,652	2,937,154	57,192,282
Gulf of Mexico	24,570	598,311	33,607,076	104,355,021
West	32,887	733,118	29,517,336	62,118,004
Southeast	18,888	402,438	11,108,623	24,650,323
Northeast	15,185	260,056	9,775,768	19,253,186
Great Lakes	14,805	310,855	8,835,522	19,027,089
North Pacific	2,412	47,561	2,744,865	8,643,807
Pacific	4,338	118,083	4,465,464	8,625,298
Total	154,492	3,258,074	102,991,808	303,865,010

Source: OCM, 2022a

Note: Totals from Table 3.12-2 may not exactly match the total or the “All Ocean Sectors” row from Table 3.12-1 due to rounding.

Economic data from NOAA’s ENOW 2016 dataset are presented in Sections 3.12.1.1 through 3.12.1.6 for each of the six sectors that compose the ocean economy, highlighting the importance of contributions from ocean and Great Lakes-dependent activities to the nation’s economy. As stated above, NOS data acquisition informs charting that provide for safe navigation that is crucial to the ocean economy. NOS data serve a variety of users including commercial and recreational mariners, emergency and coastal managers and responders, researchers, educators, and others. Furthermore, these data provide information that is essential for coastal resiliency planning for coastal communities, particularly on the East Coast.

3.12.1.1 Tourism and Recreation

In 2016, the tourism and recreation sector of the ocean economy had more business establishments and employed more people than all the other five sectors combined. It was also the largest sector measured in terms of GDP, accounting for about 41 percent of the total ocean economy. This sector includes a wide range of businesses that attract or support ocean-based tourism and recreation: eating and drinking places, hotels and lodging, scenic water tours, parks, marinas, recreational vehicle parks and campsites, and associated sporting goods manufacturing (OCM, 2022b).

While this sector employs more people and pays more in total wages than any of the other sectors of the ocean economy, the seasonal nature of the activities and the large number of part-time jobs (which are often held by students and others just entering the workforce) accounts for the relatively low average annual wages for employees ($25,000). From 2015 to 2016, tourism and recreation gained 73,000 jobs, accounting for most of the employment growth in the ocean economy. The majority of the jobs are in hotels and restaurants. These two industries together account for 94 percent of employment and 92 percent of GDP in this sector. Although vacationers stay at hotels and eat in restaurants, many of the coastal and oceanic amenities that attract visitors are free, such as beach visitation and swimming. These “nonmarket” activities generate no direct employment, wages, or GDP. However, they are usually key drivers for all of the market-based activity, and can be greatly affected by ecosystem health, water quality, and the associated aesthetics (OCM, 2022b).

California and Florida are the two major contributors to the sector, accounting for more than one-third of the sector's total employment and GDP in 2016 (OCM, 2022b). A summary of the tourism and recreation sector by region is shown in **Table 3.12-3**.

Table 3.12-3. Tourism and Recreation Sector by Region (2016)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
Mid-Atlantic	36,407	600,271	16,520,850	34,367,599
West	27,363	535,852	14,075,099	29,398,853
Gulf of Mexico	16,249	338,837	7,096,812	14,781,708
Southeast	15,502	335,204	7,611,164	16,378,267
Great Lakes	12,355	240,214	4,929,997	11,097,080
Northeast	12,458	189,098	4,520,523	9,732,781
Pacific	4,020	105,573	3,439,781	7,400,476
North Pacific	1,618	22,691	533,652	1,075,758
Total	125,972	2,367,746	58,727,878	124,232,520

Source: OCM, 2022a

3.12.1.2 Marine and Coastal Transportation

The marine and coastal transportation sector includes businesses engaged in the traffic of deep-sea and intracoastal freight, marine and intracoastal passenger services, warehousing, and the manufacturing of navigation equipment. This sector accounted for 14.3 percent of the employment and 21.2 percent of the GDP of the U.S. Ocean and Great Lakes economy. About 21.5 percent of employment and 25.1 percent of GDP attributable to the sector are supported by California. The rest is distributed across the nation, concentrated around major ports (OCM, 2022b). A summary of the marine and coastal transportation sector by region is shown in **Table 3.12-4**.

Table 3.12-4. Marine and Coastal Transportation by Region (2016)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
West	2,384	127,202	10,398,448	20,053,221
Mid-Atlantic	2,217	124,407	8,770,712	15,833,490
Gulf of Mexico	1,980	80,392	5,127,189	11,637,926
Great Lakes	1,231	55,354	3,107,550	5,652,450
Southeast	1,417	45,053	2,488,822	5,638,885
Northeast	430	23,178	2,007,429	3,599,582
North Pacific	229	2,253	158,625	393,735
Pacific	102	3,806	303,100	687,602
Total	10,191	467,453	32,726,192	64,313,381

Source: OCM, 2022a

Warehousing is the largest component of this sector in terms of employment, accounting for 50 percent of total sector employment. These figures include loading, unloading, and warehousing cargo and the movement of cargo in and out of harbors, but they do not include the value of the cargo itself. The $1.5 trillion of cargo imported or exported through U.S. ports in 2016 is suggestive of the large indirect effects of coastal ports; not only are maritime commerce and navigation linked to other ocean uses, they are also linked to land-based transportation needs (OCM, 2022b). Over 82,000 vessel calls were made at U.S. ports during 2015 (USDOT, 2017). Vessels carrying cargo are becoming larger and have deeper drafts than ever before. These vessels include bulk ships carrying iron, coal, and grain for export; heavy-load vessels carrying project cargo (large, heavy, high value or critical pieces of equipment for the project they are intended for); container ships carrying general export and import cargo for markets around the U.S. and the world; and tankers carrying petroleum and other liquids used to power U.S. transportation systems and industry (OCM, 2022b). Many of these goods are also transported along coastal and inland waterways, which transport approximately 15 percent of U.S. freight at the lowest unit cost of any transportation method (USACE, 2012a). Imported and exported goods account for 40 percent of U.S. foreign trade as measured by value and 69 percent as measured by weight. These effects are realized across the nation, accruing as benefits to the producers of agricultural and manufactured products that are sold in international markets and to the manufacturers and retailers whose businesses rely on imported goods (OCM, 2022b).

3.12.1.3 Offshore Mineral Extraction

Offshore mineral extraction includes oil and gas exploration and production, as well as limestone, sand, and gravel mining in the coastal and marine environment. This sector accounted for 4.1 percent of the total employment in the ocean economy in 2016, but contributed 26.4 percent of the GDP. Offshore mineral extraction is capital-intensive, requiring substantial investments in research, engineering, infrastructure, and operational equipment such as oceangoing vessels and drilling platforms. Much of the work in this sector takes place in hazardous conditions, and is one of the reasons the average annual wage per employee in this sector was $153,000 – almost three times the national average (OCM, 2022b).

Oil and gas production is the largest component of this sector and is principally located in the Gulf of Mexico, as shown in **Table 3.12-5**. The Gulf of Mexico, both onshore and offshore, is one of the most important regions for energy resources and infrastructure. Gulf of Mexico federal offshore oil production accounts for 17 percent of total U.S. crude oil production and federal offshore natural gas production in the Gulf accounts for 5 percent of total U.S. dry gas production. Crude oil production in federal waters exceeds 1.5 million barrels/day and dry gas production is 1.2 trillion cubic feet annually. Over 45 percent of total U.S. petroleum refining capacity is located along the Gulf Coast, as well as 51 percent of total U.S. natural gas processing plant capacity (EIA, 2022a, 2022b). Oil prices fell sharply between 2015 and 2016, leading to declines in the inflation-adjusted GDP of the offshore mineral extraction sector (down 18 percent) and the ocean economy as a whole (down 7 percent).

Table 3.12-5. Offshore Mineral Extraction by Region (2016)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
Gulf of Mexico	3,336	106,792	17,411,920	70,099,694
West	548	9,710	1,030,956	2,930,128
Mid-Atlantic	318	1,700	119,839	387,286
Great Lakes	277	921	64,564	305,312
North Pacific	170	11,525	1,529,061	5,972,744
Southeast	152	522	24,845	65,239
Northeast	123	659	45,198	314,739
Pacific	11	110	11,828	45,866

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
Total	4,960	132,007	20,241,667	80,130,037

Source: OCM, 2022a

Limestone, sand, and gravel production is generally performed in support of marine and coastal construction activities and is, therefore, widely distributed among the U.S. coastal states. Generally speaking, states with large economies and long coastlines such as California, Washington, Florida, and Texas have the greatest production of sand, gravel, and limestone (OCM, 2022b).

3.12.1.4 Living Resources

The living resources sector includes the commercial fishing, fish hatcheries and aquaculture, seafood processing, and seafood markets industries. The living resources sector accounted for 3 percent of the employment and 4 percent of GDP of the ocean economy in 2016 (OCM, 2022b). Seafood processing converts the whole fish or shellfish harvested by fishermen or produced by aquaculture operations into the products that are sold at retail stores or restaurants. It is the largest producer in the living resources sector, accounting for 41 percent of the contribution to GDP. The seafood market industry retails fresh, frozen, and cured fish and seafood items such as tuna, salmon, lobster, and shrimp. Products are sold at various brick-and-mortar locations including independent markets, delicatessens, fishmongers, and butcher shops. Fish and seafood markets and counters operating within a supermarket are excluded from this industry, as are online sales of fish products. The seafood market industry accounts for most of the employed workers at 46 percent of the sector (OCM, 2022b). In 2015, the seafood industry supported 1.2 million full-and part-time jobs and generated $144.2 billion in sales, $39.7 billion in income, and $60.6 billion in value-added impacts nationwide. The seafood retail sector generated the largest employment impacts across sectors at 573,000 jobs, the largest income impacts ($13.3 billion), and the largest value-added impacts ($18.2 billion) (NMFS, 2017e).

Commercial fishing can be an important component of a community's identity. Lobster, crab, oysters, and finfish are important to cultural identities from Maine to the Chesapeake Bay on the Mid-Atlantic Coast, Apalachicola Bay in Florida, and Grays Harbor in Washington. Shrimp and crawfish are an integral part of Cajun culture and Creole cuisine in Louisiana. Even seafood processing and marketing can shape cultural identities; consider the examples of Cannery Row in Monterey, California, and the Pike Place Market in Seattle, Washington (OCM, 2022b). The impact of fishing and seafood in the Western, Gulf of Mexico, Mid-Atlantic, and Northeast regions' cultural identities is reflected in the number of establishments, employment, wages, and contribution to GDP (see **Table 3.12-6**).

Table 3.12-6. Living Resources Economy by Region (2016)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
West	1,802	21,654	1,137,858	2,899,629
Gulf of Mexico	1,625	17,117	590,094	1,943,584
Mid-Atlantic	1,667	14,102	572,160	1,947,744
Northeast	1,637	11,791	658,892	1,892,138
Southeast	855	7,143	275,500	841,473
Great Lakes	451	4,101	172,990	486,094
North Pacific	324	10364	469,313	1,116,862

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
Pacific	153	1,591	65,019	165,399
Total	8,517	87,869	3,941,825	11,292,923

Source: OCM, 2022a

The living resource sector relies on the health of coastal and ocean ecosystems. The sector also depends on coastal wetlands that serve as habitat, juvenile nurseries, and feeding grounds for marine fish; estuaries that are the primary habitat for oysters and other shellfish; and the open ocean ecosystems where much of the finfish harvesting occurs. The health of these ecosystems can be affected by a wide range of other activities which underscores the need for wise use, conservation, monitoring, and management of ocean and coastal resources. For example, **Figure 3.12-1** shows coastal wetlands in Alaska that serve as a nursery and rearing habitat for juvenile Pacific salmon. These “salmon factories” are crucial for maintaining the wild salmon stocks upon which the commercial salmon fishery industry in Alaska depends.

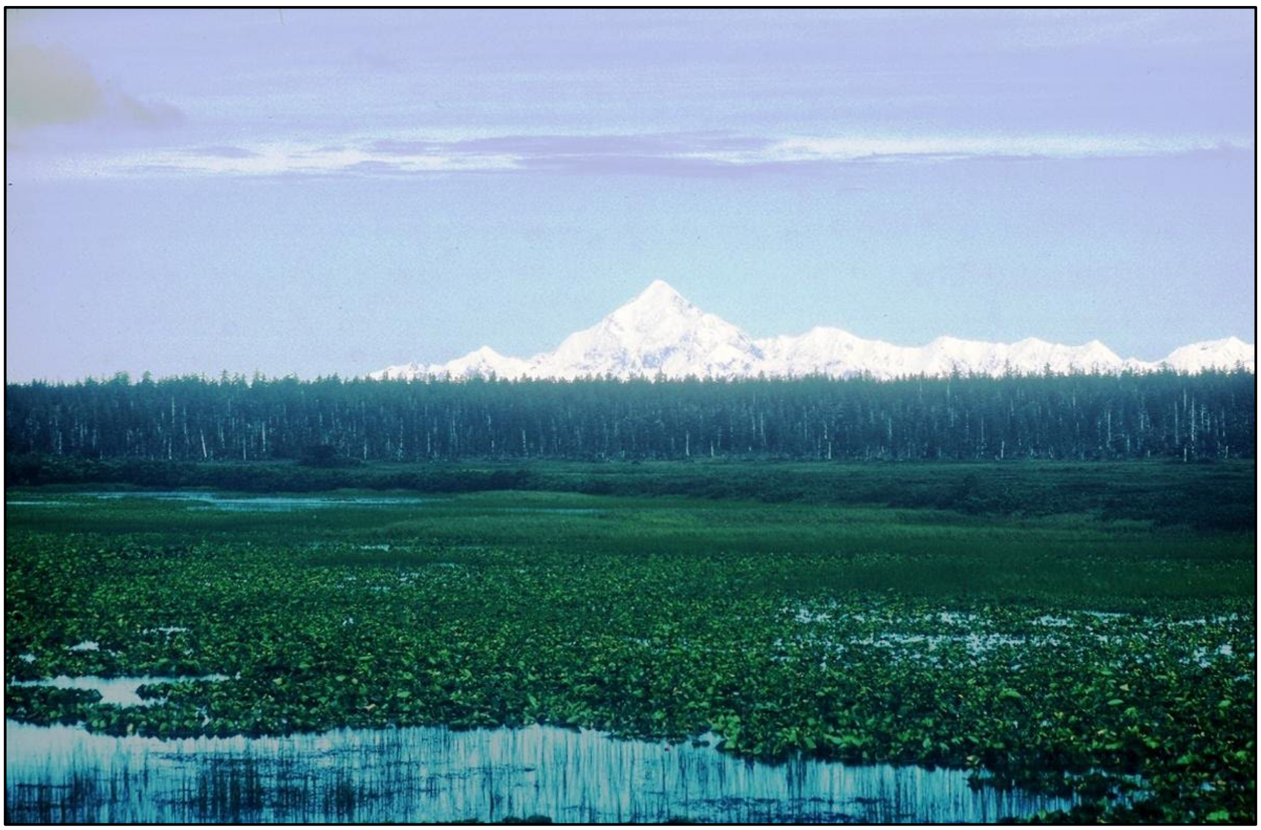


Photo Credit: Leon Kolankiewicz

Figure 3.12-1. Coastal Wetland in Alaska Serves as Nursery and Rearing Habitat for Juvenile Pacific Salmon

3.12.1.5 Marine Construction and Planning

The marine construction sector accounts for heavy construction activities associated with dredging of navigation channels, beach renourishment, and pier building[11]. Marine construction accounted for 1.4 percent of the employment and 2 percent of the GDP in the ocean economy in 2016. While the sector represents a small percentage of the ocean economy, it is an integral component, paying one of the highest annual average wages per employee of $72,000, much higher than the national average of $54,000. Furthermore, construction activities such as dredging navigation channels and renourishing beaches are vital to the marine transportation and tourism and recreation sectors (OCM, 2022b).

Coastal resilience planning is an increasingly important component of marine and coastal construction. Rising sea levels and extreme weather events are constantly eroding coastlines throughout the action area. Erosion rates vary considerably from location to location and year to year, but average less than 1 m (2-3 ft) annually along the Atlantic coast and over 2 m (6 ft) annually in areas bordering the Gulf of Mexico (Heinz Center, 2000). Pacific coastlines tend to erode less than 0.3 m (1 ft) each year, but this lower rate is primarily a result of averaging episodic cliff erosion events, which can erode over 31 (100 ft) of coastline at one time, over many years (Heinz Center, 2000). Nationwide, annual coastal erosion may be responsible for $500 million in property loss to coastal landowners, including both damage to structures and loss of land. Approximately 87,000 homes are currently located in low-lying land or coastal bluffs that are likely to erode into the ocean by 2060. The federal government currently spends over $150 million annually on coastal resilience enhancement, including beach nourishment and other erosion prevention measures such as structural rip-rap installation (USGCRP, 2018).

Marine construction activities occur in most regions of the U.S., but are highly concentrated in Florida, Texas, California, and Louisiana, which together in 2016 accounted for about 56 percent of the employment and about 54 percent of GDP contribution from this sector. Marine construction economics by region are shown in **Table 3.12-7**.

[11] Data for activities supporting offshore oil and gas production would normally be considered a form of marine construction. However, the underlying data on these activities are almost always suppressed because of the small number of businesses in any one area. In many cases, protecting the confidentiality of these businesses requires the suppression of the entire sector, including information for activities that could otherwise be reported. For this reason, these activities are not included in ENOW's data on the ocean economy. The effect of this omission is most prominent in the Gulf of Mexico and Alaska (OCM, 2022b).

Table 3.12-7. Marine Construction Economy by Region (2016)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
West	486	8,653	784,166	1,569,650
Gulf of Mexico	719	15,904	1,055,460	1,974,990
Mid-Atlantic	617	8,571	681,813	1,360,598
Northeast	159	2,425	110,256	193,613
Southeast	597	5,550	300,605	639,694
Great Lakes	326	2,074	154,677	303,677
North Pacific	47	354	35,066	59,171
Pacific	30	1,126	116,360	238,177
Total	3,053	45,092	3,267,443	6,397,310

Source: OCM, 2022a

3.12.1.6 Ship and Boat Building

This sector includes the construction, maintenance, and repair of ships, recreational boats, commercial fishing vessels, ferries, and other marine vessels. The ship and boat building sector accounted for 4.8 percent of employment and 6 percent of GDP in the ocean economy in 2016. The construction, maintenance, and repair of ships in particular (as opposed to recreational boats, commercial fishing vessels, ferries, and other marine vessels) accounted for about 83 percent of the sector's employment and 84 percent of GDP (OCM, 2022b).

Large shipyards are concentrated in a few locations around the country. However, boat building and repair activity is spread throughout the country, with concentrations in areas with high levels of commercial fishing and recreational boating. In 2016, Virginia contributed most to employment in this sector, accounting for 22 percent of the national total. Washington State was the largest contributor to GDP, accounting for 23 percent of the total. Kitsap County, Washington contributed more to the nation's ship and boat building sector than any other county in the U.S.; it alone accounted for about 9 percent of the employment and 18 percent of the GDP in the nation's ship and boat building sector (OCM, 2022b). The number of establishments, employment, wages, and contribution to GDP are shown by region in **Table 3.12-8**.

Table 3.12-8. Ship and Boat Building by Region (2016)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
West	304	30,044	2,090,809	5,266,522
Gulf of Mexico	573	37,561	2,225,882	3,737,732
Mid-Atlantic	173	38,528	2,702,482	3,288,397
Northeast	188	28,371	2,139,833	2,825,495
Southeast	365	8,959	407,687	1,086,764
Great Lakes	81	6,920	351,895	928,987
North Pacific	24	372	19,147	25,538
Pacific	22	5,873	529,376	87,778
Total	1,751	157,912	10,521,187	17,498,842

Source: OCM, 2022a

3.12.2 Environmental Consequences for Socioeconomic Resources

This section discusses potential impacts of Alternatives A, B, and C on socioeconomic resources.

3.12.2.1 Methodology

NOS activities would not substantially directly impact socioeconomic resources. The collection of oceanic data in Alternatives A, B, and C would not result in the hiring of personnel. Instead, NOS projects would support the collection of ocean data in order to provide information for a variety of users including commercial and recreational mariners, commercial and recreational fishing industries, renewable and non-renewable energy developers, emergency and coastal managers and responders, researchers, educators, and others (NERACOOS, No Date). The data collected would allow businesses and coastal economies to increase operational efficiency and reduce risks associated with oceanic activities.

As discussed in Section 3.2.2, significance criteria were developed for each resource analyzed in this Final PEIS to provide a structured framework for assessing impacts from the alternatives and the significance of the impacts. The significance criteria for socioeconomic resources are shown in **Table 3.12-9**.

Table 3.12-9. Significance Criteria for the Analysis of Impacts to Socioeconomic Resources

Impact Descriptor	Context and Intensity	Significance Conclusion
Negligible	There would be no detectable effect on businesses and employment; the recreational experience and revenue from recreational expenditures; coastal economic systems; or sectors of the larger Ocean and Great Lakes economies in response to NOS projects and the resulting data. Several coastal towns or the coastal economy of a state could be impacted by NOS activities. Impacts would be temporary and would last the duration of and immediately after project activities.	Insignificant
Minor	There would be a detectable effect on businesses and employment; the recreational experience and revenue from recreational expenditures; coastal economic systems; or sectors of the larger Ocean and Great Lakes economies in response to NOS projects and the resulting data. Several coastal towns or the coastal economy of a state and/or the coastal economies of several states could be impacted by NOS activities. Impacts would be short-term and would last beyond activities, up to one year.	
Moderate	There would be a sizeable effect on businesses and employment; the recreational experience and revenue from recreational expenditures; coastal economic systems; or sectors of the larger Ocean and Great Lakes economies in response to NOS projects and the resulting data. The coastal economies of several states and/or most of or all of the coastal economies in the Exclusive	

Impact Descriptor	Context and Intensity	Significance Conclusion
	Economic Zone (EEZ) would be impacted by activities. Impacts would be short-term and/or long-term, lasting longer than one year.	
Major	There would be a substantial effect on businesses and employment; the recreational experience and revenue from recreational expenditures; coastal economic systems; or sectors of the larger Ocean and Great Lakes economies in response to NOS projects and the resulting data. The coastal economies of several states and/or most of or all of the coastal economies in the EEZ would be impacted by activities. Impacts would be short-term and/or long-term, lasting longer than one year.	Significant

3.12.2.2 Alternative A: No Action - Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

Although the survey effort under Alternative A would vary by year (see **Table 3.4-4**), the greatest number of nautical miles surveyed over the five-year period would be in the Southeast Region (over 50 percent). The survey effort in each of the other four regions are of a similar order of magnitude (approximately 10 percent in each region for each of the five years), and is slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 16 percent). Additionally, survey effort in the Great Lakes would average 2,917 nm (5,402 km) annually, as compared to the remaining annual average survey effort of 529,592 nm (980,803 km). In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as the type, location and depth of surveys, that add nuance to this trend.

3.12.2.2.1 Economic Benefits of Coastal and Marine Data

NOS conducts recurring surveys throughout the action area to characterize ocean features (e.g., habitat, currents, bathymetry, marine debris). Data collected from these projects are used by NOS and other entities, both public and private, to produce charts, maps, and other hydrographic products that are relied upon by mariners, scientists, shipping and fishing industries, and many other users in the U.S. and beyond. Therefore, although few direct economic impacts (i.e., job creation, large capital investment) are anticipated as a result of Alternative A, the distribution and availability of data collected as a result of NOS activities could indirectly benefit ocean economy stakeholders by increasing the efficiency and risk management of ocean-related operations.

Quantifying the indirect economic benefits of increased ocean surveying and mapping data, quality, and availability is inherently difficult due to the lack of available data necessary to quantify economic impacts over the entire action area. The economic benefits of ocean surveying and mapping data are derived from the value of the information and the effects that information has on the behavior of individuals and organizations. The standard measure of these economic benefits is the value that users of the information place on it, based on their willingness to pay for such information to either enhance their uses of ocean resources or to avoid harms that may come from oceanic or atmospheric phenomena affecting individuals and organizations. The propensity of users to pay for such information is a measure of "social surplus" (i.e., the value of the information in excess of the costs of acquiring it). When such value accrues to businesses, it is referred to as “producer surplus”; when it accrues to individual users, it is “consumer surplus” (Kite-Powell et al., 2004). The economic information needed to compile estimates of both the total users of such information and the value they place on such information is only sporadically available and usually incomplete. As such, attempts to quantify these values would be highly subjective, speculative, and would not accurately represent the intensity or extent of impact across the entire action area.

Nearly all sectors of the ocean economy would benefit from the data tools and products resulting from data collection during NOS projects. Kite-Powell et al.’s 2004 “Estimating the Economic Benefits of Regional Ocean Observing Systems” evaluates the potential economic benefits that can be realized by developing and deploying enhanced data collection systems (e.g., data collection buoys) within the action area. Although NOS uses different methods than those analyzed by Kite-Powell et al. (2004) to collect data, the primary economic impacts of the alternatives would result from data products and tools developed from data collected during NOS projects and would be consistent with the resulting impacts of increased data collection described by Kite-Powell et al. (2004) regardless of the differing collection methods. As such, the results of the Kite-Powell et al. (2004) report serve as the primary basis for this economic impact analysis. The report examines five major affected economic activities, including recreational activities (e.g., boating, beach going, fishing); transportation (e.g., freight, cruise ships); health and safety (e.g., search and rescue, oil spill and hazard cleanup, property damage); energy (e.g., oil and gas development, electric generation management); and commercial fishing.

Kite-Powell et al. (2004) conducted reviews of these activities in 10 coastal regions (Pacific Northwest, California, Gulf of Mexico, Florida, Southern Atlantic coast, Mid Atlantic coast, New England/Gulf of Maine, Alaska, Hawai’i, and the Great Lakes) to establish baseline economic conditions and the potential impact of improved coastal and marine data quality and availability. Benefits were estimated using a multi-phased modeling process. Baseline estimates were first calculated by conservatively assuming that total social surplus generated from increased coastal and marine data quality and availability within a specific economic sector was one percent of the total economic activity (i.e., revenues or expenditures, depending on the benefit) of the sector reported in publicly available economic data sources. This assumption reflects the likelihood that changes in consumer and producer surplus elicited by coastal and marine data are small relative to the total aggregate level of expenditures and revenues within a sector, and is standard in the estimation of economic benefits from weather and atmospheric data. The second phase of the estimation process used fine-scale economic modeling of representative regional economic activities as case studies to validate the magnitude of estimates from the first phase of modeling; the activities modelled in phase two were selected on the basis of data availability (Kite-Powell et al., 2004).

Table 3.12-10 summarizes the potentially affected economic sectors, their predominant region(s) of influence, and descriptions of the types of indirect benefits from increased coastal and marine data, quality, and availability.

Table 3.12-10. Summary of Benefits to Activities Affected by Coastal and Marine Data

Activity		Region*	Description of Benefit
Health & Safety	Search & Rescue	Pacific Northwest, Gulf of Maine, Mid Atlantic coast, South Atlantic coast, California, Alaska, Hawai’i,	Costs saved to U.S. Coast Guard plus value of lost lives saved; cost saved to local rescue squads plus value of lost lives saved; value of

Activity		Region*	Description of Benefit
		Florida, Great Lakes, Gulf of Mexico	life; avoidance of costly accidents or collisions
	Oil Spills	Pacific Northwest, California, Gulf of Mexico	Reductions in clean up and compensation costs
	Tropical Storm Prediction	South Atlantic	Reduced loss of life, evacuation cost, and lost tourism revenue
	Residential Property	Florida South Atlantic	Avoided costs from earlier preparation for storms; coastal resilience planning
	Beach Restoration	California	Daily cost saving on beach restoration from optimized planning
Recreational Activities	Recreational Fishing	Pacific Northwest, Mid Atlantic coast, Southern Atlantic coast, Florida, Gulf of Mexico, California, Hawai'i, Great Lakes	Willingness to pay for improved charts and maps; increased licensing and chartering expenditures
	Recreational Boating	California, Gulf of Mexico, Gulf of Maine, Mid Atlantic coast, South Atlantic coast, Alaska, Hawai'i, Florida, Great Lakes, California	Willingness to pay for improved charts and maps; increased chartering and fuel expenditures
	Beaches	Florida, Great Lakes, California	Beach-related consumer expenditures; increased economic impact; operating cost savings; increased business sales; increased visitor daily values; increased consumer surplus
Transportation	Freight	Pacific Northwest, Gulf of Maine, Mid-Atlantic coast, South Atlantic coast, Alaska, Florida, Great Lakes, California, Gulf of Mexico	Daily cost savings from optimized route-planning
	Cruise Ships	Pacific Northwest	
Energy	Electric Load Planning	Great Lakes	Avoided use of most expensive peak generators; operating cost savings
	Oil and Gas Development	Gulf of Mexico	Operating cost savings; increased accuracy of oceanographic risks in design
Commercial Fishing		Pacific Northwest Gulf of Maine Mid-Atlantic coast	Increased landed values; total regional economic impact in industries dependent on living resources (e.g., seafood processing,

Activity	Region*	Description of Benefit
		retail seafood market); reduced operating costs

Source: Kite-Powell et al., 2004.

*The regional designation of impacts reported in this table were contingent upon the availability of economic data for the region and therefore may not fully represent the overall regional influence of a given economic activity. Also note that the Gulf of Mexico region in this study excludes the west (Gulf) coast of Florida.

The Kite-Powell et al. (2004) report provides information on the general order of magnitude of economic benefits produced as a result of improved coastal and marine data quality and availability; estimates of economic activity resulting from enhanced data quality and availability can range broadly and are not meant to be a descriptive accounting of all possible economic outcomes. As such, the estimates provided in the subsequent paragraphs serve only to provide context for the general economic impacts of Alternative A. Nonetheless, Kite-Powell et al. (2004) indicate that annual benefits to recreational fishing, recreational boating, energy development and production, and commercial fishing from improved coastal and marine data quality and availability range in the hundreds of millions of dollars per year for each sector. The following sections provide descriptions of the economic impacts to each of these sectors.

3.12.2.2.2 Health and Safety

Health and safety activities refer to planning and operations that contribute to the health and safety of ocean users and their property (i.e., coastal real estate, boats, or small businesses). These activities contribute to all other sectors of the ocean economy by reducing inherent risks involved with other commerce-producing maritime activities or capital (e.g., recreational boating, commercial fishing) and primarily benefit from increased data quality and availability through increased operational efficiency and risk reduction related to extreme weather events. Search and rescue operations, oil spill modeling and hazard cleanup, and reduction of property damage are anticipated to contribute an additional $275 million to the ocean economy per year with increased ocean data quality and availability (Kite-Powell et al., 2004).

Search and rescue teams rely on bathymetric charting and mapping to establish search areas and plan rescue operations. Improving the spatial and temporal resolution of ocean data would continue to increase the likelihood of successful search and rescue operations while also reducing their cost. Successful search and rescue operations additionally contribute to the ocean economy by minimizing loss of life in the event of catastrophe, which preserves future economic contributions from saved individuals and reduces inherent risk associated with oceanic activities or employment. Improved ocean mapping would also allow ocean resource managers to more effectively predict the spread of volatile chemicals, such as oil, in the event of a spill, allowing for more precise targeting of response efforts and reducing the overall cost of restoration. Similarly, more precise bathymetric charting and mapping of collision hazards would allow for more optimized route planning that could reduce the occurrence of costly marine accidents; collisions and groundings accounted for 16 percent of all marine vessel insurance claims at a total cost of $1.56 billion from 2013 to 2018 or approximately $300 million annually (Allianz, 2019). These savings are demonstrated in the success of the PORTS system, which uses an integrated network of real-time oceanographic data collectors to aid navigation and is estimated to generate $300 million in economic benefits annually from reducing risk and increasing the operational efficiency of vessels (NOAA, No Date-f).

Data collected during NOS projects would continue to reduce costs associated with recovery from extreme weather events and natural disasters. After hurricanes or other severe weather events have moved through an area, NOS would continue to survey areas of critical marine infrastructure such as ports and shipping channels to identify submerged storm debris or transported sediment that could prevent ships carrying food and medical supplies from reaching affected areas. These efforts would reduce the risk of collisions with storm debris and would increase the operational efficiency of recovery and restoration efforts.

Although no direct economic impacts (i.e., job creation, capital investment) are anticipated within the health and safety sector as a result of Alternative A, the indirect economic benefits of increased operational efficiency of rescue missions and risk reduction related to extreme weather events facilitated by data collected under Alternative A would range in the magnitude of hundreds of millions of dollars and would be distributed among coastal economies throughout the action area. Furthermore, the data collected under Alternative A would be available to the public indefinitely, and indirect economic benefits resulting from its use and distribution would persist beyond the conclusion of activities. Overall, the economic impacts of ocean data procured under Alternative A on health and safety would be indirect, **beneficial**, and **moderate**, and therefore **insignificant**.

3.12.2.2.3 Recreational Activities

Recreational activities, for the purposes of this analysis, refer to recreational consumption of ocean resources primarily through beach visitation, boating, and sport fishing. Recreational activities are a main component of the ocean economy; recreation and tourism contributed 2.4 million jobs and $124 billion to the GDP in 2016. Increased coastal and marine data availability and quality greatly benefit the recreational activity sector by allowing stakeholders to make informed decisions about ocean resources. Beachgoing, recreational boating, and recreational fishing would be expected to increase their contribution to the ocean economy by approximately $430 million per year with increased ocean data quality and availability (Kite-Powell et al., 2004).

Recreational boaters rely on accurate ocean charts and maps to transit ocean waters safely; improved ocean data quality would continue to allow recreational boaters to more effectively plan potential routes around prevailing winds, currents, and bathymetry. Finally, improved bathymetric data would continue to improve transit efficiency for recreational fishermen.

Although few direct economic impacts (i.e., job creation, large capital investment) are anticipated within the recreational activity sector as a result of Alternative A, the indirect economic benefits of enhanced decision-making by ocean economy stakeholders facilitated by data collected under Alternative A would range in the magnitude of hundreds of millions of dollars and would be distributed among coastal economies throughout the action area. Furthermore, the data collected under Alternative A would be available to the public indefinitely, and indirect economic benefits resulting from its use and distribution would persist beyond the conclusion of activities. Overall, the economic impacts of ocean data procured under Alternative A on recreational economic activity would be indirect, **beneficial**, and **moderate**, and therefore **insignificant**.

3.12.2.2.4 Transportation

Transportation activities refer to the transit of goods and passengers throughout the EEZ and are a substantial component of the ocean economy, contributing 467,000 jobs and $64 billion to the GDP. Transportation activities benefit from increased data quality and availability primarily through improving operational efficiency of vessel transit. The transportation of freight and the transportation of passengers via cruise ships are expected to increase their contribution to the ocean economy by approximately $127 million per year with increased ocean data quality and availability (Kite-Powell et al., 2004).

The primary benefit of increased ocean data to the transportation sector is enhanced route-planning capabilities. Improved charts, maps, and bathymetry resulting from data collected during NOS projects would continue to allow ship crews and decision-makers to plan transit routes more efficiently, avoiding costs associated with longer routes and delays. Furthermore, much of the transport along the Alaska coast involves cargo that is critical to businesses and projects owned and operated by Alaska Natives. Accurate surveying and mapping data would continue to yield additional social and economic benefits to these groups. However, it is important to note that much of the navigationally important part of the action area has been previously surveyed, and ocean data collected under Alternative A are not expected to open a substantial number of novel transit routes or shipping lanes. NOS data collection efforts in the Alaska region could potentially yield a small number of novel shipping routes in areas previously restricted by sea ice, but the economic impact of these routes is difficult to estimate given the current lack of mapping coverage and underlying risks of arctic maritime navigation (NOS, No Date-c). As such, the increased ocean data quality and availability resulting from Alternative A would primarily increase the efficiency of existing routes as opposed to discovering new routes. Nonetheless, the current operating performance efficiency of maritime shipping is low when compared to other industries (Panayides et al., 2011) and improved route planning could have a substantial marginal impact on the overall efficiency of the industry.

Although no substantial direct economic impacts (i.e., job creation, large capital investment) are anticipated within the transportation sector as a result of Alternative A, the indirect economic benefits of enhanced route-planning capabilities and daily cost savings stemming from the data collected by NOS would range in the magnitude of hundreds of millions of dollars and would be distributed among coastal economies throughout the action area. Furthermore, the data collected under Alternative A would be available to the public indefinitely and indirect economic benefits resulting from its use and distribution would persist beyond the conclusion of activities. Overall, the economic impacts of ocean data procured under Alternative A on transportation would be indirect, **beneficial**, and **moderate**, and therefore **insignificant**.

3.12.2.2.5 Energy

Energy-related activities, for the purposes of this analysis, refer to the development and distribution of energy resulting from ocean resources and contributed 132,000 jobs and $80 billion to the GDP in 2016. These activities primarily benefit from increased ocean data quality and availability by increasing the operational efficiency of energy planning and more precise targeting of potential oceanic oil and gas resources. The predominant oceanic energy activities, electric load planning and oil and gas development, would likely contribute an additional $70 – $138 million to the ocean economy per year with increased ocean data quality and availability (Kite-Powell et al., 2004).

Increased precision and resolution of bathymetric data resulting from NOS data collection would reduce the uncertainty and risk associated with oceanic oil and gas development as well as the operating costs of existing energy infrastructure. Risk reduction also allows for greater levels of investment in the development of oceanic oil and gas resources, which spurs economic activity in coastal regions through job creation and revenues from employees. However, it is important to note that NOS projects and activities would not specifically identify or quantify offshore oil and gas resources; doing so is outside of the scope of this analysis and is typically accomplished by private companies using proprietary equipment and methodologies.

Although no direct economic impacts (i.e., job creation, large capital investment) are anticipated within the energy sector as a result of Alternative A, the indirect economic benefits of increasing the operational efficiency of energy planning and more precise targeting of potential oceanic oil and gas resources facilitated by data collected under Alternative A would range in the magnitude of tens or hundreds of millions of dollars and would be distributed among coastal economies throughout the action area. Furthermore, the data collected under Alternative A would be available to the public indefinitely, and indirect economic benefits resulting from its use and distribution would persist far beyond the conclusion of activities. Overall, the economic impacts of ocean data procured under Alternative A on energy-related activities would be indirect, **beneficial**, and **moderate**, and therefore **insignificant**.

3.12.2.2.6 Commercial Fishing

Commercial fishing refers to the harvest of living ocean resources for market and is a critical component of the ocean economy; in 2016 the living resource sector provided nearly 90,000 jobs and $11 billion to the GDP. With increased ocean data quality and availability, commercial fishing activities are expected to increase their contribution to the ocean economy by over $500 million (Kite-Powell et al., 2004).

Commercial fishermen rely on marine charts, maps, and bathymetry information that are updated using data collected during NOS projects. These data products are used to select potential fishing locations and plan transit routes. Improving the spatial and temporal resolution of these data products would continue to increase the landed values of fish and reduce risks of unsuccessful voyages, particularly in fisheries with short seasons and limited fishing grounds such as the Alaskan salmon fishery. These benefits are especially important to small, independent fishing operations with limited cash reserves and coastal fishing communities with local economies largely dependent on the commercial fishing industry. Improved data collection would also continue to increase the efficiency of route planning, thereby reducing the operational costs of fishing vessels while increasing the safety of crew members.

Impacts to commercial fishing from vessel presence or gear interaction during NOS projects would be very unlikely. NOS communicates with the public on future survey projects through announcements such as the annual Office of Coast Survey story map and, when appropriate, public “Notices to Mariners” to provide general information on timing and locations of planned projects. This helps minimize interference with commercial and recreational fishing and reduces the potential for interactions with fishing gear like lobster traps.

Alternative A could adversely impact fishery resources, but impacts would be minor and insignificant. Detailed analysis can be found in Section 3.7 (Fish), Section 3.8 (Aquatic Macroinvertebrates) and Section 3.9 (Essential Fish Habitat). Effects to fish from Alternative A may include some stress responses without permanent physiological damage and disruption to breeding, feeding or other activities but without any impacts on population levels. There would not be long-term changes in habitat availability and use or in fish behavior. NOS developed mitigation measures in coordination and consultation with expert agencies including NMFS to avoid and minimize any potential effects. Mitigation measures to protect fisheries include implementing mandatory invasive species prevention procedures, following MARPOL discharge protocols, and minimizing bottom disturbance. Overall, impacts to commercial fishing under Alternative A would be **adverse**, but **negligible**, and therefore **insignificant**.

Although no direct economic impacts (i.e., job creation, large capital investment) are anticipated within the commercial fishing sector as a result of Alternative A, the indirect economic benefits of increased landed values and operating cost reductions facilitated by data collected under Alternative A would range in the magnitude of hundreds of millions of dollars and would be distributed among coastal economies throughout the action area. Furthermore, the data collected under Alternative A would be available to the public indefinitely, and indirect economic benefits resulting from its use and distribution would persist beyond the conclusion of activities. Overall, the economic impacts of ocean data procured under Alternative A on commercial fishing would be indirect, **beneficial**, and **moderate**, and therefore **insignificant**.

3.12.2.2.7 Overall Economic Impacts of Alternative A

Data collected under Alternative A would continue to improve the quality and quantity of ocean data and related data products, including marine charts, maps, and hydrographic models of ocean conditions. These data and data products would contribute to the ocean economy indirectly, primarily by increasing operational efficiency and reducing risks associated with using ocean resources in a variety of economic sectors (e.g., route-planning, fishing ground selection, targeting of oil and gas resources, closing/opening recreational areas). Indirect economic benefits would likely range in the magnitude of hundreds of millions of dollars for each sector, although it is important to note these estimates are broadscale and contingent on assumptions of data use and availability. Benefits would be most pronounced in the recreational, commercial fishing, and health and safety sectors of the ocean economy; the energy and transportation sectors would also indirectly benefit from data collected under Alternative A, but to a lesser extent. Overall, Alternative A would have an indirect, **beneficial**, and **moderate** impact on the ocean economy, and therefore **insignificant**.

3.12.2.3 Alternative B: Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations

Under Alternative B, all of the activities and equipment operations proposed in Alternative A would continue but at a higher level of effort, although the percentage of nautical miles covered by project activities in each region would be the same as under Alternative A. As under Alternative A, the greatest number of nautical miles surveyed over the five-year period would be in the Southeast Region (over 50 percent). The survey effort in each of the other four regions are of a similar order of magnitude (approximately 10 percent in each region for each of the five years), and is slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 16 percent). Additionally, survey effort in the Great Lakes would average 3,208 nm (5,942 km) annually, as compared to the remaining annual average survey effort of 582,551 nm (1,078,884 km). In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as the type, location and depth of surveys, that add nuance to this trend.

Project activities under Alternative B would take place in the same geographic areas and timeframes as under Alternative A; however, Alternative B would include a larger number of activities and projects, and thus nautical miles traveled, than Alternative A. Overall, there would be an additional 264,796 nm (490,402 km) of survey effort under Alternative B as compared to Alternative A. The types and mechanisms of impacts would remain the same in Alternative B as discussed for Alternative A; ocean data collected under Alternative B would be used by other entities to create data products to increase the operational efficiency and reduce inherent risks of the oceanic industry. Since these impacts are largely indirect in nature and data collected would be available to a wide variety of users throughout the action area, the resulting impacts would not necessarily be geographically correlated with the collection of data.

Therefore, the difference between the two alternatives is primarily a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative B as compared to Alternative A.

As such, the economic benefits of impacts of Alternative B would be the same or slightly, but not appreciably, larger than those discussed above under Alternative A. Overall, the economic impacts of Alternative B on the ocean economy would be indirect, **beneficial**, and **moderate**, and therefore **insignificant**.

3.12.2.4 Alternative C: Upgrades and Improvements with Greater Funding Support

Under Alternative C, all of the activities and equipment operation proposed in Alternatives A and B would continue but at a higher level of effort, although the percentage of nautical miles in each region would be the same as under Alternatives A and B. In addition, there would be an overall funding increase of 20 percent relative to Alternative B, thus the level of survey activity would increase further. As under Alternatives A and B, the greatest number of nautical miles surveyed over the five-year period would be in the Southeast Region (over 50 percent). The survey effort in each of the other four regions are of a similar order of magnitude (approximately 10 percent in each region for each of the five years), and is slightly greater in the Alaska Region where the survey effort would be somewhat higher overall (approximately 16 percent). Additionally, survey effort in the Great Lakes would average 3,500 nm (6,482 km) annually, as compared to the remaining annual average survey effort of 635,510 nm (1,176,964 km). In general, it is expected that level of effort and overall impacts trend together (i.e., greater impacts where the survey effort is higher), but there are other factors, such as the type, location and depth of surveys, that add nuance to this trend.

Project activities under Alternative C would take place in the same geographic areas and timeframes as under Alternatives A and B; however, Alternative C would include more projects and activities, and thus more nautical miles traveled, than Alternatives A and B. Overall, there would be an additional 264,796 nm (490,402 km) of survey effort under Alternative C as compared to Alternative B, and an additional 529,592 nm (980,803 km) as compared to Alternative A. The types and mechanisms of economic impacts would remain the same in Alternative C as discussed for Alternatives A and B; ocean data collected under Alternative C would be used by other entities to create data products to increase the operational efficiency and reduce inherent risk of oceanic industry. Since these impacts are largely indirect in nature and data collected would be available to a wide variety of users throughout the action area, the resulting impacts would not necessarily be geographically correlated with the collection of data. Therefore, the difference between the alternatives is primarily a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative C as compared to Alternatives A and B.

As such, the economic benefits of impacts of Alternative C would be the same or slightly, but not appreciably, larger than those discussed above under Alternatives A and B. Overall, the economic impacts of Alternative C on the ocean economy would be indirect, **beneficial**, and **moderate**, and therefore **insignificant**.

3.13 ENVIRONMENTAL JUSTICE

EO 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" requires that federal agencies consider as a part of their action any disproportionately high and adverse human health or environmental effects to minority and low-income populations. Agencies are required to ensure that these potential effects are identified and addressed.

The EPA defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." The goal of "fair treatment" is not to shift risks among populations, but to identify potential disproportionately high adverse impacts on minority and low-income communities and identify alternatives to mitigate any adverse impacts. For the purposes of assessing environmental justice under NEPA, the CEQ defines a minority population as one in which the percentage of minorities exceeds 50 percent or is substantially higher than the percentage of minorities in the general population or other appropriate unit of geographic analysis (CEQ, 1997a). Low-income populations are defined as households with incomes below the Federal poverty level.

3.13.1 Affected Environment

The majority of the impacts identified in this Final PEIS are to the aquatic environment, and as such, the environmental justice analysis considers potential disproportionate impacts on minority and low-income populations that utilize resources from the ocean. The analysis focuses on those minority and low-income populations that hunt marine mammals and fish for subsistence uses. While some communities described below also engage in subsistence hunting of terrestrial species, these species are not discussed in this section since NOS activities occur in aquatic environments; thus, the focus is on species hunted on sea ice, in coastal waters, and in the open ocean. Potential impacts to these communities would be considered disproportionate not only because subsistence hunting/fishing is essential for their survival, but also because these activities help to maintain and preserve their culture and tradition, play a key role in their local economies, and foster their overall physical and mental well-being. The cultural, spiritual, nutritional, and economic importance of each marine species to various Alaska Native populations as well as other indigenous tribes in the U.S. is described. The cultural, spiritual, nutritional, and economic importance of subsistence fishing in various regions of the U.S. is also described. This section also discusses how, when, and where each species is hunted for subsistence use.

3.13.1.1 Subsistence Hunting and Fishing

Subsistence uses are defined as "customary and traditional" uses of wild resources for food, shelter, fuel, clothing, tools, transportation, handicrafts, barter, and customary trade (ADF&G, 2017a). Subsistence hunting is central to the customs and traditions of many Alaska Native populations as well as other indigenous tribes in the U.S. In Alaska, 11 cultures can be distinguished geographically: the Eyak, Tlingit, Haida, and Tsimshian peoples live in the Southeast; the Inupiaq and St. Lawrence Island Yupik live in the north and northwest parts of Alaska; the Athabascan peoples live in Alaska's interior; and the south-central Alaska and the Aleutian Islands are home to the Alutiiq (Sugpiaq) and Unangax peoples (AFN, No Date). A majority of these communities rely on harvests of whales, seals, sea lions, and other marine mammals, as well as fish species such as salmon, halibut, and cod for their nutritional, religious, and cultural needs. Other indigenous tribes in the U.S., such as the Chippewa and Ojibwe tribes inhabiting the Great Lakes region, fish for catfish, trout, and whitefish for subsistence needs.

While the MMPA prohibits the take (i.e., hunting, killing, capture, and/or harassment) of marine mammals, Section 101(b) of the MMPA allows Alaska Natives to take marine mammals for subsistence purposes and/or for materials to create authentic articles of handicraft or clothing, provided taking is not done in a wasteful manner. The federal government cannot regulate the Alaska Native take unless the population being harvested is declared to be depleted (NSB, No Date-a). Furthermore, Section 119 of the MMPA allows Alaska Native Organizations (ANOs) to enter into cooperative agreements with NMFS or the USFWS to co-manage Alaska Native marine mammal harvests. This exception to the marine mammal take prohibition does not currently extend to the continental U.S., but members of the Makah Tribe in the northwestern tip of Washington State (on the Olympic Peninsula), who have traditionally hunted whales for subsistence, have requested authorization to hunt eastern North Pacific gray whales. The Tribe's proposal to NMFS for the issuance of a waiver of the MMPA take prohibition is described below in Section 3.13.1.2, Gray Whales (NMFS, No Date-f).

The following sections provide a background on the subsistence hunting and fishing practices of Alaska Native communities and other indigenous tribes in the U.S. and a description of species that are hunted or fished. This discussion is organized by species, since many tribes hunt and fish the same species. Information on geographic distribution and migration patterns of marine mammals and fish species is included in Section 3.5, Marine Mammals and Section 3.7, Fish, respectively.

3.13.1.2 Bowhead Whale (*Baleana mysticetus*)

The bowhead whale is one of the most culturally important resources harvested by Alaska Natives. The Inupiat and Siberian Yupik Alaska Natives have hunted the bowhead whale for thousands of years and knowledge of subsistence whaling continues to be taught to their children beginning at an early age (Brower and Hepa, 1998). Prior to the arrival of the whales during each migration, ritual ceremonies are performed in special houses known as "karigi" to ensure a hunt and to honor the whale (NOAA, 2018b). The Inupiat community celebrates the harvest of bowhead whales each June during the summer festival called Nalukataq. The community engages in singing, dancing, and blanket tossing, as well as solemn moments of prayer and reflection. Fried whale blubber or "muktuk" and other traditional foods are eaten. People of every age and gender participate to show their appreciation for the hard work that got them through the frigid winter (Dunn, 2016).

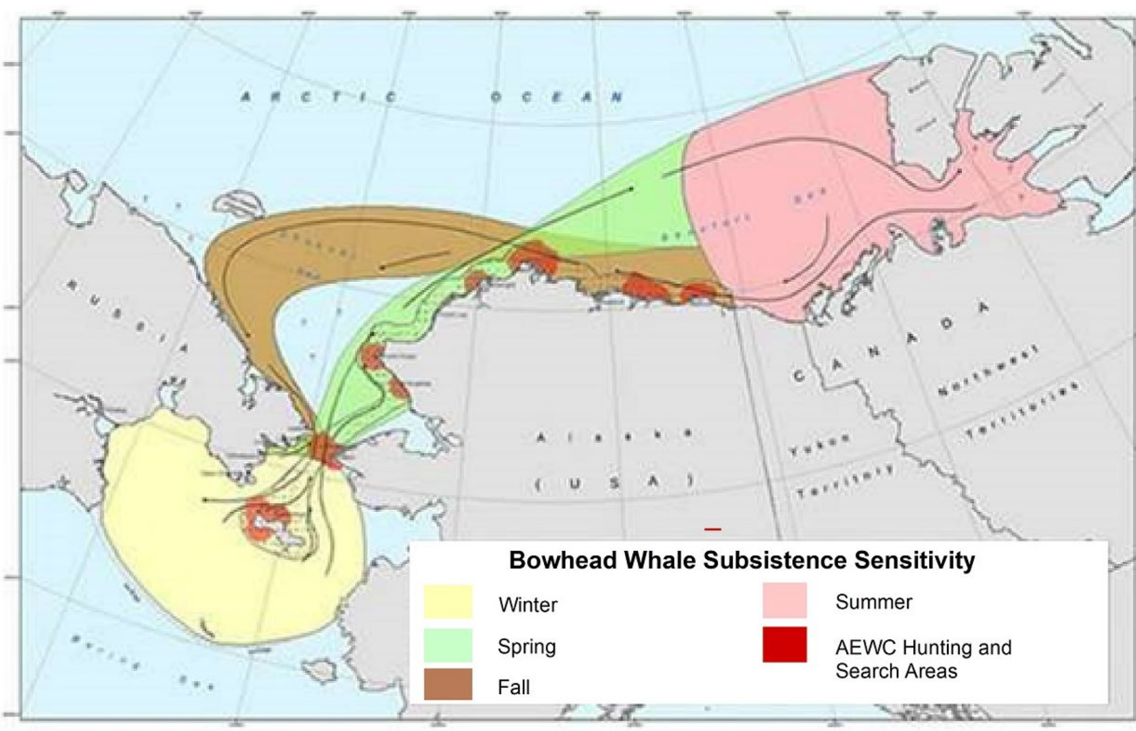
The Inupiat and Siberian Yupik people, who inhabit 11 bowhead whaling villages along the western and northern coasts of Alaska, as shown in **Figure 3.13-1**, regulate their bowhead whale subsistence activities via the Alaska Eskimo Whaling Commission (AEWC) (IWC, No Date-a). The AEWC communities hunt bowheads for the nutritious food that they provide and use their baleen and large bones to make handicrafts (NOAA, 2018b).

Source: IWC, No Date-a

Figure 3.13-1. Alaska Bowhead Whaling Communities

The AEWC conducts subsistence harvest in accordance with a cooperative agreement with NMFS, which is responsible for the implementation of the International Whaling Commission (IWC) strike quota in the U.S. (NMFS, 1999). The term 'strike quota' refers to the limitation on the number of whales that may be struck by hunters, and is the sum total of the whales that are successfully and unsuccessfully landed. Recently, the IWC set a 7-year block catch limit of 392 bowhead whales landed for the years 2019 through 2025 for four of its member countries (Denmark [Greenland], Russia [Chukotka], St. Vincent and the Grenadines [Bequia] and the U.S. [Alaska]), with an annual strike quota of 67 whales. In 2018, NOAA released a Final EIS to issue annual catch limits of bowhead whales to the AEWC for the years 2019 and beyond. Under the preferred alternative identified in that EIS, NMFS would assign AEWC an annual strike quota of 67 bowhead whales. AEWC would not be allowed to exceed their total of 336 landed whales over any six-year period. Additionally, unused strikes from previous years may be carried forward and added to the annual strike quota of subsequent years, to allow for variability in hunting conditions from one year to the next. (NOAA, 2018b).

Figure 3.13-2 shows the AEWC bowhead hunting and search areas across all seasons in red. The spring hunting season extends from March to May and the fall season starts in August and ends in October. The westerly AEWC communities engage in bowhead hunting during the species' spring migrations whereas the villages of Nuiqsut and Kaktovik participate in fall hunts (NOAA, 2018b). For selected communities, such as the Saint Lawrence Island communities of Gambell and Savoonga in the northern Bering Sea, winter harvest of whales is common (i.e., in December and January) (IWC, No Date-b). Hunters engage in whale-watching on the ice near the water to spot whales migrating north from the Bering Sea. When one is spotted, the team pushes an *umiak*, or a seal skin boat, onto the water to commence hunting. Seal skin boats are used due to their light weight, durability, and silence in the water (NOAA, 2018b). Bowhead hunters use traditional weapons such as harpoons to hunt the whales while sitting in their umiak (Stone, 2018). Lances made from stone, ivory, and bone may also be used. Over the years, bowhead hunters have adapted their hunting techniques per mandates issued by IWC. For example, slight modifications to instruments have been in use since the 19th century (e.g., darting guns and shoulder guns) (NOAA, 2018b).



Source: NSB, No Date-a

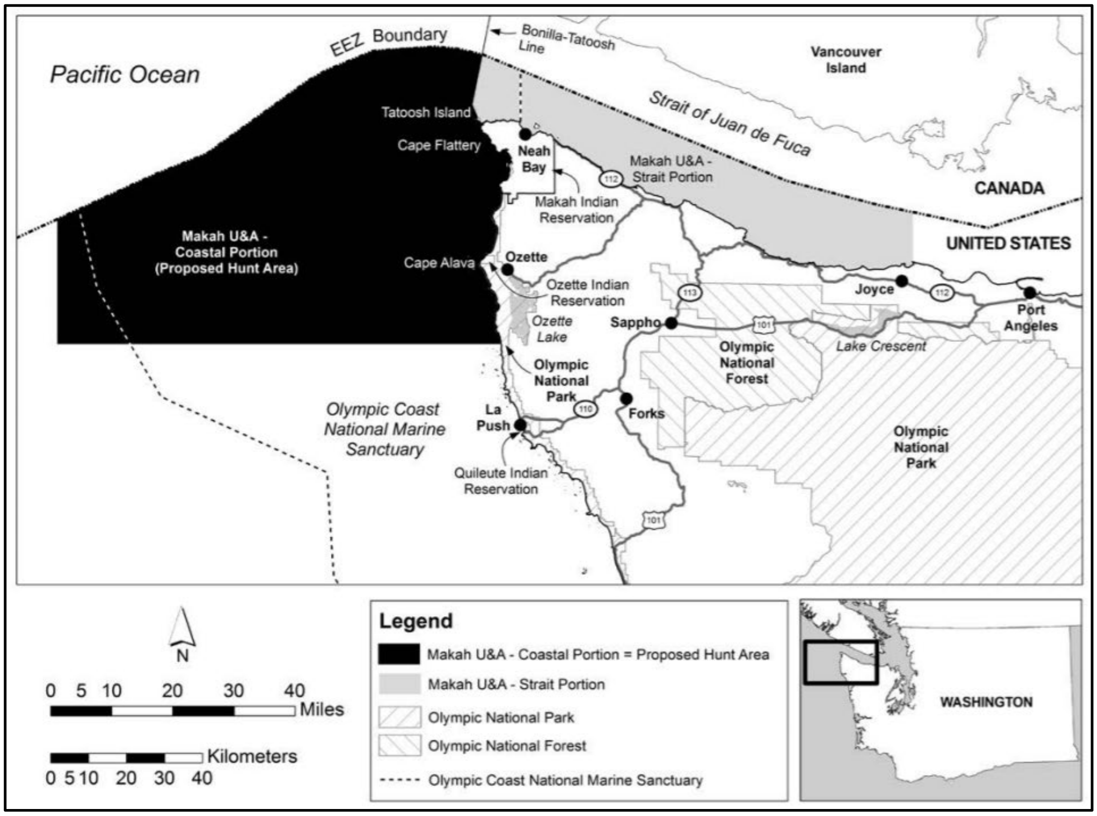
Figure 3.13-2. Bowhead Whale Hunting Areas

3.13.1.3 Gray Whale (*Eschrichtius robustus*)

As stated in Section 3.13.1, the MMPA prohibits the take of marine mammals, including gray whales, by any group other than the Alaska Natives. Thus, while members of the Makah Tribe in the state of Washington are currently not authorized to hunt for gray whales, they have requested NMFS to waive the MMPA take moratorium on the species so that their tradition of whale hunting could continue. This section details the proposal put forth by the Tribe to NMFS.

Since the 1990s, the Tribe has sought to exercise their right to whale, as established under the Treaty of Neah Bay. In 2002, a federal court determined that the Tribe must first apply for a waiver of the MMPA take moratorium, which the Tribe submitted in 2005. NOAA responded by announcing a hearing on August 12, 2019 to consider the issuance of a waiver of the take moratorium and the regulations (NMFS, 2022). If approved, the waiver could enable the Tribe to conduct ceremonial and subsistence hunting of eastern

North Pacific gray whales in Pacific Ocean waters near its reservation on the northwestern tip of Washington's Olympic Peninsula, as shown in **Figure 3.13-3** below (NMFS, 2015c). Since a decision on this issue is currently pending, subsistence hunting of gray whales is not discussed in detail. If the Makah tribe is granted the right to hunt gray whales before the release of the Final EIS, this section would be developed further.



Source: NMFS, 2015c

Figure 3.13-3. Proposed Gray Whale Hunting Area

3.13.1.4 Beluga Whale (*Delphinapterus leucas*)

For Alaska Natives, subsistence hunting of belugas encompasses social and religious values and is tied to custom and tradition. The native village of Tyonek, for example, has a close cultural tie to beluga whales. Tyonek is located in upper Cook Inlet (southwest of Anchorage), and is accessible only by boat or plane. The Alutiiq Eskimos and Dena'ina Athabascans of Tyonek have occupied the Cook Inlet area for several hundred years, and the village is home to approximately 200 residents who participate in traditional subsistence hunting of belugas. Without it, the community faces economic stress because they cannot rely on the beluga oil, blubber, and meat (Boelens, 2013). Belugas are principally used for human consumption, either as meat or "maktak," which consists of skin and the outer layer of blubber. The oil derived from the blubber is used for cooking and for fuel. The meat may also be used as dog food. Beluga bones are sometimes used in crafts (ADF&G, No Date-b). Apart from being an important food source, beluga hunting also provides the community with a way to pass on skills to younger generations, strengthen cultural identity through participation in a traditional activity, and unite the community (Boelens, 2013).

Belugas are harvested by Alaska Natives living in coastal villages from Tyonek in Cook Inlet to Kaktovik in the Beaufort Sea[12]. Hunting is done in the spring as whales travel northward through leads in the ice, as well as during the summer and autumn when they are in the open water (ADF&G, No Date-b).

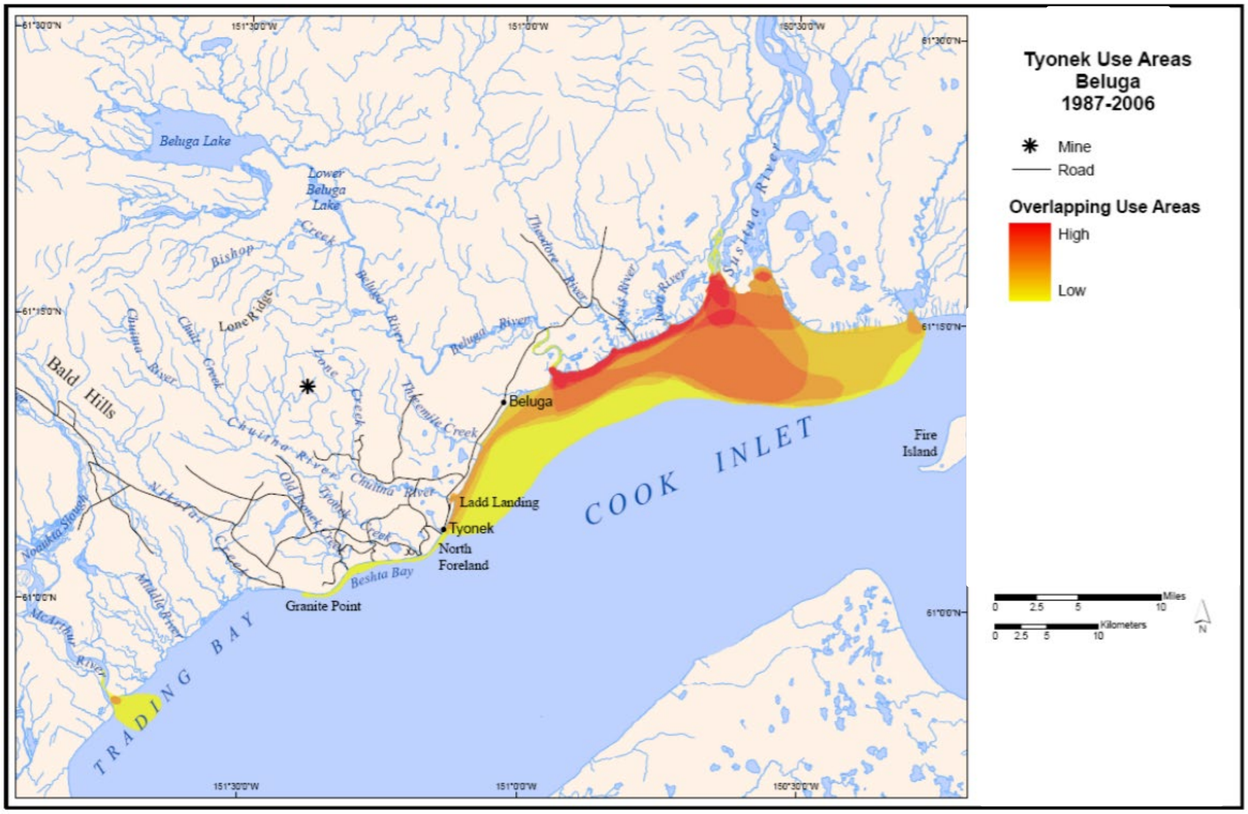
All beluga whale populations are protected under the MMPA. Harvests are considered sustainable for the Beaufort Sea, Bristol Bay, eastern Bering Sea, and eastern Chukchi Sea stocks; the IWC does not currently set a take limit on these four stocks of belugas, since the federal government does not have the authority to regulate the Alaska Native take unless the population being harvested is declared depleted under the MMPA (NSB, No Date-b). The Cook Inlet DPS is listed as endangered under ESA and depleted under MMPA (NMFS, No Date-a).

In 2008, NMFS issued final regulations to establish long-term limits on the maximum number of Cook Inlet beluga whales that may be taken by Alaska Natives for subsistence and handicraft purposes. The final rule established a harvest level for a five-year period based on the average abundance of beluga whales in the previous five-year period and the growth rate during the previous 10-year period. A harvest is not allowed if the previous five-year average abundance is less than 350 beluga whales (Muto et al., 2018). For example, if the beluga whale population averages 350-399 for a five-year block and their growth rate is determined to be high, then the harvest limit would be set at eight strikes for the next five-year hunting period (NOAA, 2008a). No beluga whales from the Cook Inlet stock have been harvested since 2005 since their average abundance has consistently numbered below 350 (Muto et al., 2018).

The primary beluga whale hunting areas are located within upper Cook Inlet, off the mouths of the Chuitna and Susitna River systems, among others, as shown in **Figure 3.13-4** below. Native hunting camps are located on two islands in the Susitna River delta. Hunting begins in April when hunters launch motorboats from Anchorage to access these camps and hunt in or near the river mouths. A common hunting technique involves isolating a whale from a group and pursuing it into shallow waters. The whales are shot with high-powered rifles and harpooned to help with their retrieval (NOAA, 2008a).

[12] The following Alaska Native communities harvest beluga whales from sustainable stocks (NSB, No Date-b):

- Beaufort Sea Stock: Barrow, Diomede, Kaktovik, Kivalina, Nuiqsut, Point Hope
- Eastern Chukchi Sea Stock: Wainwright, Point Lay
- Eastern Bering Sea Stock: Norton Sound (Elim, Golovin, Nome/Council, Saint Michael, Shaktoolik, Unalakleet, White Mountain); Yukon (Alakanuk, Chevak, Emmonak, Hooper Bay, Kotlik, Marshall, Mountain Village, Nunam Iqua, Pilot Station, Pitka's Point, Saint Mary's, Scammon Bay)
- Bristol Bay Stock: Aleknagek, Clarke's Point, Dillingham, Egegik, Igiugig, Iliamna, Levelock, Manokotak, Naknek
- Cook Inlet Stock: Tyonek



Source: NOAA, 2008a

Figure 3.13-4. Beluga Hunting Areas (Cook Inlet stock)

3.13.1.5 Northern Fur Seal (*Callorhinus ursinus*)

The Alaska Native residents of St. Paul and St. George Islands (two principal islands of the Pribilof Islands), called the Aleut or Unangan people, have historically relied upon northern fur seal harvests as a major food source and cornerstone of their culture (NMFS, 2019c).

Northern fur seals are protected under the MMPA. The Pribilof Islands/eastern Pacific stock is listed as depleted under the MMPA (NMFS, No Date-a). Any taking of adult fur seals or pups, or the intentional taking of sub-adult female fur seals is prohibited (50 CFR § 216.72). And while the taking of northern fur seals is prohibited under the Fur Seal Act (FSA) of 1966, certain provisions under this Act authorize Pribilovians to take fur seals on the Pribilof Islands if such taking is for subsistence uses and is not accomplished in a wasteful manner.

The residents of St. George Island are currently authorized under Section 105 of the FSA to harvest sub-adult male fur seals[13] 124.5 cm (49 in) long or less for subsistence uses. The annual harvest occurs from June 23 until August 8 and uses traditional methods, which include the use of harpoons, bow and arrow, or stunning followed immediately by exsanguination. Additionally, annual harvest of young, male fur seals[14] on St. George Island occurs between September 16 and November 30, with a harvest limit of 150.

[13] A sub-adult fur seal is a fur seal between 2-5 years old and less than 124.5 cm (49 in) long (NMFS, 2017f).

[14] Young, male fur seals refer to pups, or a fur seal less than a year old and dependent on its mother for food (NMFS, 2017f).

Pribilovians on St. George Island are authorized to harvest up to a total of 500 male fur seals per year over the course of both the sub-adult male harvest and the young, male harvest (50 CFR § 216.72).

In response to a petition from the Aleut Community of St. Paul Island (ACSPI), NMFS issued a final rule on October 2, 2019 to change the management of the subsistence use of the eastern Pacific stock of the northern fur seals. The rule allows Pribilovians on St. Paul Island greater flexibility to meet their subsistence needs by hunting fur seals throughout the year. Aside from maintaining the annual upper take limit of 2,000 sub-adult male fur seals, the rule allows the take of female seals incidental to the hunt and harvest of male seals up to 1 percent of the upper limit. The first season would occur from January 1 to May 31, during which juvenile male fur seals could be taken by hunters using firearms; and the second season would occur from June 23 to December 31, during which pups and juvenile[15] male fur seals could be harvested using alternative hunting methods (NMFS, 2019c).

3.13.1.6 Steller Sea Lion (*Eumetopias jubatus*)

The Stellar sea lion is an important subsistence resource for Alaska Natives, who hunt them primarily for food (Loughlin, 2009). Other than for consumptive uses, stellar sea lions are harvested for their oil and blubber – primarily by the Aleut of the Aleutian and Pribilof Islands and the Alutiiq in certain communities of Kodiak Island and the Gulf of Alaska. They may also be used occasionally by Tlingit, Haida, Tsimshian, and Yupik groups (ADF&G, 2013a).

The species is protected under MMPA throughout its range. The western DPS is listed as depleted under MMPA and endangered under ESA. The eastern DPS was delisted from ESA following an increase in its stock (NMFS, No Date-a).

Prior to 1992, no comprehensive program estimated the level of subsistence harvest of sea lions in Alaska. However, available information indicates that sea lions were being harvested in at least 60 coastal communities on the Bering Sea, in the Aleutian Islands, and on the Gulf of Alaska (NOAA, 2008b). Steller sea lions are reportedly taken during spring (March – April) and fall (September – November) (ADF&G, 2013a). Results show the annual take decreasing substantially from about 550 sea lions in 1992; to about 200 in 1996; to between 165 and 215 from 1997 to 2004. Available evidence indicates that the current take level of subsistence harvest of Steller sea lions does not substantially reduce the expected recovery rate of Steller sea lions (NOAA, 2008b). Consequently, NOAA has not issued Steller sea lion take limits and this species continues to be harvested in coastal communities on the Bering Sea, in the Aleutian Islands, and on the Gulf of Alaska. In November 2006, an agreement was signed between the Aleut Marine Mammal Commission (AMMC) and NMFS to co-manage Steller sea lions (both eastern and western DPSs) and monitor the harvest of this species for subsistence use (NOAA, 2017).

3.13.1.7 Harbor Seal (*Phoca vitulina*)

Harbor seals are vital to traditional and subsistence use for many Alaska Natives, including the Aleut of the Aleutian Islands; the Alutiiq and Eyak of the Pacific Gulf Coast; the Tlingit, Haida, and Tsimshian of the Southeast archipelago; and the Yup'ik of the Southwest Alaska. The Dena'ina of Cook Inlet occasionally hunt harbor seals (ADF&G, 2013a). The meat, organs, and oil from the harbor seal's blubber are important parts of the diet of many Alaska Natives; and the hide is used to make clothing and handicrafts (ADF&G, No Date-c).

[15] Juvenile male fur seals are defined as male seals up to 7 years, excluding pups (NMFS, 2019c). Male pups are the fur seals less than one year old (NMFS, 2017f).

Traditionally, harbor seals were hunted using tools such as harpoons, spears, clubs, bows and arrows, nets, and in later times, rifles. The seasonal patterning of harbor seal takes generally shows two distinct hunting peaks: the first during spring, and a second during fall-early winter, with a low point in June. The geographic distribution of harbor seal takes indicates highest harvest numbers in the Southeast region by the Tlingit and Haida people, followed by the North Pacific Rim and Kodiak Islands (ADF&G, 2009a, 2009b).

The harbor seal is protected under MMPA throughout its range (NMFS, No Date-a). As with Steller sea lions described in the previous section, the harbor seal subsistence harvest is co-managed by AMMC and NMFS. In 2012, an estimated 595 harbor seals were hunted by Southeastern Alaska Native communities. Substantially more adult harbor seals were harvested than juveniles or pups. Seal takes generally peaked in March, May, and October, and were lowest in December, January, April, and June (ADF&G, 2013a).

3.13.1.8 Ice Seals *(Erignathus barbatus, Pusa hispida, Phoca largha, and Histriophoca fasciata)*

Ice seals include bearded, ringed, spotted, and ribbon seals. They are vital to Alaska Natives and are hunted by 64 communities across five geographic regions delineated by regional native governments and corporations: Yukon-Kuskokwim Delta (Association of Village Council Presidents), Bristol Bay (Bristol Bay Native Association), Bering Strait (Kawerek, Inc.), Northwest Arctic (Maniilaq Association), and North Slope (North Slope Borough). Ice seals are an important component in maintaining Alaska Native subsistence culture because seals are a source of food; their skins are a source for clothes, boats, and crafts (Nelson et al., 2019; ISC, 2019).

The Okhotsk (foreign) and Beringia (U.S.) DPSs of bearded seals are listed as threatened under ESA and depleted under MMPA (NMFS, No Date-a). Domestic ringed seal subspecies are listed as threatened and foreign subspecies are listed as endangered under ESA; all are considered depleted under MMPA (NMFS, No Date-a). The only recognized stock of spotted seals in the U.S., the Alaska stock, is listed as threatened under the ESA and depleted under MMPA (NMFS, No Date-a). Ribbon seals are protected under the MMPA and are included in NMFS's Species of Concern list (NMFS, No Date-a).

Hunting implements used today include harpoons and rifles, in combination with boats and snow machines, as well as radios and GPS. Ice seals are hunted on open waters, on sandy or rocky shores, and from ice or floe edges according to region and season (ADF&G, 2007). They are hunted in varying seasons or year-round depending on ice and weather conditions in the region, though most hunting occurs in spring and fall (Nelson et al., 2019; ISC, 2019). Ice seals are broadly hunted along the coast from approximately Kaktovik on the Beaufort Sea in the north to Clark's Point on Kvichak Bay in the south and along Nunivak and Saint Lawrence Islands (Nelson et al., 2019).

In 2003, the Ice Seal Committee and NMFS entered into an agreement to co-manage Alaska Ice Seal populations, in part to protect the culture and way of life of Alaska Natives who rely on the harvest of ice seals for subsistence uses (NSB, No Date-c). NMFS does not currently impose limits on the take of ice seals by Alaska Natives for subsistence use since harvest is considered sustainable (Nelson et al., 2019).

3.13.1.9 Northern Sea Otter (*Enhydra lutris kenyoni*)

Northern sea otters (particularly the Alaskan Southeast and Southcentral stocks) are primarily hunted by the Tlingit and Haida people inhabiting southeastern Alaska. Sea otters are hunted for their furs, and the handicrafts and clothing made from sea otter fur are generally sold or traded for subsistence purposes

(USFWS, 2007). Only Alaska Natives (Indians, Aleuts, and Eskimos) of at least one-fourth Alaska Native blood who reside in Alaska and who dwell on the coast of the North Pacific Ocean or the Arctic Ocean are allowed to harvest sea otters, provided the harvest is not wasteful (50 CFR Part 18).

Of the three stocks of sea otters occurring in Alaska, only the Southwest Alaska DPS is listed as threatened under ESA and depleted under MMPA. There is no harvest limit or permit needed for hunting sea otters, but hunters are required to have their raw sea otter hides and skulls tagged by a USFWS tagger within 30 days of harvest per MMPA's Marking, Tagging, and Reporting Program (MTRP)[16] (USFWS, No Date-e). Sea otters may be harvested any time during the year (USFWS, 2007); however, the peak hunting season commonly occurs during fall (ADF&G, 2013b). Although MMPA does not limit the areas of Alaska where sea otters may be harvested, there may be some areas with hunting or access restrictions, such as national parks, state game sanctuaries, or private land. There are no federal restrictions on the methods in which sea otters may be taken (USFWS, No Date-f). Usually, hunters fly or boat to the hunting areas and use modern weapons such as rifles to hunt the otters (Vox, 2014; The Guardian, 2015).

The ADF&G has reported a rise in sea otter hunting activities between 2010–2014 compared to previous years. The year 2013 yielded the biggest reported harvest on record for sea otters with 2,044 otters harvested across the state. This number dipped to 1,237 in 2014 (USFWS, 2014f).

3.13.1.10 Polar Bear (*Ursus maritimus*)

Polar bears have played an important role in indigenous Arctic cultures for millennia. In parts of the Arctic, the Inuit and other cultures hunt polar bear as part of a subsistence lifestyle and ancient cultural traditions. The Inuit believe that 'Nanuq', or polar bear is a wise and powerful creature. Of all the animals they traditionally hunted, polar bears were the most prized. Hunters paid respect to Nanuq's spirit by hanging its skin in an honored place in their home for several days. For a male bear the hunters would offer the bear's spirit knives and bow-drills; if female, they would offer knives, skin-scrapers, and needle cases (PBI, No Date). Polar bears are hunted for their meat, and their fur is used for clothing and blankets. Parts of the bear are also used for handicrafts (ADF&G, No Date-d).

The polar bear is designated as threatened under ESA. Two stocks of polar bears occur in Alaska: the SBS stock and the CBS stock. Management of both populations are shared with other nations. In 1988, the North Slope Borough Department of Wildlife Management (representing Alaska Natives) and the Inuvialuit Game Council (representing Canadians) signed an agreement to coordinate management of the SBS stock. The Inuvialuit-Inupiat Polar Bear Commission, as established under this agreement, set a harvest quota of 70 bears: 35 bears for the U.S. and 35 bears for Canada. In 2007, a bilateral agreement between the U.S. and Russia was ratified and established a process to maintain the subsistence use by the Native peoples of both countries and the conservation of the CBS population (ADF&G, 2008). In 2018, the total possible annual harvest of CBS bears set by the U.S.-Russia Polar Bear Commission was increased from 58 to 85 (The Seattle Times, 2018).

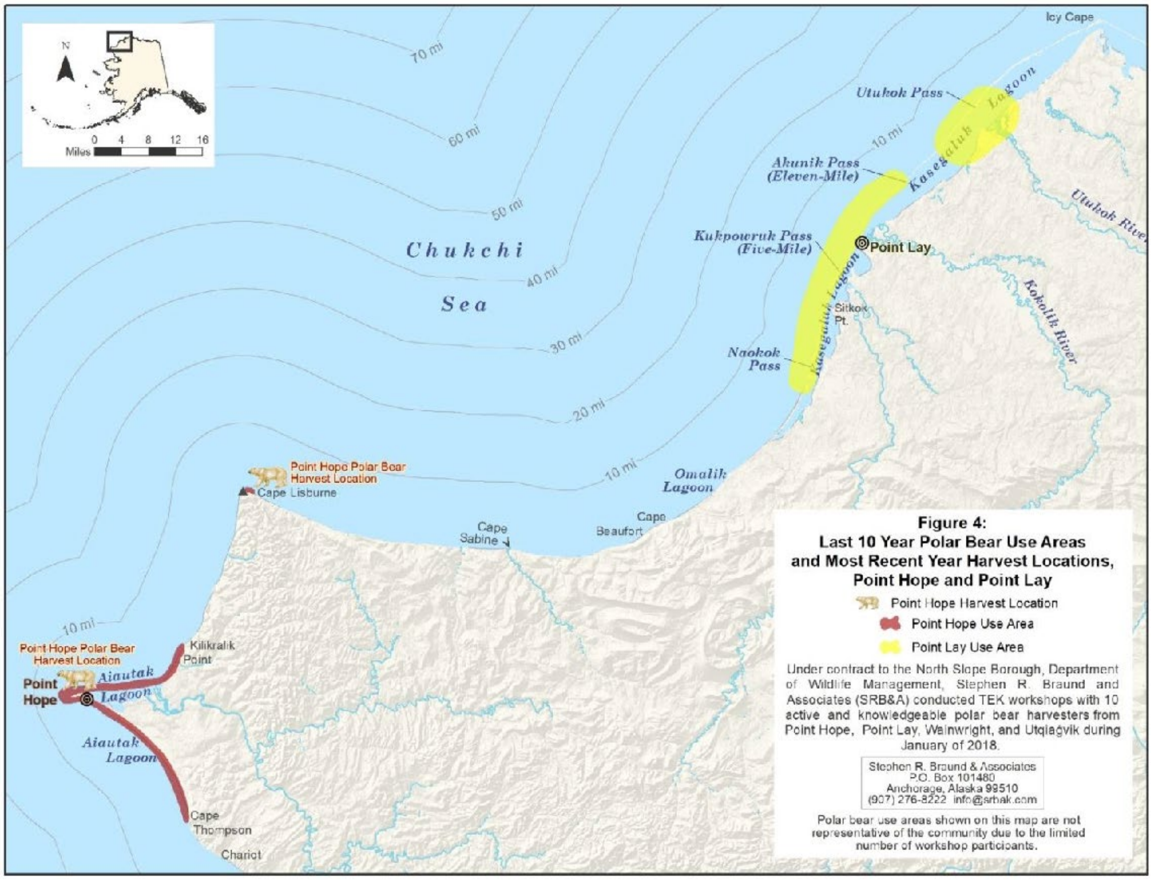
Figure 3.13-5 shows the Alaska Native communities that hunt the CBS stock of polar bears for subsistence use. The exact timing of polar bear hunting varies by village and depends on the community's social calendar and the timing of other subsistence activities. However, they are primarily hunted between November and April; hunters prefer to catch them in late fall and early winter because the bears are

[16] The MMPA requires that all sea otter and polar bear hides and skulls, and all walrus tusks be tagged by a representative of the USFWS. This program is implemented through resident MTRP taggers located in coastal villages and communities throughout Alaska (USFWS, No Date-e).

healthier at that time (Voorhees et al., 2014). In general, hunting areas are confined to locations 5-8 km (3-5 mi) offshore along the ice leads and areas with barrier islands, as shown in **Figure 3.13-6** for Point Lay and Point Hope hunting communities (NSB, 2018). Bears are hunted using snow machines, all-terrain vehicles, boats, and on foot, depending on the season and condition of the sea ice (Voorhees et al., 2014).

Source: Voorhees et al., 2014

Figure 3.13-5. Alaska Native Communities Engaged in Polar Bear Subsistence Hunting



Source: NBS, 2018

Figure 3.13-6. Polar Bear Hunting Areas for the CBS Stock in Point Hope and Point Lay Communities

3.13.1.11 Pacific Walrus *(Odobenus rosemarus divergens)*

Walruses are an essential cultural and natural subsistence resource to the Alaskan coastal Yupik and Inupiaq communities, and have sustained these communities and culture for millennia (EWC, No Date). The meat, blubber, skin, and organs provide a healthy and rich source of food; the hides can be processed into rope or used to cover boats; and the stomach lining is used to make traditional drums for Eskimo dances. The ivory tusks are used for jewelry, artwork, and other handicrafts (ADF&G, No Date-e).

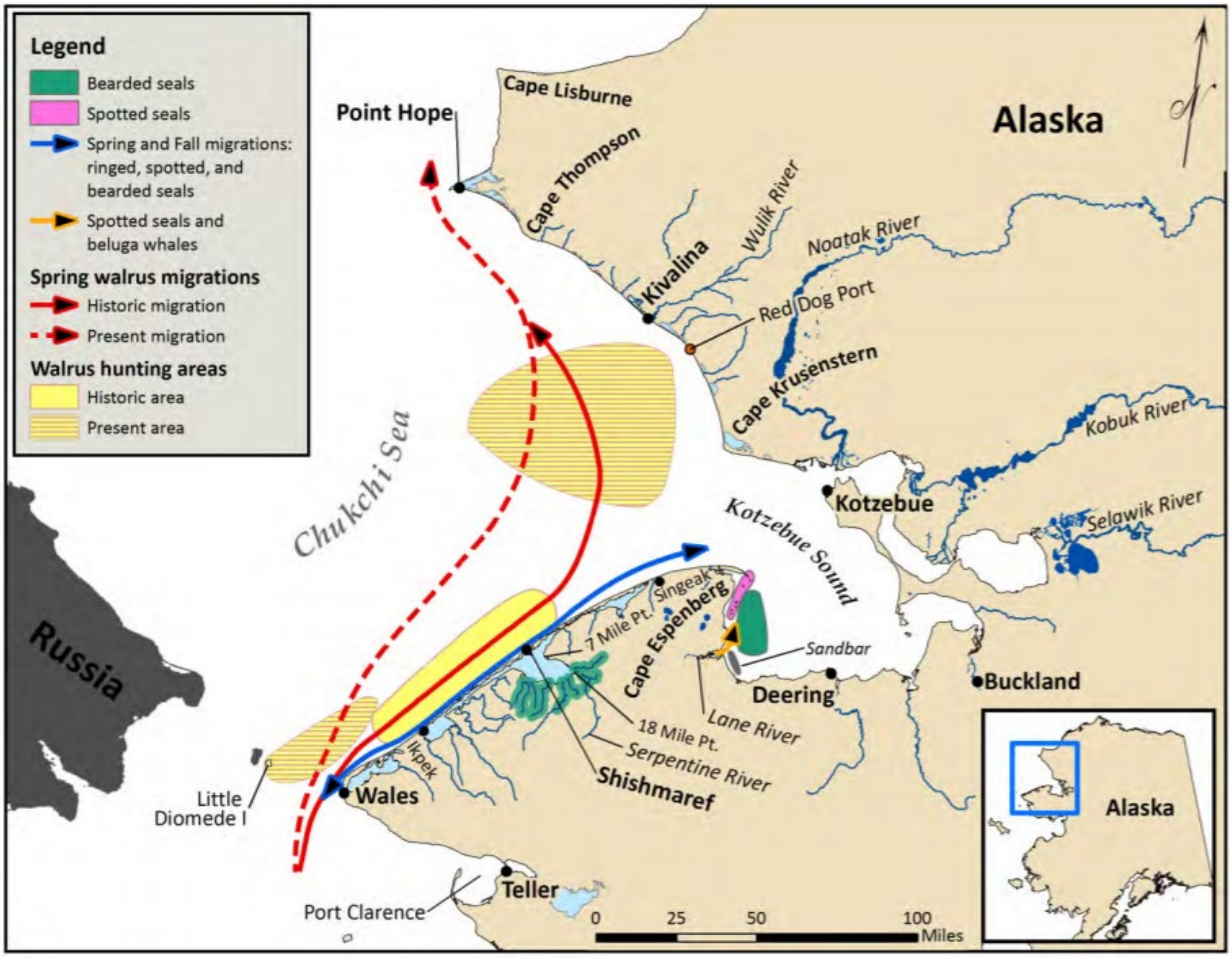
Walrus hunting was an opportunity for the elders to pass on their traditional values across generations. Young men had to earn the respect of the senior hunters and the right to lead hunts themselves by demonstrating their knowledge of the rules. Hunting was a highly organized activity since it was essential that the walrus be treated in a proper manner, called cakarpeknaki, or 'with respect and without waste'. Only the most experienced hunters were allowed to harpoon or shoot walrus. Walruses were swiftly taken with a thrust or shot near the back of the head. As technology advanced, skin boats, harpoons, and spears were replaced by wooden boats, outboard motors, and rifles on the Round Island. Historically, Qayassiq, or Round Island, was an important spot for walrus hunting as it was accessible in good weather and had an abundance of walruses during the preferred fall hunt. The capacity of the boats used to transport the carcasses back to mainland villages determined the harvest limits. Walrus hunting continues to be integral to maintaining the cultural identity and upholding the traditions of the Yupik and Inupiaq communities (Fall and Chythlook, 1998).

Since the Pacific walrus is not listed as depleted or endangered, the agreement between USFWS and the Eskimo Walrus Commission (EWC) for the co-management of the species[17] does not limit the areas of Alaska where it may be harvested and imposes no restrictions on the methods in which walruses may be taken. There is no harvest limit for Pacific walruses, provided that harvest does not occur in a wasteful manner (USFWS, No Date-g). In Little Diomede for example, walruses are important year-round food sources and are primarily hunted during their spring migration. Hunting may also occur to a limited extent during summer and fall seasons when walruses feed and haul out in the area. Many hunters travel 64-81 km (40-50 mi) out during the spring hunting season to find walruses in open water. Environmental conditions such as winds, currents, and ice conditions determine the geographic extent of hunting areas. The prime hunting area for this region is within the 16-32-km (10-20-mi) radius of Little Diomede Island. During summer, hunters may only travel 8-16 km (5-10 mi) out and in fall, this distance is reduced to 5-6 km (3-4 mi) (Kawerak Inc., 2013).

Walrus hunting on the Round Island within the Walrus Island State Game Sanctuary is an exception where a season and a quota have been established through a co-management agreement with the Qayassig Walrus Commission, USFWS, and ADF&G (USFWS, No Date-g)[18]. Alaska Natives are permitted to hunt walruses from September 10 through October 20 annually, with the harvest limit set at 20 walruses (ADF&G, 2017b). **Figure 3.13-7** shows the historical and present-day walrus hunting areas in Northwestern Alaska in the Chukchi Sea.

[17] The co-management agreement between USFWS and EWC covers the Pacific walrus hunting practices of the St. Lawrence Island Yupik, Central Yupik, and Inupiat Alaska Natives across 19 villages: Utkiagvik, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue, Shishmaref, Little Diomede, Wales, Brevig Mission, King Island, Nome, Gambell, Savoonga, Unalakleet, Stebbins, Mekoryuk, Kwigillingok, and Manokotac.

[18] This agreement covers the Yupik hunting practices across nine villages: Togiak, Twin Hills, Manokotak, Aleknagik, Dillingham, Clark's Point, Ekuk, Ekwok, and New Stuyahok.



Source: ADF&G, 2016a

Figure 3.13-7. Historical and Present-Day Walrus Hunting Areas

Several thousand walruses are legally harvested in Alaska and Russia every year. In the U.S. between 2006 and 2010, subsistence harvest mortality levels have ranged from 3,828 to 6,119 animals per year (USFWS, 2014g). The annual harvest in Alaska is monitored by the USFWS.

Table 3.13-1 summarizes the subsistence hunting information related to each of the species of marine mammals describes in this section.

Table 3.13-1. Summary of Subsistence Hunting of Marine Mammals

Species	Communities engaged in subsistence hunting	Hunting Season	Hunting Areas	Harvest limits
Bowhead Whale	Iñupiat and Siberian Yup'ik people across 11 whaling villages: Gambell, Savoonga, Wales, Little Diomede, Kivalina, Point Hope, Point Lay, Wainwright, Utqiagvik, Utqiagvik, Nuiqsut, and Kaktovik.	Typically occurs during spring (March through May) and autumn (August through October). Hunters on Saint Lawrence Island communities of Gambell and Savoogna may harvest whales during the winter (December and January) as well.	As shown in Figure 3.13-2. Only the Western Arctic bowhead stock is hunted for subsistence.	For each of the years 2019 through 2025, the number of bowhead whales struck may not exceed 67, with unused strikes from the three prior quota blocks carried forward and added to the annual strike quota of subsequent years, provided that no more than 50 percent of the annual strike limit is added to the strike quota for any one year. The combined strike quota set by the IWC for 2019 is 100 (67 + 33).
Beluga Whale	Beaufort Sea, Bristol Bay, eastern Bering Sea, and eastern Chukchi Sea stocks: Alaska Native across 6 regions comprising 34 villages - North Slope: Utqiagvik, Point Hope, Point Lay, Wainwright Kotzebue Sound: Buckland, Deering, Kivalina, Kotzebue, Noatak Norton Sound: Council/Nome, Elim, Koyuk, Shaktoolik, Saint Michael, Stebbins, Unalakleet Yukon Delta: Alakanuk, Emmonak, Hooper Bay, Kotlik, Mountain Village, Nunam Iqua, Pilot Station, Pitka's Point,	Spring, and summer and autumn open water period	As shown in Figure 3.13-4 for the Cook Inlet stock. Primary hunting areas are within upper Cook Inlet. Native hunting camps exist on two islands in Susitna River delta.	No harvest limits on the Beaufort Sea, Bristol Bay, eastern Bering Sea, and eastern Chukchi Sea stocks. For the Cook Inlet stock, harvest limits vary by year.

Species	Communities engaged in subsistence hunting	Hunting Season	Hunting Areas	Harvest limits
	Saint Mary's, Scammon Bay Kuskokwim: AVCP/Bethel, Platinum, Toksook Bay Bristol Bay: Aleknagik, Dillingham, Levelock, Manokotak, South Naknek Cook Inlet stock: Primarily, the Alutiiq Eskimos and Dena'ina Athabascan of Tyonek village			
Northern Fur Seal	Unangans of St. Paul and St. George Islands	St. Paul Island: January 1 to May 31; June 23 to December 31 St. George Island: June 23 to August 8; September 16 through November 30	St. Paul and St. George Islands of the Pribilof Islands	St. Paul Island: Up to 2,000 juvenile male fur seals annually. A maximum of 20 mortalities of female fur seals associated with subsistence reasons are authorized. St. George Island: Up to a total of 500 male fur seals per year over the course of both the sub-adult male harvest and the male young of the year harvest. Pribilovians may harvest up to 150 male fur seal young annually. Up to three mortalities of female fur seals are authorized each year for subsistence reasons.
Steller Sea Lion	Aleut Hunters in the Aleutian and Pribilof Islands and 16 communities in Alaska that hunt the eastern DPS.	Year-round with harvest quantities varying seasonally. Peak harvest months are in spring (March – April) and fall (September – November).	Range of Western and Eastern DPS	No harvest limits

Species	Communities engaged in subsistence hunting	Hunting Season	Hunting Areas	Harvest limits
Harbor Seal	Aleut of the Aleutian Islands; the Alutiiq and Eyak of the Pacific Gulf Coast; the Tlingit, Haida, and Tsimshian of the Southeast archipelago; the Yup'ik of Southwest Alaska; and the Dena'ina of Cook Inlet	Varies by region and species abundance. Seal takes generally peak in March, May, and October, and are lowest in December, January, April, and June.	Aleutian Islands, Pribilof Islands, Bristol Bay, North Kodiak, South Kodiak, Prince William Sound, Cook Inlet/Shelikof Strait, Glacier Bay/Icy Strait, Lynn Canal/Stephens Passage, 30 50 Sitka/Chatham Strait, Dixon/Cape Decision, Clarence Strait	No harvest limits
Ice Seals	Approximately 64 coastal communities harvest ice seals in western and northern Alaska.	Varies by region	Broadly hunted along the coast from approximately Kaktovik on the Beaufort Sea in the north to Clark's Point on Kvichak Bay in the south and along Nunivak and Saint Lawrence Islands.	No harvest limits
Northern Sea otter	Tlingit and Haida people inhabiting southeastern Alaska.	Year-round; peak hunting season commonly occurs during fall.	MMPA does not limit the areas of Alaska where sea otters may be harvested.	No harvest limits
Polar Bear	Iñupiat and Siberian Yup'ik Alaska Natives across 15 villages: Kaktovik, Nuiqsut, Utqiagvik, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue, Shishamaref, Diomede, Wales, Brevig Mission, King Island, Gambell, Savoonga	Varies by region. Majority of the bears are harvested between November and April.	The MMPA does not limit the areas in Alaska where polar bears may be harvested. There may be some hunting or access restrictions, such as on national parks or private land.	Southern Beaufort Sea stock: 35 bears for the U.S. annually (voluntary quota) Chukchi/Bering Seas stock: U.S./Russia combined quota of 85 bears annually
Pacific Walrus	St. Lawrence Island Yup'ik, Central Yup'ik, and Iñupiat people across 19 villages: Utkiagvik, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue,	Year-round, though the prime hunting season is in the spring (mid-April to early June). September 10 - October 20 for	The MMPA does not limit the areas of Alaska where Pacific walruses may be harvested. However, areas such as National Parks, state game sanctuaries, or	This species is not listed as depleted under the MMPA and is not designated as threatened or endangered under the ESA. No harvest limits are currently imposed

Species	Communities engaged in subsistence hunting	Hunting Season	Hunting Areas	Harvest limits
	Shishmaref, Little Diomede, Wales, Brevig Mission, King Island, Nome, Gambell, Savoonga, Unalakleet, Stebbins, Mekoryuk, Kwigillingok, and Manokotac Additionally, the Yup'ik people authorized to hunt Pacific walrus on Round Island inhabit 9 villages: Togiak, Twin Hills, Manokotak, Aleknagik, Dillingham, Clark's Point, Ekuk, Ekwok, and New Stuyahok	subsistence hunting at Round Island.	private lands may have hunting or access restrictions Round Island waters and beaches within 5 km (3 mi) of Round Island.	for subsistence purpose. Round Island sets a harvest limit of 20 walrus (including struck and lost animals).

3.13.1.12 Subsistence Fishing

For numerous minority and low-income communities across the U.S., subsistence fisheries play an important role in ensuring a secure supply of food and strengthening the cultural and traditional aspects of community life. Subsistence fishing for finfish (such as salmon, halibut, herring, bottomfish, smelt, etc.) and shellfish (such as Dungeness crab, king crab, Tanner crab, shrimp, clams, abalone, etc.) is common throughout Alaska and is an important element of the state’s social and cultural heritage, as well as a crucial component of the subsistence sector of Alaska’s economy (ADF&G, 2020). Similarly, indigenous tribes on the West Coast retain strong spiritual and cultural ties to various species of fish based on thousands of years of use for tribal religious/cultural ceremonies, subsistence, and commerce. Some commonly fished species include steelhead, halibut, whiting, sturgeon, lamprey, etc. Many Pacific Northwest Indian tribes reserve the right to fish in the “Usual and Accustomed” fishing places and are co-managers of the fisheries with the states and federal government (NMFS, No Date-g).

This section provides a description of some of the important fish species used for subsistence purposes by Alaska Natives, indigenous tribes, and other minority and low-income communities; the cultural importance of these species; the common fishing practices and methods; and the established fishing seasons and areas, as applicable.

3.13.1.12.1 Pacific Salmon

Salmon[19] are important to the diets, economies, cultures, and identities of many Alaska Native and tribal communities of the Pacific Northwest. For Alaska Natives, salmon accounts for 32 percent of the wild

[19] The section provides a combined narrative for all five species of Pacific salmon hunted for subsistence, namely Chinook (king), Chum (dog), Coho (silver), Pink (humpback), and Sockeye (red).

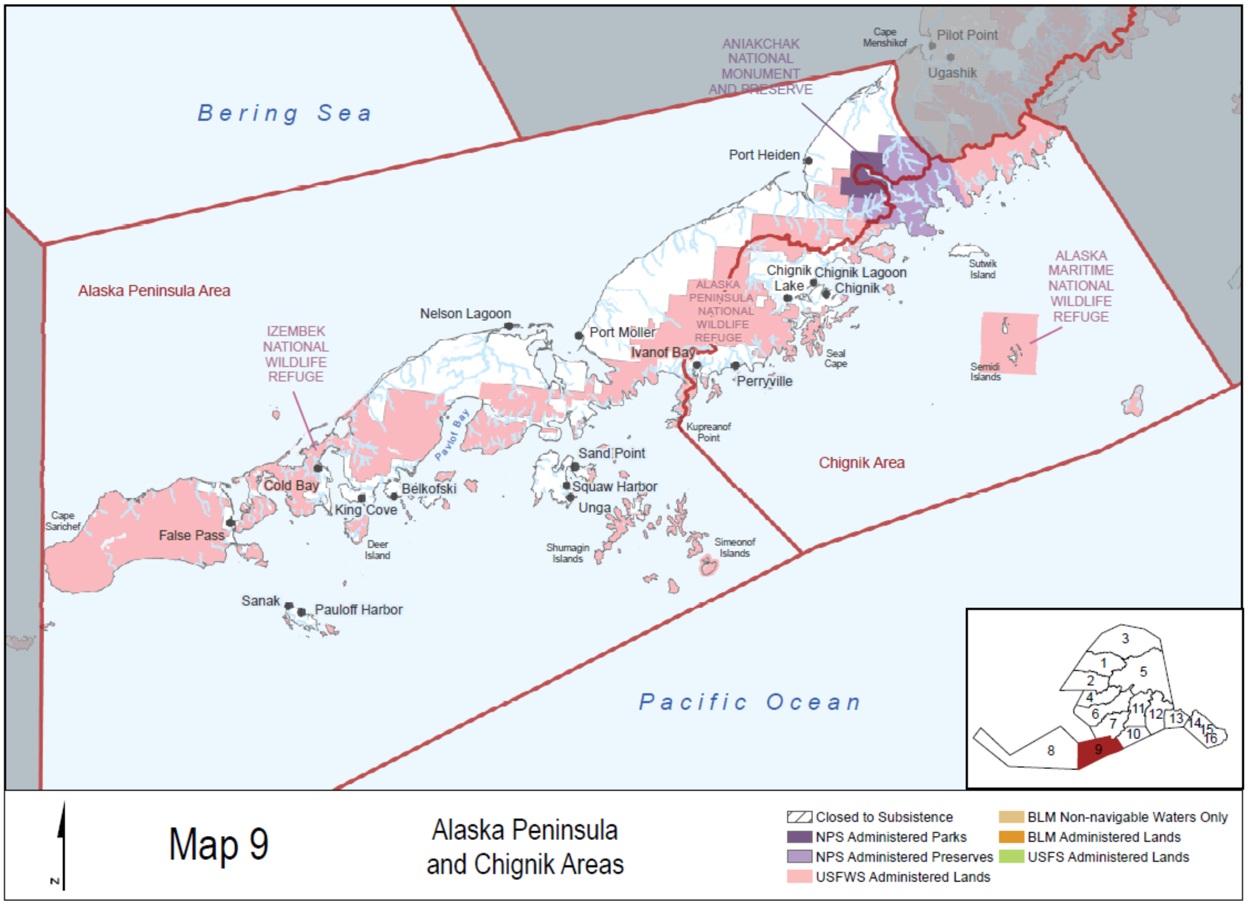
foods annually harvested for subsistence purposes in rural communities and constitutes a major portion of their food supply (ADF&G, 2019). To honor the fish that is a critical part of the Alaskan identity, the governor of Alaska signed into law a House Bill in 2016 establishing August 10th of each year as 'Alaska Wild Salmon Day' (ADF&G, 2016b). In many Native American cultures, salmon holds a special position of honor and respect and is often used as a symbol of determination, renewal, and prosperity in their artwork and literature (NLA, No Date-a). For example, Columbia River Basin salmon have long been the symbol and lifeblood of the Yakama, Umatilla, Warm Springs, and Nez Perce tribes. Salmon influences culture and intertribal interactions and is an important part of the economies of the region. It is used for religious services by numerous longhouses and churches on the reservation and annual salmon returns are widely celebrated by tribes to assure the renewal and continuation of human and all other life (CRITFC, No Date).

In Alaska, the state subsistence fisheries are managed by the Division of Commercial Fisheries, ADF&G, whereas the federal subsistence fisheries are regulated by the Federal Subsistence Board comprising five federal agencies: USFWS; National Park Service (NPS); Bureau of Land Management; Bureau of Indian Affairs; and U.S. Forest Service. Often, the state and federal subsistence fisheries occur in the same area. These entities administer regulations outlining salmon fishing seasons, acceptable fishing gear, and annual harvest limits to manage subsistence salmon harvests for different regions[20] within the state (DOI, 2021).

To qualify to fish under the federal subsistence regulations, one must have their primary place of residence in a rural area or must have lived in Alaska for the previous 12 months. While no licenses are required to take fish or shellfish for subsistence uses, state or federal subsistence fishing permits may be required for a particular fishery management area (see **Figure 3.13-8**). The permit designates the harvest limits and seasons, fishing areas, and the types and amount of fishing gear permitted. These specifications vary by region and may be modified annually.

For subsistence salmon fishing in the U.S. EEZ off Washington, Oregon, and California, PFMC is the central fishery management authority (PFMC, No Date-a). It primarily manages chinook and coho salmon fishing for different regions and groups, including for tribal ceremonial and subsistence purposes in Puget Sound, Washington coastal rivers and bays, Columbia River and its tributaries, and Klamath River and Trinity River (PFMC, No Date-b). In May 2019, NMFS established fishery management measures for the 2019 ocean salmon fisheries off Washington, Oregon, and California and the 2020 salmon seasons opening earlier than May 1, 2020. These measures outline the salmon fishing season, size requirements, gear restrictions, as well as harvest quotas for the S'Klallam, Makah, Quileute, Hoh, and Quinault tribes. For example, the Chinook harvest quota for the May 1 – June 30 fishing season is 17,500 and 17,500 for the July 1 – September 15 fishing season. Single point, single shank, and/or barbless hooks are required in the fisheries and no more than eight lines are allowed per boat (84 FR 19729, May 6, 2019).

[20] Alaska is divided into fishery management areas to implement subsistence fishing regulations for finfish, including salmon and halibut. These regions are: Kotzebue Area, Norton Sound-Port Clarence Area, Yukon-Northern Area, Kuskokwim Area, Bristol Bay Area, Aleutian Islands Area, Chignik Area, Kodiak Area, Cook Inlet Area, Prince William Sound Area, Yakutat Area, Southeastern Area.



Source: DOI, 2021

Figure 3.13-8. Subsistence Fishing in Alaska Peninsula and Chignik Areas

3.13.1.12.2 Pacific Halibut

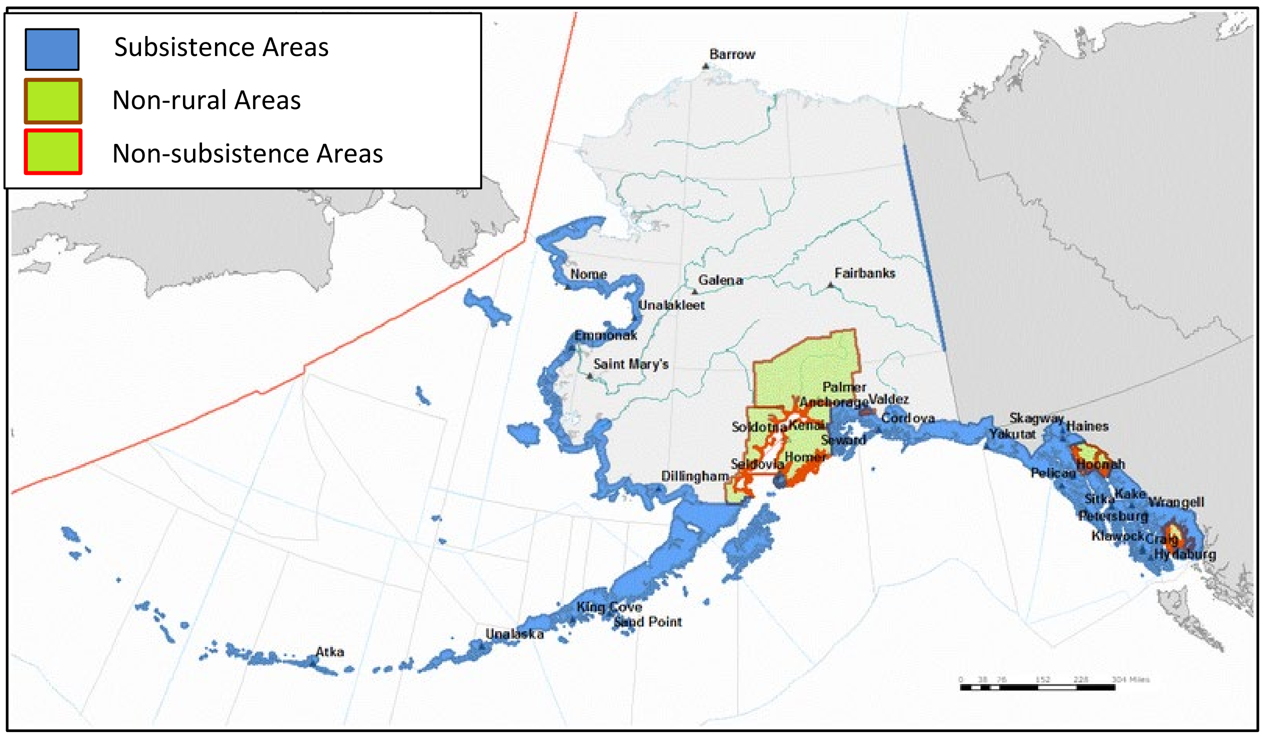
Halibut are mythologically important to many tribes in the Pacific Northwest. It is used as a clan crest in some Northwest Coast tribes and can sometimes be found carved on totem poles and potlatch dishes. The creation myths of some Kwakiutl tribes hold that their first ancestors were transformed from a halibut into a man. The halibut is a symbol of prosperity for the Haida people. Some Native Alaskan fishermen make special offering of the first halibut they catch each season (NLA, No Date-b).

Historically, Pacific halibut were fished by the indigenous people inhabiting the lands bordering the eastern North Pacific Ocean, and was an essential part of the diet of many groups who conducted their fishery by hook and line from large canoes. Today, in addition to providing recreational fisheries opportunities to indigenous groups, Pacific halibut continues to be an important subsistence and ceremonial fish. It is used to feed people at culturally important events like weddings, funerals, and naming ceremonies (IPHC, No Date).

The U.S. and Canada participate in the International Pacific Halibut Commission (IPHC) and enforce regulations governing the Pacific halibut fishery under the authority of the Northern Pacific Halibut Act of 1982 (Halibut Act) (NMFS, 2015d). Each year, the IPHC sets the total allowable catch (TAC) for halibut that will be caught in the U.S. and Canadian waters in the northeastern Pacific Ocean, and NMFS establishes regulations for U.S. waters off the coasts of Washington, Oregon, and California (Area 2A) (NMFS, No

Date-a). Thirteen western Washington tribes[21] possess treaty fishing rights to halibut. Most tribes fish inside Puget Sound. Tribal allocations include a year-round ceremonial and subsistence (C&S) component (83 FR 13080, March 26, 2018). Under the 2019 Pacific Halibut Catch Sharing Plan for Area 2A, 35 percent of the area 2A TAC is allocated to the 13 treaty Indian tribes in subarea 2A-1[22]. Tribal C&S fishery begins on January 1 and continues through December 31. No harvest limits apply to this fishery, except that when the commercial fishery is closed, treaty Indians may take and retain not more than two halibut per day per person for subsistence purposes (84 FR 9243, March 14, 2019).

Before fishing under the subsistence halibut regulations, fishermen must obtain a Subsistence Halibut Registration Certificate (SHARC). Special permits for community harvest, ceremonial, and educational purposes are also available to qualified Alaska communities and Alaska Native Tribes. Fish harvest limits and fishing seasons vary by region and depend on the type of permit issued. For example, in regulatory area 2C (Sitka Sound), SHARC permits allow fishermen to take 10 halibut per day per vessel from September 1 through May 31 using a maximum of 30 hooks per vessel, and five halibut per day per vessel from June 1 through August 31 with a maximum of 15 hooks per vessel. No power hauling equipment is allowed (NMFS, No Date-h). **Figure 3.13-9** shows a map of subsistence halibut fishing areas around Alaska.



Source: NOAA, No Date-g

Figure 3.13-9. Halibut Subsistence Fishing Areas

[21] The 13 treaty Indian tribes are: Hoh, Jamestown S'Klallam, Lower Elwha S'Klallam, Lummi, Makah, Nooksack, Port Gamble S'Klallam, Quileute, Quinault, Skokomish, Suquamish, Swinomish, and Tulalip (50 CFR § 300.64).

[22] Subarea 2A-1 includes: all waters off the coast of Washington that are north of the Quinault River (47°21.00' north latitude) and east of 125°44.00' west longitude; all waters off the coast of Washington that are between the Quinault River (47°21.00' north latitude) and Point Chehalis (46°53.30' north latitude), and east of 125°08.50' west longitude; and all inland marine waters of Washington.

Table 3.13-2 summarizes the subsistence fishing information related to salmon and halibut described in Sections 3.13.1.11.1 and 2.13.1.11.2.

Table 3.13-2. Summary of Subsistence Fishing of Salmon and Halibut

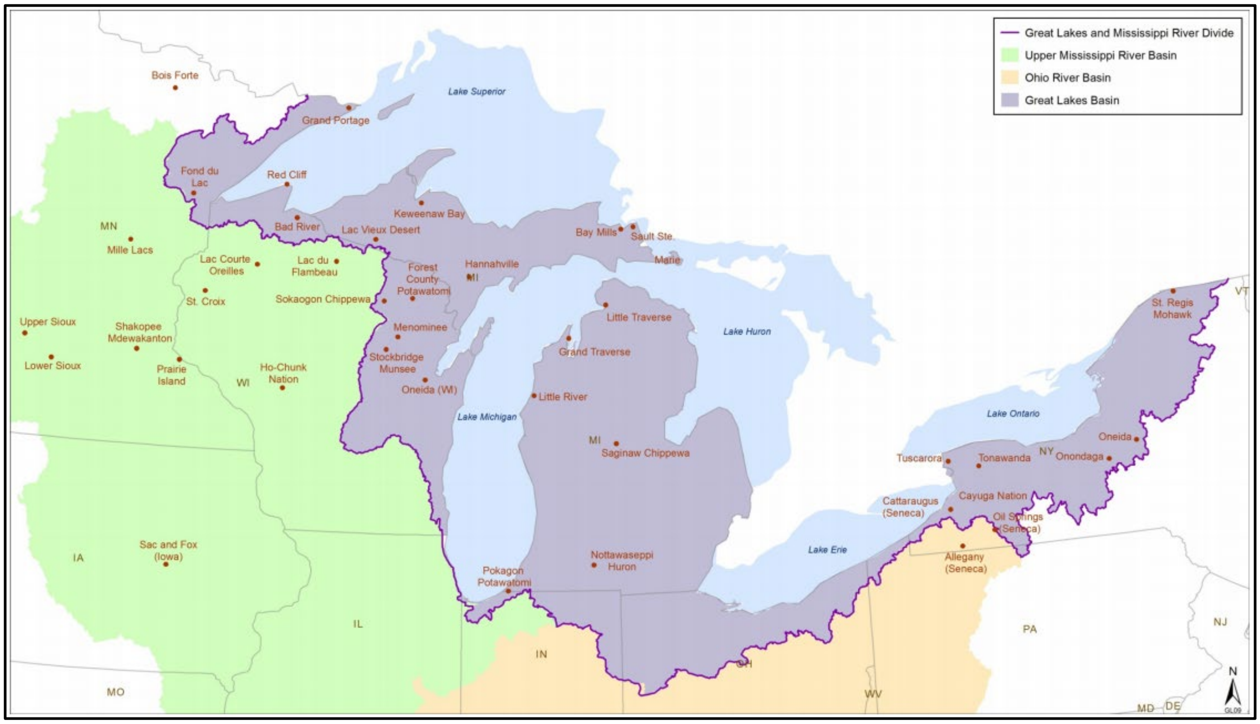
Species	Communities engaged in subsistence fishing	Hunting Season	Hunting Areas	Harvest limits
Salmon	Effectively all Alaskan Native and indigenous communities inhabiting coastal and riverine areas of the Pacific Northwest.	Varies by region.	Coastal waters and rivers of Alaska and the Pacific Northwest.	Varies by region and permit.
Halibut	North Pacific Halibut Act of 1982 identifies over 120 Alaska Native communities eligible to harvest subsistence halibut. Additionally, 13 western Washington tribes possess treaty fishing rights to halibut.	Generally year-round, though limits may vary by season in certain regulatory areas.	North Pacific Halibut Act of 1982 designates specific areas for the 13 treaty tribes.	Varies by regulatory area and permit type.

3.13.1.12.3 Other Fish Species

For numerous Native American tribes that reside within the U.S. portion of the Great Lakes Basin, Upper Mississippi River Basin, and Ohio River Basin, fishing for subsistence is an important element of their traditional way of life. Sixteen of the 37 federally recognized tribes that occupy these lands have retained their right to hunt, fish, and gather under several treaties signed with the federal government (referred to as "treaty tribes")[23] and continue subsistence harvesting in the Great Lakes and Upper Mississippi River Basins (see **Figure 3.13-10**). Although the communities that engage in subsistence activities and the harvests associated with these activities are small, the activities play a crucial role in the tribes' cultural identities. For example, the Chippewa or Ojibwe conduct species ceremonies at the beginning and

[23] The 16 federally recognized treaty tribes in the Great Lakes region are as follows: Grand Portage Band of Lake Superior Chippewa Indians (Wisconsin [WI]), Fond du Lac Band of Lake Superior Chippewa Indians (Minnesota [MN]), Mille Lacs Band of Ojibwe (MN), St. Croix Chippewa Indians of Wisconsin (WI), Lac Courte Oreilles Band of Ojibwe (WI), Lac du Flambeau Band of Lake Superior Chippewa Indians (WI), Lac Vieux Desert Band of Lake Superior Chippewa Indians (Michigan [MI]), Bad River Band of Lake Superior Chippewa Tribe (WI), Red Cliff Band of Lake Superior Chippewa Indians (WI), Keweenaw Bay Indian Community (MI), Sokaogon Chippewa Community (WI), Sault Ste. Marie Tribe of Chippewa Indians (MI), Bay Mills Indian Community (MI), Little Traverse Bay Bands of Odawa Indians (MI), Little River Band of Ottawa Indians (MI), and Grand Traverse Band of Ottawa and Chippewa Indians (MI).

towards the end of each fishing season. Generally, only a few tribal members engage in subsistence harvesting, but their harvest is shared with family, friends, and those in the community unable to fish. Subsistence harvesting is at the core of the tribes' cultural identity and is an indication of their status as sovereign entities. It is an activity cherished by all, even those members of the community who are not presently engaged in the practice (USACE, 2012b).



Source: USACE, 2012b

Figure 3.13-10. Federally Recognized Tribes in and Around the Great Lakes Basin

Historically, traditional subsistence resources utilized by the tribes varied with the season and local environment. Though fishing was conducted year-round, Chippewa men would travel to and camp out at productive fishing sites during the summer and fall seasons. Traditional methods included the use of nets, weirs and traps, fish spears, angling, poisons, bows and arrows, and fishing lures. Some of the fish species historically harvested by the Great Lakes tribes included catfish, freshwater cod, char/lake trout, smelt, grayling, and whitefish (USACE, 2012b).

Present-day subsistence fishing practices have continued the use of traditional methods of harvesting such as gill nets, seine nets, spear fishing, angling, and catching by hand. These methods are regulated by individual tribes and inter-tribal organizations, such as the Chippewa Ottawa Resource Authority (CORA) and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC), due to their potential to capture many fish at once and potentially deplete their numbers. The fish species that are regulated are monitored closely by these organizations due to their popularity with subsistence fishers and the risk of overfishing. **Table 3.13-3** provides an overview of the species of fish harvested and the fishing methodologies employed by the tribes regulated by CORA and GLIFWC.

Table 3.13-3. Subsistence Fishing in the Great Lakes Basin*

Regulatory Authority	Member Tribes	Fish Species Harvested	Harvest Limits
Chippewa Ottawa Resource Authority	Bay Mills Indian Community	Bass, catfish, common carp, lake sturgeon, salmon (coho, chinook), smelt, trout (brown, brook, lake, rainbow), lake whitefish, yellow perch	No more than 45 kgs (100 lbs.) of all species in possession
	Grand Traverse Band of Ottawa and Chippewa Indians		
	Little River Band of Ottawa Indians		
	Little Traverse Bay Bands of Odawa Indians		
	Sault Ste. Marie Tribe of Chippewa Indians of Michigan		
Great Lakes Indian Fish and Wildlife Commission	Bay Mills Indian Community	Walleye, muskellunge, largemouth bass, smallmouth bass, northern pike, lake sturgeon, burbot	Varies per species and tribe
	Keweenaw Bay Indian Community		
	Lac Vieux Desert Band of Lake Superior Chippewa Indians		
	Bad River Band of Lake Superior Chippewa Tribe		
	Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin		
	Lac du Flambeau Band of Lake Superior Chippewa Indians of Wisconsin		
	Lac Courte Oreilles Band of Ojibwe		
	Sokaogon Chippewa Community		
	St. Croix Chippewa Indians of Wisconsin		
	Mille Lacs Band of Ojibwe		
	Fond du Lac Band of Lake Superior Chippewa Indians		

Source: USACE, 2012b

*Table 3.13-3 is not a comprehensive table of all tribes that practice subsistence fishing and all the fish species that they harvest.

For several Native American tribes living in the Gulf Coast area of the U.S., fishing for subsistence is a crucial component of their daily livelihood. For example, the Miccosukee Tribe inhabiting the Everglades National Park in Florida rely on native fish species such as red ear, largemouth bass, and blue gill for subsistence, recreational, and cultural uses (Miccosukee Tribe of Indians, 2010). Under Florida state law, members of the Miccosukee and Seminole Tribes are authorized to take fish for subsistence purposes at any time within the boundaries of their respective reservations and can exercise their fishing rights within the Big Cypress Preserve (Florida Statute § 285.09). Similarly, the Mississippi Band of Choctaw Indians can legally engage in subsistence fishing year-round within the exterior boundaries without obtaining any Tribal or state license or permit. Other Native American tribes located in the Gulf Coast region that engage in subsistence fishing activities include the Chitimacha, Tunica-Biloxi, Coushatta, Houma, and Jena Band of Choctaws (MMS, 2002).

Several distinct ethnic, cultural, and low-income groups that inhabit the Gulf Coast are dependent on the natural resources provided by its marshes, barrier islands, coastal beaches, and wetlands (BOEM, 2012).

Low incomes tend to coincide with concentrations of minority populations across all of the Gulf Coastal States: African-American, Hispanic, and/or Asian-Americans (MMS, 2002). Coastal minority communities and low-income groups rely heavily on Gulf Coast fisheries and other traditional fishing activities to supplement their diet. Subsistence fishing in these regions is poorly documented and a comprehensive account of this activity is not available (BOEM, 2012).

Hawaiian fishing communities are also dependent on or engaged in recreational, subsistence, and traditional fishing practices. Fish species such as blue marlin, mahimahi, goatfishes, trevallys and other jacks, scad, skipjack tuna, smallmouth bonefish, snappers, wahoo, and yellowfish tuna are most commonly harvested. Charter fishing and related forms of recreation contribute to the state's tourism economy. Non-commercial fishing is an important part of the Hawaiian culture, and sharing of seafood among family and friends are particularly important local traditions (NMFS, 2015d).

In other territories in the Pacific Islands region, such as American Samoa, nearshore fishing is undertaken largely for purposes of subsistence. Extensive fish and shellfish are harvested by residents from reef areas adjacent to the island villages. In the Commonwealth of the Northern Mariana Islands, reef-associated fish, shallow-water bottomfish, and reef invertebrates such as shellfish and crabs are consumed by anglers, their immediate family, extended family, and friends. Fishing primarily occurs for social and cultural purposes, rather than economic. Similarly, the people of Guam, including various immigrant communities, continue to depend on fishing and locally caught seafood to reinforce and perpetuate cultural traditions such as community sharing of food (NMFS, 2015d).

3.13.2 Environmental Consequences for Environmental Justice

This section discusses potential impacts of the activities associated with Alternatives A, B, and C on Alaska Natives, indigenous tribes, and other minority and low-income communities (collectively referred to as "EJ communities" throughout this section) who hunt marine mammals and/or fish primarily for their subsistence, as well as for cultural and recreational purposes.

3.13.2.1 Methodology

The causes from NOS project activities that may impact marine mammals and fish hunted for subsistence or other purposes described in the affected environment section in the action area include: (1) active underwater acoustic sources (i.e., from echo sounders, ADCPs, and acoustic communication systems); (2) vessel and equipment sounds - underwater and airborne (i.e., from surface vessels; ROVs and autonomous systems; low-flying aircraft); (3) vessel presence, including equipment in the water (i.e., visual and physical disturbance to and risk of collisions with marine mammals); (4) human activity (i.e., onboard vessels, on land during tide gauge and GPS reference station installation, and underwater during SCUBA operations); (5) accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters (i.e., from vessel operations); (6) trash and debris (i.e., potential for entanglement and ingestion); and (7) air emissions (i.e., from smokestacks and outboard motors). Potential impacts on marine mammals and fish are discussed in Sections 3.5 and 3.7, respectively, and are referenced throughout this section as it relates to the ability of EJ communities to hunt or fish for subsistence or other purposes.

NOS projects may also indirectly benefit EJ communities with the availability of new mapping and charting information. Economic benefits are discussed in Section 3.12, Socioeconomics. The associated potential benefits on EJ communities are discussed below.

As discussed in Section 3.2.2, significance criteria were developed for each resource analyzed in this PEIS to provide a structured framework for assessing impacts from the Proposed Action and the significance of the impacts. The significance criteria for environmental justice are shown in **Table 3.13-4**.

Table 3.13-4. Significance Criteria for the Analysis of Impacts to Environmental Justice

Impact Descriptor	Context and Intensity	Significance Conclusion
Negligible	No observable decrease in the total annual subsistence catch numbers of a species hunted by low-income or minority communities. No observable increase in the time required and the distance traveled to catch or harvest the same amount compared to previous years in which NOS projects did not occur. Impacts from any given project would be temporary (lasting the duration of and immediately after NOS projects and activities).	Insignificant
Minor	A detectable decrease in the total annual subsistence catch numbers of a species hunted by minority or low-income communities, or a detectable increase in time needed and the distance traveled to harvest or catch the same amount compared to previous years in which NOS projects did not occur. Impacts from any given project would be temporary or short-term (lasting beyond NOS activities, up to 1 year).	
Moderate	A notable decrease in the total annual subsistence catch numbers of a species hunted by minority or low-income communities, or a notable increase in the time needed and the distance traveled to harvest or catch the same amount compared to previous years in which NOS projects did not occur. Impacts would be short-term.	
Major	Disproportionally high and adverse impacts on minority or low-income populations' continued ability to subsistence hunt. A substantial decrease in the total annual subsistence catch numbers of a species hunted by minority or low-income communities, or a substantial increase in the time needed and distance traveled to harvest or catch the same amount compared to previous years in which NOS projects did not occur. Impacts would be long-term (lasting longer than 1 year).	Significant

3.13.2.2 Alternative A: No Action - Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels

Impacts of Alternative A are discussed by impact causing factors for marine mammals and fish species harvested for subsistence by EJ communities. As indicated in **Table 3.4-4**, survey efforts under Alternative A would vary by year. Although the greatest number of nautical miles surveyed for proposed activities over the five-year period would be in the Southeast Region (over 50 percent), the only impacts on subsistence hunting of marine mammals are expected to occur in the Alaska Region. Any impacts on gray whales would have no effect on the subsistence activities of the Makah Tribe residing in Washington state since there is currently a moratorium on gray whale hunting in the continental U.S. The greatest overall impacts on subsistence fishing are expected to occur in the Alaska Region, West Coast Region (particularly the Pacific Northwest), Great Lakes Region, and the Pacific Islands Region due to the prevalence of Alaska Natives, indigenous tribes, and other minority and low-income communities that engage in subsistence fishing activities in these regions. Since subsistence hunting and/or fishing activities in the Greater Atlantic and Southeast regions are not well documented, the scope of discussion of the potential impacts of the project in these regions is limited.

Under each impact causing factor, only the marine mammal and/or fish species that would be impacted by that factor is discussed. For example, since those cetaceans hunted for subsistence purposes (bowhead, gray, and beluga whales) live primarily underwater, the impact of air emissions on these species is not considered. This is followed by an analysis of these impacts on the subsistence hunting and fishing activities of the EJ communities.

3.13.2.2.1 Active Underwater Acoustic Sources

Sections 3.5.2.3 and 3.7.2.2 detail the adverse impacts of noise from active underwater acoustic sources on cetaceans, pinnipeds, fissipeds, and fish. As shown in the tables listing the total injury and behavioral disruption exposure estimates in Section 3.5.2.3, cetaceans, pinnipeds, and fissipeds important to the subsistence of Alaska Natives would only be subject to behavioral disruption exposures. The impacts to fish species would primarily be behavioral and may result in their temporary migration away from the sound sources affecting them. Such disturbances would be limited to the relatively small portion of a population that may be located near the active sound source.

Potential adverse impacts to subsistence activities as they relate to EJ communities primarily include behavioral disruptions in individual animals. The disturbance from underwater active acoustic sources could cause the species movements to be deflected farther offshore, causing them to temporarily abandon areas where hunting and harvesting habitually occur. Displaced individuals could exhibit more wary or skittish behavior, making them harder to strike/catch (BOEM, 2018a). Hunting/fishing crews could be required to travel greater distances from shore to the new hunting areas, which could lead to increased expenditure on gas, additional travel time, and potential increased risk to crews from adverse weather, depending upon the time of the year. Greater hunting distances would also mean longer distances to tow the harvested animal to shore, during which time it may spoil (NMFS, 2016b). This could lead to a decrease in the number of species successfully harvested by subsistence hunters/fishers.

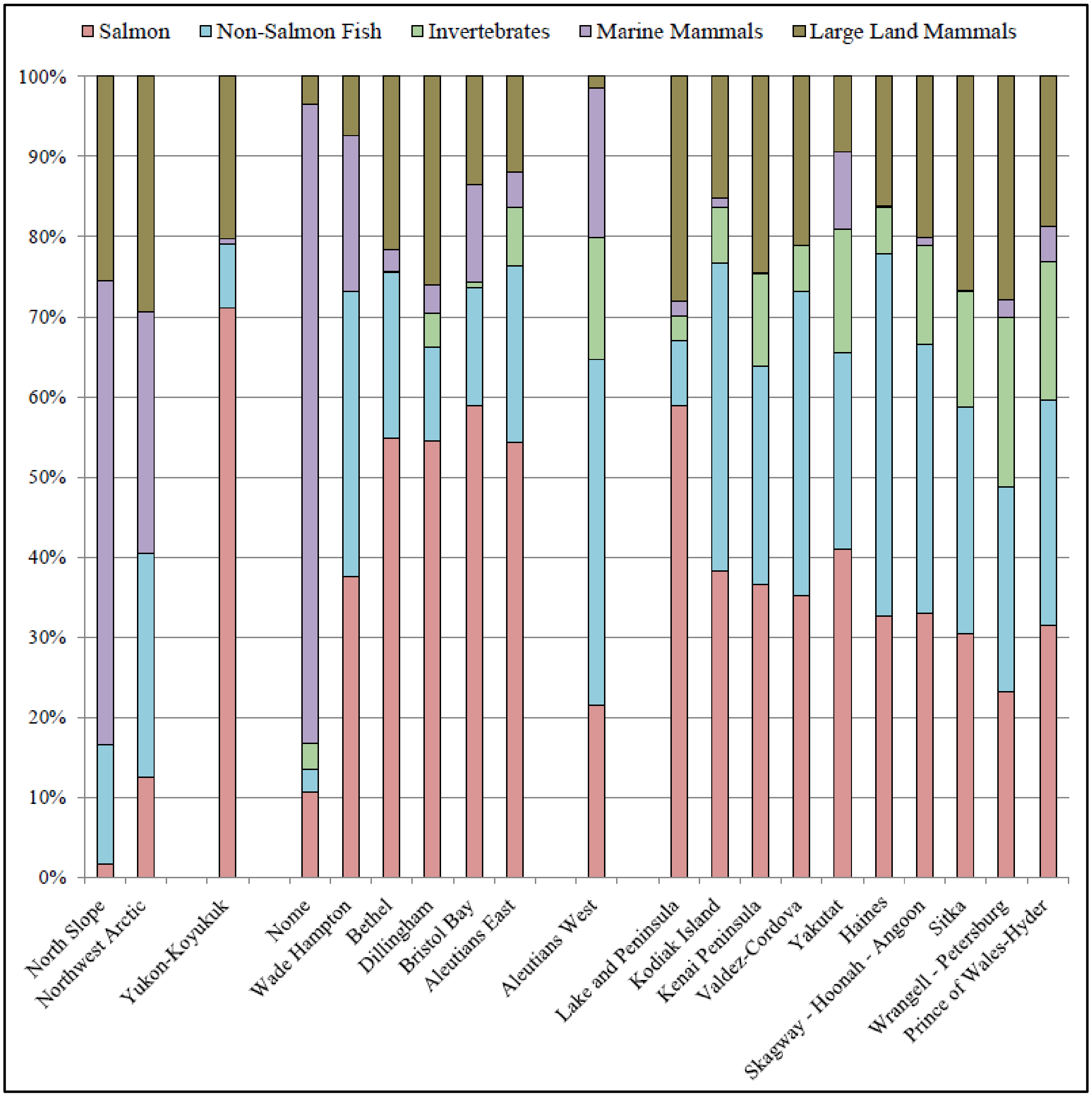
The magnitude of the impacts would depend on the degree of overlap between the hunting season and the activities, with greater adverse impacts on EJ communities that rely on species that are only hunted during specific seasons to account for animal migration patterns and seasonal changes in weather and ice, as described in Section 3.13.1. Survey and whaling seasons are bound to overlap due to safety and weather considerations, therefore it would not be practicable for NOS to avoid surveying activities during all subsistence hunting seasons. For species with designated hunting seasons, increased hunting time could potentially decrease harvest numbers. Since surveys would occur in the spring/summer months in Alaska, the spring bowhead whale harvest of the Iñupiat and Siberian Yup'ik people, the spring and summer beluga harvest, and the spring and summer northern fur seal harvest of the Unangans of St. Paul and St. George Islands could be particularly impacted[24]. Impacts on the harvest limits of other species of marine mammals and fish would be relatively less pronounced due to year-round hunting provisions.

For some subsistence communities, the decrease in harvest numbers of marine mammals could have adverse economic impacts. The Iñupiat and Siberian Yup'ik people inhabiting remote areas in the northern and western coasts of Alaska primarily rely on the harvest of bowhead whale for subsistence. Food available for purchase in the village grocery stores is often expensive. A pound of beef, for example, could cost anywhere between $10 - $20. Harvesting whale brings an average of approximately 1.1 million to 2 million pounds of food per year, which is shared among members of Alaska's Native subsistence communities. Replacing the food derived from whale with beef would cost the subsistence communities approximately $11 - $30 million per year (IWC, No Date-a). However, these communities do not entirely rely on a single species to meet their subsistence requirements. In addition to whales, seals, fish, and other marine species, terrestrial resources such as caribou, moose, small game, and edible roots and berries are also commonly harvested by the residents of northern and western Alaskan villages (BOEM, 2018a).

Most EJ communities across all five geographic regions rely on the harvest of fish for subsistence purposes. **Figure 3.13-11** shows the dependence of Alaskan communities on salmon and non-salmon fish species compared to other resources for subsistence. Similarly, many minority and low-income communities, especially in the Pacific Northwest, Great Lakes, Gulf of Mexico, and Pacific Islands regions engage in subsistence fishing for their dietary requirements. These communities could be adversely affected due to the behavioral disruptions experienced by fish species exposed to underwater acoustic sources. However, given the small spatial extent of no more than a few project vessels operating at any one time relative to the generally large-scale distribution of fish populations, the impacts would be minimal.

As described in Section 3.13.1, since most marine mammals and fish species harvested for subsistence are also crucial to the traditions and customs of Alaska's Native subsistence communities, decreased harvest or catches could also have an adverse cultural impact on these communities. A loss of sociocultural values can occur with a loss of eating and sharing traditional subsistence foods since this activity is a substantial contributor to cultural identity, tradition, and social bonds in Alaskan communities. Harvest loss, if sustained, could result in disruptions of food sharing patterns, which could diminish general health, nutritional health, and well-being of affected individuals (BOEM, 2018a).

[24] "Designated hunting seasons" refer to hunts that are limited to specific seasons due to animal migration patterns and seasonal changes due to weather and ice. These are described in detail in Section 3.13.1. The Proposed Action would not place any additional restrictions on the bowhead whale quota allocated by IWC or during hunting seasons. NOS acknowledges the importance of Alaska Native subsistence resources. Therefore, NOS is committed to ongoing communication with Alaskan communities to avoid impacts that could directly or indirectly affect subsistence resources.



Source: NMFS, 2016c

Figure 3.13-11. Proportions of Major Subsistence Species Groups Harvested in Alaska Communities

NOS program offices routinely communicate their project plans through designated NOAA representatives to Alaska Native and Pacific Northwest tribal communities through outreach letters and/or at established meetings. Typically, NOS conducts initial coordination in an informal fashion, such as via emails, to determine the need for a more formal consultation process in the future. These letters/meetings are used to inform the tribal or subsistence communities of upcoming NOS plans for or updates to projects that overlap areas designated as fishing or hunting grounds. NOS would attend meetings to provide a platform for Alaska Native and Pacific Northwest tribal communities to voice any of their thoughts or concerns, particularly those pertaining to treaty or subsistence hunting and fishing activities. NOS would work closely with tribal or subsistence communities to ensure concerns related to projects in areas designated as fishing or hunting grounds for ceremonial or subsistence species, especially during crucial fishing or hunting seasons, are addressed as appropriate. Through this communication strategy, NOS would minimize the potential for adverse impacts on Alaska and the Pacific Northwest communities.

Subsistence species would only be subject to behavioral disruption exposures and would primarily experience behavioral disruptions. The amount of time individuals may exceed behavioral thresholds would on average be for less than 2-3 minutes. These disturbances are expected to be transient and surveys, once completed in a given area, would not generally be repeated for years, thus limiting an individual's behavioral disruption to a few minutes. However, the number of individual animals impacted over the five-year project period would be much greater than the number that is actually harvested and consumed by EJ communities in Alaska. Therefore, the overall effects of active underwater acoustic sources on subsistence hunting activities of marine mammals would continue to be **adverse** and **moderate.** Impacts to subsistence fishing communities would continue to be **adverse** and **minor**. Overall, it is unlikely that these activities would generate sounds loud enough to cause direct mortality; therefore, a reduction in the population abundance of subsistence species is not anticipated. Since subsistence communities rely on the harvest of multiple species of marine mammals and fish, as well as terrestrial resources to fulfill their subsistence, economic, and cultural needs, adverse effects would continue to be **insignificant**.

3.13.2.2.2 Vessel and Equipment Sounds

As described in Sections 3.5.2.3 and 3.7.2.2, all cetaceans, pinnipeds, fissipeds, and fish species crucial for subsistence could be adversely impacted due to changes in behavioral patterns caused by sounds generated by surface vessels, ROVs, autonomous systems, and low-flying aircraft.

The impact of primary concern to EJ communities is the behavioral disturbance to subsistence species, including displacement of species from their current hunting grounds, evasive maneuvers, and avoidance behaviors. Hunting areas generally tend not to have fixed geographic locations and may vary slightly from year to year (move closer to or further away from the shore), a phenomenon that hunting/fishing crews are generally accustomed to. However, if the species migrate too far outside of these areas, in response to vessel and equipment sounds, it could lead to adverse impacts on EJ communities. Hunting/fishing crews would be required to travel greater distances from shore to the new hunting areas, increasing gas expenditures, adding travel time, and potentially putting the crew at greater risk for adverse weather, depending upon the time of the year. Greater hunting distances would also mean longer distances to tow the harvest to shore, during which time it may spoil (NMFS, 2016d). This could lead to a decrease in the number of species successfully harvested by subsistence hunters/fishers.

The magnitude of impact would vary based on the degree of behavioral disruption caused by factors such as vessel speed, size, location, frequency, pattern of travel, as well as timing of the activities. Since most surveys in the Alaska Region would occur in spring/summer seasons, impacts would be greater on the communities engaged in subsistence hunting/fishing activities during this time. These include bowhead whales harvested by the Iñupiat and Siberian Yup'ik people, beluga whales harvested by Alaska Natives across 34 villages, as well as northern fur seals harvested by the Unangans of St. Paul and St. George Islands.

Since cetaceans, certain pinnipeds, and fish species are less responsive to aircraft in comparison to vessels in water, the sound emitted by aircraft overflights and their visual presence is not expected to make these species unavailable to, or more difficult to harvest by subsistence hunters/fishers. Aircraft disturbances would have a greater impact on walruses and polar bears. Overall, potential adverse impacts from aircraft would be minimal considering the relatively low level of aircraft activity that would occur (once or twice a year) along with the short duration of exposure to sound and visual disturbance.

Adverse impacts to subsistence fishing communities, particularly in the Pacific Northwest, Great Lakes, and Gulf of Mexico regions could occur from vessel sound disturbances, resulting in the displacement of fish from areas where they are harvested. However, these impacts would be temporary. No impacts to fish are expected from the sound and visual disturbance generated by aircraft.

Most marine mammals and fish species harvested for subsistence are also crucial to the traditions and customs of Alaska's Native subsistence communities, and decreased harvest could also have an adverse cultural impact on these communities. A loss of sociocultural values can occur with a loss of eating and sharing traditional subsistence foods since this activity is a substantial contributor to cultural identity, tradition, and social bonds in Alaskan communities. Harvest loss, if sustained, could result in disruptions of food sharing patterns, which could diminish general health, nutritional health, and well-being of affected individuals (BOEM, 2018a).

As mentioned above, NOS routinely communicates project plans to Alaska Native and Pacific Northwest tribal communities either formally or informally. NOS would continue to attend meetings to provide a platform for Alaska Native and Pacific Northwest tribal communities to voice their thoughts or concerns, particularly those pertaining to treaty or subsistence hunting and fishing activities. NOS would work closely with tribal or subsistence communities to ensure that concerns related to projects in areas designated as fishing or hunting grounds for ceremonial or subsistence species, especially during crucial fishing or hunting seasons, are addressed as appropriate. Through this communication strategy, NOS would minimize the potential for adverse impacts on Alaska and the Pacific Northwest communities.

Overall, the effects of vessel and equipment sounds on subsistence hunting of marine mammals would continue to be **adverse** and **minor**, whereas the impacts to subsistence fishing communities would continue to be **adverse** and **negligible**. Since vessel sounds are currently a prevalent source of ambient underwater sound, vessel sounds would not be at levels expected to cause anything more than possible temporary or short-term behavioral changes and would cause minimal impacts on subsistence harvests. Multiple activities occurring simultaneously in the Alaska Region could lead to greater magnitudes. However, since subsistence communities rely on the harvest of multiple species of marine mammals and fish to fulfil their subsistence and cultural needs, adverse effects would continue to be **insignificant**.

3.13.2.2.3 Vessel Presence, Traffic, and Movement of Equipment in Water

As summarized in Sections 3.5.2.3 and 3.7.2.2, the impacts on cetaceans, pinnipeds, fissipeds, and fish from vessel presence, traffic, and movement of equipment in water of primary concern to subsistence EJ communities include temporary displacement a short distance from preferred habitats, and the possibility of reduced harvest numbers due to the potential of marine mammal vessel strikes resulting in death.

The presence of vessels in water and the underwater movement of equipment would cause species to scatter from their preferred habitats and therefore be less readily available for subsistence hunting/fishing activities. Entanglement with ropes and wires attached to the equipment could trap an individual and adversely impact harvest quantities. Species could also be indirectly impacted from these activities due to disturbance caused to the species on which they prey, which could result in the migration of the subsistence species in search of areas with a greater prey supply. Displaced species are expected to return to their preferred habitats and resume normal activities once the vessel leaves the area. In the event that the species stray too far away from their usual hunting grounds, there would be adverse impacts to the subsistence communities from increased travel time, and additional expenditure on gas (as discussed above under Vessel and Equipment Sounds). Mortality of subsistence species as a result of their collision with vessels could potentially reduce the number of marine mammals available for harvest, which would adversely impact subsistence hunting activities. However, the likelihood of a vessel strike would be very low.

The magnitude of impact would vary based on the degree of behavioral disruption caused by factors such as vessel speed, size, location, frequency, and pattern of travel, as well as the timing of the activities. Since most surveys in the Alaska Region would occur in spring/summer seasons, impacts would be greater on the communities engaged in subsistence hunting/fishing activities during this time. These include bowhead whales harvested by the Iñupiat and Siberian Yup'ik people, beluga whales harvested by Alaska Natives across 34 villages, and northern fur seals harvested by the Unangans of St. Paul and St. George Islands.

Adverse impacts to subsistence fishing communities, particularly in the Pacific Northwest, Great Lakes, and Gulf of Mexico regions, could occur from vessel wake and underwater turbulence, resulting in the displacement of fish from areas where they are harvested. However, these impacts would be temporary. Fish are expected to return to the area and resume normal activities once the vessel departs or the turbulence ceases.

Most marine mammals and fish species harvested for subsistence are also crucial to the traditions and customs of Alaska's Native subsistence communities, and decreased harvest could also have an adverse cultural impact on these communities. A loss of sociocultural values can occur with a loss of eating and sharing traditional subsistence foods since this activity is a substantial contributor to cultural identity, tradition, and social bonds in Alaskan communities. Harvest loss, if sustained, could result in disruptions of food sharing patterns, which could diminish general health, nutritional health, and well-being of affected individuals (BOEM, 2018a).

NOS routinely communicates its project plans through designated NOAA representatives to Alaska Native and Pacific Northwest tribal communities through outreach letters and/or at established meetings. Typically, NOS conducts initial coordination in an informal fashion, such as via emails, to determine the need for a more formal consultation process in the future. These letters/meetings are used to inform the tribal or subsistence communities of upcoming NOS plans for or updates to projects that overlap areas designated as fishing or hunting grounds. NOS would attend meetings to provide a platform for Alaska Native and Pacific Northwest tribal communities to voice any of their thoughts or concerns, particularly those pertaining to treaty or subsistence hunting and fishing activities. NOS would work closely with tribal or subsistence communities to ensure concerns related to projects in areas designated as fishing or hunting grounds for ceremonial or subsistence species, especially during crucial fishing or hunting seasons, are addressed as appropriate. Through this communication strategy, NOS would minimize the potential for adverse impacts on Alaskan and Pacific Northwest EJ communities.

Although vessel traffic is considered a common source of disturbance and the presence of survey vessels is expected to cause only temporary disturbances, subsistence hunters tend to have a great sensitivity to vessel presence and traffic while hunting for marine mammals. Additionally, the likelihood of animal mortality due to vessel strikes would continue to cause **adverse** and **moderate** impacts to subsistence hunting of marine mammals. Impacts to subsistence hunting communities across all five geographic regions would continue to be **adverse** and **negligible**. Since survey efforts would be dispersed across five geographic regions over a period of five years, and surveys would likely not be repeated in the same area, adverse effects would continue to be **insignificant**.

3.13.2.2.4 Human Activity

As mentioned in Sections 3.5.2.3 and 3.7.2.2, human activity on vessels above the surface of the water would not be expected to have any effects on cetaceans or fish underwater, and would therefore have no impacts on whale hunters and fishers. Pinnipeds and fissipeds that are on land or ice could be affected by the sound from human activity onboard vessels; however, the sounds and presence from the vessels themselves would likely be greater. The impacts from vessel sounds and presence on EJ communities are discussed above.

During SCUBA operations, the presence of divers could temporarily disturb the marine mammals and fish in the vicinity but is not expected to make the species unavailable for or more difficult to harvest by subsistence hunters/fishers.

Disturbance caused by onshore human activity during tide gauge installation and maintenance, as well as installation of shore-based GPS reference stations, could affect pinnipeds and polar bears, if such activities occur near pinniped haul out areas or close to polar bear habitats. This could temporarily displace the species from their hunting areas, which would adversely impact subsistence hunting activities resulting in increased travel time and additional expenditure on gas (as discussed above under Vessel and Equipment Sounds). Although very rare, disturbance from onshore human activities could cause female polar bears in maternity dens to abandon their cubs, resulting in mortality of the cubs. Human-bear interactions during tide gauge and GPS reference system installation could result in injury or mortality of both bears and humans. This could have adverse impacts on EJ communities, particularly the Iñupiat and Siberian Yup'ik people of Alaska, by decreasing the number of polar bears available to hunt. However, since disturbances from human activity would only occur temporarily, impacts would be minimal.

To minimize impacts on subsistence hunting/fishing activities, NOS routinely communicates project plans to Alaska Native and Pacific Northwest tribal communities either formally or informally. NOS would attend meetings to provide a platform for Alaska Native and Pacific Northwest tribal communities to voice any of their thoughts or concerns, particularly those pertaining to treaty or subsistence hunting and fishing activities. NOS would work closely with tribal or subsistence communities to ensure concerns related to projects in areas designated as fishing or hunting grounds for ceremonial or subsistence species, especially during crucial fishing or hunting seasons, are addressed as appropriate.

The effects of human activities on subsistence hunting/fishing activities would continue to be **adverse** and **minor** and would primarily impact subsistence hunting of pinnipeds and fissipeds. Multiple activities occurring simultaneously in the Alaska Region could lead to larger magnitudes and more widespread impacts. Since these subsistence communities rely on the harvest of multiple species of marine mammals and fish to fulfill their subsistence and cultural needs, adverse effects are expected to continue to be **insignificant**.

3.13.2.2.5 Accidental Leakage or Spillage of Oil, Fuel, and Chemicals into Surrounding Waters

The effects of accidental leakage or spillage of oil, fuel, and chemicals on subsistence hunting/fishing activities would continue to be **adverse** and **minor**. Impacts would be greater if accidental leakages or spills occurred within or adjacent to hunting areas, or if they adversely impacted prey species. Species would try to avoid such areas or migrate to areas with a greater supply of prey, making them less available to, or more difficult to harvest by subsistence hunters/fishers. Additionally, if marine mammals/fish contaminated with oil, fuel, and/or chemicals are harvested and consumed by subsistence communities, public health could be adversely impacted due to the potential for bioaccumulation of these substances. Overall, impacts to subsistence hunting/fishing activities resulting from accidental leaks or spills would be minimal; therefore, adverse effects are expected to continue to be **insignificant**.

3.13.2.2.6 Trash and Debris

Effects of marine trash and debris on subsistence hunting/fishing activities would continue to be **adverse** and **negligible**. These impacts would occur for several reasons. Species could become accidentally entangled with cables, lines, nets, or other objects which have detached from vessels and become suspended in the water column. This could have the effect of rendering an entangled animal easier to capture during subsistence hunting. Although it is possible that lines, cables, nets, and other objects could detach from a vessel used by NOS and become debris in which marine mammals could get entangled, it is not very likely.

Species are not expected to be displaced from their habitats, thus no impacts associated with the abandonment of hunting areas are expected to be caused by trash and debris. Adverse impacts could result from the ingestion of trash or debris by individuals. Consumption of meat contaminated from ingestion of pollutants could have indirect adverse impacts on the health of subsistence communities; however, impacts from ingestion are expected to be minimal and would only occur accidently. Additionally, vessel operators would be required to comply with USCG and EPA regulations to minimize adverse impacts from discarded trash and debris in hunting areas. Overall, impacts to subsistence hunting/fishing activities resulting from marine trash and debris would be minimal, and adverse effects are expected to continue to be **insignificant**.

3.13.2.2.7 Air Emissions

Effects of air emissions on subsistence hunting/fishing activities would continue to be **adverse** and **negligible** and would primarily impact subsistence hunting of pinnipeds and fissipeds and subsistence fishing activities. Pinnipeds and fissipeds could be exposed to air pollutants emitted by survey vessels; however, such emissions would be temporary and ephemeral and dissipate rapidly into the air. Emissions may not reach animals on land or ice as vessels would maintain a required distance away. Smokestack and motor emissions from project vessels could adversely affect fish habitat by increasing water acidity. Overall, impacts to subsistence hunting/fishing activities resulting from effects to air quality would be minimal, as discussed in Section 3.15; therefore, the adverse effects are expected to continue to be **insignificant**.

3.13.2.2.8 Availability of New Mapping and Charting Information

Hydrographic surveys conducted by NOS would provide valuable information about essential habitat for species of fish and marine mammals harvested for subsistence in the form of topographic maps of the seafloor, and in the form of fishery and marine mammal distribution maps. Scientists use estimates of biomass and population from these surveys to conduct annual stock assessments of various species to improve understanding of the species' life history, and the ecological and physical factors affecting their distribution and abundance. This information, in combination with data collected from mapping the sea ice and vessel traffic, could contribute to the economic stability of subsistence communities. Consequently, this could help ensure a stable supply of food, and help preserve a traditional culture based on subsistence harvesting that has continued for centuries (NOAA, No Date-a).

As reported by NOAA in 2018, Alaskan and Arctic waters, where a majority of subsistence hunting and fishing occurs, are largely uncharted with modern surveys, and many areas that have soundings were surveyed using older, outdated technology. In addition to providing information about fish and marine mammal habitats, benefits from surveying would include safer navigation, availability of weather and tsunami forecasts and storm surge events that affect local communities, and identification of the location of historic wrecks (NOAA, 2018b).

3.13.2.2.9 Conclusion

Since the effects of impact causing factors on EJ communities range from none to moderate, the overall impact of Alternative A on the subsistence hunting and fishing, local economy, and culture of EJ communities would continue to be **adverse** and **minor** to **moderate**; thus, impacts of Alternative A would continue to be **insignificant**. The mapping and charting information generated by Alternative A would continue to yield **beneficial** effects for EJ communities.

3.13.2.3 Alternative B: Conduct Surveys and Mapping for Coastal and Marine Data Collection with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations

The same impact causing factors for marine mammals and fish, and therefore for EJ communities that hunt and/or fish for subsistence, considered under Alternative A are considered under Alternative B. Under Alternative B, all of the activities and equipment operations proposed in Alternative A would continue but at a higher level of effort, although the percentage of nautical miles covered by the project in each region would be the same as under Alternative A. Thus, as stated under Alternative A, the only impacts on subsistence hunting of marine mammals are expected to occur in the Alaska Region. Any impacts on gray whales would have no effect on the subsistence activities of the Makah Tribe residing in Washington state since there is currently a moratorium on gray whale hunting in the continental U.S. The greatest overall impacts to subsistence fishing are expected to occur in the Alaska Region, West Coast Region (particularly the Pacific Northwest), Great Lakes Region, and the Gulf of Mexico due to the prevalence of Alaska Natives, indigenous tribes, and other minority and low-income communities that engage in subsistence fishing activities.

Projects under Alternative B would take place in the same geographic areas and timeframes as under Alternative A; however, Alternative B would include more projects and activities, and thus more nautical miles traveled, than Alternative A. Overall, NOS survey effort would cover an additional 264,796 nm (490,402 km) under Alternative B (see **Table 3.4-5**) as compared to Alternative A (2,647,958 nm [4,904,017 km] total) across all regions over the five-year period. The types and mechanisms of impacts would remain the same in Alternative B as discussed for Alternative A. Therefore, the difference between the two alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative B as compared to Alternative A.

As discussed in Sections 3.5.2.4 and 3.7.2.3, impacts of Alternative B on cetaceans, pinnipeds, and fissipeds would be the same or slightly, but not appreciably, larger as those under Alternative A for the following impact causing factors: vessel and equipment sounds; vessel presence, traffic and movement of equipment in water; human activity; accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters; trash and debris; and air emissions. Consequently, for these six factors, the impacts of Alternative B on Alaska Natives primarily engaged in subsistence hunting of marine mammals (and who may or may not fish for subsistence), would be the same, or slightly greater as compared to Alternative

A. For fish species, the effects of all seven impact causing factors under Alternative B, including active underwater acoustic sources, would be the same or slightly, but not appreciably, greater than those discussed under Alternative A. Thus, the corresponding impacts of Alternative B on EJ communities involved only in subsistence fishing (such as the indigenous tribes of the Pacific Northwest, the Great Lakes region, and the Gulf of Mexico) would be the same or slightly, but not appreciably, greater as those under Alternative A for all seven impact causing factors.

As shown in the tables listing the total behavioral disruption exposure estimates in Section 3.5.2.4, active underwater acoustic sources would lead to behavioral disruption exposure of cetaceans, pinnipeds, and fissipeds important to the subsistence of Alaska Natives. Since behavioral disruption exposure of individual animals would be somewhat higher under Alternative B, the impact on subsistence hunting activities of Native Alaskans would be slightly, but not appreciably, larger than those discussed under Alternative A.

3.13.2.3.1 Conclusion

The additional projects and nautical miles traveled under Alternative B across five regions would result in greater impacts on subsistence hunting and fishing activities of EJ communities overall, compared to Alternative A, but not so great that the magnitude of a particular impact causing factor would increase. Therefore, the impacts of Alternative B on Environmental Justice would be **adverse**, **minor** to **moderate**, and **insignificant**. The mapping and charting information generated by Alternative B would yield slightly greater **beneficial** effects for EJ communities than would occur under Alternative A.

3.13.2.4 Alternative C: Upgrades and Improvements with Greater Funding Support

The same impact causing factors for marine mammals and fish, and therefore for EJ communities that hunt and/or fish for subsistence, considered under Alternatives A and B are considered under Alternative C. Under Alternative C, all of the activities and equipment operation proposed in Alternative A would continue but at a higher level of effort, although the percentage of nautical miles in each region would be the same as under Alternative A. In addition, there would be an overall funding increase of 20 percent relative to Alternative B, thus the level of survey activity would increase further. The only impacts on subsistence hunting of marine mammals are expected to occur in the Alaska Region. Any impacts on gray whales would have no effect on the subsistence activities of the Makah Tribe residing in Washington state due to the moratorium on gray whale hunting in the continental U.S. The greatest overall impacts on subsistence fishing are expected to occur in the Alaska Region, West Coast Region (particularly the Pacific Northwest), the Great Lakes Region, and the Gulf of Mexico due to the prevalence of Alaska Natives, indigenous tribes, and other minority and low-income communities that engage in subsistence fishing activities in these regions.

Projects under Alternative C would take place in the same geographic areas and timeframes as under Alternatives A and B; however, Alternative C would include more projects and activities, and thus more nautical miles traveled, than Alternatives A and B. Overall, there would be an additional 264,796 nm (490,402 km) of survey effort under Alternative C (see **Table 3.4-6**) as compared to Alternative B (2,912,753 nm [5,394,419 km] total), and an additional 529,592 nm (980,803 km) as compared to Alternative A (2,647,958 nm [4,904,017 km] total) across all regions over the five-year period. The types and mechanisms of impacts would remain the same in Alternative C as discussed for Alternatives A and B. Therefore, the difference between the two alternatives is a matter of scale with an increased activity level, although distributed unevenly among the different types of activities, leading to a corresponding, incremental increase in effects under Alternative C as compared to Alternatives A and B.

As discussed in Sections 3.5.2.5 and 3.7.2.4, impacts of Alternative C on cetaceans, pinnipeds, and fissipeds would be the same or slightly, but not appreciably, greater than those under Alternatives A and B for the following impact causing factors: vessel and equipment sounds; vessel presence, traffic and movement of equipment in water; human activity; accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters; trash and debris; and air emissions. Consequently, for these six factors, the impacts of Alternative C on Alaska Natives primarily engaged in subsistence hunting of marine mammals (and who may or may not fish for subsistence), would be the same as, or slightly larger, compared to Alternative A and B. For fish species, the effects of all seven impact causing factors under Alternative C, including active underwater acoustic sound sources, would be the same or slightly, but not appreciably, greater than those discussed under Alternatives A and B. Thus, the corresponding impacts of Alternative C on EJ communities involved only in subsistence fishing (such as the indigenous tribes of the Pacific Northwest and the Great Lakes region) would be the same or slightly, but not appreciably, greater as those under Alternative A and B for all seven impact causing factors.

As shown in the tables listing the total behavioral disruption exposure estimates in Section 3.5.2.5, active underwater acoustic sources would lead to behavioral disruption exposure of cetaceans, pinnipeds, and fissipeds important to the subsistence of Alaska Natives. Since behavioral disruption exposure of individual animals would be somewhat higher under Alternative C compared to Alternatives A and B, the impact on subsistence hunting activities of Native Alaskans would be slightly, but not appreciably, larger than those discussed under Alternatives A and B.

3.13.2.4.1 Conclusion

The additional projects and nautical miles traveled under Alternative C across five regions would result in greater impacts on subsistence hunting and fishing activities of EJ communities overall than would occur under Alternatives A and B; however, impacts would not be so great that the magnitude of a particular impact causing factor would increase. Therefore, the impacts of Alternative C on environmental justice would be **adverse**, **minor** to **moderate**, and **insignificant**. The mapping and charting information generated by Alternative C would yield incrementally greater **beneficial** effects for EJ communities than Alternatives A and B.

3.14 Resources Considered but Dismissed from Further Analysis

NEPA and the CEQ regulations direct agencies to prepare NEPA documents that are "concise, clear, and to the point" (40 CFR Part 1500.2(b)). NEPA reviews should focus on important environmental issues and avoid "amassing needless detail" (1500.1(b)). Environmental analysis should focus on significant issues (meaning pivotal issues, or issues of critical importance), discussing insignificant issues only briefly (1500.4(c)). Furthermore, agencies are directed to discuss impacts in proportion to their significance, and if the impacts are not deemed significant there should be only enough discussion to show why more study is not warranted (1502.2(b)).

In those cases where impacts from the Proposed Action are not anticipated or are expected to be imperceptible or nondetectable, resources are dismissed from detailed analysis. Four such resources were identified and the rationale for their dismissal is provided below.

3.14.1 Air and Water Quality

NOS considered two resources, air quality and water quality, with regard to discharges from equipment used in NOS projects. Analyzing air quality as a resource considers atmospheric conditions such as the concentration of criteria air pollutants and GHGs. Analyzing water quality as a resource considers aquatic conditions such as the concentration of dissolved solids and DO, acidity, and temperature. Vessels and aircraft would emit a variety of criteria air pollutants including nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter, volatile organic compounds (VOCs), carbon monoxide (CO), and GHG emissions (e.g., CO_2). Vessels would also discharge treated sanitary and domestic wastes from USCG-approved Marine Sanitation Devices (MSDs) and could potentially spill oil, fuel, or chemicals into the water.

The potential impacts to air and water quality from air emissions, wastewater discharges, and accidental spills are minimized through compliance with comprehensive maritime protocols, namely the MARPOL 73/78 Annexes. **Table 3.14-1** summarizes each applicable MARPOL 73/78 annex by pollution source, its title, U.S. signatory status, and implementing legislation, law and/or regulations, or applicable Coast Guard guidance.

Table 3.14-1. MARPOL Annexes Applicable to Vessels

Annex	Pollution Source	Title	U.S. Signatory*	Implementation Legislation/ Regulations/Guidance
I	Oil	Regulations for the Prevention of Pollution by Oil	Yes	• Act to Prevent Pollution from Ships of 1980 (APPS) 33 U.S.C. § 1901 – 1912 • 33 CFR Parts 151,155, 156, 157 • Marine Safety Manual, Vol. II • Navigation and Vessel Inspection Circular (NVIC) No. 6-94 • CG-PCV Policy Letter No. 06-01 • CG-3PCV Policy Letter No. 06-09 • CG-MOC Policy Letter No. 04-11, Rev. 1

Annex	Pollution Source	Title	U.S. Signatory*	Implementation Legislation/ Regulations/Guidance
IV	Sewage	Regulations for the Prevention of Pollution by Sewage from Ships	No	• Clean Water Act (CWA) 33 U.S.C. § 1251 et seq. • Federal Water Pollution Control Act (FWPCA) (as amended by the CWA) • 33 CFR 159 • Marine Safety Manual, Vol. II • NVIC No. 01-09
V	Garbage	Regulations for the Prevention of Pollution by Garbage from Ships	Yes	• APPS 33 U.S.C. § 1901 – 1912 • 33 CFR 151 • Marine Safety Manual, Vol. II
VI	Air	Regulations for the Prevention of Air Pollution from Ships	Yes	• APPS 33 U.S.C. § 1901 – 1912 • 44 U.S.C. § 7401-7671 • 40 CFR 94 • CG-543 Policy Letter No. 09-01 • CG-CVC Policy Letter No. 12-04 • USCG & EPA Revised Protocols on Referrals under MARPOL Annex VI as implemented by APPS (effective 03/04/2015)

Source: USCG, No Date

*Indicates whether the U.S. has agreed to comply with this annex. In the case of sewage, the CWA applies to vessels even though the U.S. is not a signatory to the annex.

NOS adheres to NOAA's environmental procedures which comply with MARPOL 73/78 and relevant air and water quality implementing legislation, regulations, and guidance listed in the above table. For example, discharge restrictions for vessel waste and emissions management include handling all hazardous and regulated materials in accordance with applicable laws and appropriately training crew members in materials storage and usage. In addition, NOS projects are dispersed throughout the action area, which would minimize any impact from air emissions and wastewater discharges from a single vessel or aircraft. NOS vessels also represent only a negligible portion of total oceanic vessel traffic, and any resulting impacts produced would be indistinguishable from those produced by all other vessels within the action area. Therefore, potential impacts from emissions and wastewater discharges on air and water quality are generally expected to be imperceptible or nondetectable and is not analyzed further. However, where relevant, the effects from accidental leakage or spillage of oil, fuel, and chemicals, and air emissions from project vessel engines is briefly analyzed where the impacts may be detectable in the context of other resources. For example, the impact of accidental leaks on Sea Turtles is discussed in Section 3.6.2.2.4 and the impact of air emissions on Sea Turtles is discussed in Section 3.6.2.2.7.

3.14.2 Soils and Geology

Impacts to soils and geological resources occur primarily in terrestrial areas and tend to be from activities that come in direct contact with them. NOS projects are predominantly aquatic actions that infrequently come into contact with terrestrial areas. Smaller scale activities associated with installation, maintenance, and removal of land-based tide gauges and GPS stations do require access to terrestrial areas. However, the disturbance resulting from these activities is minimal and impacts to soils and geology would be imperceptible or nondetectable. As such, potential impacts to soils and geology as a resource are not analyzed further.

3.14.3 Airborne Noise for Human Receptors

A noise is an undesirable sound, one that interferes with communication, is intense enough to damage hearing, or is otherwise intrusive. The main source of airborne noise associated with NOS projects is the operation of vessel engines. Noise could also be generated from airplanes occasionally used in survey activities, flying overhead as well as taking off and landing on landing strips, and floatplanes taking off and touching down on water surfaces.

Airborne noise from vessels used by NOS close to shore would generally be imperceptible or nondetectable to nearby human receptors given the ambient noise of other boat and ship traffic. The acoustic signature of vessels used by NOS would be indistinguishable from other sources of noise near docks, marinas, and ports. While at sea, the airborne noise of vessels used by NOS would be perceptible, but would not be a source of concern given the distance to the human environment. Sound produced by underwater acoustic equipment is outside of the range of human hearing and is not transmitted between water and air; therefore, these sounds are imperceptible to humans in water or air.

Noise from flyovers, take-offs, and landings of fixed-wing aircraft associated with NOS projects would be perceptible by human observers, but very infrequent, localized, and short in duration.

For the reasons presented above, the impact of airborne noise from NOS projects on human receptors is not expected to be perceptible or detectable or of concern. Therefore, potential impacts of airborne noise on human receptors are not analyzed further.

3.14.4 Select Freshwater Taxa

NOS projects may include activities within U.S. freshwater bodies, such as the U.S. portion of the Great Lakes and major lakes such as Tahoe, Mead, Champlain, Okeechobee, and parts of major rivers such as the Mississippi, Missouri, Hudson, and Columbia. Impacts to many freshwater species have been analyzed in the Fish, Birds, and Aquatic Macroinvertebrates resource sections. However, there may be a small number of NOS projects that occur in other freshwater bodies where select freshwater taxa such as amphibians, mammals, and reptiles occur. Analysis of impacts for these select freshwater taxa was not carried forward for the following reasons.

NOS projects within freshwater bodies would occur far less frequently than in marine environments. For example, from 2016 to 2021, less than 3 percent of NOS projects occurred in freshwater bodies.

Based on a preliminary analysis, some stressors are likely to cause adverse, negligible impacts, including vessel presence, vessel wake, and accidental spills. The nature of these impacts is very similar to those analyzed in the Fish, Birds, Marine Mammals, and Aquatic Macroinvertebrates resource sections. The remaining stressors analyzed in this Final PEIS are not likely to affect these select freshwater taxa or are expected to be de minimis. The resulting incremental impacts would not be any greater than those already experienced by other freshwater species.

Project specific reviews would be conducted to determine if any select freshwater ESA-listed species are present in a project area; if those ESA-listed species are identified, NOS would then consult with the

USFWS or NMFS, as applicable. Therefore, potential impacts to these freshwater species are not analyzed further in this Final PEIS.

3.15 Relationship Between Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

Section 102(C)(iv) of NEPA and 40 CFR 1502.16 require an EIS to address the relationship between local short-term uses of the human environment and the maintenance and enhancement of long-term productivity. This involves the consideration of whether a proposed action is sacrificing environmental resources in the long term for some short-term value to the project proponent or the public.

Many of the proposed NOS surveying and mapping projects may cause short-term adverse impacts on resources including marine/aquatic wildlife and habitats. However, these impacts are generally predicted to be minor and temporary and thus would not lead to any lasting effects.

The Proposed Action would provide the public and private sectors with nautical charts, benthic habitat condition maps, current and tide charts, and other products necessary for safe navigation, economic security, and environmental sustainability. The data collected by NOS are used to conserve, preserve, and restore ecological resources, including marine/aquatic wildlife and habitat, coral reefs, and cultural and historic resources. The data allow federal, state, and local governments to make informed decisions about fishing areas and other natural resource management issues. Thus, the Proposed Action provides long-term, beneficial effects to environmental resources. None of the alternatives would entail short-term uses of the environment that would compromise, impair, or reduce long-term environmental productivity.

3.16 Irreversible and Irretrievable Commitments of Resources

Section 102(C)(v) of NEPA requires an EIS to address "any irreversible and irretrievable commitments of resources which would be involved in the Proposed Action should it be implemented." Irreversible and irretrievable commitments of resources refer to losses to or impacts on natural resources that cannot be recovered or reversed.

Irreversible commitments of resources are those that cannot be regained. "Irreversible" applies mainly to the effects from use or depletion of nonrenewable resources, such as fossil fuels or cultural resources, or to factors such as soil productivity that are renewable only over long periods of time. Under Alternatives A, B, and C, the use of non-renewable energy sources would be an irreversible commitment of resources. Non-renewable energy consumption would occur via the combustion of fossil fuels (diesel fuel) in vessels used by NOS. However, the amount of fossil energy consumed would represent a minute fraction of that consumed annually by the nation's governmental, commercial, and recreational boat and shipping fleet. It would be an even smaller fraction of the nation's aggregate annual fossil fuel consumption.

Irretrievable commitments of resources are those that are lost for a period of time, but not permanently. No irretrievable commitments of resources are expected from implementation of the Proposed Action.

3.17 Unavoidable Adverse Impacts

Section 102(2)(c)(ii) of NEPA requires that an EIS include information on "any adverse environmental effects which cannot be avoided should the proposed action be implemented." Unavoidable adverse impacts are the effects on the human environment that would remain after mitigation measures and best practices have been applied. They do not include temporary or permanent impacts that would be mitigated. While these impacts do not have to be avoided by the planning agency, they must be disclosed, considered, and mitigated where possible (40 CFR § 1500.2[e]). All three alternatives (A, B, and C) of the Proposed Action would have the same unavoidable adverse impacts but to different degrees because the level of effort differs. Alternative B would have slightly greater unavoidable adverse impacts than

Alternative A, and Alternative C would have slightly greater unavoidable adverse impacts than Alternatives B and A.

The Proposed Action would entail unavoidable adverse impacts on marine and aquatic habitats; marine mammals; sea turtles; fish; aquatic macroinvertebrates; EFH; and seabirds, shorebirds, coastal birds, and waterfowl. While unavoidable, these adverse impacts would mostly vary from negligible to minor; they would not be significant adverse impacts. For the marine and aquatic organisms in particular, the unavoidable adverse impacts would result mostly from underwater noise through the operation of vessel engines and use of underwater acoustic equipment. There would also be a low level of unavoidable adverse impacts from disturbance due to presence and associated sight, smell, and sound of humans and their equipment in remote locations where wildlife populations are unaccustomed to human intrusion and encroachment.

The Proposed Action would also entail unavoidable adverse impacts to cultural and historic resources and environmental justice. These unavoidable adverse impacts would range from negligible to moderate in overall magnitude but would still be insignificant. Cultural and historic resources subjected to unavoidable impacts would include submerged cultural or historic resources, coastal infrastructure, viewsheds of nearshore historic properties and designed cultural landscapes, and subsistence hunting and fishing areas including Traditional Cultural Properties. Unavoidable adverse environmental justice impacts would mostly be related to potential effects of the Proposed Action on subsistence hunting, fishing, and other traditional harvests.

In summary, while the Proposed Action would entail the potential for unavoidable adverse impacts on a variety of resources, none of these impacts would be significant.

3.18 Comparison of Impacts

Table 3.18-1 compares the environmental consequences for Alternatives A, B, and C. For each resource analyzed in Sections 3.4 through 3.13, the impacts are summarized by impact causing factor and by alternative overall.

Table 3.18-1. Summary Comparison of Impacts

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
Habitats	Impacts to habitats from water column disruptions under Alternative A would continue to be **adverse** and **negligible.** Impacts to habitats from activities involving physical disturbance to bottom substrate; sedimentation, turbidity, and chemical contaminants; increased ambient underwater sound levels; and onshore activities under Alternative A would continue to be **adverse** and **negligible** to **minor.** The impact on habitats from invasive species dispersal facilitated by activities under Alternative A would likely continue to be **adverse** and **minor.** Impacts to habitat areas resulting from Alternative A would not cause	Impacts of Alternative B on habitats throughout the action area would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. Impacts to habitat areas resulting from Alternative A would not cause long-term changes in the availability of space, shelter, cover, or nutrients necessary for dependent species and would not substantially increase in intensity with the increased level of effort of Alternative B. Overall, impacts to habitats under Alternative B would be **adverse**, **minor**, and **insignificant**.	Impacts of Alternative C on habitats throughout the action area would be the same or slightly, but not appreciably, larger than those under Alternatives A and B for each impact causing factor. Impacts to habitat areas resulting from Alternatives A and B would not cause long-term decreases in the availability of space, shelter, cover, or nutrients necessary for dependent species and would not substantially increase in intensity with the increased level of effort of Alternative C. Overall, impacts to habitats under Alternative C would be **adverse**, **minor**, and **insignificant**.

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	long-term changes in the availability of space, shelter, cover, or nutrients necessary for dependent species. Overall, impacts to habitats under Alternative A would continue to be **adverse, minor**, and **insignificant.**		
Marine Mammals	Impacts on marine mammals (cetaceans, pinnipeds, sirenians, and fissipeds) from trash and debris and air emissions under Alternative A would continue to be **adverse** and **negligible.** Impacts from human activity under Alternative A would continue to be **adverse** and **negligible** on cetaceans and sirenians and **adverse** and **minor** on pinnipeds and fissipeds**.** Impacts on marine mammals (cetaceans, pinnipeds, sirenians, and fissipeds) from accidental oil, fuel, or chemical spills under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts on marine mammals (cetaceans, pinnipeds, sirenians, and	Impacts of Alternative B on marine mammals would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. Impacts to marine mammals resulting from Alternative A would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts of Alternative B on marine mammals, including ESA-listed species, and habitat, including	Impacts of Alternative C on marine mammals would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. Impacts to marine mammals resulting from Alternatives A and B would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts of Alternative C on marine mammals, including ESA-

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	fissipeds) from active underwater acoustic sources, vessel and equipment sound, vessel presence and movement of equipment in the water under Alternative A would continue to be **adverse** and **minor.** Impacts on pinnipeds and fissipeds from air emissions under Alternative A would continue to be **adverse** and **negligible**. Although a vessel strike is very unlikely, debilitating injury or mortality of one or a few individuals could occur and impacts would be **adverse** and **moderate,** or greater if an ESA-listed species is affected. If a walrus stampede occurs due to vessel or aircraft disturbance, the impact could be **adverse** and **moderate** or greater. If polar bears are disturbed at denning sites or if polar bear-human interactions occur, the impact could be **adverse** and **moderate**. Potential impacts from underwater acoustic sources include injury exposures in the form of hearing loss	designated critical habitat, would be **adverse, minor,** and **insignificant.**	listed species, and habitat, including designated critical habitat, would be **adverse, minor,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	(PTS) on cetaceans, but such injury would be rare and confined to a few individual high-frequency cetaceans. It would also include behavioral disruption exposures of cetaceans, pinnipeds, sirenians and fissipeds, but the amount of time individuals may exceed the behavioral exposure threshold would be on average less than a few minutes. Impacts to marine mammals resulting from Alternative A would be temporary or short-term and would not be considered outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Overall, impacts of Alternative A on marine mammals, including ESA-listed species, and habitat, including designated critical habitat, would continue to be **adverse, minor,** and **insignificant.**		
Sea Turtles	Impacts to sea turtles and their habitats from active underwater acoustic sources, vessel and equipment sound, and onshore	Impacts of Alternative B on sea turtles and their habitats would be the same or slightly, but not appreciably, larger than those that	Impacts of Alternative C on sea turtles and their habitats would be the same or slightly, but not appreciably, larger than those that

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	activities under Alternative A would continue to be **adverse** and **negligible.** Impacts to sea turtles and their habitats from vessel presence and movement, underwater activities, and air emissions under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts to sea turtles and their habitats from accidental oil, fuel, or chemical spills would continue to be **adverse** and **negligible** to **minor.** Although the effects of impact causing factors on sea turtles and their habitats range from **negligible** to **moderate**, moderate impacts could occur in the very unlikely event of an accidental spill of oil, fuel, or chemicals. Likewise, in the very unlikely event of a vessel strike, injury or death to sea turtles would also constitute a **moderate** or greater impact. Impacts to sea turtles resulting from Alternative A would not cause long-	would occur under Alternative A for each impact causing factor. Impacts to sea turtles resulting from Alternative A would not cause long-term changes in habitat availability and use, sea turtle behavior, or energy expenditures and would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts on sea turtles and their habitat, including designated critical habitat, would be **adverse, minor,** and **insignificant**.	would occur under Alternatives A and B for each impact causing factor. Impacts to sea turtles resulting from Alternatives A and B would not cause long-term changes in habitat availability and use, sea turtle behavior, or energy expenditures and would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts on sea turtles and their habitat, including designated critical habitat, would be **adverse, minor,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	term changes in habitat availability and use, sea turtle behavior, or energy expenditures. Overall, impacts under Alternative A on sea turtles and their habitats, including designated critical habitat, would continue to be **adverse, minor,** and **insignificant.**		
Fish	Impacts to fish and their habitats from vessel wake and turbulence; vessel sound; accidental spill of oil, fuel, or chemicals; and disturbance of the ocean/lake/river bottom under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts to fish and their habitats from active underwater acoustic sources and air emissions under Alternative A would continue to be **adverse** and **minor.** Impacts to fish resulting from Alternative A may include some stress responses without permanent physiological damage, and may disturb breeding, feeding, or other activities but without any impacts on	Under Alternative B, impacts on fish and fish habitat would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. Impacts to fish resulting from Alternative A may include some stress responses without permanent physiological damage, and may disturb breeding, feeding, or other activities but without any impacts on population levels; additionally, there would not be long-term changes in habitat availability and use or in fish behavior. These impacts would not substantially increase in intensity with the	Impacts of Alternative C on fish and fish habitat would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. Impacts to fish resulting from Alternatives A and B may include some stress responses without permanent physiological damage, and may disturb breeding, feeding, or other activities but without any impacts on population levels; additionally, there would not be long-term changes in habitat availability and use or in fish behavior. These impacts would not substantially increase in intensity

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	population levels; additionally, there would not be long-term changes in habitat availability and use or in fish behavior. Overall, impacts of Alternative A on fish, including ESA-listed species, and fish habitat, including designated critical habitat, would continue to be **adverse, minor,** and **insignificant.**	increased survey effort of Alternative B. Overall, impacts of Alternative B on fish, including ESA-listed species, and fish habitat, including designated critical habitat, would be **adverse, minor,** and **insignificant.**	with the increased survey effort of Alternative C. Overall, impacts of Alternative C on fish, including ESA-listed species, and fish habitat, including designated critical habitat, would be **adverse, minor,** and **insignificant.**
Aquatic Macroinvertebrates	Impacts to aquatic macroinvertebrates and their habitats from underwater acoustic sources, vessel sound, and air emissions under Alternative A would continue to be **adverse** and **negligible.** Impacts to aquatic macroinvertebrates and their habitats from vessel wake and underwater turbulence; accidental spill of oil, fuel, or chemicals; and disturbance of the ocean/lake/river bottom under Alternative A would continue to be **adverse** and **negligible** to **minor.** Overall, impacts of Alternative A on aquatic macroinvertebrates, including ESA-listed species, and habitats,	Under Alternative B, impacts on aquatic macroinvertebrates and their habitats would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts of Alternative B on aquatic macroinvertebrates, including ESA-listed species, and habitats, including designated critical habitat, would be **adverse, minor,** and **insignificant.**	Under Alternative C, impacts on aquatic macroinvertebrates and their habitats would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts of Alternative C on aquatic macroinvertebrates, including ESA-listed species, and habitats, including designated critical habitat, would be **adverse, minor,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	including designated critical habitat, would continue to be **adverse, minor,** and **insignificant.**		
Essential Fish Habitat (EFH)	Impacts to EFH from disturbance of the water column under Alternative A would continue to be **adverse** and **negligible.** Impacts to EFH from physical impacts to bottom habitat; increase in sedimentation, turbidity, or chemical contamination; dispersal of invasive species; and increase in ambient sound under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts to EFH resulting from Alternative A would be infrequent, geographically widely distributed, and likely to elicit a minimal or temporary response from prey species or cause short-term changes to physical characteristics (i.e., changes in water quality). Overall, impacts of Alternative A on EFH would continue to be **adverse, minor,** and i**nsignificant.**	Under Alternative B, impacts on EFH would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. Impacts to EFH resulting from Alternative A would be infrequent, geographically widely distributed, and likely to elicit a minimal or temporary response from prey species or cause short-term changes to physical characteristics (i.e., changes in water quality). These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts of Alternative B on EFH would be **adverse, minor,** and **insignificant**.	Under Alternative C, impacts on EFH would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. Impacts to EFH resulting from Alternatives A and B would be infrequent, geographically widely distributed, and likely to elicit a minimal or temporary response from prey species or cause short-term changes to physical characteristics (i.e., changes in water quality). These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts of Alternative C on EFH would be **adverse, minor,** and **insignificant**.

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
Seabirds, Shorebirds and Coastal Birds, and Waterfowl	Impacts to birds and their habitats from active underwater acoustic sources and vessel and equipment sound under Alternative A would continue to be **adverse** and **negligible.** Impacts to birds and their habitats from aircraft sound, vessel presence and movement, underwater activities, onshore activities, and air emissions under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts to birds and their habitats from accidental oil, fuel, or chemical spills would continue to be **adverse** and **minor** to **moderate.** Although the effects of impact causing factors on birds and their habitats range from **negligible** to **moderate**, moderate impacts could occur in the very unlikely event of an accidental spill of oil, fuel, or chemicals. Likewise, in the very unlikely event of a vessel strike, injury or death to birds could constitute greater impacts.	Under Alternative B, impacts on birds and their habitats would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. Impacts to birds resulting from Alternative A would generally persist only for the duration of an activity and would not be expected to cause any long-term changes in habitat use and availability or energy expenditure outside of the natural range of variation. These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts on of Alternative B on birds, including ESA-listed species, and habitats, including designated critical habitat, would be **adverse, minor,** and **insignificant.**	Under Alternative C, impacts on birds and their habitats would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. Impacts to birds resulting from Alternatives A and B would generally persist only for the duration of an activity and would not be expected to cause any long-term changes in habitat use and availability or energy expenditure outside of the natural range of variation. These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts on of Alternative C on birds, including ESA-listed species, and habitats, including designated critical habitat, would be **adverse, minor,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	Impacts to birds resulting from Alternative A would generally persist only for the duration of an activity and would not be expected to cause any long-term changes in habitat use and availability or energy expenditure outside of the natural range of variation. Overall, impacts on of Alternative A on birds, including ESA-listed species, and habitats, including designated critical habitat, would continue to be **adverse, minor,** and **insignificant.**		
Cultural and Historic Resources	Impacts to cultural and historic resources from installation, maintenance, and removal of tide gauges, buoys, and GPS reference stations under Alternative A would continue to be **adverse** and **negligible** to **minor.** Impacts to cultural and historic resources from bottom sampling under Alternative A would continue to be both **adverse** and **beneficial, permanent,** and **negligible** to **minor.** Beneficial impacts would occur if a resource were discovered that led to	Under Alternative B, impacts on cultural and historic resources would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, impacts of Alternative B to cultural and historic resources would be **adverse, moderate,** and **insignificant.**	Under Alternative C, impacts on cultural and historic resources would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, impacts of Alternative C to cultural and historic resources would be **adverse, moderate,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	the identification of a culturally-significant artifact or a previously undocumented historic site. Impacts to cultural and historic resources from anchoring under Alternative A would continue to be **adverse, permanent,** and **negligible** to **moderate.** Impacts on subsistence hunting and fishing, including Traditional Cultural Places, under Alternative A would continue to be **adverse** and **negligible** to **moderate.** Although the effects of impact causing factors on cultural and historic resources range from **negligible** to **moderate**, moderate impacts that could occur if the integrity of a resource is diminished would be very unlikely. Overall, impacts of Alternative A to cultural and historic resources would continue to be **adverse, moderate,** and **insignificant.**		

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
Socioeconomic Resources	The economic impacts of ocean data procured under Alternative A on health and safety, recreational economic activity, transportation, and energy-related activities would continue to be **indirect, beneficial,** and **moderate**. Impacts to commercial fishing under Alternative A would continue to be **adverse** and **negligible**. Data collected under Alternative A would continue to improve the quality and quantity of ocean data and data products. Overall, Alternative A would continue to have **indirect, beneficial**, and **moderate** impacts on the ocean economy.	The economic benefits of impacts of Alternative B would be the same or slightly, but not appreciably, larger than those discussed above under Alternative A. These impacts would not substantially increase in intensity with the increased survey effort of Alternative B. Overall, Alternative B would have **indirect, beneficial**, and **moderate** impacts on the ocean economy.	The economic benefits of impacts of Alternative C would be the same or slightly, but not appreciably, larger than those under Alternatives A and B. These impacts would not substantially increase in intensity with the increased survey effort of Alternative C. Overall, Alternative C would have **indirect, beneficial**, and **moderate** impacts on the ocean economy.
Environmental Justice	Impacts of underwater acoustic sources on subsistence hunting of marine mammals under Alternative A would continue to be **adverse** and **moderate**, and the impacts to subsistence fishing communities would continue to be **adverse** and **minor**.	Under Alternative B, impacts on environmental justice would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. These impacts would not substantially increase in intensity with the	Under Alternative C, impacts on environmental justice would be the same or slightly, but not appreciably, larger than those that would occur under Alternatives A and B for each impact causing factor. These impacts would not substantially increase in intensity

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	Impacts of vessel and equipment noise on subsistence hunting of marine mammals under Alternative A would continue to be **adverse** and **minor**, and the impacts to subsistence fishing communities would continue to be **adverse** and **negligible**. Impacts of vessel and equipment presence and movement on subsistence hunting of marine mammals under Alternative A would continue to be **adverse** and **moderate**, and the impacts to subsistence fishing communities would continue to be **adverse** and **negligible**. Impacts of human activities and accidental leakage or spillage of oil, fuel, and chemicals on subsistence hunting and fishing under Alternative A would continue to be **adverse** and **minor**. Impacts of marine trash and debris and air emissions on subsistence hunting and fishing activities under	increased survey effort of Alternative B. Overall, impacts of Alternative B on environmental justice would continue to be **adverse, minor** to **moderate,** and **insignificant.**	with the increased survey effort of Alternative C. Overall, impacts of Alternative C on environmental justice would continue to be **adverse, minor** to **moderate,** and **insignificant.**

Resource	Alternative A: No Action – Conduct Surveys and Mapping for Coastal and Marine Data Collection with Current Technology and Methods, at Current Funding Levels	Alternative B: Conduct Surveys and Mapping with Equipment Upgrades, Improved Hydroacoustic Devices, and New Tide Stations	Alternative C: Upgrades and Improvements with Greater Funding Support
	Alternative A would continue to be **adverse** and **negligible**. The availability of new mapping and charting information under Alternative A would have **beneficial** effects on EJ communities. Overall, impacts of Alternative A on environmental justice would continue to be **adverse, minor** to **moderate,** and **insignificant.**		

4.0 CUMULATIVE IMPACTS

Cumulative impacts are defined by the Council on Environmental Quality (CEQ) regulations in 40 Code of Federal Regulations (CFR) 1508.7 (1978) as the "impact on the environment which results from the incremental impact of the [proposed] action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time."

Cumulative effects may be additive or interactive. Additive effects are the sum of the effects on a resource; for example, groundwater pumping for agricultural irrigation, domestic consumption, and industrial cooling and process activities that all contribute incrementally and additively to drawing down a groundwater aquifer. Interactive effects may be either countervailing – where the net adverse cumulative effect is less than the sum of the individual effects – or synergistic – where the net adverse cumulative effect is greater than the sum of the individual effects. An example of a countervailing effect is when particulate matter and aerosol air pollutants, which tend to block or reflect insolation (sunlight or incoming solar radiation) and thus cool the planet surface, counteract the warming or radiative forcing effect of carbon dioxide emitted at the same time. The discharge of nutrients and heated water to a river that combine to cause an algal bloom and subsequent loss of dissolved oxygen greater than the additive effects of each individual pollutant is an example of a synergistic effect. CEQ recommends that the cumulative impact analysis be narrowed as much as possible to focus on important issues at a national, regional, or local level (CEQ, 1997b). The first step in the cumulative impacts analysis is to identify cumulative actions. The second step is to analyze how, if at all, the effects of the Proposed Action may contribute to the effects of the cumulative actions thereby resulting in cumulative impacts (Section 4.2).

4.1 CUMULATIVE ACTIONS

Per 40 CFR 1508.25(a)(2), cumulative actions are those past, present, and reasonably foreseeable future actions that must be addressed in a cumulative effects analysis because their environmental effects may combine with the effects of the Proposed Action addressed in the National Environmental Policy Act (NEPA) document (CEQ, 1997b). Based on the scope of the National Ocean Service (NOS) Proposed Action and the amount of information available regarding the past, present, and reasonably foreseeable future actions taking place in the action area that was defined in Chapter 2, NOS has considered actions taking place during a 17-year period spanning from 2010 to 2027. Due to the volume and diversity of these cumulative actions, this section identifies specific projects and programs, both public and private sector, but also relevant environmental and economic trends.

In addition to the more substantial or widespread cumulative actions described in Sections 4.1.1-4.1.12, the resources in the action area, particularly biological resources, are sensitive to other human activities that should also be considered in the cumulative impact analysis, when appropriate. These additional activities include:

- Accumulation of marine debris from marine or terrestrial sources (e.g., plastics, polystyrene, glass, metals, or rubber);
- Accidental or illicit discharges (e.g., oil or fuel spills or other introduction of chemical contaminants);
- Habitat encroachment from onshore and nearshore development (e.g., as a function of coastal population growth);

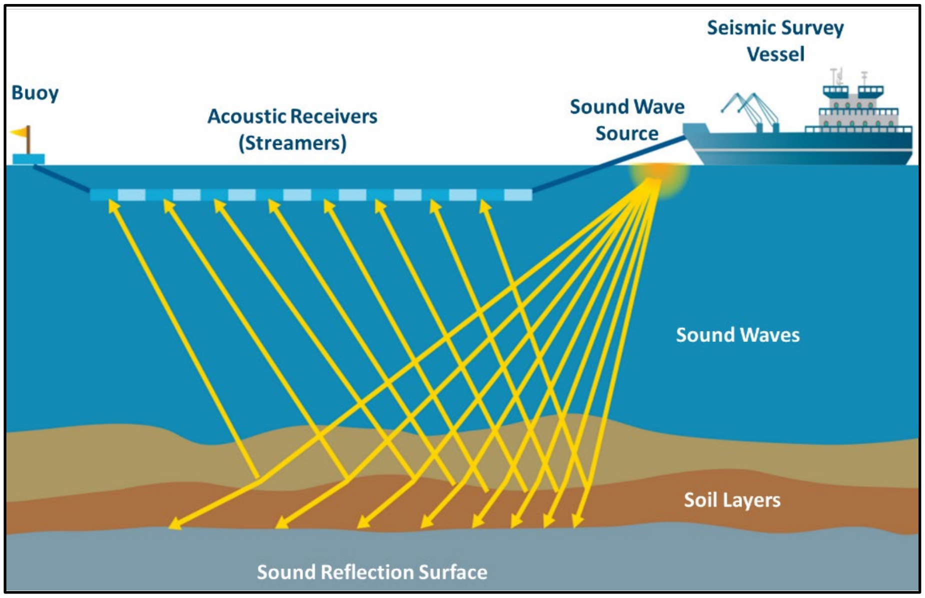
- Illegal, unreported, and unregulated (IUU) fishing;
- Flows of non-point source pollutants, contaminants, sediments, and nutrients from urbanized and agricultural areas in watersheds into coastal waters, with the greatest adverse effects experienced in waters with limited circulation such as bays, sounds, and estuaries.

As a result of the ongoing global coronavirus disease 2019 (COVID-19) pandemic, there has been a measurable decrease in maritime activities, including the delay and cancellation of ocean research projects, to ensure the health and safety of maritime workers and the coastal population. The reduction in overall maritime activity such as shipping, fishing operations, recreation/tourism, and research efforts would be expected to reduce long-term and short-term impacts on coastal environments and the ambient ocean sound level; however, impacts are not fully known (NOAA, 2020b). At the same time, the ongoing pandemic is expected to reduce the beneficial economic impacts of many maritime activities (NMFS, 2021b). Despite the potential short- and long- term cumulative effects of the ongoing global COVID-19 pandemic on the resources evaluated in this Final Programmatic Environmental Impact Statement (PEIS), the pandemic is not considered in this analysis because its effects are not fully known. In general, decreases in maritime activity would be expected to decrease impacts to the coastal environment; therefore, the conservative assumption is to assess cumulative impacts under pre-pandemic cumulative actions.

4.1.1 Other Surveying and Mapping Efforts in the Action Area

As of the summer of 2010, only 906,496 square kilometers (km^2) (350,000 square miles [mi^2]) of seafloor, less than 8 percent of the U.S. Exclusive Economic Zone (EEZ), had been mapped in the Atlantic, Pacific, Gulf of Mexico, and Arctic (NSTC, 2013). As of 2020, 43 percent of the 8,905,960 km^2 (3.4 million square nautical miles [nm^2]) of U.S. underwater territory is mapped to modern standards (NOAA, 2020c). Given the many applications of the collected data, agencies at all governmental levels, universities, non-profit research institutions, and the private sector, conduct surveying and mapping projects in the action area.

Other agencies or private groups performing hydrographic surveys would use echo sounders and equipment similar to those described in Chapter 2. Surveying and mapping projects that use a combination of different equipment and techniques can be referred to by what they are mapping rather than by the type of surveying equipment used. Benthic (ocean floor or lake bottom) habitat mapping entails using a combination of techniques, such as acoustics and lidar, to create a spatially explicit way to identify submerged features (NPS, 2018). Geological and geophysical (G&G) surveys are used to map gas hydrate deposits, bedrock characteristics, and marine mineral resources (BOEM, 2018b; USGS, 2019a). Marine seismic surveys are a type of G&G survey that use a variety of acoustic sources to image sediment and rock deep below the seafloor (USGS, 2019a). For example, deep penetration seismic airgun surveys are conducted by vessels towing an array of airguns that produce low frequency sound pulses that penetrate deep into the subsurface and are then reflected and recorded by receivers to image deep geological features (BOEM, 2018b). This mechanism is illustrated in **Figure 4.1-1** below.



Source: BOEM, 2018a

Figure 4.1-1. Deep Penetration Seismic Airgun Surveying

High resolution geophysical (HRG) surveys are another type of G&G survey which use sound waves that are reflected off submerged structures to collect data on conditions both at the seafloor and the shallow subsurface. HRG equipment generally includes the sonar survey equipment described in Chapter 2 (e.g., multibeam echo sounders, side-scan sonars, sub-bottom profilers). HRG systems usually use higher frequencies than those used in seismic airgun surveys and image smaller structures with a higher level of detail (BOEM, 2018b). HRG surveys, deep penetration seismic surveys, and other types of G&G surveys are used during the preliminary resource assessment phases for Oil and Gas (O&G) exploration, renewable energy siting, and marine mineral projects (BOEM, 2018b).

Surveying and mapping projects can also involve the collection of “core” (samples that preserve surface and subsurface sediment layers) and “grab” samples from the seafloor. Additional equipment used in these projects can include pressure gauges for measuring waves and currents, Acoustic Doppler Current Profilers (ADCPs) for measuring water depth, autonomous and towed instrumentation for characterizing ocean chemistry, and optical backscatter remote-sensing instruments for estimating the concentration of sediment in the water column (USGS, 2020).

Coordination within the ocean and coastal mapping community is facilitated through the Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM) under the National Ocean Council (NSTC, 2016; IOCM, No Date-a). In addition to NOAA, other federal agencies that undertake or permit surveying and mapping projects include Bureau of Ocean Energy Management (BOEM), Federal Emergency Management Agency (FEMA), National Park Service (NPS), Naval Oceanographic Office (NAVO), United States Army Corps of Engineers (USACE), and United States Geological Survey (USGS).

Universities, Non-Profit Research Institutions, and Other Private Sector Efforts. Many of the federal agencies that undertake or permit surveying and mapping projects support research conducted at universities, non-profits, and other institutions. Ocean use activities are coordinated through the University-National Oceanographic Laboratory System (UNOLS), an organization of academic institutions and National Laboratories (UNOLS, No Date). UNOLS vessels conduct a wide array of research activities including marine seismic research and oceanographic aircraft research (UNOLS, 2021).

Given the exceptional variability and vast number of surveying and mapping activities in the action area, it is not possible to provide an exhaustive list of all projects in the action area; however, by identifying regional surveying and mapping needs and using incidental take authorization data, reasonably foreseeable surveying and mapping projects are described for each region.

Due to their potential impact to marine mammals, surveying and mapping projects that use active acoustic sources require incidental take authorizations granted by the National Marine Fisheries Service (NMFS) under the Marine Mammals Protection Act (MMPA) (NMFS, 2019d). A list of recent surveying and mapping projects that require incidental take authorization is presented for each region below as a representative, not exhaustive, list of other surveying and mapping projects. These projects are categorized as G&G surveys, ecological monitoring, or fisheries management and research because of the difference in potential impact. G&G surveys are typically localized and require the use of high intensity active acoustic sources that penetrate the surface of the seafloor, while ecological monitoring and fisheries management and research generally use lower intensity active acoustic sources. Projects with an active take authorization status and projects with a take authorization application in-process are considered reasonably foreseeable to occur within the next five years and are categorized as ongoing activities. Projects that have been granted take authorizations that have expired within the past 10 years are considered activities that have occurred within the past 10 years. Smaller data acquisition projects and hydrographic surveys that did not require incidental take authorization are not captured in **Tables 4.1-1-4.1-5**. Although projects that require take authorization are not the only projects occurring in the action area, they are used as a representative list because projects that require take authorization are expected to be the projects with the greatest impact.

4.1.1.1 Greater Atlantic Region

The Chesapeake Bay is the largest of 130 estuaries in the U.S. and much of it has not been charted since the 1930s and 1940s, causing great interest in new surveying and mapping of the area (NOAA, No Date-h). Additionally, the National Science Foundation (NSF) has funded marine geophysical surveys off the New Jersey coast and Cape Hatteras and has previously partnered with the USGS to conduct seismic surveys throughout the Atlantic (NSF, No Date). Additional surveying and mapping projects are expected to occur in the region for offshore renewable energy project siting, ecological monitoring, fisheries management, and navigational purposes; a representative list of these projects is presented below in **Table 4.1-1** (NOAA, No Date-h; NMFS, 2019d).

Table 4.1-1. Representative List of Surveying and Research Projects within the Greater Atlantic Region

Type of Surveying and Mapping Activity	Project Category	General Location / Geographic Scope	Project Lead	Project/Permit Description
Ongoing Activities				
Ecological Monitoring	Research/Other	Eastern MA NWRs	USFWS	Seabird and shorebird monitoring and research

Type of Surveying and Mapping Activity	Project Category	General Location / Geographic Scope	Project Lead	Project/Permit Description
Fisheries Management and Research	Research/Other	Atlantic Coast Region	NMFS NEFSC	Northeast fisheries and ecosystem research activities
		Atlantic Ocean south of Long Island	NMFS SEFSC	Fisheries and ecosystem research activities in the Atlantic Ocean
G&G Survey	Offshore Wind	NY	Equinor Wind LLC	Offshore wind surveys
		Offshore New England	Orsted Ocean Wind LLC	Marine site characterization surveys, offshore NJ
		Offshore of DE and MD	Skipjack	Site characterization surveys
Activities within the Past 10 years				
Ecological Monitoring	Research/Other	Cape Cod MA NWRs; Eastern MA NWRs	USFWS	Seabird and shorebird monitoring and research
G&G Survey	Offshore Wind	Nantucket Sound, MA	Cape Wind Associates	High-resolution seismic survey in Nantucket Sound, MA
		Offshore RI	Deepwater Wind LLC	Marine site characterization surveys, offshore NY
		Offshore RI	Deepwater Wind New England LLC	Marine site characterization surveys, offshore NY, RI
		MA	DONG Energy MA LLC	Geophysical and Geotechnical Surveys Offshore MA
		Offshore DE	Garden State Offshore Energy LLC	Marine site characterization (geophysical and geotechnical) surveys for Skipjack Wind farm
		Offshore Atlantic City, NJ	Ocean Wind LLC	Marine site characterization surveys, offshore NJ
		NY	Statoil	Offshore wind surveys
	Research/Other	Atlantic Ocean off NJ	Lamont Doherty Earth Observatory / NSF	Marine seismic survey in Atlantic Ocean off NJ
		Atlantic Ocean off the Eastern Seaboard	USGS	Marine seismic survey in the Atlantic Ocean off the Eastern Seaboard

Type of Surveying and Mapping Activity	Project Category	General Location / Geographic Scope	Project Lead	Project/Permit Description
		Northwest Atlantic	USGS	Geophysical surveys

Source: NMFS, 2019d

NEFSC = Northeast Fisheries Science Center; NMFS = National Marine Fisheries Service; NSF = National Science Foundation; NWR = National Wildlife Refuge; SEFSC = Southeast Fisheries Science Center; USFWS = U.S. Fish and Wildlife Service; USGS = U.S. Geological Survey

4.1.1.1.1 Great Lakes

There are no projects that require incidental take authorizations in the Great Lakes because there are no marine mammals; however, the Great Lakes region is one of NPS's current benthic mapping priorities. NPS has collected multibeam sonar and backscatter data at all the Great Lakes Parks (NPS, 2018). More surveying and mapping projects are likely to occur in the Great Lakes region for habitat conservation and navigational purposes.

4.1.1.2 Southeast Region

Additional surveying and mapping projects are expected to occur in the Southeast region for oil and gas siting, offshore renewable energy project siting, ecological monitoring, fisheries management, and navigational purposes; a representative list of these projects is presented below in **Table 4.1-2** (NOAA, No Date-i; NMFS, 2019d).

Table 4.1-2. Representative List of Surveying and Research Projects within the Southeast Region

Type of Surveying and Mapping Activity	Project Category	General Location / Geographic Scope	Project Lead	Project/Permit Description
Ongoing Activities				
Ecological Monitoring	Research/Other	10 Major Bay systems of TX	Texas Parks and Wildlife	Fishery independent monitoring activities
Fisheries Management and Research	Research/Other	Eastern Caribbean; Gulf of Mexico; Western Caribbean	NMFS SEFSC	Fisheries and ecosystem research activities in the Atlantic Ocean
G&G Survey	Offshore Wind	Offshore NC	Avangrid Renewables, LLC	Site characterization surveys off NC
	Oil and Gas	Gulf of Mexico	BOEM	Seismic surveys in the Gulf of Mexico

Type of Surveying and Mapping Activity	Project Category	General Location / Geographic Scope	Project Lead	Project/Permit Description
Activities within the Past 10 years				
G&G Survey	Offshore Wind	Offshore VA	Dominion Energy Virginia	Unexploded Ordinance Survey in Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0497) (Lease Area)
	Research/Other	Atlantic Ocean off NC	Lamont Doherty Earth Observatory / NSF	Seismic survey in the Atlantic Ocean off NC
		Northwest Gulf of Mexico	USGS	Seismic survey in the deep water of the Gulf of Mexico

Source: NMFS, 2019d

BOEM = Bureau of Ocean Energy Management; NMFS = National Marine Fisheries Service; NSF = National Science Foundation; SEFSC = Southeast Fisheries Science Center; USGS = U.S. Geological Survey

4.1.1.3 West Coast Region

Hydrographic surveying projects planned along the Pacific Coast include geologic hazard assessments, seafloor mapping projects in the area provide multibeam bathymetry, acoustic backscatter data, and water column data that are used for earthquake, tsunami, and landslide hazard assessments and situational awareness products (NOAA, No Date-j). The NSF has funded marine geophysical surveys off the coasts of Oregon, Washington, and Central California and more specifically, the Cascadia Subduction Zone, which extends from northern Vancouver Island to Northern California (NSF, No Date). Additional surveying and mapping projects are expected to occur in the region for offshore energy siting, ecological monitoring, fisheries management, hazard assessment, and navigational purposes; a representative list of these projects is presented below in **Table 4.1-3** (NOAA, No Date-j; NMFS, 2019d).

Table 4.1-3. Representative List of Surveying and Research Projects within the West Coast Region

Type of Surveying and Mapping Activity	Project Category	General Location / Geographic Scope	Project Lead	Project/Permit Description
Ongoing Activities				
Ecological Monitoring	Research/Other	CA and OR	UC Santa Cruz	PISCO rocky intertidal monitoring in CA and OR

Type of Surveying and Mapping Activity	Project Category	General Location / Geographic Scope	Project Lead	Project/Permit Description
Fisheries Managemen t and Research	Research/Other	California Current Research Area; Lower Columbia River Research Area; Puget Sound Research Area	NMFS NWFSC	Northwest fisheries and ecosystem research activities
		California Current Research Area	NMFS SWFSC	Fisheries and ecosystem research activities in the Pacific Ocean
G&G Survey	Research/Other	Northeast Pacific	Lamont Doherty Earth Observatory / NSF	Marine Geophysical Survey in the Northeast Pacific
		Off Oregon North; Off Oregon South	Scripps Institution of Oceanography	Seismic survey in the Northeastern Pacific Ocean
Activities within the Past 10 years				
Ecological Monitoring	Research/Other	Palmer's Point; Point Dume; Point Arena; Ten Mile	UC Santa Cruz	PISCO rocky intertidal monitoring in CA and OR
G&G Survey	Research/Other	Southeast Farallon Islands, CA	Gulf of the Farallones NMS, CA	Abalone survey, CA
		Line Islands	Lamont Doherty Earth Observatory / NSF	Low-energy seismic survey in the Pacific Ocean, Line Islands
		Cascadia Thrust Zone north, WA; Cascadia Thrust Zone south, OR; Juan de Fuca Plate study area, Pacific Northwest	Lamont Doherty Earth Observatory / NSF	Seismic survey in the Northeast Pacific Ocean
		Central Pacific Ocean	Scripps	Research seismic survey in the Central Pacific Ocean

Source: NMFS, 2019d

NMFS = National Marine Fisheries Service; NMS = National Marine Sanctuary; NSF = National Science Foundation; NWFSC = Northwest Fisheries Science Center; PISCO = Partnership for Interdisciplinary Studies of Coastal Oceans; SWFSC = Southwest Fisheries Science Center; UC = University of California

4.1.1.4 Alaska Region

Some parts of the Alaska coastline, including the vast majority of the Lisianski Inlet next to Chichagof Island in the Alexander Archipelago, were last surveyed in 1917 (NOAA, No Date-k). Some soundings in the Arctic region date back to the work of Captain Cook in the 18th century. In the time since these surveys, the retreat of arctic sea ice has increased vessel traffic in the region, resulting in an even greater need for updated maps. The Port of Kodiak has seen many groundings and near misses due to the number of dangers to navigation that exist in this area. Additional surveying and mapping projects are expected to occur in these areas for navigational purposes, ecological monitoring, fisheries management, offshore energy siting, and offshore Liquified Natural Gas (LNG) projects; a representative list of these projects is presented below in **Table 4.1-4** (NOAA, No Date-k; NMFS, 2019d).

Table 4.1-4. Representative List of Surveying and Research Projects within the Alaska Region

Type of Surveying and Mapping Activity	Project Category	General Location / Geographic Scope	Project Lead	Project/Permit Description
Ongoing Activities				
Ecological Monitoring	Research/Other	Boulder Island; Flapjack Island; Geikie Rock; Lone Island	NPS - Glacier Bay National Park	Seabird research and monitoring in Glacier Bay National Park, AK
		Kachemak Bay; Katmai National Park and Preserve; Kenai Fjords National Park	NPS - SWAN	Research and Monitoring Activities in Southern Alaska National Parks
Fisheries Management and Research	Research/Other	Bering Sea and Aleutian Islands; Chukchi and Beaufort Seas; Gulf of Alaska	NMFS AFSC	Fisheries Research
G&G Survey	Offshore LNG	Cook Inlet, AK	ExxonMobil Alaska LNG LLC	Geophysical and geotechnical survey in Cook Inlet, AK
	Oil and Gas	Cook Inlet, AK	Apache Alaska Co.	Seismic survey in Cook Inlet, AK
	Research/Other	Alaska	Lamont Doherty Earth Observatory / NSF	Marine Geophysical Survey in the Gulf of Alaska
Activities within the Past 10 years				
Ecological Monitoring	Research/Other	Boulder Island; Flapjack Island; Geikie Rock; Lone Island	NPS - Glacier Bay National Park	Seabird research and monitoring in Glacier Bay National Park, AK

Type of Surveying and Mapping Activity	Project Category	General Location / Geographic Scope	Project Lead	Project/Permit Description
G&G Survey	Offshore LNG	Cook Inlet, AK	ExxonMobil Alaska LNG LLC	Geophysical and geotechnical survey in Cook Inlet, AK (2016)
	Oil and Gas	Cook Inlet, AK	Apache Alaska Co.	Seismic survey in Cook Inlet, AK
		Beaufort Sea, AK	BP	Open water seismic survey
		Prudhoe Bay, AK	BP	Prudhoe Bay, AK seismic survey
		Foggy Island Bay, AK	BP	Shallow geohazard surveying Foggy Island Bay, AK
		Beaufort Sea, AK	Hilcorp	Shallow geohazard survey in the Beaufort Sea, AK
		Beaufort and Chukchi Seas, AK	ION Geophysical	Seismic surveys in the Beaufort and Chukchi Seas, AK
		Zone 1 Cook Inlet, AK; Zone 2 Cook Inlet, AK	SAExploration Inc.	Seismic survey in Cook Inlet, AK
		Beaufort Sea, AK	SAExploration Inc.	Seismic surveys in Beaufort Sea, AK
		Ice gouge survey Beaufort Sea, AK	Shell	Open water survey in the Beaufort and Chukchi Seas, AK
		Ice gouge survey Chukchi Sea, AK	Shell	Open water survey in the Beaufort and Chukchi Seas, AK
		Shallow hazards survey Beaufort Sea, AK	Shell	Open water survey in the Beaufort and Chukchi Seas, AK
		Strudel scour survey Beaufort Sea, AK	Shell	Open water survey in the Beaufort and Chukchi Seas, AK
		Chukchi Sea, AK	Shell	Seismic survey in the Chukchi Sea, AK
		Chukchi and Beaufort Seas, AK	Shell Gulf of Mexico Inc.	Ice overflight surveys in the Chukchi and Beaufort Seas, AK

Type of Surveying and Mapping Activity	Project Category	General Location / Geographic Scope	Project Lead	Project/Permit Description
		Chukchi Sea, AK	StatOil	3D seismic survey in Chukchi Sea, AK
		Alaskan Chukchi Sea	StatOil	Shallow hazards seismic survey in the Alaskan Chukchi Sea
		Chukchi Sea, AK	TGS-NOPEC Geophysical Co.	Seismic survey in the Chukchi Sea, AK
	Research/Other	Unidentified island, Eastern Aleutian Islands, AK	BLM	Survey activities in the Eastern Aleutian Islands, AK
		Western Gulf of Alaska	Lamont Doherty Earth Observatory / NSF	Seismic survey in the Western Gulf of Alaska
		Central Gulf of Alaska	USGS	Geophysical survey in the Central Gulf of Alaska
		Central-Western Bering Sea	USGS	Geophysical survey in the Central-Western Bering Sea
		Central Gulf of Alaska	USGS	Research seismic survey in the Central Gulf of Alaska

Source: NMFS, 2019d

AFSC = Alaska Fisheries Science Center; BLM = Bureau of Land Management; LNG = Liquified Natural Gas; NMFS = National Marine Fisheries Service; NPS = National Parks Service; NSF = National Science Foundation; SWAN = Southwest Alaska Inventory and Monitoring Network; USGS = U.S. Geological Survey

4.1.1.5 Pacific Island Region

The USGS plans to map coral reefs including sediment- or pollutant-impacted reefs, and those of special significance and concern such as reefs in state or national parks, national wildlife refuges, or national marine sanctuaries as part of a Pacific Coral Reefs Project (USGS, 2019b). Additional surveying and mapping projects are expected to occur in the region for habitat conservation, fisheries management, and navigational purposes; a representative list of these projects is presented below in **Table 4.1-5** (NMFS, 2019d).

Table 4.1-5. Representative List of Surveying and Research Projects within the Pacific Island Region

Type of Surveying and Mapping Activity	Project Category	General Location / Geographic Scope	Project Lead	Project/Permit Description
Ongoing Activities				
Fisheries Management and Research	Research/ Other	American Samoa Archipelago Research Area; Hawaiian Archipelago Research Area; Mariana Archipelago Research Area; Western and Central Pacific Research Area	NMFS PIFSC	Pacific Islands fisheries and ecosystem research activities
Activities within the Past 10 years				
G&G Survey	Research/ Other	Central Pacific Ocean	Lamont Doherty Earth Observatory / NSF	Seismic survey in Central Pacific Ocean
		CNMI	Lamont Doherty Earth Observatory / NSF	Seismic survey in CNMI
		Emperor Seamounts; Main Hawaiian Islands	Lamont-Doherty Earth Observatory	Marine Geophysical Surveys by the R/V Marcus G. Langseth in the North Pacific Ocean, 2018/2019
		Wake island	Scripps Institution of Oceanography	Low-energy seismic survey in the Western Tropical Pacific Ocean
		Central Pacific Ocean	University of Hawai'i	Marine Geophysical Survey in the Central Pacific Ocean

Source: NMFS, 2019d

CNMI = Commonwealth of the Northern Mariana Islands; NMFS = National Marine Fisheries Service; PIFSC = Pacific Island Fisheries Science Center; SWFSC = Southwest Fisheries Science Center; NSF = National Science Foundation

4.1.1.6 Expected Increases in Ocean Surveying and Mapping

Over the next decade, surveying and mapping projects are expected to increase throughout the action area to meet the existing regional needs described above and to meet new mapping goals. The November 2019 *Presidential Memorandum on Ocean Mapping of the United States Exclusive Economic Zone and the*

Shoreline and Nearshore of Alaska (2019 Presidential Memo) cited the importance of the ocean economy to the nation and the need for updated and complete mapping of the EEZ to support it. Sections 2 and 3 of the memorandum specifically address the need to develop a strategy for mapping the entire EEZ and Alaska, respectively (The White House, 2019). In light of the 2019 Presidential Memo, the number and frequency of surveying and mapping projects in the action area, specifically in the Alaska region, are expected to increase.

NOAA has also committed to supporting and contributing to Seabed 2030, an international joint project between the Nippon Foundation and the General Bathymetric Chart of the Oceans (GEBCO) Guiding Committee with the goal of producing a complete, high-resolution bathymetric map of the world's seabed from the coasts to the deepest trenches by the year 2030 (OCS, 2018). While the majority of the project is outside the geographic scope of this analysis, future hydrographic surveys and mapping within the U.S. EEZ will be driven by data gap assessments completed in support of this project and the 2019 Presidential Memo. Future hydrographic surveying methods could include collaborative mapping missions, crowdsourced bathymetry from essential partners such as fishing boats, ocean-going carriers, and recreational vessels, and technological innovations that force-multiply capacities to collect sonar data efficiently in remote and challenging locations (OCS, 2018).

Both Seabed 2030 and the 2019 Presidential Memo make comprehensive ocean mapping a priority for the coming decade (IOCM, No Date-b). With this increase, new and more efficient technologies to rapidly characterize the ocean are expected to be developed. For example, NOAA has announced a four-year Cooperative Research and Development Agreement (CRADA) with a private company, Ocean Infinity, to develop deep-water autonomous technologies that can gather ultra-high-resolution ocean information (NOAA, 2020c).

In addition to the use of various active acoustic sources, other impact causing factors associated with all types of surveying and mapping projects include seafloor disturbance to collect bottom samples, vessel presence, impacts to the water column, vessel and equipment noise, and the potential for accidental discharges. Other surveying and mapping efforts in the action area would likely contribute cumulative impacts related to all resources covered in this PEIS.

4.1.2 Offshore Oil and Natural Gas Development

BOEM manages the exploration and development of offshore energy by the O&G industry on the 2.5 billion-acre U.S. outer continental shelf (BOEM, 2018b). The U.S. outer continental shelf comprises the portion of the seabed lying seaward of State coastal waters to the out border of the EEZ. As per the Outer Continental Shelf Lands Act (OCSLA), BOEM can grant leases for the exploration, development, and production of O&G and other mineral resources on the outer continental shelf. Each lease covers up to 2,331 hectares (ha) (6.8 nm^2) and is generally a square measuring 4.8 by 4.8 km (3 by 3 mi) (BOEM, No Date-a).

Interested companies must submit plans to BOEM prior to initiating any activity to explore a block for resources and/or to develop and produce O&G resources (BOEM, No Date-b). Following the preliminary G&G surveys described in Section 4.1.1, offshore oil and natural gas development generally involve the following phases with corresponding impact causing factors:

1) <u>Exploration</u>, which may include the use of mobile drilling units to drill a series of individual wells to locate and test the recoverability of oil and gas reserves and increased vessel traffic to and from the site;

2) Development, which generally involves continued vessel traffic in the area, barge operations, drilling multiple wells in close proximity to each other, and the construction and installation of a platform to collect recovered oil and gas and a pipeline to transfer the oil and gas to the shore;

3) Production/extraction, which involves continued vessel traffic and the extraction of the oil and gas and its transport to shore for processing; and

4) Decommissioning/platform removal, which involves the demolition of oil and gas infrastructure or abandonment of structures; demolition involves increased boat and barge traffic to and from the site and could potentially involve the use of explosives.

Each phase of oil and natural gas development would involve active underwater acoustic sources, seafloor disturbance including sampling and drilling, dredging, vessel presence, vessel and equipment noise, impacts to the water column, potential accidental discharges and oil spills, and air emissions (BOEM, 2019b).

4.1.2.1 Oil and Gas Energy Programs

The National Outer Continental Shelf Oil and Gas Leasing Program (National Outer Continental Shelf Program) specifies the size, timing, and location of potential leasing activity. For this reason, reviewing the program lease sale schedules in addition to reviewing the incidental take authorizations granted to oil and gas projects by NMFS under the MMPA provides a good understanding of previous, current, and reasonably foreseeable O&G projects. Projects which are currently in the preliminary G&G surveying phase were presented in the previous section (Section 4.1.1). Currently, BOEM is working under the 2017-2022 National Outer Continental Shelf Program. BOEM updates the program in five-year increments, and has published a draft proposed National Outer Continental Shelf Program for 2019-2024 (BOEM, No Date-c; BOEM, 2018c). The 2019-2024 Draft Proposed Program Lease Sale Schedule is summarized in **Table 4.1-6** below.

Table 4.1-6. BOEM 2019–2024 Draft Proposed Program Lease Sale Schedule

Sale Year	Region	Program Area
2019	Alaska	Beaufort Sea
2020	Alaska	Chukchi Sea
	Pacific	Southern California
	Gulf of Mexico	Western, Central, and Eastern Gulf of Mexico*
		Western, Central, and Eastern Gulf of Mexico*
	Atlantic	South Atlantic
		Mid-Atlantic
2021	Alaska	Beaufort Sea
		Cook Inlet
	Pacific	Washington/Oregon
		Northern California
		Central California
	Atlantic	North Atlantic
	Gulf of Mexico	Western, Central, and Eastern Gulf of Mexico*
		Western, Central, and Eastern Gulf of Mexico*
2022	Alaska	Chukchi Sea

Sale Year	Region	Program Area
	Pacific	Southern California
	Atlantic	Mid-Atlantic
		South Atlantic
	Gulf of Mexico	Western, Central, and Eastern Gulf of Mexico*
		Western, Central, and Eastern Gulf of Mexico*
2023	Alaska	Beaufort Sea
		Cook Inlet
		Hope Basin
		Norton Basin
		St. Matthew-Hall
		Navarin Basin
		Aleutian Basin
		St. George Basin
		Bowers Basin
		Aleutian Arc
		Shumagin
		Kodiak
		Gulf of Alaska
	Pacific	Central California
		Northern California
	Gulf of Mexico	Western, Central, and Eastern Gulf of Mexico*
		Western, Central, and Eastern Gulf of Mexico*
		Eastern and Central Gulf of Mexico **
	Atlantic	Straits of Florida
		North Atlantic
2024	Alaska	Chukchi Sea
	Gulf of Mexico	Western, Central, and Eastern Gulf of Mexico*
		Western, Central, and Eastern Gulf of Mexico*
		Eastern and Central Gulf of Mexico **
	Atlantic	South Atlantic
		Mid-Atlantic

Source: BOEM, 2018c

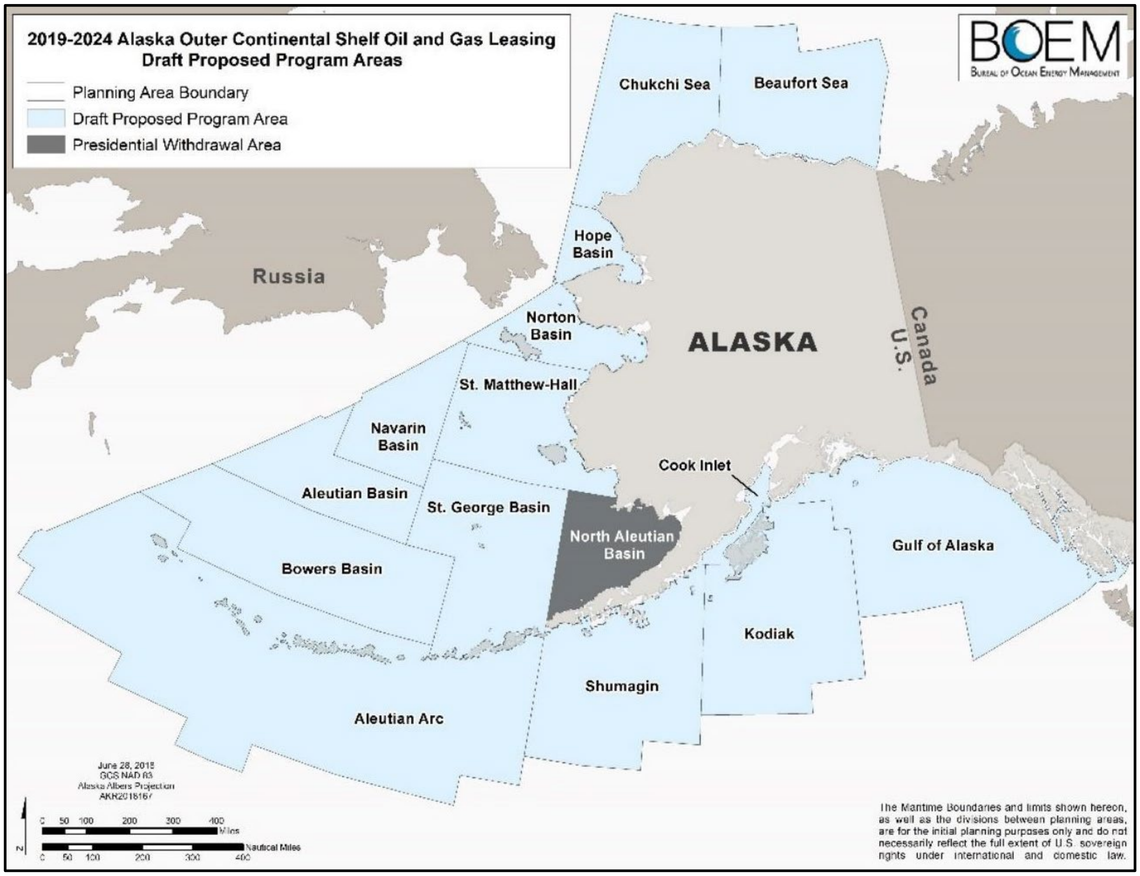
*All available areas, not including those subject to the Gulf of Mexico Energy Security Act (GOMESA) moratorium through June 30, 2022. The GOMESA mandates that the states of Texas, Louisiana, Mississippi, and Alabama receive a portion of revenues from new oil and natural gas development in federal waters adjacent to the respective state (BOEM, 2018c).

**Those areas available following the expiration of the GOMESA moratorium.

4.1.2.2 Alaska Outer Continental Shelf Region

The Arctic region in total contains an estimated 13 percent of the world's undiscovered oil and 30 percent of undiscovered natural gas (USCG, 2018). The Alaska outer continental shelf encompasses the Beaufort and Chukchi Seas, the Bering Sea, Cook Inlet, and the Gulf of Alaska, spanning more than 404,685,642 ha

(1,179,875 nm^2). Alaska contains more than 9,656 km (6,000 mi) of coastline – more coastline than in the rest of the U.S. combined (BOEM, No Date-c). There are 54 active leases in the Alaska region (BOEM, 2019c; BOEM, 2019d). The O&G leasing program areas are depicted below in **Figure 4.1-2**.



Source: BOEM, No Date-c

Figure 4.1-2. Alaska Outer Continental Shelf Program Areas

Decreasing sea ice and diminishing onshore oil production are creating incentives for further exploration offshore in the Arctic region as a whole (USCG, 2018). With the exception of the take authorization granted to ExxonMobil in the Santa Barbara Channel, all projects that have been granted incidental take authorizations for construction and operation relating to oil and gas development have occurred in the Alaska region (NMFS, 2019d). A summary of these projects is presented below in **Table 4.1.7** as a representative, not exhaustive, list of offshore oil and gas development projects. Projects with an active take authorization status and projects with a take authorization application in-process are considered reasonably foreseeable to occur within the next five years and are categorized as ongoing activities. Projects that have been granted the requested take authorizations that have expired within the past 10 years are considered activities that have occurred within the past 10 years. Although projects that require take authorization are not the only projects occurring in the action area, they are used as a representative list because projects that require take authorization are expected to be the projects with the greatest impact.

Table 4.1-7. Representative List of Oil and Gas Projects within the Alaska Region

General Location/ Geographic Scope	Project Lead	Project/Permit Description
Ongoing Activities		
Cook Inlet, AK	Hilcorp Alaska LLC	Oil and Gas activities
Cook Inlet, AK	Harvest Alaska (Hilcorp)	Cook Inlet Pipeline Cross Inlet Extension
Arctic, AK	Hilcorp Alaska	Liberty Drilling and Production Island[1]
North Slope, AK	Hilcorp Alaska, Eni	Ice road Construction
Activities within the Past 10 years		
Chukchi Sea, AK	Shell Gulf of Mexico Inc.	Drilling program in the Chukchi Sea, AK
Beaufort Sea, AK	Hilcorp Alaska	Operation of NorthStar facility in the Beaufort Sea, AK
Beaufort Sea, AK	Shell	Beaufort Sea exploratory drilling
Chukchi Sea, AK	Shell	Chukchi Sea exploratory drilling

1 – The Liberty Drilling and Production Island project is on hold.

Source: NMFS, 2019d

4.1.2.3 Atlantic Outer Continental Shelf Region

The Atlantic outer continental shelf region is divided into four planning areas: North Atlantic, Mid-Atlantic, South Atlantic, and Straits of Florida. No active O&G leases currently exist in the Atlantic outer continental shelf region; and none are proposed under the current 2017-2022 Outer Continental Shelf Oil and Gas Leasing Program (BOEM, No Date-d).

4.1.2.4 Gulf of Mexico Outer Continental Shelf Region

The Gulf of Mexico outer continental shelf consists of three planning areas (Western, Central, and Eastern Gulf of Mexico); however, the Gulf of Mexico region also manages the four Atlantic outer continental shelf planning areas which all together span 174,014,826 ha (507,346 nm^2). The Gulf's Central and Western planning areas (offshore Texas, Louisiana, Mississippi, and Alabama) remain the nation's primary offshore source of O&G, generating about 97 percent of all offshore O&G production (BOEM, No Date-e). As described in BOEM's Gulf of Mexico region Oil and Gas Production Forecast: 2018-2027, annual oil production is anticipated to continue to increase through 2024. Annual gas production volumes are anticipated to remain relatively consistent from 2018 to 2027 with an average rate of decline of less than 1 percent annually (BOEM, 2017b).

4.1.2.5 Pacific Outer Continental Shelf Region

The Pacific outer continental shelf region has issued 470 leases and currently has 34 active leases, which together cover 72,248 ha (211 nm^2) in offshore California, Oregon, Washington, and Hawai'i. O&G production facilities have been installed in 23 of the active leases, all of which are located off the coast of California (BOEM, No Date-a). However, NMFS granted a marine mammal take authorization to only one project in the region (ExxonMobil conductor pipe installation activities at Harmony Platform in Santa Barbara Channel, CA in 2014), which has since expired (NMFS, 2019d).

Offshore oil and natural gas development would likely contribute cumulative impacts related to all of the resources covered in this Final PEIS.

4.1.3 Offshore Renewable Energy Development

Offshore renewable energy consists of several sources, including wind energy and ocean wave and current energy, also known as hydrokinetic energy. BOEM is the agency responsible for overseeing offshore renewable energy development in federal waters (BOEM, No Date-f).

4.1.3.1 Wind Energy

Both nationally and globally, wind power is one of the fastest growing forms of electricity generation. Wind turbines convert the kinetic energy of wind into electricity. Offshore winds tend to blow harder and more uniformly than on land because there are no mountains, trees, and artificial structures to obstruct wind currents. Since higher wind speeds can produce much more electricity, and do so more reliably than onshore wind farms, developers are increasingly interested in pursuing offshore wind energy resources. There are extensive, potentially productive areas for wind energy available offshore on the continental shelf (DOSITS, No Date-a).

Offshore wind facility design and engineering depends on site-specific conditions, particularly water depth, seabed geology, and wave loading. Following the preliminary G&G surveys described in Section 4.1.1, the remaining three phases of a wind farm's life cycle entail underwater sounds of varying intensity and duration:

1) <u>Construction</u>, which may include drilling, pile driving, use of explosives, dredging, cable laying, increased vessel traffic to and from the site, and barge operations;
2) <u>Operation</u>, including long-duration sound associated with mechanical vibrations when the turbine blades are spinning as well as periodic maintenance vessel traffic, continuing over the 20- to 25-year lifetime of the installation; and
3) <u>Decommissioning</u>, which may include mechanical cutting and explosive detonation as well as increased boat and barge traffic to and from the site.

In the coming years, the majority of offshore wind project activity is expected to be in the pre-construction and construction phase. During the operational phase (**Figure 4.1-3**), by far the longest of these phases, low-frequency sound is generated when the turbine blades are spinning. Vibrations inside the nacelle (housing for the generator, gearbox, and other parts) are transmitted down the main turbine shaft and into its foundation under the seabed. These vibrations then propagate both into the seafloor and the water column. The sound is primarily below 1 kilohertz (kHz) (generally below 700 hertz [Hz]), with a source level of 80-150 decibels (dB) re 1 µPa (micropascal) @ 1 m. Aerodynamic noise produced by the motion of the rotor blades through the air may also penetrate the water through an airborne path. Sound levels increase somewhat as wind speed increases and blades rotate faster. The type of wind turbine foundation also affects the propagation of underwater sound (DOSITS, No Date-a).

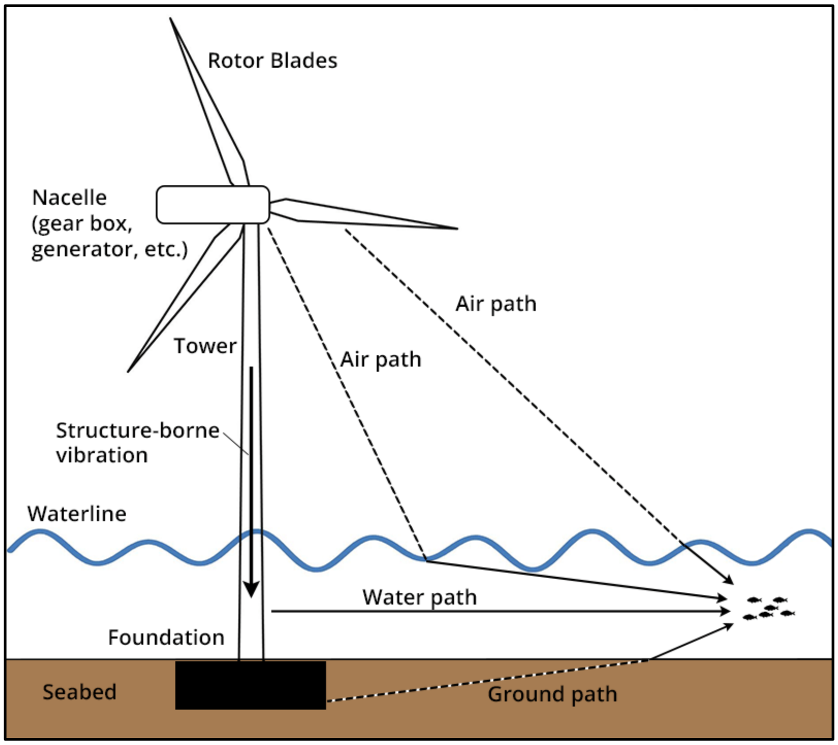
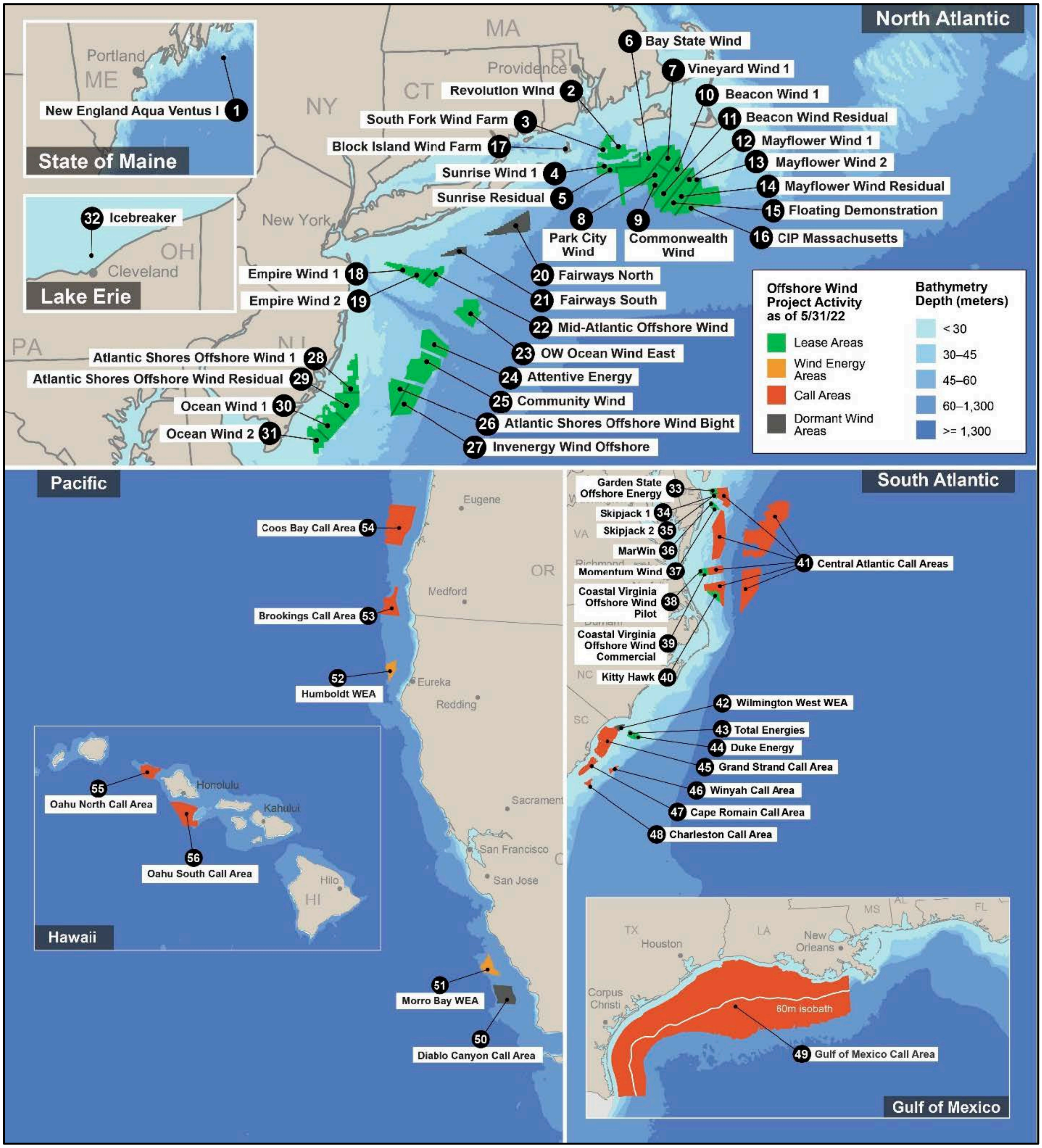


Figure 4.1-3. Acoustic Pathways for Underwater Noise from an Offshore Wind Turbine in Operation

Image Credit: DOSITS, No Date-a, modified from Kikuchi, 2010

As of May 2022, the U.S. generates about 42 megawatts (MW) of offshore wind energy. There are currently two offshore wind farms in operation: the first, Block Island Wind Farm in Rhode Island, began operating in 2016 with a capacity of 30 MW, and the second, by Dominion Energy off the coast of Virginia, began operating in 2020 with a capacity of 12 MW (Musial et al., 2022).

The offshore wind industry in the U.S. is poised for an exponential increase in project activity, especially by coastal states aiming to take advantage of offshore wind energy, such as New York, New Jersey, Massachusetts, Connecticut, Maryland, Virginia, and California. Two new wind farms are currently under construction: Vineyard Wind 1 located off the coast of Massachusetts would produce 800 MW once it is operational in 2024, and Sound Fork Wind Farm located off the coast of Massachusetts and Rhode Island would produce 132 MW once it is operational in 2023. There are 18 lease areas in development at the permitting stage, which means that the developer has surveyed the lease area and submitted its Construction and Operations Plans to BOEM and is awaiting approval of the proposed project. The projects in the permitting stage have the potential to yield about 18,851 MW of offshore wind energy if the projects are approved and the sites become operational. BOEM has announced that it expects to complete the review of at least 16 of these Construction and Operations Plans by 2025, clearing the path for the development of offshore wind farms in the near future. Another 17 lease areas are at the site control stage, which means the developer has acquired the rights to develop the lease area and has begun surveying the area. The projects in the site control stage could potentially yield almost 16,000 MW. Additionally, two areas off the coast of California, Humboldt Bay and Morro Bay, were designated as wind energy areas in November 2021, meaning these areas can be put up for a lease sale in the future. These locations would likely be subdivided into five new lease areas and could potentially yield up to 4,532 MW of offshore wind energy. BOEM also designates certain areas as “Call Areas” which are locations that have been identified for their wind potential (Musial et al., 2022). The locations of U.S. offshore wind energy projects and areas for potential wind development are shown in **Figure 4.1-4**.



Source: Musial et al., 2022; Dormant Wind Areas are previously categorized wind energy areas that are no longer being actively reviewed or developed by BOEM.

Figure 4.1-4. Locations of U.S. Offshore Wind Energy Projects and Areas for Potential Wind Development in the North Atlantic, South Atlantic, and Pacific

In 2021, the Biden Administration announced its national goal of deploying 30 GW of offshore wind energy by 2030. The effort would support the creation of approximately 77,000 new jobs, with more than 44,000 workers employed in offshore wind and nearly 33,000 additional jobs in communities supported by offshore wind activities. It would generate enough electricity to power over 10 million homes in the U.S. and cut 78 million metric tons of carbon dioxide emissions. The goal would spur $12 billion in capital investment annually, including the construction of up to 10 new manufacturing plants for offshore wind turbine components, new ships to install offshore wind turbines, and up to $500 million in port upgrades. This plan also establishes a pathway to deploy 110 GW or more of offshore wind energy in the U.S. by 2050, which would create 77,000 offshore wind jobs and more than 57,000 additional jobs in communities supported by offshore wind activity (DOE, 2021).

The U.S. offshore wind energy supply chain saw significant growth in 2021 and 2022 with 10 new major domestic manufacturing facilities announced at ports along the East Coast. These facilities would contribute to the wind energy supply chain by building components such as turbine blades, towers, platforms, arrays and export cables, and offshore substations. The U.S. supply chain is anticipated to grow as more projects begin construction and could generate between $1.6 and 6.2 billion of added value to the economy each year, along with 12,300 to 49,000 new manufacturing jobs (Musial et al., 2022).

4.1.3.2 Other Offshore Renewable Energy

Tidal, wave, and current energy are clean, renewable resources that can be harnessed wherever changing tides, waves, or currents move a significant volume of water, especially off the coasts of urban centers where there is high electricity demand. Marine and Hydrokinetic (MHK) energy is an untapped resource for the U.S. and though still a new industry, the U.S. Department of Energy's (DOE) Water Power Program is researching projects to accelerate wave, tidal, and current projects and overall development of the MHK market. These projects include project siting activities, market assessments, environmental impact analyses, and research supporting technology commercialization (DOE, No Date-a). Due to the relatively steep continental slope and deep water off the West Coast and Hawai'i, different types of offshore renewable energy technologies have been proposed for the Pacific region than for the Atlantic region (BOEM, No Date-g). While the U.S. is pursuing ocean current energy, it is still in the early stages of development. Submerged water turbines, similar to wind turbines, may also be deployed on the outer continental shelf in the coming years to extract energy from ocean currents (BOEM, No Date-h).

Ocean Thermal Energy Conversion (OTEC) is a process to power a turbine to produce electricity by harnessing the temperature differences (thermal gradients) between ocean surface waters and deep ocean waters. OTEC systems using seawater as the working fluid can use the condensed water to produce desalinated water. As of 2015, the Natural Energy Laboratory of Hawai'i Authority, a leading test facility for OTEC technology, has supplied electricity to the local electricity grid. Conditions for OTEC systems exist in tropical coastal areas such as Hawai'i, south Florida, and the Caribbean (DOE, No Date-b).

Impact causing factors associated with other offshore renewable energy projects would likely include vessel presence, vessel and equipment noise, impacts to the water column, potential accidental discharges, the construction and installation of structures and cables connected to the shore (BOEM, 2019b). The development of offshore renewable energy would likely contribute cumulative impacts related to all resources covered in this PEIS.

4.1.4 Climate Change

For more than 200 years, since the beginning of the industrial revolution, the concentration of carbon dioxide (CO_2) in the atmosphere has increased due to the burning of fossil fuels and land use change (e.g., increased vehicular and power plant emissions and deforestation). Increased concentrations in CO_2 and other greenhouse gases in earth's atmosphere trap the sun's heat and raise temperatures, changing the earth's climate system. The years between 2013 and 2021 all rank among the ten warmest years on record; 2021 was the sixth warmest year on record with a global temperature that was 0.84°Celcius (C) (1.51 °Fahrenheit [F]) above the 20th century average. The world's oceans are of particular concern because the ocean absorbs about 90 percent of the heat generated by rising emissions (NCEI, 2022). In addition, the ocean absorbs about 30 percent of the CO_2 that is released in the atmosphere (NOAA, 2013). Therefore, as global temperatures and the level of atmospheric CO_2 increase, so does the level of CO_2 in the ocean. In order to fully understand the impacts of climate change, the spatial boundary for analysis will be increased in this section to include international waters.

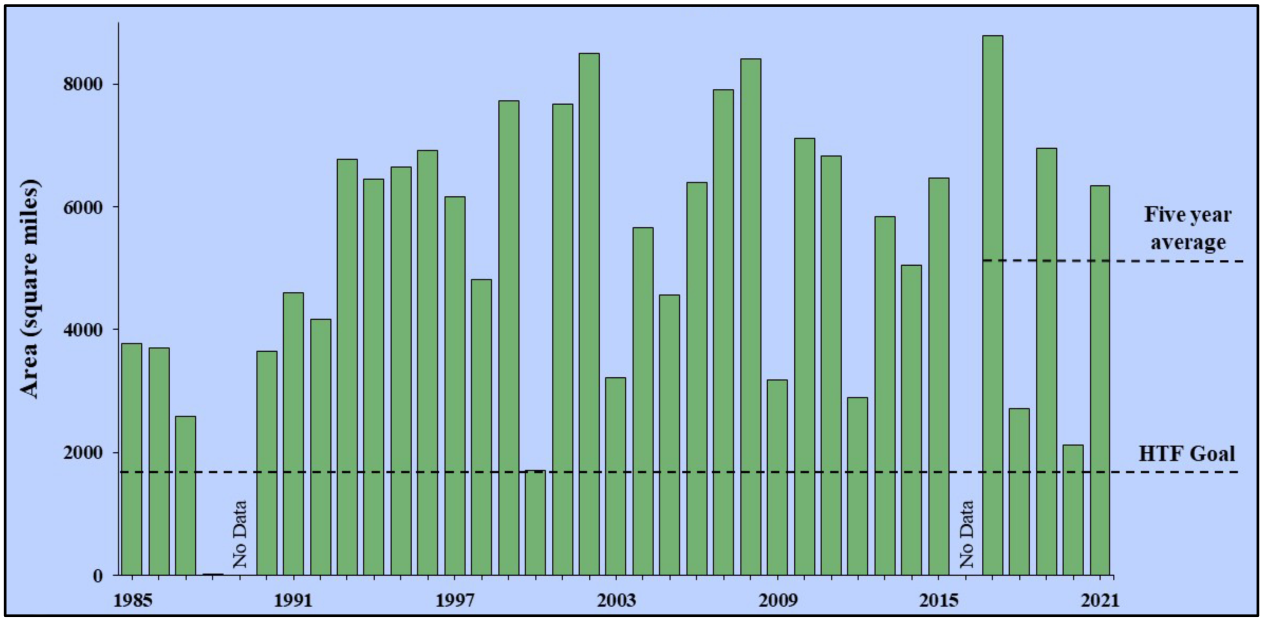
Warming. Between 1900 and 2016, global ocean surface waters have warmed on average 0.7° ± 0.08°C (1.3° ± 0.14°F) (USGCRP, 2018). In 2021, global ocean surface temperatures were 0.65 ± 0.16°C (1.17 ± 0.29°F) above average, which is the sixth highest average on record since 1880. This translates to an increase in the amount of energy absorbed by the ocean, also known as the ocean's heat content (OHC). Since records of OHC started in 1955, the seven highest OHC measurements have all occurred in the last seven years; 2021 exceeded the previous record set in 2020 (NCEI, 2022). In the last decade, the ocean has absorbed a large amount of heat resulting in record temperatures.

The warming of the ocean impacts sea levels, circulation and currents, productivity, and the functioning of entire ecosystems (USGCRP, 2018). For example, higher global temperatures have led to the melting of glaciers and icecaps which has caused sea levels to rise. In addition, as the ocean heats up, the water expands and contributes to sea level rise (NCEI, 2022). Sea levels in the U.S. have risen up to 0.6 meters (m) (2 feet [ft]) in the past century. As much as 4,921 km^2 (1,900 mi^2) of coastal wetlands have been lost in Louisiana alone during this period. The amount of future sea-level rise will depend on the expansion of ocean volume and the response of glaciers and polar ice sheets. A rise in sea level of up to 1.2 m (4 ft) in this century has been predicted, but even another 0.6-m (2-ft) rise would cause major loss of coastal wetlands (USGCRP, 2009).

Deoxygenation. Increased CO_2 levels in the atmosphere are also causing a decline of dissolved oxygen (DO) concentrations in the ocean. Ocean warming leads to deoxygenation because temperature has a direct influence on how much oxygen is soluble in water. Oxygen is less soluble in warmer waters; therefore, the concentration of DO is lower in waters that have been warmed by climate change (USGCRP, 2018). Low levels of oxygen can suffocate fish and other marine life, leading to fish kills and other marine life mortalities.

Deoxygenation can also occur from "oxygen demanding" pollutants entering the water, mostly from nitrogen and phosphorus nutrients associated with agricultural/fertilizer runoff (USGCRP, 2018). This has become an annual occurrence in the Gulf of Mexico, which receives nutrient runoff from the Mississippi River and incurs large areas of very low dissolved oxygen, also known as dead zones. The Gulf of Mexico's dead zone in 2021 was 6,334 square miles, which was larger than the five-year average of 5,380 square miles, as seen in **Figure 4-1.5**. The resulting low levels of oxygen are insufficient to support most marine life, rendering that area unusable for species and forcing them to move to other areas. The Hypoxia Task

Force (HTF), which includes federal and state agencies and tribes, has set a goal of reducing this dead zone to below 2,000 square miles by 2035 (NOAA, 2021).



Source: NOAA, 2021

Figure 4.1-5. Size of Annual Dead Zone (green bars) in the Gulf of Mexico (1985 to 2021)

Acidification. The ocean absorbs about 30 percent of the CO_2 that is released in the atmosphere; as more CO_2 is emitted into the atmosphere, more CO_2 is absorbed by the ocean. When CO_2 is absorbed by seawater, a series of chemical reactions occur, resulting in the increased concentration of hydrogen ions. Acidity is measured as a function of the concentration of hydrogen ions (pH), so the increased concentration of hydrogen ions causes the seawater to be more acidic. The ocean's average pH is typically about 8.1 pH units. During the last 200 years, the pH of surface ocean waters has fallen by about 0.1 pH units. Since pH is measured on a logarithmic scale, this change represents approximately a 30 percent increase in acidity. As the ocean continues to absorb more CO_2, the pH would continue to decrease and the ocean would become more acidic (NOAA, 2013).

A portion of the excess hydrogen ions react with carbonate (CO_3^{2-}) ions to form bicarbonate (HCO_3^-), this causes carbonate ions to be relatively less abundant (Hardt and Safina, 2008; NOAA, 2020d). Carbonate ions are a critical component of calcium carbonate ($CaCO_3$), which many marine macroinvertebrates use to manufacture shells and exoskeletons. When the concentration of carbonate ions in ocean water is low enough, exposed $CaCO_3$ structures such as shells, exoskeletons, and coral skeletons are more difficult to build and maintain and can even begin to dissolve or disintegrate (NOAA, 2020d; USGCRP, 2018).

These processes (warming, deoxygenation, and acidification) represent only a few ways that the ocean environment would be stressed as a result of climate change. Overall, these stressors are expected to persist at current levels or increase above current levels as the effects of climate change continue to evolve and impact the ocean environment. Impact causing factors associated with climate change include changes to water characteristics (including temperature, acidity, and oxygen concentration), sea level rise, increased storm severity and frequency, and coastal erosion, all of which contribute to coastal infrastructure damage and the increased need to construct protective infrastructure such as barriers and seawalls (BOEM, 2019b). Climate change would likely contribute cumulative impacts related to habitats; marine mammals; sea turtles; fish; aquatic macroinvertebrates; essential fish habitat (EFH); seabirds, shorebirds and coastal birds, and waterfowl; cultural and historic resources; and Environmental Justice.

4.1.5 Commercial Shipping and Recreational Boating

About 90 percent of imports and exports enter and exit by ship through the nation's 40,233 km (25,000 mi) of navigable channels. By 2025, global demand for waterborne commerce is expected to more than double, which will increase the level of vessel traffic in the action area. Compared to land-based transportation by road and rail, the transportation of goods by waterways is considered to be a more economical, efficient, and environmentally sound mode of transport. For example, one Great Lakes bulk carrier has approximately the same cargo capacity as seven 100-car freight trains (USCG, 2018). Part of maintaining waterways for safe navigation includes dredging to maintain channel depths in harbors and inland waterways. The USACE dredges nearly 300 million cubic yards of material each year to keep the nation's waterways navigable. Much of this dredged material is reused for environmental restoration projects, including the creation of wetlands (USACE, No Date).

Designated shipping lanes occur throughout all regions of the action area with a higher concentration around urban centers with major ports. Shipping lanes and other areas with operational restrictions within the action area are shown below in **Figure 4.1-6**.

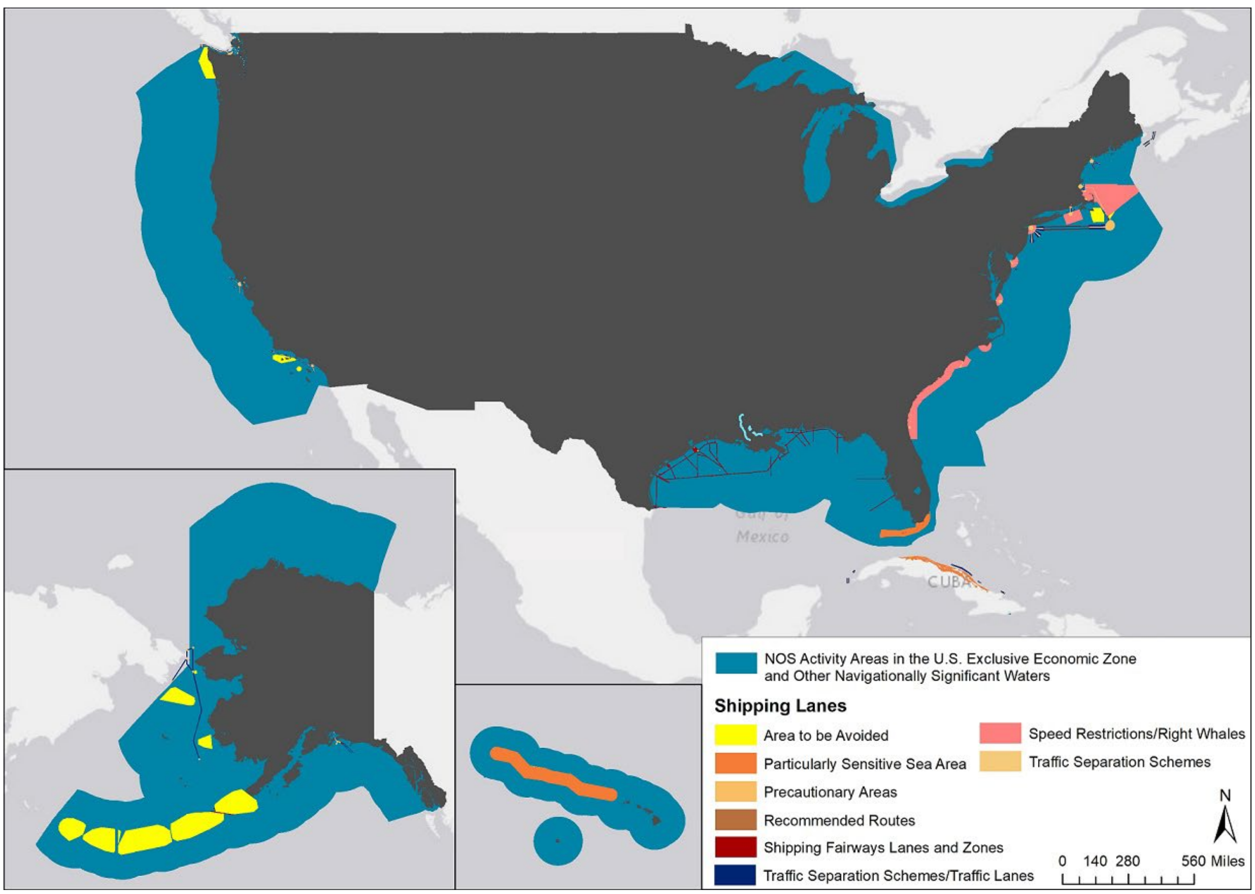
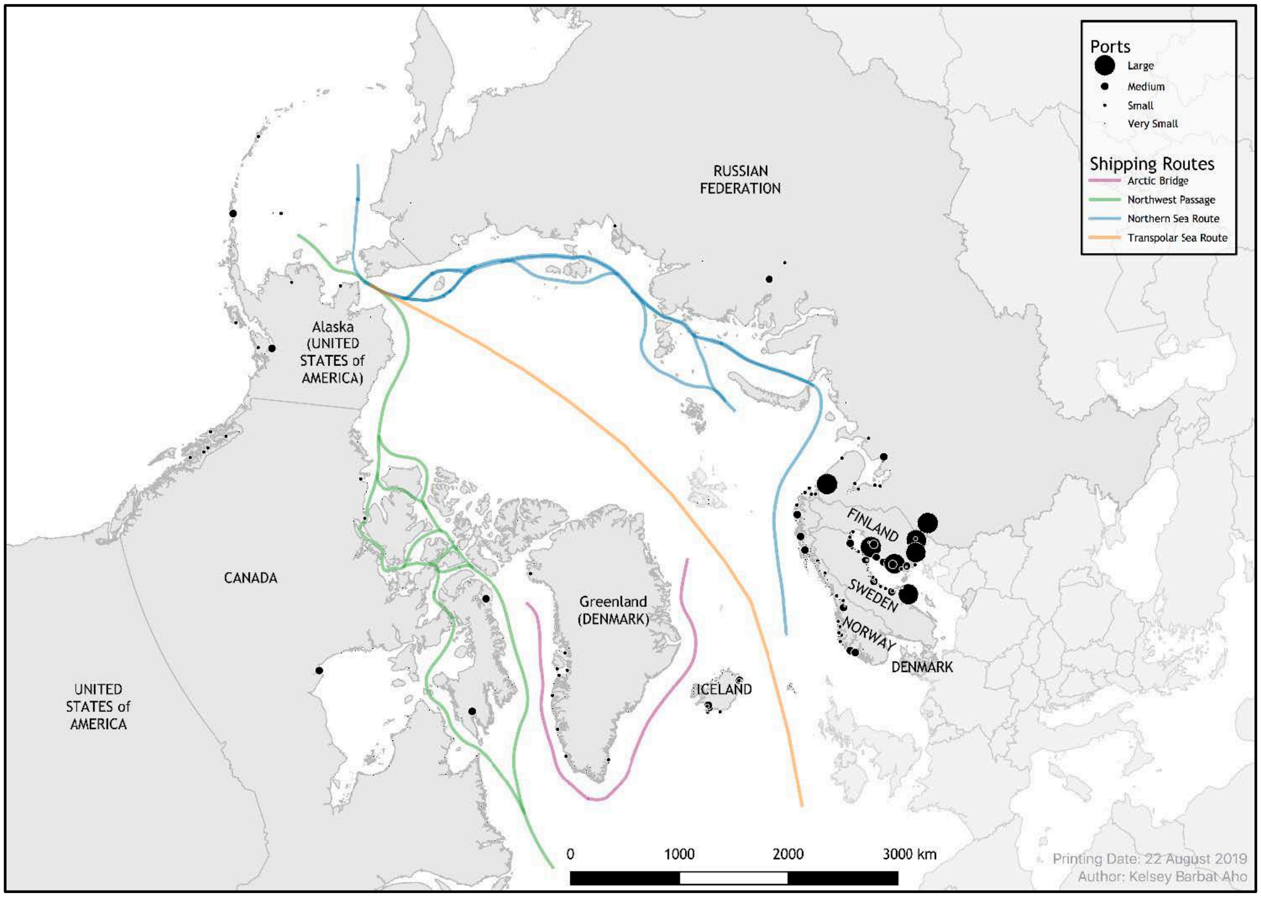


Figure 4.1-6. Shipping Lanes and Vessel Traffic Restrictions within the Action Area

Shipping trends in the Alaska region are expected to vary in the near-term future because the Arctic region is undergoing dramatic changes due to the effects of climate change. Temperatures in the Arctic are rising more than two times faster than the rest of the planet, and increasing ocean temperatures have caused a decrease in the amount of seasonal sea ice (Boylan and Elsberry, 2019; Hoegh-Guldberg and Bruno, 2010). Currently, Arctic vessels require icebreaker escorts, but projections show that as early as 2030, unescorted navigation in the Arctic may be possible; by 2050, it is probable. Three principal Arctic shipping routes connect the Atlantic and Pacific: The Northwest Passage, the Northern Sea Route, and the Transpolar Sea Route illustrated in **Figure 4.1-7** below (Boylan and Elsberry, 2019).



Source: Boylan and Elsberry, 2019

Figure 4.1-7. Arctic Vessel Routes

The Northwest Passage (shown in green in **Figure 4.1-7**) refers to the sea route that extends from the Pacific Ocean, over Alaska, through the Canadian archipelago, between Canada and Greenland, and into the Atlantic Ocean. The Northern Sea Route (shown in blue in **Figure 4.1-7**) is the route along the north coast of Russia, extending from the Kara Sea in the west through the Bering Strait in the east. It is a large component of the Northeast Passage, which runs along the north coasts of Russia and Europe and connects the Pacific Ocean to the Atlantic Ocean. The Transpolar Sea Route (shown in orange in **Figure 4.1-7**) would represent a third Artic shipping route; however, this route is hypothetical since it involves ice-free conditions through the Central Arctic which have not been observed yet.

New maritime navigational opportunities are expected as ice coverage in the Artic Ocean changes with rising temperatures. The ice along both the Northwest Passage and the Northern Sea Route is being reduced at the highest rate across the Arctic (Boylan and Elsberry, 2019). Observations have shown decreasing multi-year ice and increasing open water during the Arctic summer and early fall, making seasonal maritime navigation more feasible and increasing the potential for commercial shipping during summer months (USCG, 2018). These sea routes are advantageous to the commercial shipping industry because they have the potential to reduce the time it takes to transport goods between Asian and European ports by several days; they also provide an alternative to routes passing through the Panama or Suez Canals (Boylan and Elsberry, 2019; USCG, 2018). In addition, economic development drives much of the current maritime activity in the region. The Arctic contains an estimate 13 percent of the world's undiscovered oil and 30 percent of undiscovered natural gas. As sea ice decreases, these untapped resources create incentives for further exploration offshore to extract these commodities.

With an increase in vessel traffic, secondary trends to consider include an increase in operational and illicit vessel emissions, anthropogenic sounds in the sea, opportunities for the propagation and spread of invasive species, and an increased risk of vessel strikes. Impact causing factors associated with commercial shipping and recreational boating include vessel presence, vessel noise, impacts to the water column, potential accidental discharges, and air emissions (BOEM, 2019b). Increases in commercial shipping and recreational boating within the action area would likely contribute cumulative impacts related to all resources covered in this PEIS.

4.1.6 Assessment and Extraction of Marine Minerals

BOEM is responsible for identifying non-energy resources on the outer continental shelf; this includes managing the use of mineral and sand resources (BOEM, 2019e). BOEM's Marine Minerals Program (MMP) manages non-energy minerals (primarily sand and gravel) for coastal restoration, and commercial leasing of gold, manganese, and other hard minerals (BOEM, 2019e). Following preliminary G&G surveys, marine mineral projects typically involve the dredging of sediment using either a hopper dredge which suctions the material or a cutterhead dredge which pumps material to be closer to the project area at which point the material is transferred to a pipeline connected to the shore (BOEM, 2019b).

As of 2018, the MMP had executed 55 negotiated agreements and completed 45 coastal restoration projects for more than 512 km (318 mi) of shoreline in Florida, Louisiana, Maryland, Mississippi, New Jersey, North Carolina, South Carolina, and Virginia. To complete these projects, the MMP has provided nearly 150 million cubic yards of offshore sand resources to coastal communities and federal agencies—that amount of sand would cover Manhattan, New York to a depth of more than 1.8 m (6 ft). In the past few years, BOEM has experienced a substantial increase in the number of requests for negotiated agreements from governmental agencies to use offshore sand resources. This trend is most likely due to a diminishing supply of available material in near shore waters, increased coastal erosion as a result of more frequent and intense storms, and sea level rise. The MMP is planning to sponsor new offshore sediment surveys from Maine to Texas that build on MMP's plans following Hurricane Sandy in 2012, when BOEM supported coastal restoration projects in several Atlantic states. Sediment studies are also being conducted offshore of California (BOEM, 2019e).

In addition to using mineral resources for restoration projects, pursuant to Executive Order 13817 issued in December 2017, the MMP and the USGS are collaborating to research 35 critical minerals (i.e., minerals used in manufacturing, consumer products, or are otherwise economically important) along the outer continental shelf (BOEM, 2019e).

In addition to seafloor disturbance and dredging, impact causing factors associated with these activities would likely include vessel presence, vessel and equipment noise, impacts to the water column, potential accidental discharges, and air emissions (BOEM, 2019b). The assessment and extraction of marine minerals would likely contribute to cumulative impacts related to habitats; marine mammals; sea turtles; fish; aquatic macroinvertebrates; EFH; seabirds, shorebirds and coastal birds, and waterfowl; cultural and historic resources; and socioeconomic resources.

4.1.7 Offshore Carbon Storage Resource Assessments

Carbon storage is the process of removing carbon from the atmosphere or capturing it and depositing it for storage in a reservoir beneath the earth's surface. While there are no offshore carbon storage or sequestration projects currently underway or planned, the National Energy Technology Laboratory (NETL) in coordination with the DOE, BOEM, state geologic surveys, and other institutions have and continue to support offshore carbon storage resource assessments in the Mid-Atlantic, Southeast, and Gulf Coast regions. These projects utilize existing G&G data from existing or abandoned wells, available seismic surveys, and existing core samples to conduct prospective storage resource assessments. These projects have identified offshore sites with the potential to store at least 30 million metric tons (MMT) of CO_2 and are preliminary steps to identify regions of interest for offshore carbon storage projects (NETL, No Date). Once a site is identified and leased, carbon storage projects would likely require building infrastructure including the drilling of CO_2 injection wells and construction of a pipeline to transport CO_2 from the shore (BOEM, 2019b; Cameron et al., 2018). Following preliminary G&G surveys, offshore carbon storage projects would likely involve seafloor disturbance including drilling carbon injection wells, anchoring, and constructing structures and pipelines to shore. The operation of an offshore carbon storage project would include the capture of CO_2 emissions and transport via submarine pipeline to injection wells; however, within the next several years these projects are unlikely to progress beyond the initial G&G surveying phase (BOEM, 2019b).

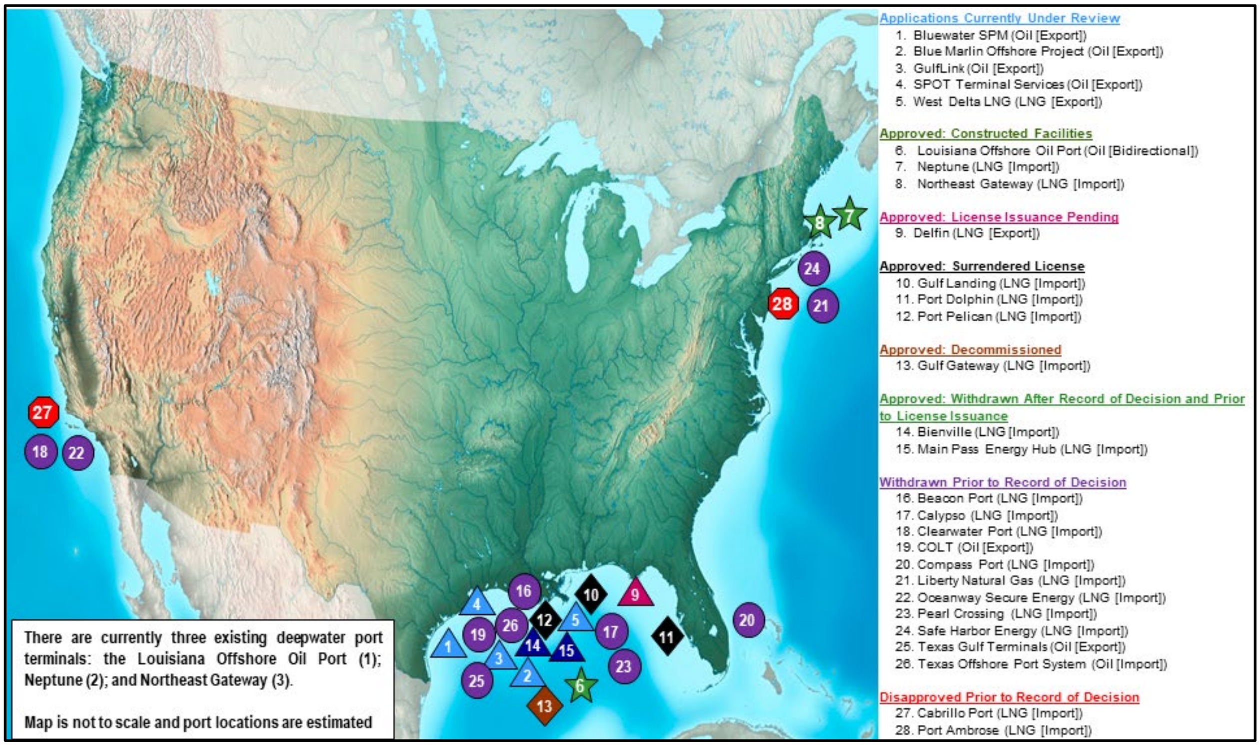
Impact causing factors associated with offshore carbon storage resource assessments would likely include vessel presence, vessel and equipment noise, impacts to the water column, potential accidental discharges, and air emissions. Offshore carbon storage resource assessments would likely contribute cumulative impacts to habitats; marine mammals; sea turtles; fish; aquatic macroinvertebrates; EFH; seabirds, shorebirds and coastal birds, and waterfowl; socioeconomic resources; and Environmental Justice.

4.1.8 Construction and Operation of Offshore Liquified Natural Gas (LNG) Terminals

Liquefied natural gas (LNG) is a form of natural gas that has been cooled down so that it has a reduced volume (only $1/600^{th}$ of its gaseous state) such that it can be more readily transported across the ocean via specialized ships (EIA, 2022a). At terminals on the coasts, the liquid is re-gasified and distributed via pipeline networks. LNG is imported to and exported from the U.S. through both offshore and onshore terminals. Licensing of offshore LNG terminals (deepwater ports) is under the jurisdiction of the U.S. Coast Guard (USCG) and the Maritime Administration (MARAD) (BOEM, 2014a).

The design and construction activities required to build new offshore LNG terminals varies depending on the capacity needed and location of the terminal. New LNG terminals use existing infrastructure if possible or require the construction of new infrastructure such as platforms and underwater pipelines and cables (CEE, 2006). To ensure the stability of these structures, the company constructing the LNG facility typically conducts G&G surveys of the area to determine if the seabed is suitable for such infrastructure installations. These preliminary G&G surveys are described above in Section 4.1.1. Following these preliminary surveys, LNG projects generally involve three phases: construction and installation, operation, and decommissioning (BOEM, 2019b).

There are currently three operational facilities: Louisiana Offshore Oil Port and Neptune and Northeast Gateway, which are both located offshore Massachusetts. Other deepwater port license and application statuses located around the continental U.S. are shown in **Figure 4.1-8** below (MARAD, 2021). In addition to the ports shown in the figure below, there are LNG ports and interests in Alaska including the Kenai LNG Terminal and the Alaska LNG Project (North Slope Borough).



Source: Adapted from MARAD Deepwater Port Licensing Program Map (MARAD, 2021)

Figure 4.1-8. Deepwater Port Location and Status Map

Overall, activities pertaining to the operation and construction of offshore LNG terminals are expected to continue at current levels or increase over the next several years in the Greater Atlantic, Southeast, and West Coast regions of the action area. The impact causing factors associated with the construction and installation of LNG terminals would involve seafloor disturbance for construction, vessel presence, vessel and equipment noise, impacts to the water column, potential accidental discharges, and air emissions. Similarly, the operation of LNG terminals would include vessel presence, vessel and equipment noise, impacts to the water column, potential accidental discharges, and air emissions. The decommissioning of LNG facilities may include demolition activities and structure removal (BOEM, 2019b). The construction and operation of offshore LNG terminals would likely contribute cumulative impacts related to all the resources considered in this Final PEIS.

4.1.9 National Defense and Homeland Security Activities

The U.S. Navy, USCG, U.S. Customs and Border Protection, U.S. Air Force, U.S. Marine Corps, and U.S. Army conduct operations and training exercises within the EEZ to ensure national security (NOS, 2016; NMFS, 2019d). Operations that are not compatible with commercial or recreational transportation are confined to Operating Areas (OPAREAs) away from commercially used waterways and/or inside Special Use Airspace (U.S. Fleet Forces, 2009). Military activities can include fleet training and testing, submarine and anti-submarine training, gunnery exercises, launch activities, missile training, and other training activities. These activities can involve the deployment of surface and subsurface vessels from small craft to large ships, high speed pursuits, live fire actions, underway refueling, and vessel anchoring (NOS, 2016). In addition to these activities, the Navy uses Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar systems, Mid-Frequency Active Sonar (MFAS), and High-Frequency Active Sonar (HFAS) for training and testing activities.

SURTASS LFA sonar systems are long-range sensors that transmit in the low frequency band (i.e., below 1 kHz). The two basic types of sonar used in the SURTASS LFA sonar system are passive and active sonar. Passive sonar detects sound created by a source and active sonar detects objects by creating a sound pulse that is transmitted through the water, reflects off a target object, and returns in the form of an echo to be detected. The Navy plans to upgrade SURTASS LFA sonar systems to a more compact LFA (CLFA) system that has a transmission frequency between 100 to 500 Hz; however, the operational characteristics and environmental impacts are expected to remain the same. The typical LFA sonar signal is not a constant tone but rather a series of sound transmissions referred to as a "wavetrain," lasting on average 60 seconds with 6 to 15 minutes between wavetrains. Hydrophones on the vessel then detect the returning echoes from submerged objects. The Navy plans to increase the annual number of LFA sonar transmission hours from 496 to 592 hours within the next five years and expects to continue operating at this higher level into the foreseeable future. Prior to 2018, the Navy used SURTASS LFA sonar in the non-polar areas of the Atlantic, Pacific, and Indian oceans and the Mediterranean Sea. The Navy currently uses SURTASS LFA sonar in the western and central North Pacific and eastern Indian oceans, overlapping with the Pacific Island region of the action area (Navy, 2018b).

Similar to LFA sonar, the Navy uses MFAS and HFAS emit non-impulsive sound waves to detect objects, safely navigate, and communicate. MFAS transmits sound at frequencies between 1 kHz and 10 kHz. MFAS is the Navy's primary tool for detecting and identifying submarines. HFAS transmits sound at frequencies between 10 kHz and 100 kHz. HFAS has a small effective range, but provides higher resolution of objects and is able to detect smaller objects. Active sonar is rarely used continuously during training and testing activities and operates using a low duty cycle when in use. Training activities that use sonar typically employ several hours to hundreds of hours of sonar use per exercise. These sources are expected to continue to be used in training and testing activities throughout the action area (Navy, 2015; Navy, 2018a).

A summary of national defense and homeland security projects that have required incidental take authorizations from NMFS is presented below in **Table 4.1-8** as a representative, not exhaustive, list of projects. Projects with an active take authorization status and projects with a take authorization application in-process are considered reasonably foreseeable to occur within the next five years and are categorized as ongoing activities. Projects that have been granted the requested take authorizations that have expired within the past 10 years are considered activities that have occurred within the past 10 years. Although projects that require take authorization are not of the only projects occurring in the action area, they are used as a representative list because projects that require take authorization are expected to be the projects with the greatest impact.

Table 4.1-8. Representative List of National Defense and Homeland Security Projects within the Action Area

Military Branch	General Location/ Geographic Scope	Project/Permit Description
Greater Atlantic Region		
Activities within the Past 10 years		
U.S. Navy	Eastern seaboard and PR, USVI	Atlantic Fleet Training and Testing (AFTT)
	North East Atlantic	Operations of SURTASS low frequency active sonar
Southeast Region		
Ongoing Activities		
U.S. Air Force	Gulf of Mexico	Testing and training activities in the Eglin Gulf Test and Training Range (EGTTR)
U.S. Marine Corps	Brandt island, Pamlico Sound, NC	Training activities in Pamlico Sound, NC
	Piney island, Pamlico Sound, NC	Training activities in Pamlico Sound, NC
U.S. Navy	Eastern seaboard and PR, USVI	Atlantic Fleet Training and Testing (AFTT)
	Gulf of Mexico	Atlantic Fleet Training and Testing (AFTT)
	Camp Lejeune, NC	Joint logistics over-the-shore training in VA and NC
	Fort Story, VA	Joint logistics over-the-shore training in VA and NC
	Little Creek, VA	Joint logistics over-the-shore training in VA and NC
	Eastern Indian Ocean	Operations of SURTASS low frequency active sonar
Activities within the Past 10 years		
U.S. Air Force	Eglin AFB, FL	Eglin AFB gunnery exercises, FL
	Eglin AFB, FL	Eglin AFB NEODS training operations
	Eglin AFB, FL	Eglin AFB precision strike weapons and air-to-surface gunnery exercises, FL
	Eglin AFB, FL	Maritime strike operations at Eglin AFB, FL
	FL panhandle	Maritime weapon systems evaluation program (WSEP) near FL panhandle
	offshore FL	Maritime weapons systems evaluation program, offshore FL
	offshore FL	Maritime weapons systems evaluation program, offshore FL
U.S. Marine Corps	Brandt island, Pamlico Sound, NC	Training activities in Pamlico Sound, NC
	Piney island, Pamlico Sound, NC	Training activities in Pamlico Sound, NC
U.S. Navy	Gulf of Mexico	Atlantic Fleet Training and Testing (AFTT)
	Cherry Point, NC	Cherry Point (CHPT) range complex mission activities, NC

Military Branch	General Location/ Geographic Scope	Project/Permit Description
	Corpus Christi OPAREA	Gulf of Mexico (GOMEX) range complex training exercises
	Pensacola OPAREA	Gulf of Mexico (GOMEX) range complex training exercises
	Jacksonville, FL	Jacksonville range complex, FL
	Jacksonville, FL	Jacksonville range complex, FL
	Panama City, FL	Naval Surface Warfare Center Panama City, FL
	South West Atlantic	Operations of SURTASS low frequency active sonar
	Panama City test range, FL	Testing mine reconnaissance sonar system at Panama City test range, FL
	Virginia capes, VA	Virginia capes (VACAPES) range complex, VA
West Coast Region		
Ongoing Activities		
U.S. Air Force	North sites Vandenburg AFB, CA	Vandenberg AFB launch activities, CA
	South sites Vandenburg AFB, CA	Vandenberg AFB launch activities, CA
U.S. Navy	Southern California Range Complex	Hawai'i Southern California Training and Testing (HSTT)
	San Nicolas Island, CA	Missile launches from San Nicolas Island, CA
	Pacific Northwest	Northwest training and testing activities (NWTT)
	North Pacific	Operations of SURTASS low frequency active sonar
Activities within the Past 10 years		
U.S. Air Force	North sites Vandenburg AFB, CA	Vandenberg AFB launch and harbor maintenance activities, CA
	South sites Vandenburg AFB, CA	Vandenberg AFB launch and harbor maintenance activities, CA
	Vandenburg AFB, CA	Vandenburg AFB space launch vehicle and missile operations, CA
U.S. Navy	Southern California Range Complex	Hawai'i Southern California Training and Testing (HSTT)
	Dabob Bay, WA	Keyport range complex expansion and activities, WA
	Keyport, WA	Keyport range complex expansion and activities, WA
	Quinault site, coastal WA	Keyport range complex expansion and activities, WA
	San Nicolas Island, CA	Missile launches from San Nicolas Island, CA
	North Pacific	Operations of SURTASS low frequency active sonar
	Western Pacific	Operations of SURTASS low frequency active sonar
	San Diego Bay, CA	Silver Strand Training Complex exercises near San Diego Bay, CA
	Northwest Training Range Complex	Training in the Northwest Training Range Complex (NWTRC)
	Silver Strand Training Complex, CA	Training in the Silver Strand Training Complex, CA

Military Branch	General Location/ Geographic Scope	Project/Permit Description
	Ports of LA/Long Beach, CA	West Coast civilian port defense activities
Alaska Region		
Ongoing Activities		
U.S. Navy	Gulf of Alaska	Training activities in the Gulf of Alaska temporary maritime activities area
Activities within the Past 10 years		
U.S. Navy	Beaufort Sea, Arctic Ocean	2018 IceX
	Gulf of Alaska	Training activities in the Gulf of Alaska temporary maritime activities area
Pacific Island Region		
Ongoing Activities		
U.S. Air Force	Kauai, HI	Weapon Systems Evaluation Program
U.S. Navy	Hawai’i Range Complex	Hawai’i Southern California Training and Testing (HSTT)
	Mariana Islands	Mariana Islands Training and Testing (MITT)
	Central Pacific	Operations of SURTASS low frequency active sonar
Activities within the Past 10 years		
U.S. Air Force	Kauai, HI	Long Range Strike Weapon Systems Evaluation Program
U.S. Navy	Hawai’i	Hawai’i range complex
	Hawai’i Range Complex	Hawai’i Southern California Training and Testing (HSTT)
	South Pacific	Operations of SURTASS low frequency active sonar
	Mariana Islands Range Complex	Training in the Mariana Islands Range Complex (MIRC)

Source: NMFS, 2019d

AFB = Air Force Base; NEODS = Naval Explosive Ordnance Disposal School; SURTASS = Surveillance Towed Array Sensor System

Impact causing factors associated with national defense and homeland security activities would likely include the use of active underwater acoustic sources, the use of explosives, seafloor disturbance, dredging, vessel presence, vessel and equipment noise, impacts to the water column, potential accidental discharges, and air emissions (BOEM, 2019b). Prior to testing and training activities, the Navy issues notices to mariners and will clear the ocean range; therefore, it is unlikely that impact causing factors from the majority of these activities will overlap with those of other cumulative actions considered or NOS activities. NOS will coordinate with the Navy to ensure that surveys would not occur on or near ranges during exercises. Overall, national defense and homeland security activities are expected to increase above the present level due to the ongoing and planned programs, and would likely contribute to cumulative impacts for habitats; marine mammals; sea turtles; fish; aquatic macroinvertebrates; EFH; seabirds, shorebirds and coastal birds, and waterfowl; and Environmental Justice.

4.1.10 Construction of New Submarine Telecommunication Cable Infrastructure

Submarine cables play a critical role in global interconnected networks, carrying about 99 percent of international communications traffic. Sharp growth in demand for data, fueled by bandwidth-intensive applications such as video and a proliferation of cloud-based services, has driven a considerable increase in global submarine cable deployments (Brake, 2019). The U.S.'s existing submarine cable infrastructure is already substantial and is concentrated along coastal urban centers such as New York City, Washington D.C., and San Francisco where demand on communication networks is larger; however, new cable infrastructure is needed to support growing capacity demand throughout the action area. Submarine cables typically have a 25-year lifespan, so the replacement and repair of existing cables is also expected in the next several years as current cables reach the end of their effective lifespan or become obsolete. Within the EEZ, installing or laying telecommunication cable infrastructure involves coordination with the Federal Communications Commission (FCC), USACE, and NOAA. Depending on the particular project and route characteristics, construction and maintenance of submarine cable infrastructure may include surveys of proposed cable routes; the use of specialized vessels, equipment, and divers to lay the cable; the use of equipment to bury the cable; construction of connection to onshore systems; and operation and maintenance of the cables (BOEM, 2019b).

Following preliminary G&G surveys of the cable route, the construction of new submarine telecommunication cable infrastructure generally involves the use of equipment to lay and bury the cables, the construction of a coastal landing station to connect the cables to onshore systems, maintenance and repairs, and eventual removal of cables. The impact producing factors associated with these activities include seafloor disturbance, vessel presence, vessel and equipment noise, impacts to the water column, potential accidental discharges, and air emissions (BOEM, 2019b). The construction of new submarine telecommunication cable infrastructure would likely contribute cumulative impacts related to habitats; marine mammals; sea turtles; fish; aquatic macroinvertebrates; EFH; seabirds, shorebirds and coastal birds, and waterfowl; cultural and historic resources; and Environmental Justice.

4.1.11 Commercial and Recreational Fishing

Commercial fishing is catching and selling fish and shellfish for profit, while recreational fishing is for sport or pleasure. The annual total landings, or poundage of fish, brought in by commercial fisheries has fluctuated between 4.3 and 4.4 billion kilograms (kgs) (9.4 and 9.6 billion pounds [lbs]) from 2011 to 2018. Alaska contributes the most to commercial fisheries, accounting for 58 percent of landings in 2018, followed by the Gulf of Mexico (16 percent), Atlantic (14 percent), Pacific (12 percent) and Hawai'i and the Great Lakes (less than 1 percent each) (NMFS, 2020). Over the past decade, while the amount of wild-caught seafood has remained relatively consistent from year to year, the amount raised through aquaculture has increased, though it is still less than 10 percent of the wild harvest by weight. National marine aquaculture production increased an average of 3.3 percent per year from 2009-2014 and in 2017, freshwater and marine aquaculture production was 284 million kgs (626 million lbs) (NMFS, No Date-i; NMFS, 2020). Most marine aquaculture production consists of oysters, clams, salmon, mussels, and shrimp. In addition to contributing to the seafood industry, aquaculture is also a tool to restore habitats and species. Hatchery stock is used to rebuild oyster reefs, grow wild fish populations, and rebuild threatened and endangered abalone and corals (NMFS, No Date-i).

Recreational fishing includes fishing from private/rental boats, party/charter boats, and onshore (e.g., a dock or the shore). In 2018, recreational fishers took approximately 194 million saltwater fishing trips, with 55 percent in estuaries, 35 percent in state territorial seas, and 10 percent in the U.S. EEZ. Of the 163 million kgs (359 million lbs) of harvested fish, the majority were from the Atlantic (60 percent) and Gulf of

Mexico (37 percent) (NMFS, 2020). All saltwater recreational fishing together harvested about 1/30th the combined catch (by weight) of commercial fishing in 2018.

Commercial and recreational fishing activities directly impact fishery stocks and indirectly impact seabirds and marine mammals that prey and depend on fishery stocks. Additionally, commercial and recreational fishing contribute to overall vessel traffic in the action area and therefore, the cumulative noise in the ocean. Over the 5-year project period, the amount of commercial and recreational fishing in the action area is expected to remain the same or increase. Impact causing factors associated with commercial and recreational fishing include seafloor disturbance, dredging, vessel presence, vessel and equipment noise, impacts to the water column, potential accidental discharges, and air emissions (BOEM, 2019b). Commercial and recreational fishing would likely contribute cumulative impacts related to habitats; marine mammals; sea turtles; fish; aquatic macroinvertebrates; EFH; seabirds, shorebirds and coastal birds, and waterfowl; cultural and historic resources; and Environmental Justice.

4.1.12 Coastal Development

Coastal development includes the construction, maintenance, renovation, and removal of infrastructure such as piers, lighthouses, shipping ports and storage facilities, harbors, dams, bridges, roads, buildings, and other structures to support increased levels of safe navigation, tourism, and residential, commercial, and industrial land uses. While coastal construction is concentrated along urban centers, it is expected to occur throughout the U.S. coastline in all regions of the action area. The expected increase in marine traffic, fishing operations, and offshore energy development would increase the use of existing coastal infrastructure and increase demand for the construction of new infrastructure and port facilities (BOEM, 2019b). Due to their potential impact to marine mammals, coastal construction projects require incidental take authorizations granted by NMFS under the MMPA (NMFS, 2019d). A summary of these projects is presented below in **Table 4.1-9** as a representative, not exhaustive, list of coastal development projects. Projects with an active take authorization status and projects with a take authorization application in-process are considered reasonably foreseeable to occur within the next five years and are categorized as ongoing activities. Projects that have been granted the requested take authorizations that have expired within the past 10 years are considered activities that have occurred within the past 10 years. Although projects that require take authorization are not of the only projects occurring in the action area, they are used as a representative list because projects that require take authorization are expected to be the projects with the greatest impact.

Table 4.1-9. Representative List of Coastal Development Projects within the Action Area

General Location/ Geographic Scope	Project Lead	Project/Permit Description
Greater Atlantic Region		
Ongoing Activities		
Off NY and NJ	Transcontinental Gas Pipe Line Company, LLC	Construction Activities for Raritan Bay Pipeline
New London, CT	U.S. Navy	Dock construction project
Kittery, ME	U.S. Navy	Dock expansion project
Activities within the Past 10 years		
DE and NJ	Bluewater Wind, LLC	Meteorological tower installation

General Location/ Geographic Scope	Project Lead	Project/Permit Description
Atlantic City windfarm, NJ	Fishermen's Atlantic City Windfarm, LLC	Pile placement
Eastport, ME	Maine DOT	Pier and breakwater replacement project
Kittery, ME	U.S. Navy	Waterfront improvement project
Southeast Region		
Ongoing Activities		
Tampa Bay, FL	USACE	Tampa Harbor Bay Big Bend Channel expansion
Jacksonville, FL	U.S. Navy	South Quay Wall recapitalization project
Kings Bay, GA	U.S. Navy	Submarine base waterfront construction
Activities within the Past 10 years		
Port of Miami, FL	USACE	Blasting operations
Chesapeake Bay entrance	Chesapeake Tunnel Joint Venture	Parallel Thimble Shoal Tunnel Project
Jacksonville, FL	U.S. Navy	Wharf maintenance project
West Coast Region		
Ongoing Activities		
Coos Bay, OR	USACE	North Jetty Maintenance and Repairs Project
Santa Cruz, CA	Caltrans	Murray Street Bridge seismic retrofit project
CA	Carnival Corp, City of Alameda, San Francisco Bay Area Water Emergency Transportation Authority, and Port of San Francisco	Three ferry and cruise terminal improvement and construction projects
Richmond, CA	Chevron	Wharf maintenance project
Kalama, WA	Port of Kalama	Proposed construction activities
Sant Cruz, CA	Sant Cruz Port District	Aldo's Seawall Replacement Project
Jenner, CA	Sonoma County Water Agency	Estuary Management Activities
Columbia River	USACE	Jetty System Rehabilitation, King Pile Markers Project, and Sand Island Pile Dike Test Project
Seal Beach, CA	U.S. Navy	Construction of Pier and Turning Basin
Puget Sound, WA	U.S. Navy	Structure maintenance and pile replacement
Bangor, WA	U.S. Navy	Pier extension project
Bremerton, WA	WA DOT	Dolphin Relocation project
WA	WA DOT	Two multimodal construction projects
Aberdeen, WA	WA DOT	US 101/Chehalis River Bridge-Scour Repair
Activities within the Past 10 years		
Columbia River	USACE	Jetty rehabilitation
San Francisco, CA	USACE	Pier 36/ Brannan Street wharf project

General Location/ Geographic Scope	Project Lead	Project/Permit Description
Newport, OR	Bergerson Construction, Inc.	Front Street transload facility construction
Elkhorn Slough, Monterey, CA	California Dept of Fish and Wildlife	Tidal marsh restoration project
San Francisco, CA	Caltrans	Bridge construction and demolition and seismic safety tests
Trinidad Pier, CA	Cher-Ae Heights Indian Community	Pile-driving and renovation operations
Carpinteria, CA	Chevron	Casitas Pier Fender Pile Replacement Project
Richmond, CA	Chevron	Wharf Maintenance project
WA	City of Astoria and Kitsap Transit	Two dock construction and expansion projects
Monterey County, CA	NOAA Restoration Center	Parsons slough project
Friday Harbor, WA	Port of Friday Harbor	Marina reconstruction project
Kalama, WA	Port of Kalama	Proposed construction activities
San Francisco Bay, CA	Port of San Francisco	Activities for the America's Cup
Port of Vancouver, WA	Port of Vancouver	Port of Vancouver, WA
San Diego, CA	San Diego	Construction and demolition activities and Coast Blvd sidewalk Improvements
CA	San Francisco Bay Area Water Emergency Transportation Authority	Three ferry terminal expansion and reconstruction projects and Central Bay operations and maintenance project
Seattle, WA	Seattle DOT	Seawall and pier restoration projects
Russian River estuary	Sonoma County Water Agency	Estuary management project
San Francisco, CA	The Exploratorium	Exploratorium relocation
Monterey, CA	USCG	USCG Monterey Waterfront Improvement Project
Naval Base Kitsap, WA	U.S. Navy	Naval Base Kitsap Bangor pile replacement program, test pile program, and wharf construction project.
WA	U.S. Navy	Three pier maintenance projects
San Diego, CA	U.S. Navy	Naval Base Point Loma fuel pier replacement project
San Nicolas Island, CA	U.S. Navy	County Roads and Airfield Repairs Project
Vandenburg AFB, CA	United Launch Alliance	Harbor activities related to the Delta IV/EEL vehicle
Aberdeen, WA	WA DOT	Chehalis River Bridge Repair
Woodard Bay, WA	WA Dept of Natural Resources	Restoration activities
Anacortes, WA	WA DOT	Anacortes tie-up slips replacement

General Location/ Geographic Scope	Project Lead	Project/Permit Description
WA	WA DOT	Dolphin Relocation project and wingwall replacement project
Whidbey Island, WA	WA DOT	Coupeville timber towers preservation project
Manette Bridge, WA	WA DOT	Manette Bridge replacement project
WA	WA DOT	Four multi-modal construction projects
WA	WA DOT	Two ferry terminals construction projects
Vashon Island, WA	WA DOT	Vashon Ferry Terminal trestle seismic project
WA	WA Ferries	Span replacement project
Alaska Region		
Ongoing Activities		
AK	Alaska DOT	Four ferry terminal construction projects
AK	Alaska DOT, Federal Aviation Administration (FAA), Skagway, AK, and White Pass and Yukon Route	Five dock construction, replacement, and expansion projects
AK	Donlin Gold, LLC	Gold mining and marine barging in coastal waters
Ketchikan, AK	City of Ketchikan	Removal of Berth II Rock Pinnacles
Hoonah, AK	Duck Point Development II, LLC	Cruise Ship Berth Construction
Juneau, AK	Jim Erickson	Erickson residence marine access project
Juneau, AK	Juneau	Three harbor and waterfront projects
Sitka, AK	Sitka Alaska	Lightering float pile replacement project
Activities within the Past 10 years		
AK	Alaska DOT and Huna Totem Co.	Four ferry terminal improvement projects
AK	City of Unalaska, UniSea, Inc., FAA, Sitka Alaska, and Ketchikan Dock Co	Five dock construction, replacement, and expansion projects
St. Paul Island, AK	NMFS Alaska Region	Repair of observation towers and walkways
Port of Anchorage	Port of Anchorage	Test pile program
Pacific Island Region		
Activities within the Past 10 years		
Honolulu, HI	Honolulu Seawater Air Conditioning, LLC	Honolulu seawater air conditioning project, HI

Source: NMFS, 2019d

DOT = Department of Transportation; USACE = U.S. Army Corps of Engineers; USCG = U.S. Coast Guard

Impact causing factors associated with coastal construction include seafloor disturbance, vessel presence, vessel and equipment noise, impacts to the water column, potential accidental discharges, and air emissions (BOEM, 2019b). Coastal construction would likely contribute cumulative impacts related to habitats; marine mammals; sea turtles; fish; aquatic macroinvertebrates; EFH; and seabirds, shorebirds and coastal birds, and waterfowl.

4.2 Cumulative Effects on the Environment

As described in Section 4.1, NOS is considering actions taking place in the action area during a 17-year period from 2010 to 2027 in the assessment of cumulative effects. The following sections analyze the cumulative impacts for each resource covered in Chapter 3. The analysis first summarizes the cumulative effects of the cumulative actions identified in 4.1, then considers how the NOS-related incremental impacts of Alternatives A, B, and C, when added to or acting synergistically with the cumulative effects of other past, present, and reasonably foreseeable future actions, would contribute to overall cumulative impacts. The analysis of cumulative effects also considers other human actions and activities that contribute to the existing condition of coastal habitats, including encroachment from onshore, nearshore, and offshore development (e.g., coastal population growth, light pollution); flows and runoff of pollutants into coastal waters from onshore land uses, including urban, residential, industrial, and agricultural; and accidental or illicit discharges of oil, fuel, chemicals, or waste.

4.2.1 Habitats

All past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects to habitats. The following section addresses habitats in general, but discussion of cumulative impacts on habitats for other more specific resources may be found in these other sections of this chapter: 4.2.2.4 (Marine Mammals), 4.2.3.3 (Sea Turtles), 4.2.4.4 (Fish), 4.2.5.3 (Aquatic Macroinvertebrates), 4.2.6 (Essential Fish Habitat), and 4.2.7.3 (Sea Birds, Shorebirds and Coastal Birds, and Waterfowl).

The cumulative impacts in the following subsections are categorized by their relevance to the following essential characteristics of habitat:

- space needed for individual and population growth and normal behavior;
- food, water, air, light, minerals, and other nutritional or physiological requirements;
- cover or shelter requirements;
- sites needed for breeding, reproduction, or rearing of offspring.

4.2.1.1 Physical Impacts to Habitat Bottom Substrate

NOS activities under the Proposed Action including anchoring, collection of bottom grab samples, installation of tide gauges and remote global positioning system (GPS) reference systems, use of dropped/towed camera systems, and self-contained underwater breathing apparatus (SCUBA) operations could contribute to overall cumulative impacts associated with the presence and movement of vessels and construction, operation, and decommissioning of long-term installations (e.g., LNG terminals, energy infrastructure, and submarine telecommunications) on the bottom substrate throughout marine, freshwater, and estuarine areas in the action area. These cumulative impacts could reduce the availability of space, shelter, cover, and nutrients for dependent species.

The agitation of ocean, lake, or river bottom sediments during NOS projects and other cumulative actions requiring the presence and movement of crewed vessels or the construction, operation, and decommissioning of long-term installations could cumulatively reduce the availability of space, shelter, cover, and nutrients for dependent species throughout the action area by physically removing or altering underwater structure. Many cumulative actions requiring crewed vessel operations could also entail anchoring, collection of bottom samples, or trailing of camera systems and other equipment. Equipment, vessels, or displaced water from vessel wakes could potentially contact bottom substrate throughout the action area, removing or damaging underwater structures such as submerged vegetation, macroalgae, and coral reefs.

This reduction of underwater structure would reduce the shelter and cover necessary for the survival or offspring development of many marine and freshwater taxa, particularly those organisms at lower levels of the aquatic food chain, and could potentially reduce the overall aquatic biodiversity of the area through cascading trophic impacts (i.e., reduced prey availability reduces the abundance of higher-level predators). However, impacts from NOS activities to bottom substrates would be temporary and would be mitigated by avoiding repeated NOS surveys in the same location. For both NOS projects and other actions these impacts would be largely confined to the immediate vicinity of their source and would not likely appreciably impact the total amount of underwater structure within the action area. Long-term installations, including renewable or fossil fuel energy installations, could also damage underwater structural features and would likely cumulatively reduce the total amount of space available to dependent species for the lifetime of the installation. However, any potential reductions in space would be limited to the immediate vicinity of constructed manmade structures, which could also serve as settlement strata for many species of marine and freshwater macroinvertebrates and subsequently attract and retain organisms from higher levels of the aquatic food chain.

The majority of cumulative impacts on bottom substrates would be limited to the immediate vicinity of vessels, trailed equipment, or onshore, nearshore, and offshore renewable and fossil fuel energy development and would not likely cause long term changes in the availability of space, shelter, cover, or nutrients for dependent species outside of the range of natural variation. The above-described NOS effects can also occur in almost all human use of water. These effects would be indistinguishable in type from other human uses. Overall, aggregate cumulative bottom substrate impacts would occur regardless of the chosen alternative, would be short-term and long-term, and could result in **adverse** and **negligible** to **minor** impacts on habitat areas throughout the action area. The contribution to these aggregate, adverse cumulative impacts on bottom substrate from any of the three NOS alternatives would be **negligible**.

4.2.1.2 Increase in Sedimentation, Turbidity, and/or Chemical Contaminants in Habitats

Crewed vessel , ROV, and autonomous vehicle operations; anchoring; dropped/towed camera systems; collection of bottom grab samples; installation of tide gauges and remote GPS reference systems; and SCUBA operations under the Proposed Action could contribute to overall cumulative impacts associated with the presence and movement of vessels, construction, operation, and decommissioning of long-term installations (e.g., LNG terminals, energy infrastructure, and submarine telecommunications), coastal erosion resulting from climate change, and runoff from expanding coastal development in conjunction with coastal population growth. The result would be a cumulative increase in sedimentation, turbidity and the presence of chemical contaminants throughout marine, freshwater, and estuarine areas in the action area, reducing the availability of space, shelter, cover, and nutrients for dependent species.

The presence and movement of vessels and trailing equipment during both NOS projects and other cumulative actions, in conjunction with underwater construction activities, such as blasting and leveling, could potentially stir up bottom sediment, cumulatively increasing the level of sedimentation and turbidity within the action area. Rising sea levels as a result of climate change will also continually erode coastlines along the EEZ over the next five years and could further contribute to increased turbidity within these areas. High levels of sedimentation and turbidity can potentially cause direct respiratory damage to aquatic species and block sunlight necessary for photosynthesis by aquatic plants, macroalgae, and phytoplankton.

These impacts could cumulatively lower the overall nutrient availability or reduce the cover and structure available to dependent species from submerged vegetation or macroalgae within the action area. Furthermore, increases in sedimentation and turbidity reduce the penetration of sunlight through the water column, which changes the wavelengths of light reaching fish and benthic species. Photosynthetic marine species are dependent on sunlight and often have a narrow band of wavelengths of light that they are able to use; increased sedimentation and turbidity could cumulatively hinder or prohibit photosynthesis in oceanic habitat areas, reducing nutrient cycling and primary production by marine phytoplankton and reducing shelter and cover provided by submerged plants and macroalgae. Suspended material may also react with DO in the water and result in temporary or short-term oxygen depletion to aquatic resources, including vegetation and aquatic macroinvertebrates, and could further exacerbate impacts to habitat areas from reduced nutrient and cover availability.

During both NOS projects and other cumulative actions, the presence and movement of vessels, construction and presence of long-term renewable or fossil fuel energy installations could cumulatively increase the concentration of contaminants within the water column when considered in tandem with current agricultural or urban runoff from onshore commercial development in conjunction with coastal population growth and accidental or illicit discharges of oil, fuel, or chemical contaminants. The magnitude of the majority of these impacts is contingent on the size, location, and chemical composition of the source discharge or spill. The majority of contaminants, including oil and fuel, currently entering the aquatic environment are less dense than water and float on the surface until they evaporate, typically within several days. Floating contaminants typically do not affect habitat characteristics below the surface of the water, however contaminants introduced to shallow marine habitat areas harm seagrass ecosystems close to the water surface and could potentially cause extensive mortality of the seabed and reduce the available cover and shelter that many marine species require to avoid predation, reproduce, and rear or develop offspring.

Additionally, seagrass mortality reduces the nutrient availability for seagrass foragers in these areas, including echinoderms, fish, manatees, and sea turtles. Chemical contaminants also cling or adhere to structural features in all aquatic habitat areas, which serve as additional exposure vectors to fish and aquatic macroinvertebrates and result in changes in growth rates or behavior, injuries, and death of exposed individuals. Coastal runoff includes chemical contaminants such as fertilizers or detergents with high levels of nitrates and phosphates. Influxes of nutrients or chemicals in shallow marine, estuarine, and coastal wetland habitat areas elicit algal blooms, which often are toxic for many marine species and reduce DO concentrations as dying algae are oxidized, thereby reducing the overall habitat quality of the affected area. Denser contaminants sink below the surface of the water and negatively impact coral colonies in shallow marine habitat areas through mortality, tissue death, reduced growth, impaired reproduction, bleaching, and reduced photosynthetic rates. Ongoing reduction of coral coverage reduces the structure and shelter necessary for prey species and will continue to reduce the overall biodiversity of affected areas through cascading impacts throughout the food chain. Bioaccumulation of some toxic chemicals also disproportionately impacts higher level predators which consume contaminated prey items and ultimately reduces top-down ecosystem regulation and nutrient availability of affected habitat areas.

Overall, increased sedimentation, turbidity, and chemical contamination within the action area would predominantly be dissipated by prevailing currents or winds in seconds to minutes. Temporary reductions in water quality are not expected to cumulatively reduce the availability of space, shelter/cover, nutrients, or breeding/rearing grounds in any of the habitat types found throughout the action area outside the range of natural variability. It is also an NOS practice to generally avoid repeated NOS surveys in the same location, thereby mitigating impacts of increased sedimentation, turbidity, and chemical contamination within the action area. The above-described NOS effects can also occur in almost all human use of water. These effects would be indistinguishable in type from other human uses. Overall, aggregate cumulative impacts to all aquatic habitat areas from increased sedimentation, turbidity, and/or chemical contamination would be **adverse** and **negligible** to **minor** in magnitude. The contribution to these aggregate, adverse cumulative impacts from any of the three NOS alternatives would be **negligible**.

4.2.1.3 Increased Ambient Sound Levels in Habitats

Crewed vessel, remotely operated vehicle (ROV), and autonomous vehicle operations and the use of echo sounders, acoustic communications systems and ADCPs under the Proposed Action, could contribute to overall cumulative impacts on ambient sound levels associated with the presence and movement of vessels, other surveying and mapping activities, and construction, operation, and decommissioning of long-term installations (e.g., LNG terminals, energy infrastructure, and submarine telecommunications). These could result in a cumulative increase in the ambient sound environment throughout marine, freshwater, and estuarine areas in the action area, reducing the availability of space, shelter, cover, and nutrients for dependent species.

Crewed vessel, ROV, and autonomous vehicle operations from both NOS projects and other actions and underwater construction activities in support of long-term installations, would generate underwater sound and vibrations at low- to mid-frequencies that overlap with the hearing ranges of many aquatic prey species. Increases in the ambient sound level of aquatic habitat areas could potentially reduce the habitat quality of preferred feeding or breeding grounds and displace disturbed animals from these areas. Increased ambient sound can also mask biologically important sounds which elicit predator-avoidance or mating behaviors, cause hearing loss, and/or generally have an adverse effect on an organism's stress levels and immune system. Reduction of prey species would reduce food and nutrient availability for top-level predators in aquatic habitat areas and could potentially result in cascading impacts throughout the local aquatic food chain and reduced biodiversity. However, crewed vessel transits would be infrequent in any given area and the exposure of prey species to vessel sound would be limited to the immediate vicinity of vessels and would only persist for the duration of vessel transit through the habitat area. The cumulative contribution to background sound in the ocean from vessels operated by NOS would not be substantial and the exposure of prey species to these sounds at the levels and lengths of time that may cause anything other than minimal adverse effects would be unlikely. NOS sound sources would be localized and short term and would not likely overlap with other sound sources.

The use of active underwater acoustic sources in other surveying mapping activities, national defense and homeland security activities, and oil, gas, carbon storage, or renewable energy assessments would involve directional and brief repeated signals which could cumulatively increase the ambient sound environment of aquatic habitat areas. Although the active underwater acoustic sources used by NOS described in Chapter 2 would not be perceptible to most marine prey species, other active underwater acoustic sources commonly used in support of cumulative actions have a greater propensity to injure marine prey due to the high intensity and large-scale propagation of the broadband sound they produce. These high intensity sources, including airguns, could have a more substantial impact on habitat areas than the NOS sources described in Section 3.4, especially when considered cumulatively. Exposure of marine prey to this sound could result in the same adverse impacts to the aquatic food chain as those discussed in the preceding paragraph. However, active underwater acoustic sources used by NOS are typically only operated while a ship is in motion and habitat areas would only be exposed to emitted acoustic energy for a very short duration. Furthermore, these sources are highly directional in nature, and the energy of their emitted acoustic signals would drop off rapidly with distance from the source. Therefore, impacts on marine prey species would be predominantly limited to temporary behavioral and stress-startle response, and the likely cumulative impact on the overall habitat quality would be negligible to minor in any given area.

Sound from vessel operations (both NOS and other) and underwater construction activities from other actions, which would generate sounds in the mid- and low-level frequencies, are within the hearing range of most prey species but would be infrequent, geographically widely distributed, and likely to cumulatively elicit a minimal or temporary response. It is also an NOS practice to generally avoid repeated surveys by NOS in the same location, thereby mitigating increased ambient sound levels within the action area. A majority of the sounds generated by underwater acoustic sources are well above the hearing frequencies of the most prey species, thus they are unlikely to cause cumulative behavioral disturbance and hearing impairment. Increased ambient sound levels throughout the action area would not likely cause cumulative long-term changes in the availability of space, shelter, cover, or nutrients for dependent species outside of the range of natural variation. The above-described NOS effects can also occur in almost all human use of water. These effects would be indistinguishable in type from other human uses. Overall, the cumulative impact of increased ambient sound levels throughout the action area would be **adverse** and **negligible** to **minor** in magnitude. The contribution to these aggregate, adverse cumulative impacts on ambient underwater sound levels from any of the three NOS alternatives would be **negligible**.

4.2.1.4 Facilitated Dispersal of Invasive Species in Habitats

All activities under the Proposed Action which entail the use of the same physical equipment and instruments in geographically disparate regions (e.g., crewed vessel, ROV, and autonomous vehicle operations; anchoring; and the use of echo sounders), could contribute to cumulative impacts from all actions detailed in Section 4.1 in conjunction with ongoing climate change. Cumulatively, they could facilitate the dispersal of invasive species throughout marine, freshwater, and estuarine areas in the action area, reducing the availability of space, shelter, cover, and nutrients for dependent endemic species.

Cumulative actions from both NOS and other entities would occur in all freshwater and marine regions of the action area and could involve transit and surveying across large swaths of the action area using the same physical equipment and survey instrumentation. These larger voyages or projects could potentially inadvertently transport invasive macroinvertebrate larvae, vertebrate eggs or animals, plant seeds, or algae propagules in ballast water or on equipment surfaces to novel areas, thereby facilitating their dispersal and establishment. Invasive species often have large numbers of offspring and limited or no natural threats or predators outside of their native habitat, allowing them to outcompete locally endemic species for space and nutrients.

Over time, invasive species could propagate far beyond the initial site of establishment, which could cumulatively result in cascading impacts to the local food chains through the extirpation of local predators and prey due to reduced nutrient cycling and availability. These impacts would cumulatively change habitat structure and reduce the habitat value of affected areas in the long-term or permanently after the establishment of invasives; these species and their resulting impacts would persist until all invasive organisms were removed from a given area through aggressive trapping, harvesting, or use of pesticides such as glyphosate. Global rising sea temperatures as a result of ongoing climate change could cumulatively exacerbate these impacts by shifting the distribution of ideal abiotic habitat conditions (e.g., water temperature or acidity) for endemic species. Invasive species typically have wider ranges of tolerability for abiotic environmental conditions, allowing them to withstand climate-related stresses and either outcompete less tolerant endemic species or establish themselves in habitat areas vacated by endemic species dispersed by altered abiotic environmental conditions.

Physical equipment and instruments used in consecutive projects in disparate geographically regions could potentially serve as transmission vectors for invasive species, which could cumulatively reduce the habitat value of their area of introduction by outcompeting endemic plants, animals, and algae. After establishment, cumulative impacts could potentially spread beyond project areas and persist until invasive species are suppressed or removed from these areas via aggressive management techniques and procedures, reducing the availability of space, shelter, cover, or nutrients for dependent species outside of the range of natural variation. However, vessel crews on NOS projects would implement invasive species control procedures such as deballasting or equipment washing as required by law, reducing the likelihood of invasive propagation. It is also an NOS practice to generally avoid repeated surveys by NOS in the same location, thereby mitigating dispersal of invasive species within the action area. The above-described NOS effects can also occur in almost all human use of water. These effects would be indistinguishable in type from other human uses. Overall, given its relatively low likelihood of occurrence, the aggregate, **adverse** cumulative impact of invasive species dispersal would be **minor** to **moderate** in magnitude. The contribution to these aggregate, adverse cumulative impacts on invasive species dispersal from any of the three NOS alternatives would be **negligible**.

4.2.1.5 Impacts to the Water Column in Habitats

Crewed vessel, ROV, and autonomous vehicle operations; use of sound speed data collection equipment and bottom grab samplers; operation of drop/towed cameras and video systems; and SCUBA operations under the Proposed Action could contribute to cumulative impacts from the presence and movement of vessels associated with all cumulative actions, including raising and lowering of equipment, and construction, operation, and decommissioning of long-term installations (e.g., LNG terminals, energy infrastructure, and submarine telecommunications). In aggregate, these could cumulatively disturb the water column throughout marine, freshwater, and estuarine areas in the action area, reducing the availability of space, shelter, cover, and nutrients for dependent species.

Wakes from crewed vessels, ROVs, and autonomous vehicles used in support of other surveying and mapping activities; fossil fuel, renewable, or carbon storage assessments; homeland security activities; and expanded recreational boating and commercial fishing would create turbulence and generate wave and surge effects in the water column. This displacement of water could cumulatively disrupt important environmental gradients, including temperature, salinity, DO, turbidity, and nutrient supply. Propellers from vessels could also cause water column destratification and elevated water temperatures. Vessel movements through the water column could cumulatively disrupt benthic communities in shallow areas and other prey species and cause mortality to floating eggs and larvae by physically damaging them with the hull or other ship parts, including the propulsion system. These disruptions would likely reduce the availability of space, shelter, and nutrients for dependent species within oceanic and shallow marine habitat areas and could cumulatively disrupt food chains, ultimately reducing the overall biodiversity of the study area. However, the vast majority of cumulative disturbance impacts to habitat areas would be limited to the immediate vicinity of vessels, and would only persist for the duration of transit or survey activities within the affected area.

Instruments, gear, and personnel that interact with the water column, including anchors and chains, bottom sampling equipment, echo sounders, airguns, and fishing lines or nets could cumulatively disturb or displace nearby benthic communities and other prey species. Reduction of prey species would reduce food and nutrient availability for top-level predators in aquatic habitat areas and could potentially result in cascading impacts throughout the local aquatic food chain and reduced biodiversity. Lines connecting equipment to a vessel could also become entangled with, damage, or kill underwater structural habitat features such as seagrass or corals. Reduction of underwater structure would likely cumulatively reduce the space, shelter, and cover necessary for the avoidance of predators by prey species and the rearing or development of offspring. Additionally, the expansion of commercial or recreational fishing could disturb, entangle, or directly target aquatic predators and prey species, which could drastically cumulatively alter food chains and energy flows throughout the action area. However, the vast majority of cumulative disturbance impacts to habitat areas would be limited to the immediate vicinity of instruments, gear, or personnel and would only persist for the duration of the activity. Mobile species would likely only be minimally displaced from project areas and would not experience long-term changes in the availability of space, structure, shelter, or nutrients outside the range of natural variability.

Most of the cumulative disturbance and displacement impacts to the water column would still likely be limited to the immediate vicinity of the source and would not persist beyond the conclusion of a project. It is also an NOS practice to generally avoid repeated surveys by NOS in the same location, thereby mitigating increased disturbance and displacement impacts to the water column within the action area. The above-described NOS effects can also occur in almost all human use of water. These effects would be indistinguishable in type from other human uses. Overall, aggregate impacts of all actions described in Section 4.2.1.5 would not likely cause cumulative, long-term changes in the availability of space, shelter, cover, or nutrients for dependent species in habitat areas throughout the action area outside of the range of natural variation; thus, aggregate, **adverse** cumulative impacts would be considered **negligible** to **minor** in magnitude. The contribution of the NOS Proposed Action to these aggregate, adverse cumulative impacts from any of the three NOS alternatives would be **negligible**.

4.2.1.6 Impacts to Terrestrial Habitats

Installation of tide gauges and remote GPS reference systems under the Proposed Action could contribute to cumulative impacts on terrestrial habitats from construction, operation, and decommissioning of long-term installations (e.g., LNG terminals, energy infrastructure, and submarine telecommunications), coastal erosion resulting from climate change, and currently expanding coastal development in conjunction with coastal population growth. Cumulatively, these actions could degrade or reduce terrestrial habitat areas throughout the action area, reducing the availability of space, shelter, cover, and nutrients for dependent species.

The installation of or access to semi-permanent to permanent structures or equipment, such as LNG terminals, energy infrastructure, submarine telecommunications, and coastal commercial development, in conjunction with ongoing coastal erosion resulting from climate change could cumulatively reduce the quantity and quality of coastal terrestrial habitat throughout the action area. Many species of marine and terrestrial animals, including all Endangered Species Act (ESA)-listed bird species described in Section 3.10 and ESA-listed sea turtles, breed and nest along the coast. During onshore access or construction activities, vegetation in and adjacent to the project area could be trampled by foot traffic, damaged, or cleared, cumulatively reducing cover and shelter necessary for terrestrial or marine animals to avoid predation, breed, and nurture offspring. Repeated disturbances could result in long-term changes in terrestrial prey distributions and could ultimately reduce the overall biodiversity of habitat areas due to reduced nutrient cycling and availability. Light pollution from these structures could also disorient terrestrial animals, further disrupting terrestrial and aquatic food chains within the area.

Similarly, ongoing coastal erosion and commercial and residential development of coastal areas will continue to encroach upon existing coastal terrestrial habitat areas in all directions, further cumulatively reducing the space available for terrestrial animals. However, the majority of NOS onshore installations would only occupy very small portions of terrestrial habitat and any affected terrestrial components would likely recover post-installation. Disturbances resulting from the accessing of NOS installations would be limited to the immediate vicinity of the project area and would not persist beyond the conclusion of activity in the area. NOS's onshore installations are not expected to reduce the availability of space, shelter, cover, or nutrients necessary for dependent species in the long term.

Generally, cumulative impacts to terrestrial habitat areas would persist for the entirety of the foreseeable future, but would not cumulatively reduce the availability of space, shelter, cover, or nutrients for dependent aquatic or terrestrial species. Disturbances to terrestrial taxa would also be limited to the immediate vicinity of onshore installations or activities and would only persist for the duration of the activity in question. It is also an NOS practice to generally avoid repeated surveys by NOS in the same location, thereby mitigating increased disturbance to terrestrial habitat within the action area. The above-described NOS effects can also occur from almost all human uses of water. These effects would be indistinguishable in type from other human uses. Overall, the aggregate, **adverse** cumulative impacts to terrestrial habitat would likely be **negligible** to **minor** in magnitude. The contribution to these aggregate, adverse cumulative impacts on terrestrial habitats from any of the three NOS alternatives would be **negligible**.

4.2.1.7 Conclusion

When considered in tandem with the NOS Proposed Action, other surveying and mapping efforts in the action area, offshore oil and natural gas development, offshore renewable energy development, climate change, commercial shipping and recreational boating, assessment and extraction of marine minerals, offshore carbon storage resource assessments, construction and operation of offshore LNG terminals, national defense and homeland security activities, construction of new submarine telecommunication cable infrastructure, commercial and recreational fishing, and coastal development would create adverse cumulative impacts to habitats. Adverse impacts to habitats could occur through bottom substrate contact, increased sedimentation, turbidity and/or chemical contamination, increased ambient sound level, facilitated dispersion of invasive species, disturbances to the water column, and terrestrial disturbance within the action area. In the short-term, the presence and movement of vessels; use of active acoustic sound sources; vessel sound; and underwater activities in conjunction with current accidental or illicit discharges of oil, fuel, chemicals, or waste, and ongoing onshore, nearshore, and offshore development could temporarily adversely affect habitat by degrading water quality and displacing marine or terrestrial prey species in the immediate vicinity of NOS activities. Disturbances and displacements resulting from activities are not expected to persist beyond the duration of activities. Onshore, nearshore, and offshore development in conjunction with ongoing anthropogenic climate change would reduce the total amount of available terrestrial habitat in the long-term, however no other activities or actions would contribute long-term impacts to habitat areas except the unlikely occurrence of widespread propagation of invasive species facilitated by a given cumulative action.

Overall, the short and long-term aggregate adverse cumulative impacts from the cumulative effects scenario (i.e., actions described in Section 4.1) on habitats throughout the action area are **negligible** to **moderate** in magnitude, with **moderate** impacts occurring only in the event of widespread propagation of invasive species, and are therefore expected to result in insignificant impacts to habitats.

Cumulative, adverse impacts from the Proposed Action in combination with the cumulative effects scenario could potentially be considered either synergistic or additive depending on the timing and location of activities and impacts. Synergistic impacts could result if any activities or actions occur in close spatial or temporal proximity within the study area. Similarly, additive cumulative impacts to habitat areas could occur if activities or actions are conducted sequentially within adjacent areas of the study area. Although the exact timing and location of NOS projects have not been finalized and are subject to change, the Southeast and Alaska regions contain the largest proportion of NOS's total miles of vessel movement in the EEZ (Section 2.4.1) and relatively high levels of marine oil and gas development. Therefore, synergistic or additive cumulative impacts are most likely to occur in either of these regions. The vast majority of cumulative impacts are confined to the immediate vicinity of project areas and would likely not impact the overall availability of space, shelter, cover, or nutrients within habitat areas outside of the range of natural variability.

The NOS Proposed Action would contribute to and have the potential to increase these cumulative impacts, but their relative contribution would be **negligible** as compared to the aggregate contributions of other cumulative actions. These impacts would occur regardless of the chosen alternative since projects under each alternative would be composed of similar activities and take place in the same geographic areas and timeframes; however, Alternatives B and C would be expected to have slightly higher cumulative impacts because these alternatives include more projects, activities, and nautical miles traveled than Alternative A.

4.2.2 Marine Mammals

All past, present, and reasonably foreseeable future actions described in Section 4.1 would contribute cumulative effects on marine mammals. Based on the analysis presented in Section 3.5 Marine Mammals, impacts of the Proposed Action would result in negligible to minor, or possibly moderate, impacts to marine mammals. The main impacts from the Proposed Action that could contribute to cumulative impacts on marine mammals are injury acoustic exposures [permanent threshold shifts or PTS] due to underwater acoustic sources; entanglement; exposure to oil, fuel, and other contaminants; and a very low likelihood of vessel strikes) and disturbance or behavioral modification (from acoustic exposures due to underwater acoustic sources; vessel noise and masking; presence and movement of vessels; and human activity). The analysis also considers that additional actions and activities contribute to the existing condition of marine mammals, including the accidental or illicit discharge of oil, fuel, chemicals, or waste. To a lesser degree, the Proposed Action could also contribute cumulative impacts to animal fitness, habitat alteration, and even animal mortality.

The following analysis considers how the NOS-related incremental impacts of the NOS Proposed Action, when added to or acting synergistically with other past, present, and reasonably foreseeable future actions, would contribute to overall cumulative impacts.

4.2.2.1 Mortality and Injury to Marine Mammals

Marine mammal mortality and injury from other cumulative actions could result from contact with spilled oil and other contaminants, vessel strikes, fishing bycatch, and entanglement. Accidental or illicit discharges of oil, fuel, chemicals, or waste contribute to the existing mortality and injury of marine mammals. Contact with spilled oil leads to loss of life or life-threatening injury to marine mammals, and can seriously threaten the continued viability of the population, potentially having a major impact if the level of mortality or debilitating injury was in sufficiently high numbers that the continued viability of the population was seriously threatened.

Vessel strikes have been and will continue to be a cause of marine mammal mortality and injury. In particular, the most vulnerable marine mammals are likely those that spend extended periods at or just below the water surface, slow-moving species, or species whose unresponsiveness to vessel sound makes them more susceptible to vessel collisions (Gerstein, 2002; Nowacek et al., 2004). Marine mammals such as dolphins, porpoises, and pinnipeds that can move quickly throughout the water column are not as susceptible to vessel strikes. Vessel strikes likely have a less than perceptible impact on the status of most marine mammal populations, but for small populations, vessel strikes may have considerable population-level impacts. Commercial fishing activities are expected to result in some injury and mortality of marine mammals because of animals taken as fisheries bycatch or entangled in fishing gear. NOS does not expect any mortality and very little injury of marine mammals as a result of the Proposed Action. The probability for collisions of vessels used by NOS with most marine mammal species is extremely unlikely considering the relatively slow speeds of survey vessels, visual observation, and the speed and agility of most marine mammal species.

Likewise, the likelihood of occurrence of an accidental spill from a vessel used by NOS would be very low. In the event that an accidental spill does occur, the volume of oil, fuel, and/or chemicals would be fairly small given the small amounts of fuel and other chemicals used for consumption that are typically onboard, as well as the proper handling of all hazardous or regulated materials in accordance with applicable laws. Injury that might occur under the NOS actions would be additive to injury and mortality associated with other cumulative actions. NOS does not anticipate mortalities to marine mammals as a result of any of the NOS alternatives. The relative contribution of the Proposed Action to overall injury would be negligible compared to other cumulative actions. Thus overall, all three alternatives would be expected to contribute negligible cumulative impacts due to mortality and injury of marine mammals.

In addition to injury impacts associated with vessel strikes, bycatch, and entanglement as discussed above, marine mammals could also be injured by underwater noise. Such noise can occur from activities including use of Navy sonar systems, seismic airgun surveys, HRG surveys, underwater drilling, underwater pile driving, and underwater use of explosives, all of which produce low to high frequency underwater noise. Direct physical injury, which may result in death, may occur from exposure to high levels of impulsive sound, such as shock waves associated with in-water explosions. Exposure to non-impulsive acoustic energy also has the potential to cause indirect death of marine mammals, which has been associated with use of Navy sonars; while the sound itself may not have directly caused death or injury, it is assumed to be a causal factor in behavior (i.e., in such cases as strandings) that led to deaths (Marine Mammal Commission, 2006; ICES, 2005). If underwater noise (at a level that causes mortality or injury) occurred at the same time and place, they could synergistically contribute to adverse cumulative acoustic impacts on marine mammals; if they do not occur at the same time and place, they could additively contribute to adverse cumulative impacts. However, the vast majority of impacts expected from cumulative underwater noise are behavioral in nature, temporary and comparatively short in duration, relatively infrequent, but which may result in behavioral disruption exposures (disturbance and behavior modification). The NOS Proposed Action could also result in both PTS/injury and behavioral disruption exposures to individuals of some marine mammal species from underwater acoustic sound sources. Although it is possible that injury that might occur under the NOS actions would be additive to injury associated with other cumulative actions, NOS projects are not likely to occur at the same time and place as other cumulative actions because conducting the NOS activities near other active acoustic activities could cause survey interference. It is also possible that the proposed action could cause a more serious behavioral response in an animal already injured by another cumulative activity. However, injury exposures would not likely be accumulative because other acoustic activities would not likely overlap in time and space with NOS projects. In addition, acoustic activities are typically temporary and localized. Additionally, the relative contribution of all three alternatives to the overall injury exposures of marine mammals in the action area would be negligible as compared to other cumulative actions.

Overall, the aggregate, **adverse** cumulative impacts to marine mammals from mortality and injury would likely be **minor** to **moderate**. The contribution to these aggregate, adverse cumulative impacts from all three NOS alternatives would be **negligible**.

4.2.2.2 Marine Mammals Disturbance and Behavioral Modifications

Disturbance and behavioral modifications of marine mammals are associated with underwater surveying and mapping equipment and construction sounds, vessel and aircraft sound, and vessel and human presence. Low frequency vessel sound occurs in the same bands in which most large whale calls and songs occur (Richardson et al., 1995) and could interfere with animals' abilities to detect important sounds (Francis and Barber, 2013). Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, and communicating with other individuals. Noise can cause behavioral disturbances, mask other sounds (including their own vocalizations), and result in injury (as discussed above) (Tyack, 2009).

Other anthropogenic sound sources in the action area include dredging, O&G operations, nearshore construction activities, G&G research operations, shipping and other large vessel noise, and military training and testing exercises. Increasing ambient sound levels may steadily erode marine mammals' abilities to communicate, find food, mate, and navigate. Noise and visual presence of aircraft would similarly disturb and stress marine mammals. Overall, there would be localized disturbance and behavioral impacts due to vessel sound, vessel movement, and human presence within specific portions of the action area during NOS projects. However, impacts are expected to be spatially localized and temporary or short-term in duration. Implementation of mitigation measures such as animal approach restrictions and low vessel speeds (see Section 3.5.2.3) are expected to minimize potential impacts on animal behavior. Other cumulative actions are unlikely to overlap in time and space with NOS projects because these activities are dispersed and the sound sources are intermittent. It is likely that distant shipping sound, which is more universal and continuous, would overlap in time and space with actions under the NOS Proposed Action. However, the Proposed Action would likely only contribute negligible cumulative impacts caused by disturbance and behavior modification of marine mammals.

Overall, the aggregate, **adverse** cumulative impacts to marine mammals from disturbance and behavioral modifications would likely be **minor**. The contribution to these aggregate, adverse cumulative impacts from all three NOS alternatives would be **negligible**.

4.2.2.3 Reduced Fitness of Marine Mammals Due to Pollutants

Pollutants from multiple sources are present in, and continue to be released into, the oceans. Long-term exposure to pollutants poses potential risks to the health and fitness of marine mammals (Reijnders et al., 2008). Reduced animal fitness associated with air emissions and water pollution due to the accidental leakage or spillage of oil, fuel, and chemicals could have potential impacts such as organ anomalies and impaired reproduction and immune function (Reijnders et al., 2008). In an oil spill, whales, dolphins, and pinnipeds may be exposed to volatile chemicals during inhalation. Marine mammals with hair, such as fur seals or sea otters, would be at risk of insulation effects. Oil and other chemicals on skin and body may result in skin and eye irritation, burns to the mucous membranes of the eyes and mouth, and increased susceptibility to infection. For mysticetes, oil can foul the baleen they use to filter-feed, thereby potentially decreasing their ability to eat.

Inhalation of volatile organics from oil or dispersants can result in respiratory irritation, inflammation, emphysema, or pneumonia. Ingestion of oil or dispersants may result in gastrointestinal inflammation, ulcers, bleeding, diarrhea, and maldigestion. If the health of an individual marine mammal were compromised by long-term exposure to pollutants, it is possible that it could alter the animal's expected response to other environmental stresses, such as underwater noise.

Considering that the amount of air emissions from vessels used by NOS would continue to be a tiny fraction as compared to emissions from all other vessel activity, and the small number of vessels used by NOS that could accidently spill oil, fuel, and chemical contaminants into the ocean, as well as the small amounts of fuel and other chemicals used for consumption that are typically onboard, the incremental increase in cumulative impacts of the NOS alternatives on marine mammal health and fitness would be negligible. The potential also exists for the impacts of ocean pollution associated with the NOS Proposed Action to be additive or synergistic as it is possible that the response of a previously stressed animal would be more severe than the response of an unstressed animal.

Overall, the aggregate, **adverse** cumulative impacts to marine mammals from reduced fitness would likely be **minor**. The contribution to these aggregate, adverse cumulative impacts from all three NOS alternatives would be **negligible**.

4.2.2.4 Alteration of Marine Mammal Habitat

Habitat alteration is associated with reduced prey/food sources and degraded water quality due to other cumulative actions, and to climate change. Overfishing of many fish stocks has resulted in significant changes in trophic structure, species assemblages, and pathways of energy flow in marine ecosystems (Jackson et al., 2001; Myers and Worm, 2003). These ecological changes may have adverse consequences for populations of marine mammals (DeMaster et al., 2001) as prey food sources are reduced. Air and water pollution can not only have adverse impacts on marine mammals themselves, as discussed above, but also on habitat as air and water quality are degraded. Increased emissions of anthropogenic greenhouse gases (GHG) [CO_2, methane (CH_4), and nitrous oxide (N_2O)] are warming the atmosphere, and rising levels of CO_2 in particular are producing changes in seawater carbon chemistry. Climate change effects include changes in air and sea temperatures, precipitation, the frequency and intensity of storms, pH level of sea water, and sea level. These changes could affect overall marine productivity, leading to altered migratory routes and timing, and changes in prey/food availability and reproductive success of marine mammals. Changes in seasonal sea ice as a result of climate change may lead to additional increases in commercial shipping, recreational boating, and other vessel traffic in marine mammal habitat in the Alaska Region. Although the NOS Proposed Action would have some adverse impacts on fish and aquatic macroinvertebrates that make up the prey/food sources for marine mammals (see Sections 3.7 Fish and 3.8 Aquatic Macroinvertebrates), these impacts would be very small as compared to other cumulative actions affecting these resources. Likewise, the impacts of the Proposed Action from accidental spills and air emissions that could contribute to degraded water quality in marine mammal habitat or to climate change would also be negligible as compared to all other cumulative actions affecting water quality and climate change. Thus, the NOS Proposed Action would only contribute negligible cumulative impacts that could alter marine mammal habitat.

Overall, the aggregate, **adverse** cumulative impacts to marine mammals from alteration of their habitat would likely be **minor** to **moderate**. The contribution to these aggregate, adverse cumulative impacts from all three NOS alternatives would be **negligible**.

4.2.2.5 Conclusion

When considered in tandem with activities associated with the NOS Proposed Action, other surveying and mapping efforts in the action area, offshore oil and natural gas development, offshore renewable energy development, climate change, commercial shipping and recreational boating, assessment and extraction of marine minerals, offshore carbon storage resource assessments, construction and operation of offshore LNG terminals, national defense and homeland security activities, construction of new submarine telecommunication cable infrastructure, commercial and recreational fishing, and coastal development would create adverse cumulative impacts to marine mammals. These adverse impacts occur through mortality and injury (due to vessel strikes, bycatch in fisheries, entanglement in fishing and other gear, contact with contaminants, and underwater noise); disturbance and behavior modification (due to underwater equipment and construction sounds, vessel and aircraft sounds, and vessel and human presence); reduced animal fitness (due to air and water pollution); and habitat alteration (due to reduced prey/food sources, degraded water quality, and climate change).

These past, present, and reasonably foreseeable future actions are expected to result in insignificant impacts to most marine mammal species, and significant impacts on some marine mammals in the action area. Overall, the cumulative impacts of all actions described in Section 4.1 affecting disturbance and behavioral modification, animal fitness, and habitat alteration are **adverse** and **moderate** as the continued viability of populations would not be threatened. These impacts would therefore be insignificant. Other impacts are considered **major** and thus significant because the cumulative effects of other cumulative actions described in Section 4.1 (particularly from vessel strikes, bycatch, entanglement, and reduced prey) are expected to result in relatively high rates of injury and mortality that could cause population declines in some marine mammal species. Therefore, cumulative impacts on marine mammals would be significant without consideration of the impacts of the Proposed Action.

Cumulative, adverse impacts from any of the alternatives in combination with the cumulative effects scenario could potentially be considered either synergistic or additive depending on the timing and location of activities and impacts. Cumulative adverse impacts could be synergistic if activities associated with the NOS Proposed Action and other cumulative actions occur in close spatial or temporal proximity. Similarly, additive effects to marine mammals may occur if actions taken by others are performed sequentially with activities associated with the NOS Proposed Action. The Proposed Action would contribute to and have the potential to increase cumulative impacts, but their relative contribution would be **negligible** as compared to aggregate contributions from other cumulative actions because the NOS impacts would be temporary or short-term, would be confined to the immediate vicinity of project areas, and would be small as compared to impacts from all other cumulative actions. NOS impacts would occur regardless of the chosen alternative since projects under each alternative would be composed of similar activities and take place in the same geographic areas and timeframes; however, Alternatives B and C would be expected to have slightly higher cumulative impacts because these alternatives include more projects, activities, and nautical miles traveled than Alternative A.

4.2.3 Sea Turtles

All past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects to sea turtles. The analysis of cumulative effects also considers that other actions and activities contribute to the existing condition of sea turtles, including habitat encroachment from onshore and nearshore development (e.g., coastal population growth, light pollution) and accidental or illicit discharge of oil, fuel, chemicals, or waste.

4.2.3.1 Mortality and Injury to Sea Turtles

Crewed vessel operations and active acoustic surveying under the NOS Proposed Action could contribute to cumulative impacts from the use of high intensity active underwater acoustic sources used by several cumulative activities, such as seismic surveys or piledriving, and the presence and movement of vessels associated with any of the past, present, or reasonably foreseeable actions. In combination, these cumulative activities would likely contribute direct injury impacts to sea turtles or their prey. Sea turtles may be able to hear low frequency sources that go down to 0.5 kHz. These low frequency sources are used in deeper water, so sea turtles exposed would likely be farther away from the source. However, underwater sound produced by the NOS active underwater acoustic sources would mostly be at frequencies reaching up to orders of magnitude above the documented sea turtle hearing range and would therefore be imperceptible to sea turtles. As such, there would not likely be cumulative effects from NOS sources even when considering that the active acoustic sources commonly used in other surveying and mapping activities, assessment and exploration of marine minerals, and offshore carbon storage assessments have a propensity to injure sea turtles.

The presence and movement of crewed vessels within the action area, including all vessels used in conjunction with activities under the Proposed Action and all past, present, and reasonably foreseeable actions, could cumulatively contribute to collisions with sea turtles that could result in sea turtle injury or mortality. Propeller and collision injuries to sea turtles arising from interactions with crewed vessels are relatively common; 20.5 percent of observed leatherback sea turtles in the Atlantic Ocean and Gulf of Mexico had sustained propeller injuries in 2004 (NMFS and USFWS, 2008). Give the low speed and small size of most vessels used by NOS (see Section 2.4.1), and that all vessels used by NOS would constantly monitor for protected species, collisions are expected to be generally avoided during NOS projects. There is also a very small possibility of temporary or permanent hearing threshold shifts in sea turtles resulting from low-frequency vessel sound from the transit of vessels through the action area. Sound produced by vessels used by NOS would typically be outside the range of source levels that could induce avoidance behaviors, limiting their contribution to cumulative impacts.

Commercial fishing activities are expected to result in some injury and mortality of sea turtles due to entanglement in fishing gear. Expanded commercial fishing operations would likely increase bycatch of sea turtles and their prey, particularly in longline or trawled fisheries where operators cannot continuously monitor trailed lines, hooks, and nets for protected species. As such, the overall abundance of sea turtle prey could be reduced.

Accidental or illicit discharges of fuel, chemicals, or waste accompanying all vessel operations within the action area contribute to the existing direct injury of turtles and prey through ingestion and interaction with spilled substances, although the intensity of the impact would be contingent upon the size and location of the spill in question. Contaminated prey or forage could also potentially serve as an additional source of contaminant exposure to sea turtles, particularly of bioaccumulated hazardous materials. Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not likely to occur during NOS activities. In the unlikely event of an accidental spill, NOS personnel are required to respond immediately to limit the extent of the spill. Also, NOS vessel operations are only a small fraction of all vessels operations in the U.S. EEZ, so they would contribute very little to overall cumulative impacts from accidental discharges of fuel, chemicals, or waste.

Light pollution from onshore and nearshore commercial, residential, or O&G development in close proximity to sea turtle nesting beaches contributes to the currently reduced likelihood of offspring survival to reproductive maturity. Nearshore NOS night operations, although not commonly conducted, could potentially contribute to cumulative coastal light pollution. Light pollution disorients sea turtle hatchlings or nesting sea turtle adult females, which navigate beaches using moonlight. Rising temperatures as part of ongoing climate change will continue to skew sea turtle sex-ratios due to temperature-dependent sex determination of sea turtle offspring. Over time, generally warmer incubation temperatures will skew the overall sex-ratio towards females and result in the reduction of overall sea turtle population numbers and genetic diversity. Ocean acidification accompanying climate change will harm the sea turtle macroinvertebrate prey species that are particularly sensitive to environmental conditions during their larval stages and will likely reduce their availability to sea turtles.

The majority of cumulative direct injury impacts would be limited to the immediate vicinity of vessels or O&G development and would not likely cause long-term changes in turtle behavioral patterns, habitat availability and use, or the demographic structure and abundance of turtle and prey populations. Similarly, climate-related impacts would not likely substantially affect turtles, although impacts would likely continue to increase over time. Overall, the aggregate, **adverse** cumulative impacts to sea turtles from direct injury would likely be **minor** to **moderate**. The contribution to these aggregate, adverse cumulative impacts from all three NOS alternatives would be **negligible** to **minor**.

4.2.3.2 Disturbance and Displacement of Sea Turtles

Sound from vessel operations under the NOS Proposed Action could contribute to the disturbance of sea turtles in conjunction with other cumulative oceanic anthropogenic activities. Sound from survey vessels, shipping vessels, commercial fishing vessels, recreational boats and underwater construction activities in support of energy infrastructure, LNG terminals, and submarine telecommunications infrastructure could also cumulatively disturb and displace turtles and their prey from the respective project areas for the duration of the activity in question. The visual presence of vessels would also likely serve as an additional source of disturbance and displacement.

Sea turtles are low frequency specialists with a generalized hearing range of 30 to 2,000 Hz (0.03 to 2 kHz) and are most sensitive to sound between 200 and 400 Hz (0.2 and 0.4 kHz). Sea turtles may be able to hear low frequency sources that go down to 0.5 kHz. Low frequency underwater acoustic sources from other cumulative actions are used in deeper water, so animals exposed would likely be farther away from the source. Underwater sound produced by NOS active underwater acoustic sources would mostly be at frequencies reaching up to orders of magnitude above the documented sea turtle hearing range and would therefore be imperceptible to sea turtles and unlikely to cause behavioral changes. Vessel sound has the potential to disrupt normal sea turtle behavior because of their high hearing sensitivity between 200 and 400 Hz.

The NOS Proposed Action would contribute to cumulative underwater disturbance from vessel movement and presence and bottom sampling. However, sea floor disturbance would be limited to relatively small portions of a given project area, and any resulting changes to water quality would be quickly dissipated by prevailing ocean currents. Reduced water quality and increased turbidity would result from the ongoing erosion of coastlines by rising sea levels, bottom sampling, or underwater construction activities, all of which could disturb and displace sea turtles/prey. Climate change will continue to raise sea levels globally for the foreseeable future, which results in continual erosion throughout the coastlines of the EEZ. Coastal erosion occurs at varying rates around the EEZ, but would be most pronounced near sea turtle breeding grounds along the Atlantic coastline, which carry a greater risk of impacting the overall sea turtle population.

Ongoing accidental or illicit discharges of fuel, chemicals, or waste from vessel operations and marine infrastructure can disturb and displace sea turtles and their prey from contaminated areas for the lifetime of the spill. The intensity of the impact is contingent upon the size and location of the spill in question and most small spills are dissipated by ocean conditions on a timescale of minutes to hours. However, there is only a very low likelihood of small spill occurrence from vessels used by NOS and no possibility of large spills given the size of vessels used by NOS. Energy installations included in the cumulative effects scenario carry a larger probability of large spills than NOS activities, particularly in offshore oil/gas installations with tankers and pipelines.

Cumulative disturbance and displacement impacts would still likely be limited to the immediate vicinity of the source and would not persist beyond the conclusion of activities, although impacts could be magnified in the unlikely occurrence of a large spill. These aggregate, adverse cumulative impacts are not expected to cause long-term changes in habitat availability, overall turtle behavioral patterns, or overall prey availability and would be considered **negligible** to **minor**. The contribution to these aggregate, adverse cumulative impacts from all three NOS alternatives would be **negligible**.

4.2.3.3 Degradation and Reduction of Sea Turtle Habitat

Impacts associated with the construction and eventual decommissioning of long-term installations (e.g., LNG terminals, energy infrastructure, and submarine telecommunications) would likely reduce the total amount of oceanic habitat available to sea turtles and their prey for the lifetime of the installation. Sea turtles and their prey would likely be displaced from these areas for the duration of the installation due to reduced water quality and various disturbances related to the operation and maintenance of the infrastructure, such as vessel traffic, low flying aircraft, waste discharge, underwater disturbance from welders, divers and wakes, and vessel sound. Following decommissioning, the development area would be reclaimed and should return to previous habitat conditions. Onshore tide gauge installations and remote GPS reference station installations under the NOS Proposed Action could cumulatively contribute to these impacts, but the footprint of tide gauge installations and reference stations is extremely small, and sea turtles and their prey are expected to return to project areas after the completion of NOS onshore activities. No long-term changes to sea turtle habitat availability or habitat use are expected.

The ongoing accidental or illicit discharges of fuel, chemicals, or waste from vessel operations and marine infrastructure contributes to currently degraded sensitive coastal beach sea turtle nesting habitat. The intensity of the impact is contingent upon the size and distance of the spill in question from nesting beaches; most small spills are dissipated by ocean conditions on a timescale of minutes to hours. However, the operation of energy installations included in the cumulative effects scenario carry a greater probability of large spills with larger and longer-lasting impacts than do NOS activities, particularly in the case of offshore oil/gas installations with tankers, drilling rigs, production platforms, and pipelines.

Coastal population growth contributes to currently degraded sea turtle nesting habitat through a variety of factors, including coastal water quality reductions from urban/agricultural runoff, encroachment by coastal development, and increased light pollution. Rising sea levels as result of climate change will continually erode coastlines along the EEZ and could potentially destroy or degrade sensitive sea turtle nesting beaches. Global rising temperatures could also shift sea turtle habitat and prey distributions northwards towards colder waters, and could ultimately reduce the total amount of available habitat or prey if the species dispersal rate is relatively lower than that of the rate of temperature changes. Seagrass, an important turtle forage, and coral reefs which shelter aquatic macroinvertebrate prey are also particularly susceptible to changes in abiotic environmental conditions and could be damaged or displaced from sea turtle habitat areas by eroding coastlines, rising temperatures, or ocean acidification.

Generally, cumulative impacts to sea turtle habitat would persist for the foreseeable future, but would not substantially reduce overall habitat availability or quality and would not substantially impact the overall structure or abundance of sea turtle or prey populations. Nesting habitat reductions could potentially impact the overall sea turtle population since turtles return to the same beach to nest annually and would not be able to relocate in the event of the destruction or degradation of their predetermined nesting beach. However, nesting beaches are generally avoided by development given the federal protection of sea turtles. Aggregate cumulative impacts to sea turtle habitat from all actions and activities would likely be **adverse**, and **minor** to **moderate**. The contribution to these aggregate, adverse cumulative impacts from all three NOS alternatives would be **negligible**.

4.2.3.4 Conclusion

Activities associated with the Proposed Action and the cumulative effects scenario have the potential to contribute cumulatively to direct injury, disturbance and displacement, and habitat reduction impacts from past, present, and reasonably foreseeable actions within the action area. In the short-term, the presence and movement of vessels could potentially result in direct injury to turtles from collisions or entanglements and would likely disturb or displace nearby sea turtles for the duration of activities. Similarly, active acoustic sound sources; vessel sound; underwater construction activities; accidental or illicit discharges of oil, fuel, chemicals, or waste; and onshore, nearshore, and offshore development would displace sea turtles and their prey in the immediate vicinity of activities. Onshore and nearshore development and the accidental or illicit discharges of oil, fuel, chemicals, or waste contribute to the currently reduced total amount of sea turtle habitat. Climate change would reduce the total amount of available sea turtle habitat in the long-term, however no other activities or actions would contribute long-term impacts to sea turtles, except the unlikely occurrence of a large oil, fuel, or chemical spill. The vast majority of cumulative impacts would be confined to the immediate vicinity of project areas and would likely not impact the overall abundance or structure of sea turtle or prey populations outside of the range of natural variability. Overall, the cumulative impacts of all actions described in Section 4.1 would contribute **negligible** to **moderate** short-term and long-term adverse cumulative effects on sea turtles, depending on the timing and location of impacts.

Cumulative, adverse impacts from the Proposed Action in combination with the cumulative effects scenario could potentially be considered either synergistic or additive depending on the timing and location of activities and impacts. Synergistic impacts could result if any activities or actions occur in close spatial or temporal proximity within the study area. Similarly, additive cumulative impacts to sea turtles, their prey, or their associated habitat could occur if activities or actions are conducted sequentially within adjacent areas of the study area. Although the exact timing and location of projects have not been finalized and are subject to change, the Southeast and Alaska regions contain the largest proportion of total vessel transit miles of the EEZ (Section 2.4.1) and relatively high levels of marine O&G development. Therefore, synergistic or additive cumulative impacts are most likely to occur in either of these regions. However, most affected animals would be located in the Southeast, because sea turtles are only occasional visitors to Alaska's Gulf Coast waters.

The NOS Proposed Action would contribute to and have the potential to increase these cumulative impacts, but their relative contribution would be **negligible** as compared to the aggregate contributions of other cumulative actions. These impacts would occur regardless of the chosen alternative since projects under each alternative would be composed of similar activities and take place in the same geographic areas and timeframes; however, Alternatives B and C would be expected to have slightly higher cumulative impacts because these alternatives include more projects, activities, and nautical miles traveled than Alternative A. The contribution to these aggregate, adverse cumulative impacts from all three NOS alternatives would be **negligible**.

4.2.4 Fish

All past, present, and reasonably foreseeable future actions described in Section 4.1 would contribute cumulative effects on fish and fish habitat. Based on the analysis presented in Section 3.7 Fish, impacts of the NOS Proposed Action would result in negligible to minor impacts on fish and fish habitat. The Proposed Action could contribute to cumulative impacts on fish, including injury (hearing loss from underwater noise), disturbance or behavioral modification (from underwater sound, vessel wake and underwater turbulence, and bottom disturbance), and habitat alteration (from vessel wake and underwater turbulence; bottom disturbance; and air emissions). The analysis also considers that other actions and activities contribute to the existing condition of fish, including the accidental or illicit discharge of oil, fuel, chemicals, or waste which can cause mortality and marine debris (e.g., plastics, glass, metals, or rubber) and flows of pollutants, contaminants, sediments, and nutrients, which can reduce the fitness of fish. The following analysis considers how the NOS-related incremental impacts of the NOS Proposed Action, when added to or acting synergistically with other past, present, and reasonably foreseeable future actions, would contribute to overall cumulative impacts on fish.

4.2.4.1 Mortality and Injury to Fish

Fish mortality and injury from other cumulative actions could result from vessel strikes, underwater noise, fishing bycatch, and entanglement. Ongoing accidental or illicit discharges of oil, fuel, chemicals, or waste contribute to the existing mortality and injury of fish. All vessel operations, as well as other cumulative actions such as drilling and construction and placement of structures within the action area could cumulatively contribute to the mortality and injury of fish through ingestion and contact with spilled oil and fuel or released contaminants. Although most adult fish are mobile enough to avoid areas with higher concentrations of contaminants, less mobile eggs, larvae, and juvenile fish would be more susceptible than adults. Vessels and in-water devices do not normally collide with adult fish, most of which can detect and avoid them. However, early life stages of most fish could be displaced by vessels and a vessel's propeller movement or propeller wash could entrain early life stages.

The cumulative potential effects from underwater acoustic sources on any stock of fish from injury (i.e., permanent loss of hearing) are considered low because NOS acoustic sources are generally outside of fish hearing ranges, although these sources could affect shad, herring, and other fish that can hear these sounds if they are within several meters of a sound source. It is possible that shipping and aircraft sounds (which are pervasive and continuous) and sound associated with underwater explosions and sonar would overlap in time and space; however, there is no evidence that the co-occurrence of these sounds would result in harmful additive impacts on fish.

Overfishing is the most serious threat that has led to the listing of ESA-protected marine fish due to mortality and population declines (Kappel, 2005; Cheung et al., 2007; Dulvy et al., 2003; Limburg and Waldman, 2009). Approximately 17 percent of the U.S.-managed fish stocks are overfished (NMFS, 2018c). Overfishing occurs when fish are harvested in quantities above a sustainable level. Overfishing impacts targeted species, and non-targeted species (i.e., bycatch species) that often are prey for other fish and marine organisms. Commercial fishing and overfishing are also the primary causes of fish entanglement. Entanglement in abandoned commercial and recreational fishing gear has also caused declines for some marine fish (Musick et al., 2009).

Although impacts that could occur under the Proposed Action would be additive to the injury and mortality of fish associated with other cumulative actions, NOS does not expect any mortality and very little likelihood for injury of fish (e.g., from accidental oil and fuel spills) as a result of implementing any of the alternatives. The likelihood of occurrence of an accidental spill from a vessel used by NOS would be very low. In the event that an accidental spill does occur, the volume of oil, fuel, and/or chemicals would be fairly small given the size of vessels used by NOS and the amounts of fuel and other chemicals they typically carry, as well as the proper handling of all hazardous or regulated materials in accordance with applicable laws. Likewise, the probability for strikes by vessels or underwater devices is unlikely. For fish species, the greatest potential for adverse impacts as a result of active underwater acoustic sources would be related to changes in behavior (see below) rather than auditory injury. The relative contribution of the Proposed Action to the overall mortality and injury of fish would be minimal as compared to other cumulative actions. The aggregate, **adverse** cumulative impacts to fish from mortality and injury would likely be **minor** to **major**. The NOS Proposed Action would be expected to contribute **negligible** cumulative mortality and injury impacts to fish.

4.2.4.2 Fish Disturbance and Behavioral Modifications

Disturbance and behavioral modifications in fish from other cumulative actions are associated with vessel operations, underwater sound, emplacement of structures, and use of underwater equipment. A significant amount of vessel traffic has taken place and is expected to continue for the foreseeable future under the cumulative effects scenario. Some studies found that most adult fish exhibit avoidance responses to vessels (Jørgensen et al., 2004; Misund, 1997) showing sudden escape responses when a vessel passes over them, including lateral avoidance or downward compression of the school. Conversely, Rostad et al. (2006) observed that some fish are attracted to different types of vessels (e.g., research vessels, commercial vessels) of varying sizes, sound levels, and habitat locations. Fish behavior in the vicinity of a vessel is therefore variable, depending on the type of fish, its life history stage, behavior, time of day, and the sound propagation characteristics of the water. Anthropogenic contributions to ambient sound in the ocean come primarily from vessel traffic, but also include other cumulative actions such as O&G operations, construction activities, dredging, and sonar. Most ambient sound is broadband and encompasses almost the entire frequency spectrum, with vessel traffic recognized as a major contributor to ocean sound in the low-frequency bands (< 1,000 Hz). The majority of soniferous fish are adapted to perceive and produce sounds in the low-frequency band, thus increased underwater sound could alter normal, biologically relevant behavior, disturbing basic life functions such as foraging, predator detection, and reproduction (Vasconcelos et al., 2007; Codarin et al., 2009). Other cumulative actions would contribute numerous sources of sound during the time period when NOS projects would take place, adding to ambient sound levels within the action area. Cumulative, low-frequency sound from multiple anthropogenic activities could have additive or synergistic behavioral effects on fish and contribute to auditory masking.

Fish could also be disturbed by structures and equipment in the water. Other cumulative actions, including O&G development, offshore renewable energy, carbon storage, and LNG terminals, have the potential for the emplacement of structures within the action area. Permanent and temporarily moored structures, including drilling rigs, barges, buoys, wind turbines, platforms, and other structures, would attract pelagic and demersal fish causing potential diversion of species from normal migratory pathways, feeding areas, and/or spawning areas. In addition, fish attracted to structures would then be subjected to chronic sound, routine discharges, and increased vulnerability to overfishing. Lights used at these structures could also enhance attractiveness for some species that are active at night. Water disturbance by underwater equipment used in other cumulative actions could also temporarily disturb and displace nearby fish. Because a towed in-water device is continuously moving, most fish are expected to move away from it or to follow behind it, in a manner similar to their responses to a vessel. When the device is removed, most fish are expected to return to the area and resume normal activities.

As vessels used by NOS would represent a negligible proportion of all vessel traffic in the action area, disturbance and behavioral modifications due to vessel operations under the Proposed Action would be minimal. Sound from NOS activities would be project-based, occurring on an intermittent basis over the period of interest. Because only small sound impacts are expected from NOS activities, impacts associated with the Proposed Action would only have a negligible incremental increase in ambient sound levels. The mobile nature of NOS surveys and the propensity of fish to temporarily move away from water turbulence that is affecting them would only lead to very small behavioral impacts on fish from the Proposed Action. The aggregate, **adverse** cumulative impacts to fish from disturbance and behavioral modification would likely be **minor** to **moderate**. The relative contribution of the NOS Proposed Action to the overall disturbance and behavioral modification of fish would be minimal as compared to other cumulative actions, and each alternative would be expected to contribute **negligible** cumulative impacts on fish behavior.

4.2.4.3 Reduced Fitness of Fish Due to Pollutants

Pollutants from multiple sources are present in, and continue to be released into, the oceans. A significant amount of vessel traffic is expected to occur under the cumulative effects scenario. All vessel operations are associated with a risk of oil and fuel spills and release of contaminants. Long-term exposure to pollutants from the accidental leakage or spillage of oil, fuel and chemicals; marine debris (e.g., plastics, glass, metals, or rubber); and flows of pollutants, contaminants, sediments, and nutrients in coastal waters stresses the health and fitness of fish. Pollution primarily impacts coastal fish that occur near the sources of land-based pollution and areas of heavy vessel traffic. However, global oceanic circulation patterns result in a considerable amount of marine pollutants and debris scattered throughout the open ocean (Crain et al., 2009). Spills of pollutants are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for large adverse effects because vessel operations personnel are required to respond immediately using established spill response procedures.

Contaminants in the marine environment that may impact marine fish include organic pollutants (e.g., pesticides, herbicides, polycyclic aromatic hydrocarbons, flame retardants, and oil), inorganic pollutants (e.g., heavy metals), and debris (e.g., plastics and wastes from dumping at sea) (Pews Oceans Commission, 2003). High chemical pollutant levels in marine fish may cause behavioral changes, physiological changes, or genetic damage in some species (Moore, 2008; Pews Oceans Commission, 2003; van der Oost et al., 2003), contributing to overall reduced health and fitness of species. Bioaccumulation of pollutants (e.g., metals and organic pollutants) is also a concern that can reduce animal fitness. Bioaccumulation is the net buildup of substances (e.g., chemicals or heavy metals) in an organism directly from contaminated water or sediment through the gills or skin, from ingesting food containing the substance, or from ingestion of the substance itself (Newman, 2019; Moore, 2008).

The aggregate, **adverse** cumulative impacts on the fitness of fish would likely be **moderate**. The relative contribution of the NOS Proposed Action to the overall fitness of fish would be minimal compared to other cumulative actions, and each alternative would be expected to contribute **negligible** cumulative impacts on fish fitness.

4.2.4.4 Alteration of Fish Habitat

Habitat alteration is associated with reduced prey/food sources, degraded water quality, and disturbance of bottom habitat due to other cumulative actions and to climate change. Prey and food sources are significantly directly reduced by overfishing, but also indirectly by changes in water quality from increased turbidity and sedimentation that create changes in the ecosystem that affect prey species and habitats. Spilled oil, fuel, and chemicals also stress the existing condition of fish habitat. Degraded water quality caused by other cumulative actions can cause increases in turbidity and sedimentation, increased water temperature, decreases in primary productivity and DO levels, introduction of invasive plant and animal species, and chemical contamination. Seafloor disturbance can damage or alter hard or soft demersal habitats important to fisheries resources. Other cumulative actions that would disturb the sea floor include commercial fishing (bottom trawling and dredging), carbon storage, dredged material disposal, LNG terminal placement, and new cable infrastructure. Seafloor disturbance can disturb, alter, or damage bottom habitat and can potentially smother demersal biota. However, these actions would affect a relatively small area of sea floor within the action area, and incremental impacts to fish habitat attributed to seafloor disturbance are expected to be minor.

Climate change effects include changes in air and sea temperatures, precipitation, the frequency and intensity of storms, pH level of seawater, currents, and sea level. These changes could affect overall marine productivity, which could affect the food resources, distribution, and reproductive success of fish. Pelagic fish stocks have unique spatial and temporal distribution patterns related to their bioclimatic niche. Climate change and the associated shifts in primary and secondary production therefore have impacts on the distribution range, migratory habits, and stock size of many marine fish species. Some species may shift away from shallow coastal waters and semi-enclosed areas, where temperatures increase fastest, into deeper cooler waters. In general, fish tend to live near their tolerance limits of a range of factors, and as a result, increased temperature and acidity, lower DO, and changes to salinity may have deleterious effects on their populations (ClimeFish, No Date).

Habitat alteration expected from the NOS Proposed Action would be caused by bottom sampling, anchoring, accidental spills of oil, fuel, and contaminants, and underwater turbulence from vessels and equipment. The small footprint of seafloor impacts under the NOS Proposed Action would account for a tiny fraction of the total sea floor in the action area, would only contribute an extremely small amount of contaminants to the ocean environment, if any, as compared to all other cumulative actions; and vessels operated by NOS would represent a negligible proportion of all vessel traffic in the action area. The aggregate **adverse** cumulative impacts from all actions on fish habitat would be **minor** to **moderate** and the contribution of the NOS Proposed Action to these impacts would be **negligible**.

4.2.4.5 Conclusion

All of the NOS alternatives would contribute to aggregate, adverse cumulative impacts on fish and fish habitat. This would occur through mortality and injury (vessel strikes, underwater sound, fishing bycatch, and entanglement); disturbance and behavior modification (due to vessel operations, underwater sound, emplacement of structures, and use of underwater equipment); and habitat alteration (reduced prey/food sources, degraded water quality, disturbance of bottom habitat, and climate change). Other actions and activities also contribute to the existing condition of fish, including the accidental or illicit discharge of oil, fuel, chemicals, or waste which can cause mortality and marine debris (e.g., plastics, glass, metals, or rubber) and flows of pollutants, contaminants, sediments, and nutrients, which can reduce the fitness of fish.

The aggregate, cumulative impacts of past, present, and reasonably foreseeable future actions are expected to result in insignificant impacts to most fish species, and may have significant impacts on some fish populations in the action area. The combined impacts of other cumulative actions affecting disturbance and behavioral modification, animal fitness, and habitat alteration would be **moderate** and **adverse** as the continued viability of populations would not be threatened, and therefore cumulative impacts would be insignificant. However, overfishing, bycatch, entanglement and reduced prey associated with other cumulative actions are expected to result in high rates of injury and mortality that could cause population declines to ESA-listed species or inhibit species recovery, resulting in **major** impacts that are significant. Although the impacts of commercial fishing are a concern for fisheries worldwide, fisheries in the action area are generally managed conservatively and in keeping with the requirements of the Magnuson-Stevens Fishery Conservation and Management Act. Many fish stocks within the action area that were historically overfished have recovered or are recovering from their overfished status and contributing to the overall trend of increasing abundance of U.S. marine fish stocks (NMFS, 2018c).

Cumulative, adverse impacts from any of the alternatives in combination with the cumulative effects scenario could potentially be considered either synergistic or additive depending on the timing and location of activities and impacts. Cumulative adverse impacts from the activities in the cumulative effects scenario could be synergistic if activities associated with the NOS Proposed Action and other cumulative actions occur in close spatial or temporal proximity. Similarly, additive effects on fish may occur if activities associated with the NOS Proposed Action and other cumulative actions are considered sequentially. Overall, cumulative impacts to fish would range from **minor** to **major**. The NOS Proposed Action would contribute to and have the potential to increase these cumulative impacts, but their relative contribution would be **negligible** because impacts would be temporary or short-term, would be confined to the immediate vicinity of project areas, and would be small as compared to impacts from all other cumulative actions. These impacts would occur regardless of the chosen alternative since projects under each alternative would be composed of similar activities and take place in the same geographic areas and timeframes; however, Alternatives B and C would be expected to have slightly higher cumulative impacts because these alternatives include more projects, activities, and nautical miles traveled than Alternative A.

4.2.5 Aquatic Macroinvertebrates

All past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects on aquatic macroinvertebrates. Based on the analysis presented in Section 3.8 Aquatic Macroinvertebrates, impacts of the NOS Proposed Action would result in negligible to minor impacts on invertebrates and their habitat. The impacts from the Proposed Action that could contribute to cumulative impacts on aquatic macroinvertebrates are direct and indirect injury and disturbance (from vessel sound, vessel wake and underwater turbulence, and bottom disturbance), and habitat alteration (from vessel wake and underwater turbulence; bottom disturbance; and air emissions).

The analysis of cumulative effects also considers that the other human actions and activities enumerated above contribute to the existing condition of aquatic macroinvertebrates, including habitat encroachment from onshore and nearshore development (e.g., coastal population growth), non-point sources of pollution, and accidental or illicit discharge of oil, fuel, chemicals, or waste. The following analysis considers how the NOS-related incremental impacts of the three NOS alternatives, when added to or acting synergistically with other past, present, and reasonably foreseeable future actions, would contribute to overall cumulative impacts on aquatic macroinvertebrates.

4.2.5.1 Direct and Indirect Injury to Aquatic Macroinvertebrates

Sound from crewed vessel operations under the NOS Proposed Action would contribute to cumulative impacts from all of the past, present, or reasonably foreseeable actions. However, based on what is known of their ability to detect underwater sound, NOS sound sources would be unlikely to cumulatively contribute to direct injury impacts to aquatic macroinvertebrates. For example, the active acoustic underwater sources used by NOS would mostly not be perceptible to aquatic macroinvertebrates. However, other active acoustic sources commonly used in other surveying and mapping activities, assessment and exploration of marine minerals, and offshore carbon storage assessments may have a greater propensity to adversely affect some aquatic macroinvertebrates, at least at close range, due to the high intensity and widespread propagation of the broadband sound they generate. These high intensity sources, including airguns, could have somewhat greater effects on aquatic macroinvertebrates than the sources described in Section 3.8, especially when considered cumulatively. In addition, the presence and movement of crewed vessels within the action area, including all vessels used in conjunction with activities under the Proposed Action and all past, present, and reasonably foreseeable actions of the cumulative effects scenario, would likely cumulatively contribute to collisions or entanglement of certain aquatic macroinvertebrates in the water column.

Accidental or illicit discharges of fuel, chemicals, or waste accompanying all vessel operations within the action area contribute to the existing direct harm to aquatic macroinvertebrates through ingestion and interaction with spilled substances, although the intensity of the impact would depend on the size and location of the spill in question. A major problem for aquatic macroinvertebrates is nutrient pollution from non-point sources onshore, principally fertilizers applied to farmlands; these nutrient loadings can cause red tides in coastal waters on both East and West Coasts, as well as a large “dead zone” of hypoxic or anoxic waters at the mouth of the Mississippi River in the Gulf of Mexico. Spills are not expected during the course of NOS operations. In the unlikely event of an accidental spill, there would be very low likelihood for large adverse impacts because vessel operations personnel are required to respond immediately using established spill response procedures.

Rising ocean temperatures as part of ongoing climate change will continue to damage coral reefs in particular, by thermally stressing coral polyps, leading to their bleaching (expelling their symbiotic algae known as zooxanthellae) and possible mortality. Ocean acidification accompanying climate change, in particular increasing atmospheric carbon dioxide concentrations, will interfere with shell and skeleton formation by certain marine calcifying aquatic macroinvertebrates that use calcium carbonate.

Most cumulative direct injury impacts would occur in the immediate vicinity of vessels or O&G development. Over the time period of analysis, climate-related impacts that have already led to the listing of many species of corals described in Section 3.8 would continue to stress these species. Aggregate, cumulative direct and indirect injury impacts from all actions range from short-term to long-term, and could result in **adverse** and **minor** to **major** impacts on aquatic macroinvertebrates. The contribution of the NOS Proposed Action to these aggregate, adverse impacts would be **negligible**.

4.2.5.2 Disturbance and Displacement of Aquatic Macroinvertebrates

Sound-producing and vessel operation activities under the NOS Proposed Action could potentially contribute to aggregate, adverse cumulative impacts along with other active underwater sound sources, especially from high intensity sources used in O&G surveying, by temporarily displacing aquatic macroinvertebrates at sites throughout the EEZ. Sound from vessels used by NOS, shipping vessels, commercial fishing vessels, recreational boats and underwater construction activities in support of energy infrastructure, LNG terminals, and submarine telecommunications infrastructure could also cumulatively disturb and displace invertebrates from the respective project areas for the duration of the activity in question.

Underwater disturbance from vessel movement and presence, and bottom sampling under the Proposed Action, in combination with reduced water quality and increased turbidity resulting from the ongoing erosion of coastlines by rising sea levels, bottom sampling, or underwater construction activities, would also disturb and displace aquatic macroinvertebrates. The small footprint of seafloor impacts under the NOS Proposed Action would account for a tiny fraction of the total sea floor in the action area, and impacts would be minimal and localized. Climate change will continue to raise sea levels globally for the foreseeable future, which results in continual erosion throughout the coastlines of the EEZ. The ongoing accidental or illicit discharges of fuel, chemicals, or waste from vessel operations and marine infrastructure contributes to currently disturbed and displaced aquatic macroinvertebrates from contaminated areas for the lifetime of the spill, though most small spills are dissipated by ocean conditions on a timescale of minutes to hours. Spills from NOS activities are unlikely to occur.

Cumulative disturbance and displacement impacts would still likely be limited to the immediate vicinity of the source and would not persist beyond the conclusion of activities. These aggregate, **adverse** impacts are not expected to cause long-term changes in habitat availability, or overall behavioral patterns, and would be considered **negligible** to **minor**. The contribution of the NOS Proposed Action to these aggregate, adverse cumulative impacts would be **negligible**.

4.2.5.3 Degradation and Reduction of Aquatic Macroinvertebrate Habitat

Onshore tide gauge installations and remote GPS reference station installations under the Proposed Action would contribute to cumulative impacts related to the degradation and reduction of aquatic macroinvertebrate habitats from the construction, operation, and decommissioning of long-term installations such as LNG terminals, energy infrastructure, and submarine telecommunications. Cumulatively, these actions would likely reduce the total amount of oceanic habitat available to aquatic macroinvertebrates for the lifetime of the installation. Aquatic macroinvertebrates would likely be displaced from these areas for the duration of the installation due to reduced water quality and various disturbances related to the operation and maintenance of the infrastructure, such as vessel traffic, waste discharge, and underwater disturbance from welders, divers and wakes. After the lifetime of the installation, the development area would be reclaimed and should return to previous habitat conditions.

While spills from NOS activities are unlikely to occur, the ongoing accidental or illicit discharges of fuel, chemicals, or waste from other vessel operations and marine infrastructure contribute to currently degraded estuarine and marine habitats. The intensity of these impacts depends on the size and distance of the spill in question from invertebrate habitats; most small spills are dispersed and dissipated by ocean conditions on a timescale of minutes to hours. Coastal population growth and elevated nutrient loadings, other contaminants, and non-point source discharges and runoff contribute to currently degraded habitat conditions for aquatic macroinvertebrates through a variety of factors, including coastal water quality reductions from urban/agricultural runoff, and encroachment by coastal development. This degradation is especially pronounced in bays and sounds with restricted water circulation, such as Chesapeake Bay in the Greater Atlantic Region and Puget Sound in the West Coast Region. The 7,000-square mile (18,130-square km) hypoxic (low-oxygen) “dead zone” that appears during the summer months in the Gulf of Mexico at the mouth of the Mississippi River is an effect of the widespread use of fertilizers (nitrogen and phosphorus nutrients) in the large Mississippi Basin.

Rising sea levels as a result of climate change will continually erode coastlines along the EEZ over the next five years and could potentially destroy or degrade habitats for aquatic macroinvertebrates. Global rising temperatures could also shift aquatic macroinvertebrate ranges northward towards cooler waters.

Generally, ongoing cumulative impacts to aquatic macroinvertebrate habitats would persist for the entirety of the foreseeable future; these impacts would not substantially reduce overall habitat quantity or availability but would continue to substantially degrade aquatic macroinvertebrate habitat quality, although populations would be unlikely to be further adversely affected in the near term. Aggregate cumulative impacts to aquatic macroinvertebrate habitat would likely be **adverse** and **minor** to **major** and the contribution of the NOS Proposed Action to these would be **negligible**.

4.2.5.4 Conclusion

Activities associated with the Proposed Action and the cumulative effects scenario have the potential to contribute cumulatively to direct and indirect injury, disturbance and displacement, and habitat reduction and degradation impacts from past, present, and reasonably foreseeable actions within the action area. In the short-term, the presence and movement of vessels could potentially result in direct injury to aquatic macroinvertebrates from collisions or entanglements and would likely disturb or displace nearby organisms for the duration of activities. Similarly, vessel sound and underwater construction activities could potentially displace aquatic macroinvertebrates in the immediate vicinity of activities. Disturbances and displacements resulting from activities are not expected to persist beyond the duration of activities, and short-term cumulative impacts would likely range from **negligible** to **moderate**. Onshore and nearshore development, non-point source pollution, and the accidental or illicit discharges of oil, fuel, chemicals, or waste all contribute to the currently reduced total amount of aquatic macroinvertebrate habitat. In conjunction with the NOS Proposed Action, ongoing climate change would reduce the total amount of available aquatic macroinvertebrate habitat in the long-term. As such, the long-term, aggregate, adverse cumulative impact of habitat reduction on aquatic macroinvertebrates would likely range from **minor** to **major**.

Cumulative, adverse impacts from any of the alternatives in combination with the cumulative effects scenario could potentially be considered either synergistic or additive depending on the timing and location of activities and impacts. Synergistic impacts could result if any activities or actions occur in close spatial or temporal proximity within the action area. Similarly, additive cumulative impacts to aquatic macroinvertebrates, or their associated habitat, could occur if activities or actions are conducted sequentially within adjacent areas of the action area. Although the exact timing and location of projects have not been finalized and are subject to change, the Southeast and Alaska regions contain the largest proportion of total vessel transit miles of the EEZ (Section 2.4.1) and relatively high levels of marine O&G development. Therefore, synergistic or additive cumulative impacts are most likely to occur in either of these regions. Most cumulative impacts would be confined to the immediate vicinity of project areas and would likely not impact the overall abundance or structure of invertebrate populations outside of the range of natural variability. Overall, the Proposed Action would contribute **negligible** short-term and long-term adverse cumulative effects, depending on the timing and location of impacts. These impacts would occur regardless of the chosen alternative since projects under each alternative would be composed of similar activities and take place in the same geographic areas and timeframes; however, Alternatives B and C would include more projects, activities, and nautical miles traveled than Alternative A, and would therefore have slightly greater impacts.

4.2.6 Essential Fish Habitat

All past, present, and reasonably foreseeable future actions described in Section 4.1 would contribute cumulative effects on EFH, including Habitat Areas of Particular Concern (HAPCs). Based on the analysis presented in Section 3.9 Essential Fish Habitat, impacts of the NOS Proposed Action would result in negligible to minor impacts on EFH. The impacts from the Proposed Action that could contribute to cumulative impacts on EFH are physical impacts to bottom habitat (e.g., from anchoring, collection of bottom grab samples, tide gauge installation, and SCUBA operations); increase in sedimentation, turbidity, and/or chemical contaminants (e.g., from operation of crewed sea-going vessels; operation of ROVs and autonomous vehicles; anchoring; collection of bottom grab samples; installation of tide gauges and GPS reference stations; and SCUBA operations); increase in sound (e.g., from operation of crewed sea-going vessels; operation of ROVs and autonomous vehicles; use of echo sounders; ADCPs; and acoustic communication systems); and impacts to the water column (e.g., from operation of crewed sea-going vessels; operation of ROVs and autonomous vehicles; anchoring; use of sound speed data collection equipment and bottom grab samplers; operation of drop/towed cameras and video systems; and SCUBA operations). The following analysis considers how the incremental impacts of the NOS Proposed Action, when added to or acting synergistically with other past, present, and reasonably foreseeable future actions, would contribute to overall cumulative impacts on EFH.

4.2.6.1 Physical Impacts to Essential Fish Habitat Bottom Habitat

Physical impacts to bottom habitat from other cumulative actions could result from such activities as commercial fishing (bottom trawling), dredging, carbon storage, O&G development, dredged material disposal, structure emplacement, and new cable infrastructure. Seafloor disturbance can alter or damage bottom habitat and can potentially smother demersal biota.

Adverse impacts from fishing, especially those using bottom-contact fishing gear, could be substantial in heavily fished areas and could affect EFH and component HAPC areas to various degrees. Bottom trawl fishing intensity has seen a rapid global expansion since the 1950s in order to meet an increasing global food demand (Watson et al., 2006); and although the highest trawling intensities are found in shallow coastal waters, bottom trawling is expanding into deeper waters (Eigaard et al., 2016).

In addition to seafloor disturbance from fishing, other cumulative actions that sample, anchor, dredge, cover, drill into, or otherwise come into contact with ocean bottom habitat can cause re-suspension of sediments into the water column, changes in bathymetric contours, and potential alteration or loss of benthic habitat. Dredging activities within the coastal zone have greatly intensified in recent decades in connection to harbor expansion work, maintenance and deepening of navigable waterways, land reclamation, coastal protection, and energy provision through the construction of wind farms (OSPAR Commission, No Date).

Globally, dredging involves the excavation of greater than 2 billion tons of sediment per year, of which approximately 80 percent is redeposited in the marine environment (EuDA, 2005). Some activities, such as mining, destroy hard substrate and severely disturb the seabed and the benthic soft substrate community. Recolonization can occur from unmined areas; but reestablishment of a community similar to that originally present is usually not possible (Thiel, 1992). Other activities also directly or indirectly introduce marine debris into the water (e.g., monofilament fishing line, nets, plastic) that often ends up on the sea floor or wrapped onto a shallow reef and causes stress on bottom habitat in EFH areas.

Although impacts that could occur under the NOS Proposed Action would be additive to the physical impacts of bottom habitat associated with other cumulative actions, NOS activities such as anchoring, installation of equipment on the sea floor, and sample collection would cause relatively very small footprints of disturbance over the very large action area as compared to all of the seafloor disturbance of all other cumulative actions. The relative contribution of the NOS Proposed Action to the overall disturbance of bottom habitat would be minimal. While aggregate, **adverse** cumulative impacts on bottom habitat in EFH areas from all actions and activities throughout the EEZ would be considered **moderate**, the contribution of the NOS Proposed Action to these adverse cumulative effects would be **negligible**.

4.2.6.2 Increase in Sedimentation, Turbidity, and/or Chemical Contaminants in Essential Fish Habitat

Increase in sedimentation, turbidity, and chemical contaminants in EFH from other cumulative actions are associated with the activities that would disturb bottom habitat as discussed above, as well as activities that deposit sediments into receiving waters, and vessel operations. Disturbance of the sea floor would stir up bottom sediment and cause turbidity in the vicinity of the activity. Additionally, sedimentation and turbidity can occur due to input of sediments into the ocean environment from upland activities that cause erosion (e.g., coastal development, beach nourishment, mining, timber harvesting, and agriculture) and from water-based actions (e.g., dam construction, port activities, drag fishing, dredging, and water diversions). Sedimentation can cause loss of important or sensitive aquatic habitat, decrease in fishery resources, loss of coral reef communities, changes in fish migration, loss of wetlands, nutrient balance changes, circulation changes, loss of submerged vegetation, and coastline alteration (Pollution Issues, No Date). Turbidity affects organisms that are directly dependent on light, like aquatic plants, because it limits their ability to carry out photosynthesis. Other organisms that depend on these plants for food and oxygen are then also impacted. For example, turbidity can harm fish by reducing food supplies, degrading spawning beds, and affecting gill function.

In addition to sedimentation and turbidity, there are large numbers of potential sources of both direct and indirect marine contamination, including tankers and other marine vessels, derelict fishing gear, military operations, ocean dumping, airborne deposition, and runoff from industrial and agricultural sources on land. The accidental leakage or spillage of oil, fuel and chemicals; marine debris (e.g., plastics, glass, metals, or rubber); and flows of pollutants, contaminants, sediments, and nutrients in coastal waters stresses the condition of EFH. A significant amount of vessel traffic is expected to occur under the cumulative effects scenario. All vessel operations are associated with a risk of oil and fuel spills and release of contaminants. Contamination from spills and discharges can accumulate in the sea floor and marine life and have a toxic effect on plants, animals, and humans through the food chain. Some chemical compounds, such as polychlorinated biphenyls (PCBs) and pesticides, can persist for many years while others, such as petroleum products, breakdown and get diluted relatively quickly. Pollution is a long-term and widespread issue in the marine environment, although it varies substantially in intensity on a local basis.

NOS activities associated with the Proposed Action, including vessel and ROV operations, anchoring, collection of bottom grab samples, installation of tide gauges and GPS reference stations, and SCUBA operations, could increase sedimentation, turbidity, and chemical discharges in EFH. As vessels used by NOS would only represent a negligible proportion of all vessel traffic in the action area, increases in sedimentation and turbidity due to vessel operations under the NOS Proposed Action would be minimal. While there would be no intentional discharges of pollutants from vessels used by NOS, there is potential for accidental spills to occur. However, the likelihood of occurrence of an accidental spill and the magnitude of a potential spills are likely to be very small and the contribution to the cumulative effects of contamination is considered negligible. Likewise, sedimentation and turbidity from NOS anchoring and land-based projects would be minimal given that they would be conducted infrequently and across a geographically widespread area, and that the footprints of disturbance would be small. Thus, the relative contribution of the NOS Proposed Action to the overall increases in sedimentation, turbidity, and chemical contaminants in EFH would be minimal as compared to other cumulative actions. Aggregate, **adverse** cumulative impacts on EFH from all sources of water pollution would be **moderate**, while the contribution from the NOS Proposed Action would be expected to be **negligible**.

4.2.6.3 Increase in Sound in Essential Fish Habitat

Increases in sound from other cumulative actions could result from vessel and aircraft operations; sonar and other underwater acoustic sources; construction, which may include drilling, pile driving, use of explosives, and dredging; and operation of facilities and structures, such as long-duration sound associated with mechanical vibrations when wind turbine blades are spinning. Noise from other cumulative actions would affect EFH by impacting different life stages of fish and aquatic macroinvertebrate prey species (prey is a potential habitat characteristic of EFH). Behavioral changes can occur, resulting in animals leaving feeding or breeding grounds (Slabbekoorn et al., 2010) or becoming more susceptible to mortality through decreased predator-avoidance responses (Simpson et al., 2016). Noise can also mask biologically important sounds and alter the natural soundscape, cause hearing loss, and/or have an adverse effect on an organism's stress levels and immune system. Cumulative sound impacts on fish are discussed in Section 4.2.4 and on aquatic macroinvertebrates in Section 4.2.5.

NOS activities under the Proposed Action that could result in an increase in underwater sound in EFH would consist of operation of crewed sea-going vessels; operation of ROVs, Uncrewed Surface Vehicles (USVs, and autonomous underwater vehicles (AUVs); and use of underwater acoustic equipment including echo sounders, ADCPs, and acoustic communication systems. The potential effects of sound associated with vessel operations, which would represent less than 0.3 percent of total vessel traffic in the action area, would be minimal as compared to the effects from sound generated by vessels and aircraft from all other cumulative actions. Sound associated with underwater acoustic sources used by NOS would be intermittent and highly directional, potential impacts on prey species would be limited to temporary behavioral and stress-startle responses, and adverse impacts are unlikely to occur due to the much higher frequencies of these instruments relative to the hearing capabilities of most prey species. The relative contribution of NOS Proposed Action to the overall increase in sound in EFH would be minimal compared to the contributions from all other cumulative actions. Overall, the aggregate, **adverse** cumulative impact from the increase in sound in EFH areas would be **minor** to **moderate**, while the contribution from the NOS Proposed Action would be **negligible**.

4.2.6.4 Impacts to the Water Column in Essential Fish Habitat

Impacts to the water column are caused by vessels or equipment moving through the water as part of activities that are part of other cumulative actions. Impacts on EFH due to climate change are also considered here. Wakes from vessels and other disturbance to the water column from equipment moving through it would create turbulence and generate wave and surge effects in the water column where habitat gradients including temperature, salinity, DO, turbidity, and nutrient supply would be temporarily disrupted. Vessel propellers could also cause water column destratification and elevated water temperatures. Vessel and equipment movement through the water column may disrupt benthic communities and other prey species in shallow areas and cause mortality to floating eggs and larvae by physically damaging them with the hull or other ship parts, including the propulsion system. Lines connecting equipment to a vessel could also become entangled with, damage, or kill submerged aquatic vegetation such as seagrass.

Climate change may affect the marine environment in a variety of ways, including changes in sea level, changes in water temperatures, more frequent or extreme weather events, and alteration of ocean currents (NMFS, 2019e). These changes and others are expected to continue over the reasonably foreseeable future and could aggregate with the effects of other cumulative actions to impact the physical water environment. These changes would in turn contribute to changes in the population and distribution of prey species such as fish and aquatic macroinvertebrates; and changes in the population and distribution of fishery resources harvested in commercial fisheries, with related socioeconomic effects (see Section 4.2.9). In addition to changes in air and water temperatures, a related effect of climate change is increased acidification in the ocean caused by dissolved CO_2. Changes in the acidity of the world's oceans are expected to continue and accelerate over the reasonably foreseeable future. Ocean acidification can harm organisms that build shells of $CaCO_3$, including calcareous phytoplankton and zooplankton, corals, bryozoans, mollusks, and crustaceans. These organisms provide shellfish resources for humans, play vital roles in marine food webs, generate sand for beaches, and add to the physical structure of the sea floor. Although the dynamics of climate change and the potential magnitude and timing of its effects are poorly understood, there is general acknowledgement that the potential impacts resulting from climate change could be substantial.

Impacts to the water column expected from the NOS Proposed Action would be caused by vessels or equipment moving through the water column in activities including operation of crewed sea-going vessels; operation of ROVs, USVs, and AUVs; anchoring; use of sound speed data collection equipment and bottom grab samplers; operation of drop/towed cameras and video systems; and SCUBA operations. These impacts would be temporary, mobile prey species would not likely move too far away, and conditions would be expected to stabilize and species would return once water column turbulence ceased. The NOS Proposed Action would only contribute a very small impact on the water column as compared to all other cumulative actions. Although CO_2 emissions from vessels used by NOS would contribute to atmospheric CO_2 levels, the contribution would be a very small fraction compared to other anthropogenic CO_2 sources. Aggregate, **adverse** cumulative impacts to the water column in EFH from all actions would be **moderate**. When aggregated with the impacts of past, present, and reasonably foreseeable future actions in the action area, the NOS Proposed Action would make a **negligible** additive contribution to cumulative adverse effects on the water column in EFH.

4.2.6.5 Dispersal of Invasive Species in Essential Fish Habitat

Dispersal of invasive species could occur from all other cumulative actions listed in Section 4.1 and in conjunction with ongoing climate change. Cumulatively, these actions could facilitate the dispersal of invasive species throughout EFH in the action area, reducing the availability of space, shelter, cover, and nutrients for dependent endemic species. Cumulative actions would occur in all regions of the action area and could involve transiting and surveying across large swaths of the action area using the same physical equipment and survey instrumentation as NOS activities. These larger transits or projects could inadvertently transport invasive macroinvertebrate larvae, vertebrate eggs or animals, plant seeds, or algae propagules in ballast water or on equipment surfaces to novel areas, thereby facilitating their dispersal and establishment. Invasive species often have large numbers of offspring and limited or no natural threats or predators outside of their native habitat, allowing them to outcompete locally endemic species for space and nutrients.

Over time, invasive species could propagate far beyond the initial site of establishment, which could cumulatively result in cascading impacts to the local food chains through the extirpation of local predators and prey due to reduced nutrient cycling and availability. These impacts would change habitat structure and reduce the habitat value of affected areas in the long term or permanently after the establishment of invasives; these invasive species and their resulting impacts would persist until all invasive organisms were removed from a given area through aggressive trapping, harvesting, or use of pesticides such as glyphosate. Global rising sea temperatures as a result of ongoing climate change could cumulatively exacerbate these impacts by shifting the distribution of ideal abiotic habitat conditions (e.g., water temperature or acidity) for endemic species. Invasive species typically have wider ranges of tolerance for abiotic environmental conditions, allowing them to withstand climate-related stresses and either outcompete less tolerant endemic species or establish themselves in habitat areas vacated by endemic species dispersed by altered abiotic environmental conditions.

Physical equipment and instruments used in consecutive projects in disparate geographically regions could potentially serve as transmission vectors for invasive species, which could cumulatively reduce the habitat value of their area of introduction by outcompeting endemic plants, animals, and algae. After establishment, cumulative impacts could potentially spread beyond project areas and persist until invasive species are suppressed or removed from these areas via aggressive management techniques and procedures, reducing the availability of space, shelter, cover, or nutrients for dependent species outside of the range of natural variation. However, vessel crews on NOS projects would implement invasive species control procedures such as deballasting or equipment washing as required by law, thereby reducing the likelihood of invasive propagation. The above-described NOS effects can also occur in almost all human use of water. These effects would be indistinguishable in type from other human uses. Overall, given its relatively low likelihood of occurrence, the aggregate, **adverse** cumulative impact of invasive species dispersal would be **minor** to **moderate**. The contribution to these aggregate, adverse cumulative impacts on invasive species dispersal from the NOS Proposed Action would be **negligible**.

4.2.6.6 Conclusion

NOS actions would contribute to the adverse cumulative impacts from all actions on EFH. This would occur through physical impacts to bottom habitat (from other cumulative actions could result from such activities as commercial fishing, carbon storage, O&G development, dredged material disposal, structure emplacement, and new cable infrastructure), increase in sedimentation, turbidity, and chemical contaminants (from activities that would disturb bottom habitat, activities that deposit sediments into receiving waters, and vessel operations), increases in sound (from vessel and aircraft operations; sonar and other underwater acoustic sources; construction, which may include drilling, pile driving, use of explosives, and dredging; and operation of facilities and structures), and impacts to the water column (from vessels or equipment moving through the water column and climate change).

The aggregate impacts of past, present, and reasonably foreseeable future actions are expected to result in insignificant impacts to EFH in the action area. The cumulative impacts of other cumulative actions affecting physical impacts to bottom habitat; increase in sedimentation, turbidity, and chemical contaminants; and increase in sound would be **moderate** and adverse as EFH would not be degraded over the long term or permanently, would continue to support sustainable fisheries, and the continued viability of prey populations would not be threatened; therefore, cumulative impacts would be insignificant. In recent years, there have been efforts to reduce pollution of ocean environments through restrictions on discharges and design features of ocean-going vessels that reduce the probability and severity of spills. As a result, more recent incidents involving unauthorized spills or discharges have either been localized and limited or, if large and widespread, have generated cleanup and mitigation responses. However, impacts to the water column from climate change could be substantial; therefore, cumulative impacts on EFH would be overall **moderate** to **major** from other cumulative actions contributing large atmospheric CO_2 levels leading to increased rates of climate change. Overall, aggregate, adverse cumulative impacts of all actions described in Section 4.1 result in **moderate** cumulative impacts.

Cumulative, adverse impacts from any of the alternatives in combination with the cumulative effects scenario could potentially be considered either synergistic or additive depending on the timing and location of activities and impacts. Cumulative adverse impacts from these activities could be synergistic if activities associated with the NOS Proposed Action and other cumulative actions occur in close spatial or temporal proximity. Similarly, additive effects on EFH may occur if activities associated with the NOS Proposed Action and other cumulative actions are considered sequentially. Overall, cumulative impacts would be considered **negligible** under the NOS Proposed Action because the impacts would be temporary or short-term, would be confined to the immediate vicinity of project areas, and would be small as compared to impacts from all other cumulative actions. The Proposed Action would contribute to and have the potential to increase cumulative impacts on EFH, but their relative contribution would be **negligible** as compared to the aggregate contributions of other cumulative actions. These impacts would occur regardless of the chosen alternative since projects under each alternative would be composed of similar activities and take place in the same geographic areas and timeframes; however, Alternatives B and C would include more projects, activities, and nautical miles traveled than Alternative A, and would therefore have slightly greater impacts.

4.2.7 Seabirds, Shorebirds and Coastal Birds, and Waterfowl

Given the ecological concordance between bird groups, impacts that would affect all groups are hereafter referred to as impacts on birds. Specific impacts based on behavior or habitat of an individual group or species are explicitly stated throughout the analysis.

All past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects to birds. The analysis of cumulative effects also considers other actions and activities on birds, including habitat encroachment from onshore and nearshore development (e.g., coastal population growth); marine debris (e.g., plastics, glass, metals, or rubber) and accidental or illicit discharge of oil, fuel, chemicals, or waste.

4.2.7.1 Direct Injury to Sea Birds, Shorebirds and Coastal Birds, and Waterfowl

Crewed vessel operations and active acoustic surveying under the NOS Proposed Action would contribute to cumulative impacts on birds along with the use of high intensity active underwater acoustic sources and the presence and movement of vessels associated with any of the past, present, or reasonably foreseeable actions. In aggregate, they would likely cumulatively contribute direct injury impacts to birds or their prey. Although exposure to the active underwater acoustic sources proposed by NOS would only occur for diving birds and would not likely be harmful, other active acoustic sources commonly used in other surveying and mapping activities, assessment and exploration of marine minerals, and offshore carbon storage assessments have a greater propensity to injure diving birds due to the high intensity and large-scale propagation of the broadband sound they produce. These high intensity sources, including airguns, could have a more substantial impact on birds than the NOS sources described in Section 3.10, especially when considered cumulatively.

The presence and movement of crewed vessels within the action area, including all vessels used in conjunction with activities under the Proposed Action and all past, present, and reasonably foreseeable actions of the cumulative effects scenario and offshore renewable energy installations, would likely cumulatively contribute to collisions or entanglement of all species of birds or their prey. All vessel movements could potentially result in collisions with airborne or floating birds and would cumulatively contribute direct injury or mortality impacts. Offshore renewable energy installations, particularly wind turbines, could similarly contribute to cumulative collision impacts since birds often are unable to recognize and avoid dangerous features of installations. Expanded commercial fishing operations would likely increase numbers of birds or their prey in bycatch, particularly in longline or trawled fisheries where operators cannot continuously monitor trailed lines, hooks, and nets for protected species. As such, the overall abundance of birds and their finfish prey would likely be reduced. Accidental collisions with birds occasionally occur at night; however, NOS will use appropriate lighting to comply with navigation rules and best safety practices, limiting the exposure of birds to onboard lighting. All project areas would be continually monitored for protected species by posted crewmembers during vessel operations, further reducing the risk of collision with birds. While spills from NOS activities are not likely, accidental or illicit discharges of fuel, chemicals, or waste accompanying other vessel operations within the study area contribute to the existing direct injury of birds and prey through ingestion and interaction with spilled substances, although the intensity of the impact would be contingent upon the size and location of the discharge in question. Contaminated prey could also potentially serve as an additional source of spill exposure to birds, particularly of bioaccumulated hazardous materials. Discharged waste is of particular concern to birds, given their propensity to ingest and entangle themselves in many forms of marine debris (e.g., plastics, glass, metals, or rubber).

When considered in tandem with crewed vessel operations, tide gauge installations, and remote GPS reference station installations under the Proposed Action, changing abiotic environmental characteristics related to ongoing climate change could potentially contribute direct injury impacts to birds or their prey. Other actions and activities that are sources of environmental stress, including ongoing habitat encroachment from onshore or nearshore development and coastal development, contribute to the current direct injury of birds. Increased light pollution from onshore and nearshore commercial or O&G development attracts or disorients bird fledglings, particularly alcids, and causes them to land in dangerous areas. Artificial-light-induced landings can result in broken limbs, internal injuries, or even fatalities when fledglings collide with buildings, electric wires and pylons, fences, and posts. Grounded fledglings are sometimes unable to take flight again, and light-induced landings leave fledglings vulnerable to predation by terrestrial animals, collisions with terrestrial vehicles or to starvation and dehydration in the event they are unable to find their way back to sea.

Similarly, ongoing climate change will continually alter marine environmental conditions throughout the timespan of this analysis, which could result in direct injury of bird prey. Although environmental conditions will not likely change to the point of directly injuring birds, ocean acidification accompanying climate change could potentially harm macroinvertebrate prey species (bivalves, gastropods, and cephalopods) that are particularly sensitive to environmental conditions during their larval stages and will likely reduce their availability to birds. Rising surface water temperatures will also reduce the solubility of oxygen in seawater (resulting in lower dissolved oxygen levels) and could inhibit or stress the respiration of all marine prey species, further cumulatively reducing prey availability for birds within the EEZ.

The majority of cumulative direct injury impacts would be limited to the immediate vicinity of vessels or O&G development and would not likely cause long-term changes in bird behavioral patterns, habitat availability and use, or the demographic structure and abundance of bird and prey population. Similarly, climate-related impacts would not likely substantially affect birds, although the magnitude of the impact will likely continue to increase over time. Overall, cumulative direct injury impacts on birds would occur regardless of the chosen alternative, would be short-term to long-term, **adverse**, and **negligible** to **minor**. The contribution of the NOS Proposed Action to these aggregate, adverse cumulative impacts would be **negligible**.

4.2.7.2 Disturbance and Displacement of Sea Birds, Shorebirds and Coastal Birds, and Waterfowl

Sound-producing and vessel operation activities under the NOS Proposed Action would contribute to cumulative effects produced by other active acoustic sound sources, especially from high intensity sources used in O&G surveying. In combination, these actions could temporarily displace diving birds and their prey throughout the EEZ and cause cumulative adverse impacts to birds. Sound from survey vessels, shipping vessels, commercial fishing vessels, recreational boats, and underwater construction activities in support of energy infrastructure, LNG terminals, and submarine telecommunications infrastructure could also cumulatively disturb and displace all species of birds and their prey from the respective project areas for the duration of the activity in question. The visual presence of vessels would also likely serve as an additional source of disturbance and displacement.

When considered in tandem with underwater disturbance from vessel movement and presence and bottom sampling under the NOS Proposed Action, reduced water quality and increased turbidity resulting from the ongoing erosion of coastlines by rising sea levels, bottom sampling, and underwater construction activities would also disturb and displace birds and prey; such activities conducted by NOS would be extremely limited. Climate change will continue to raise sea levels globally for the foreseeable future, which results in continual erosion throughout the coastlines of the EEZ. Coastal erosion occurs at varying rates around the EEZ, but would be most pronounced along the Atlantic coastline. Reduced water quality and increased turbidity in these areas from ongoing coastal erosion would likely shift prey distributions and could result in increased bird foraging effort; travel time to foraging areas could increase due to shifted prey distributions; and foraging success could decrease due to reduced visibility of prey species in turbid waters. While spills from NOS activities are unlikely, the ongoing accidental or illicit discharges of fuel, chemicals, or waste from other vessel operations and marine infrastructure contribute to currently disturbed and displaced birds and their prey from contaminated areas for the lifetime of the spill. The intensity of the impact is contingent upon the size and location of the spill in question; most small spills are dissipated by ocean conditions on a timescale of minutes to hours.

Cumulative disturbance and displacement impacts would likely be limited to the immediate vicinity of the source and would not persist beyond the conclusion of activities. These impacts are not expected to cause long-term changes in habitat availability, overall bird behavioral patterns, or overall prey availability and would be considered **adverse** and **negligible** to **minor**. The contribution of the NOS Proposed Action to these adverse cumulative impacts would be **negligible**.

4.2.7.3 Degradation and Reduction of Habitat for Sea Birds, Shorebirds and Coastal Birds, and Waterfowl

Onshore tide gauge installations and remote GPS reference station installations under the NOS Proposed Action would contribute to cumulative impacts along with the construction, operation, and decommissioning of long-term installations such as LNG terminals, energy infrastructure, and submarine telecommunications. In aggregate, these would likely reduce the total amount of oceanic and coastal habitat available to birds and their prey for the lifetime of the installations. Long-term installations would occupy space within viable habitat areas, reducing the total habitat available to birds and their prey. Furthermore, activities or actions related to the maintenance and operation of these long-term structures would degrade the habitat quality of surrounding areas. However, NOS onshore activity would likely only displace birds and prey within the immediate vicinity of the project area and would not cause any mortality or direct injury. Onshore installations would only occupy very small portions of available habitat and birds and their prey are expected to return to project areas after the completion of NOS onshore activities.

The ongoing accidental or illicit discharges of fuel, chemicals, or waste from other vessel operations and marine infrastructure contribute to currently degraded sensitive coastal nesting habitat; accidental spills from NOS activities are very unlikely. Coastal ground-nesting birds such as piping plovers and red knots breed and nest in areas below the high-water line that are particularly susceptible to contamination from spilled materials. The overall intensity of the impact is contingent upon the size and distance of the spill in question from nesting beaches; most small spills are dissipated by ocean conditions on a timescale of minutes to hours.

The existing stress from coastal population growth also contributes to the degradation of bird habitat through a variety of factors, including coastal water quality reductions from urban/agricultural runoff, encroachment by coastal development, and increased light pollution. Rising sea levels as a result of climate change will continually erode coastlines along the EEZ over the next five years and could potentially destroy or degrade coastal nesting areas, particularly of sensitive coastal ground-nesting species. However, the magnitude of these impacts is contingent upon the amount of coastal erosion within a given area.

Reduced water quality would also displace finfish prey species from eroded areas and could potentially increase the foraging energy expenditures of birds. Changing climate conditions, such as rising surface water temperatures, shifting currents, and shifting wind patterns, will change the location and intensity of deep-water upwellings, an important source of oceanic nutrients. Prey distributions will likely shift along with oceanic nutrients, which could ultimately reduce the total amount of available prey if the bird dispersal rate is relatively lower than that of their prey. Seabirds are particularly susceptible to habitat reduction because their high levels of behavioral resilience and experience-based learning limit their ability to disperse to new areas and follow shifting prey distributions.

Generally, cumulative impacts to bird habitat would persist for the entirety of the foreseeable future, but would not substantially reduce overall habitat availability or quality and would not substantially impact the overall structure or abundance of bird or prey populations. Shifting prey distributions in response to changes in oceanic nutrient cycling could potentially impact the overall population of some seabird species that return to the same areas or islands to breed or forage annually. These birds have high levels of behavioral resilience and foraging specialization and would not likely be able to follow their original prey or adapt to include new species in their diet. However, nesting areas are generally avoided by development given the federal protection of most birds under the Migratory Bird Treaty Act (MBTA), and aggregate, **adverse** cumulative impacts to bird habitat would likely be **minor**. The contribution of the NOS Proposed Action to these aggregate, adverse cumulative impacts would be **negligible**.

4.2.7.4 Conclusion

Activities associated with the Proposed Action and the past, present, and reasonably foreseeable actions described in the cumulative effects scenario have the potential to contribute cumulatively to direct injury, disturbance and displacement, and habitat reduction in the action area. In the short-term, the presence and movement of vessels and the development of offshore renewable energy installations could potentially result in direct injury to birds from collisions or entanglements and would likely disturb or displace nearby birds for the duration of activities. Similarly, changing abiotic environmental conditions resulting from ongoing climate change and the stress already placed on birds due to habitat encroachment from onshore or nearshore development could serve as additional sources of cumulative direct injury to birds and their prey. Active acoustic sound sources; vessel sound; underwater activities; and ongoing climate change would displace birds and their prey in the immediate vicinity of activities. Disturbances and displacements resulting from activities are not expected to persist beyond the duration of activities, and short-term cumulative impacts would likely range from **negligible** to **moderate**. Onshore and nearshore development and accidental discharges of oil, fuel, chemicals or waste already reduce the total amount of available bird habitat and climate change would cumulatively impact the total amount of available bird habitat in the long term. As such, the long-term cumulative impact of habitat reduction on birds would likely be **minor**.

Cumulative adverse impacts from any of the alternatives in combination with the cumulative effects scenario could potentially be considered either synergistic or additive depending on the timing and location of activities and impacts. Synergistic impacts could result if any activities or actions occur in close spatial or temporal proximity within the action area. For example, a mapping project in close proximity to an operating offshore oil well could substantially disturb birds through the visual presence and sound of both vessels used by NOS and the installation and could result in bird avoidance of project areas for longer periods of time than would be elicited by either of the impact-causing factors independently.

Similarly, additive cumulative impacts to birds, their prey, or their associated habitat could occur if activities or actions are conducted sequentially within adjacent areas of the action area. For example, water quality in coastal areas could be additively degraded if a bottom sampling project was conducted shortly after the installation of a wind turbine. Although the exact timing and location of projects have not been finalized and are subject to change, the Southeast and Alaska regions contain the largest proportion of total vessel ~~transit~~ miles of the EEZ (Section 2.4.1) and relatively high levels of marine O&G development. Therefore, synergistic or additive cumulative impacts are most likely to occur in either of these regions. The vast majority of cumulative impacts are confined to the immediate vicinity of project areas and would likely not impact the overall abundance or structure of bird or prey populations outside of the range of natural variability.

Overall, the Proposed Action would contribute a **negligible** amount to the aggregate cumulative effects from all actions described in Section 4.1 depending on the timing and location of impacts within the five-year forward projection of the entire five-year timespan of the analysis. These impacts would occur regardless of the chosen alternative since projects under each alternative would be composed of similar activities and take place in the same geographic areas and timeframes; however, Alternatives B and C would include more projects, activities, and nautical miles traveled than Alternative A, and thus contribute slightly greater impacts.

4.2.8 Cultural and Historic Resources

All past, present, and reasonably foreseeable future actions described in Section 4.1 would contribute cumulative effects to cultural and historic resources. The analysis of cumulative effects also considers the impact of other actions and activities on cultural and historic resources, including IUU fishing; accidental or illicit discharges (e.g., nutrient runoff, oil spills, or other introduction of contaminants); and flows of pollutants, contaminants, sediments, and nutrients into coastal waters.

4.2.8.1 Damage and Destruction of Submerged Cultural and Historic Resources

Anchoring, bottom sampling, and other activities that would disturb the sea floor, such as the installation of ADCPs, under the Proposed Action would contribute to cumulative impacts associated with increases in the number of vessels and boats anchoring or conducting surveying and mapping throughout the EEZ, the construction, operation, and decommissioning of long-term installations such as LNG terminals and submarine telecommunications cable and associated infrastructure, offshore and OCS oil and natural gas development, offshore renewable energy development, and the assessment and extraction of marine minerals. In combination, all these actions would likely cumulatively increase the risk of damage to submerged cultural and historic resources.

Coral reefs, vital to subsistence cultures and thus considered a cultural resource, would also be at increased risk of cumulative damage from these activities. Coral reefs host more than one quarter of all marine fish species, in addition to many other marine animals. Reefs also provide subsistence food and sustain the fishing and tourism industries (IUCN, 2022). Cultural and historic resources (including coral reefs) could be impacted by physical contact with anchors, submarine cables, equipment used for mineral extraction, and other underwater construction activities. As with vessels used by NOS operators, most vessels would anchor whenever practicable in designated areas and would avoid anchoring on shipwrecks and downed aircraft, coral reefs, and hard bottomed areas. This practice would also be followed during construction of underwater infrastructure and other activities described in Section 4.1. This practice would limit the likelihood of direct damage to known submerged cultural and historic resources, including coral reefs.

Inadvertent discovery of cultural and historic resources during construction of infrastructure such as LNG terminals is often associated with damage or destruction of the resource. These impacts would be adverse and permanent. It is possible that the inadvertent discovery of cultural and historic resources could be considered a beneficial impact due to the research potential that discovery would afford if the resource were not damaged or destroyed. For federal activities (including those requiring a federal authorization or permit), adverse impacts could be avoided or minimized to some degree through consultation between the lead agency and the State Historic Preservation Officer (SHPO) in compliance with Section 106 of the National Historic Preservation Act (NHPA) prior to construction. This communication serves to ensure avoidance of known culturally and historically significant sites, and to ensure that if cultural and historic resources are encountered, standard protocols related to protection and documentation of the resource would be followed. Generally, if a cultural or historic resource is discovered during construction, work stops until the SHPO can properly evaluate the resource.

The majority of cumulative damage impacts would be limited to the locations in which anchors are dropped or bottom sampling related to NOS projects and activities occurs, and in the immediate vicinity of offshore O&G development, assessment and extraction of marine minerals, and construction of submarine infrastructure, and would cause permanent impacts to cultural and historic resources, including coral reefs. Impacts could be either **adverse** or **beneficial**, depending on whether the resources were damaged or destroyed or protected and documented. Overall cumulative impacts to submerged cultural and historic resources from direct damage would likely be **negligible** to **moderate**; the contribution of any of the NOS alternatives to these adverse, cumulative impacts would be **negligible**.

Submerged cultural and historic resources are currently stressed due to accidental leakage or spillage of oil, fuel, and chemicals and the unintentional disposal of trash and debris, though NOS does not contribute to these actions (See Section 3.15). While not considered a cumulative impact, the stress has contributed to the existing condition of cultural and historic resources and is noteworthy. Cultural and historic resources may be exposed to hydrocarbon contamination (the result of oil spills). The effects of oil vary depending on the type of material and the condition it is in— sun-dried wood, for example, may absorb the oil more readily than shells in middens (NPS, 2010). The absorption of oil by cultural and historic resources can make radiocarbon dating impossible. Impacts from oil spills to cultural and historic resources could be permanent. Other contaminants, sediments, and nutrients can adversely impact the structural integrity of cultural and historic resources, with the greatest adverse effects occurring in waters with limited circulation such as bays, sounds, and estuaries. Impacts to cultural and historic resources from these actions and activities depend on the extent of contamination and the nature of the pollutant or other substance introduced by vessels throughout the action area.

When considered in tandem with all past, present, and reasonably foreseeable projects listed in Section 4.1, impacts stemming from climate change would cumulatively increase the likelihood of damage to submerged cultural and historic resources. Increased temperatures cause accelerated rusting in submerged resources, more rapid decay of organic materials, damage from increased biological activity at shallow underwater sites, and increased risk of damage due to decline and loss of protective sea grass or nearby coral reefs. Rising temperatures also lead to faster deterioration of newly exposed artifacts and sites. Ocean acidification will cause increased risk of damage to shipwrecks due to loss/decline of protective concretions and/or nearby coral reefs. It will also cause decline in reefs from coral bleaching.
Adverse climate change impacts will occur regardless of the chosen alternative, are long-term, and could result in **minor** to **moderate** impacts on cultural and historic resources within the next five years; the contribution of any of the NOS alternatives to these cumulative impacts would be **negligible**.

4.2.8.2 Degradation of Cultural and Historic Viewsheds

Installation of tide gauges and GPS reference stations under the Proposed Action would contribute to cumulative effects on historic viewsheds from the activities listed in Section 4.1 that involve nearshore or coastal construction activities. In aggregate, these individually negligible to minor actions would change historic viewsheds and thus cause cumulative, adverse impacts to cultural and historic viewsheds. Activities occurring within the viewshed of a nearshore historic property or designed cultural landscape could change these designed views, vistas, or view corridors and impact the integrity of the property's design, not simply cause visual effects on the integrity of a historic property's setting or other historic characteristics.

However, federal construction work proposed within the area of potential effect (APE) of coastal structures listed or eligible for listing on the National Register of Historic Places (NRHP) generally requires consultation with the appropriate SHPO prior to construction. Adherence to this protocol would help to minimize or avoid potential impacts to coastal structures listed or eligible for listing on the NRHP. Thus, the likelihood of adverse impacts to cultural and historic resources for which viewshed is a contributing element would be low, given the likely avoidance of NRHP-listed sites during the site selection process or avoidance of impacts to historic coastal structures following communication with the SHPO. Impacts would occur only within the APE of the cultural or historic resource, and would be **adverse** and **minor**; the contribution of any of the NOS alternatives to these adverse cumulative impacts would be **negligible**.

4.2.8.3 Disruption to Subsistence Hunting and Fishing, Including in TCPs

Activities producing sound and visual disturbances under the Proposed Action (e.g., the use of active underwater acoustic sources, vessel and equipment sound, physical presence of vessels and equipment in water, and human activities such as tide gauge and GPS reference station installation, and SCUBA operations), the operation and presence of vessels, equipment, and humans would contribute to cumulative impacts on subsistence hunting and fishing associated with any of the past, present, or reasonably foreseeable actions described above. Together, these would create short- and long-term adverse cumulative impacts to subsistence hunting and fishing, including those taking place in Traditional Cultural Places (TCPs). Activities that create sound and visual disturbance would cause species to move away from the shore, and subsistence hunters could be forced to temporarily abandon common hunting areas. Increased recreational and commercial fishing could reduce the availability of species important to subsistence communities; this could have long-term adverse impacts on these communities. Subsistence harvests in the marine environment could be disrupted or prolonged, or subsistence resources could be unavailable for use.

In the short-term, the presence and movement of vessels could potentially result in disturbance of traditional use in TCPs and subsistence hunting and fishing areas for the duration of project activities. Disturbance to subsistence activities and sociocultural systems are discussed in greater detail in Section 4.2.10.1. Impacts could also occur if a species important to subsistence communities were overfished or contaminated. Subsistence resources are currently stressed due to accidental leakage or spillage of oil, fuel, and chemicals and the unintentional disposal of trash and debris. Contaminated, or perceived contaminated, resources could make subsistence resources unavailable or undesirable for use (BOEM, 2015b). Contamination from oil/chemical spills would render the affected subsistence resource unsafe to eat. If the skin or fur of the animal is coated with oil, the pelt would no longer be desirable to be made into coats and other handicrafts. Spill cleanup operations could result in the closure of harvesting areas until cleanup is complete. Other actions and activities causing the contamination of subsistence resources are discussed further in Section 4.2.10.3.

However, federal actions that would have effects within a reservation or Alaska Native village; affect tribal trust resources or the rights of a federally recognized Tribe; affect a facility or entity owned or operated by a tribal government; affect Tribes, tribal governments, or a Tribe's traditional way of life; or affect TCPs or Traditional Use Areas would trigger the need for communication with Tribes. It is possible that projects that would occur in traditional hunting and fishing areas would be coordinated to avoid peak hunting and fishing seasons (e.g., whales, seals, and salmon) or times of year to the extent possible, based on information obtained from the Tribes. Activities planned to occur in any NRHP-listed TCP would need to comply with federal regulations related to the protection of these culturally significant places. Even if peak seasons and times are not avoided, cumulative disruption of subsistence hunting and fishing and other traditional practices by tribes from additional vessels in TCPs and Traditional Use Areas would be temporary, **adverse**, and **negligible** to **moderate**.

When considered in tandem with all past, present, and reasonably foreseeable projects listed in Section 4.1, impacts stemming from climate change would cumulatively increase the likelihood of impacts to subsistence hunting and fishing, including in TCPs. Climate change-induced factors such as changes in thickness and extent of sea ice, increased snowfall, drier summers and falls, and increased storms and coastal erosion could adversely affect subsistence harvest patterns by altering traditional hunting locations, impacting subsistence travel, and result in resource patterns shift and seasonal availability changes, making access to subsistence resources more difficult (NOAA, 2016). The impacts of changes in sea ice and other vital components of subsistence hunting and fishing areas on subsistence communities are described in detail in Section 4.2.10.2.

Overall, climate change could lead to changes in diversity, abundance, and distribution of traditional subsistence resources and harvest patterns, leading to long-term impacts on the availability of some subsistence resources. This could potentially threaten indigenous lifestyle and subsistence practices (NOAA, 2016). Adverse, cumulative climate change impacts will occur regardless of the chosen alternative, are long-term, and could result in **moderate** to **major** impacts on subsistence hunting and fishing; the contribution of any of the NOS alternatives to these adverse, cumulative impacts would be **negligible**.

4.2.8.4 Conclusion

When considered with the NOS Proposed Action, other surveying and mapping efforts in the action area, offshore oil and natural gas development, offshore renewable energy development, climate change, commercial shipping and recreational boating, assessment and extraction of marine minerals, offshore carbon storage resource assessments, construction and operation of offshore LNG terminals, national defense and homeland security activities, construction of new submarine telecommunication cable infrastructure, commercial and recreational fishing, and coastal development would create adverse cumulative impacts to cultural and historic resources. Adverse impacts to cultural and historic resources could occur through the damage and destruction of submerged cultural and historic resources including coral reefs, degradation of historic viewsheds, and disruption of subsistence hunting and fishing, including in TCPs.

Overall, the short-term and long-term adverse cumulative impacts from the cumulative effects scenario on cultural and historic resources range from **negligible** to **major.** Cumulative impacts to submerged cultural and historic resources from direct damage would likely be negligible to moderate. These impacts would be permanent, since damage cannot be reversed. Adverse climate change impacts will occur regardless of the chosen alternative, are long-term, and could result in minor to moderate impacts on cultural and historic resources within the next five years. Ongoing damage to cultural and historic resources from other actions and activities such as oil spills and flows of other pollutants, contaminants, sediments, and nutrients into coastal waters would be negligible to moderate, depending on the extent of contamination and the nature of the pollutant or other substance introduced by vessels throughout the project area. The likelihood of adverse cumulative impacts to cultural and historic resources for which viewshed is a contributing element from nearshore or coastal construction activities would be low, given the likely avoidance of NRHP-listed sites during the site selection process or avoidance of impacts to historic coastal structures following communication with the SHPO. Impacts would occur only within the APE of the cultural or historic resource, and would be minor. Even if peak seasons and times for subsistence hunting and fishing are not avoided, cumulative disruption of these and other traditional practices by tribes from additional vessels in TCPs and Traditional Use Areas would have negligible to moderate impacts. Impacts stemming from climate change would cumulatively increase the likelihood of impacts to subsistence hunting and fishing, including in TCPs. Adverse climate change impacts will occur to subsistence hunting and fishing practices regardless of the chosen alternative and are long-term. Impacts would be moderate to major. Cumulative impacts from climate change on subsistence hunting and fishing practices are therefore significant. As such, cumulative impacts on cultural and historic resources would be significant without consideration of the impacts of the Proposed Action.

Cumulative, adverse impacts from any of the alternatives in combination with the cumulative effects scenario could be considered as either synergistic or additive depending on the timing and location of activities and impacts. Synergistic impacts could result if any activities or actions occur in close spatial or temporal proximity within the study area. Similarly, additive cumulative impacts to cultural and historic resources could occur if activities or actions are conducted sequentially within adjacent areas of the action area. Although the exact timing and location of projects have not been finalized and are subject to change, the Southeast and Alaska regions contain the largest proportion of total miles of NOS vessel movement in the EEZ (Section 2.4.1) and relatively high levels of marine O&G development. Therefore, synergistic or additive cumulative impacts are most likely to occur in either of these regions. The vast majority of cumulative impacts are confined to the immediate vicinity of project areas and are not likely to occur within TCPs, where certain types of activity and development are not permitted.

The NOS Proposed Action would contribute to and have the potential to increase these cumulative impacts, but their relative contribution would be **negligible** as compared to the aggregate contributions of other cumulative actions. These impacts would occur regardless of the chosen alternative since projects under each alternative would be composed of similar activities and take place in the same geographic areas and timeframes; however, Alternatives B and C would include more projects, activities, and nautical miles traveled than Alternative A and thus contribute slightly greater impacts.

4.2.9 Socioeconomic Resources

Other surveying and mapping efforts in the action area, offshore oil and natural gas development, offshore renewable energy development, commercial shipping and recreational boating, assessment and extraction of marine minerals, offshore carbon storage resource assessments, the construction and operation of offshore LNG terminals, construction of new submarine telecommunication cable infrastructure, commercial and recreational fishing, and coastal development described in Section 4.1 would all contribute cumulative beneficial impacts to socioeconomic resources.

4.2.9.1 Economic Benefits to the Ocean Economy

All mapping and surveying activities under the NOS Proposed Action would contribute to cumulative impacts along with other surveying and mapping efforts in the action area associated with the past, present, and future reasonably foreseeable actions (including offshore carbon storage and carbon storage assessments, offshore O&G development, offshore renewable energy development, and the assessment and extraction of marine minerals). In aggregate, these actions would likely cumulatively contribute indirect economic benefits described in Section 3.12.2.

The high-resolution oceanographic data collected during mapping and surveying activities would be used by collecting agencies or third parties to create or improve navigational maps/charts and forecasts/nowcasts of ocean or meteorological conditions. The increased accuracy and precision of these resulting data products would benefit all major sectors of the ocean economy, including health and safety activities (including coastal or climate resilience planning), recreational activities, transportation, energy, and commercial fishing. These sectors would primarily benefit through operational cost reductions from optimized route or development planning, enhanced risk management from enhanced ocean condition forecasts and nowcasts, and increased revenues from higher landed values or enhanced precision and accuracy in the location, quantification, and extraction of oceanic energy resources. Indirect, cumulative effects would occur from further increasing operational efficiency and reducing risks (e.g., route-planning, fishing ground selection, targeting of O&G resources, closing/opening recreational areas).

Although mapping and surveying activities would not directly create large numbers of jobs or stimulate migrations of workers, mapping and surveying related to offshore carbon storage assessments and offshore development of renewable and fossil fuel energy sources would have greater indirect economic cumulative impacts compared to other sectors. The oceanographic data collected would facilitate the leasing and development of future oceanic carbon storage or offshore/nearshore energy projects, which would entail large scale job creation and capital expenditures in coastal areas near project sites.

These impacts would persist as long as the data collected and resulting data products are available for review by the public, and certainly for the entirety of the duration considered in the cumulative effects analysis. As such, other surveying and mapping efforts in the action area would cumulatively contribute long-term, indirect, **moderate, beneficial** impacts to socioeconomic resources. The contribution of the NOS Proposed Action to these aggregate, beneficial cumulative effects would likewise be long-term, indirect, **moderate**, and beneficial.

4.2.9.2 Indirect Effects on Jobs and Revenue

Indirect economic benefits resulting from all mapping and surveying activities under the Proposed Action would contribute to cumulative effects on jobs and revenue from all past, present, and future reasonably foreseeable revenue-generating actions. In combination, these would cumulatively result in indirect cumulative economic benefits to the ocean economy. Offshore O&G development, offshore renewable energy development, the expansion of commercial shipping and recreational boating, assessment and extraction of marine minerals, and the construction of LNG terminals would all generate substantial amounts of revenue within the study area. Although mapping and surveying would not directly impact these economic sectors, the enhanced accuracy and precision of ocean data resulting from mapping efforts would expedite and facilitate greater development of offshore energy resources, both from fossil fuels and renewable energy. Marine energy developments create large numbers of jobs related to the construction, operation and maintenance, and eventual reclamation in coastal areas near project sites.

Similarly, the expansion of commercial shipping will require hiring of additional crewmembers and port employees. The majority of revenue-generating cumulative actions would also require large capital expenditures in coastal regions for raw materials or necessary equipment. Second order economic benefits would be generated in coastal economies from consumer or retail expenditures by newly employed workers or the growing number of recreational boaters. These impacts would persist for the entirety of the duration of the cumulative effects analysis and beyond into the foreseeable future.

The enhanced accuracy and precision of ocean data resulting from mapping efforts would expedite and facilitate greater development of offshore energy resources. Due to the resulting revenue and jobs that would be created, cumulative impacts on socioeconomic resources would be long-term, indirect, **moderate**, and **beneficial**; the contribution of the NOS Proposed Action would also be long-term, indirect, **moderate**, and beneficial.

4.2.9.3 Conclusion

When considered with the NOS Proposed Action, other surveying and mapping efforts in the action area, offshore oil and natural gas development, offshore renewable energy development, commercial shipping and recreational boating, assessment and extraction of marine minerals, offshore carbon storage resource assessments, the construction and operation of offshore LNG terminals, construction of new submarine telecommunication cable infrastructure, commercial and recreational fishing, and coastal development would create cumulative impacts to socioeconomic resources. Impacts to socioeconomic resources could include impacts to the ocean economy and on jobs and revenue.

Overall, the short- and long-term beneficial cumulative impacts from the cumulative effects scenario on socioeconomics would be **moderate**. All NOS projects and activities associated with the Proposed Action and other surveying and mapping efforts considered in the cumulative effects scenario have the potential to contribute indirect cumulative impacts to socioeconomic resources through the collection of high-resolution oceanographic data. Data products (e.g., maps and charts) resulting from these collection efforts would benefit all sectors of the ocean economy primarily through operational cost savings, improvement of risk management, and coastal or climate resilience planning. These data products would enhance and facilitate revenue-producing activities, advantaging future oceanic carbon storage and offshore energy projects in particular, which would subsequently cause job creation and capital expenditures within coastal regions closest to project sites. Indirect, cumulative economic benefits would result from consumer or retail expenditures in coastal areas by newly employed workers or the growing number of recreational boaters. All cumulative socioeconomic impacts would likely persist for the duration of the cumulative effects study period and beyond. As such, the socioeconomic cumulative indirect benefits of these actions would be short-term and long-term and moderate in magnitude. No cumulative adverse impacts to socioeconomic resources are expected from any of the actions or activities.

Potential cumulative, adverse impacts from the Proposed Action in combination with the cumulative effects scenario could be considered either synergistic or additive depending on the timing and location of activities and impacts. Synergistic impacts could result if any activities or actions occur in close spatial or temporal proximity within the study area. For example, updated charts around popular coastal recreational areas would increase operational efficiency and safety of local boating activities; these synergistic benefits would likely result in larger expansions of recreational boating in these areas than in areas that are not surveyed. Similarly, increased accuracy and precision of ocean condition forecasts and nowcasts within a given area would act synergistically to facilitate greater implementation of local coastal or climate resilience planning in the development of commercial real estate or onshore/nearshore energy infrastructure. Additive socioeconomic cumulative impacts could also occur if activities or actions are conducted sequentially within adjacent areas of the study area. Although the exact timing and location of projects have not been finalized and are subject to change, the Southeast and Alaska regions contain the largest proportion of total vessel transit miles of the EEZ (Section 2.4.1) and relatively high levels of marine O&G development. Therefore, synergistic or additive cumulative impacts are most likely to occur in either of these regions.

The contribution of the NOS Proposed Action to beneficial, aggregate cumulative impacts would be **moderate** depending on the timing and location of impacts. These impacts would occur regardless of the chosen alternative since projects under each alternative would be composed of similar activities and take place in the same geographic areas and timeframes; however, Alternatives B and C would include more projects, activities, and nautical miles traveled than Alternative A and thus contribute slightly greater impacts.

4.2.10 Environmental Justice

All past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects on environmental justice. The cumulative effects analysis also considers that other actions and activities contributing to the existing condition of subsistence resources, including marine debris (e.g., plastics, glass, metals, or rubber); IUU fishing; and accidental or illicit discharges (e.g., nutrient runoff, oil spills, or other introduction of contaminants).

4.2.10.1 Disturbance to Subsistence Activities and Sociocultural Systems

Activities producing sound and visual disturbances under any of the three NOS alternatives (e.g., the use of active underwater acoustic sources, vessel and equipment sound, physical presence of vessels and equipment in water, and human activities such as tide gauge and GPS reference station installation, and SCUBA operations), the operation and presence of vessels, equipment, and humans would contribute to cumulative impacts associated with any of the past, present, or reasonably foreseeable actions mentioned above. In combination, these actions would create short- and long-term adverse cumulative impacts to environmental justice communities. Activities creating sound and visual disturbances would cause species to move away from the shore, and subsistence hunters could be forced to temporarily abandon common hunting areas. Subsistence harvests in the marine environment could be disrupted, prolonged; or subsistence resources could be unavailable for use. Communities which are primarily dependent on marine mammals for subsistence, such as the bowhead harvesters of northern and western Alaskan villages, would be especially impacted. Subsistence users may be required to travel farther to harvest subsistence foods at a greater cost in terms of time, fuel, wear and tear on equipment and people, and lost wages. A decline in the harvest efficiency of marine resources would likely lead to an increase in hunting pressure on terrestrial wildlife, and to an increase in competition and territorial conflicts among subsistence harvesters (BOEM, 2015b).

Activities producing sound and visual disturbances under any of the three NOS alternatives (e.g., vessel and equipment sound, physical presence of vessels and equipment in water, and SCUBA operations) would contribute to cumulative impacts that potentially disrupt subsistence fishing from the operation and presence of vessels, equipment, and humans associated with any of the past, present, or reasonably foreseeable actions and commercial and recreational fishing activities. The presence of NOS and other vessels could startle fish, making them harder to catch by subsistence fishers. Subsistence fish species could become less available or unavailable from overfishing due to commercial and recreational fishing activities, particularly in Alaska. Also, as mentioned in Section 4.2.8.3, IUU fishing activities already contribute to the reduced availability of fish, other marine species, or coral reefs important to subsistence cultures. However, in the Gulf of Mexico the impact of such activities on subsistence fishing communities would be negligible since their largest source of subsistence foods are from removals from commercial fishery catches and from activities similar to recreational harvesting (BOEM, 2012).

The cumulative impacts of past and present actions that cause disturbance to subsistence activities would adversely affect the rates of sharing between communities (NMFS, 2016d). This could adversely impact sociocultural systems by disrupting the social organization and/or institutional formation of communities, eroding cultural values, and/or disrupting the economy of households and village communities through changes in employment, personal income, and overall community prosperity. Sharing efforts among core kinship relations would likely intensify, but diminish among more remote networks of exchange. Such pressures could potentially undermine transmission of cultural aspects of subsistence activities to youth populations (BOEM, 2015b).

In general, the sound and visual disruptions from vessels, equipment, and humans are considered a common source of disturbance in the marine environment. Relative to most other cumulative actions described in Section 4.1, there would be lower impacts from the sound generated by the active underwater acoustic sources proposed by NOS. The vessels used for NOS projects would be smaller than most industrial and commercial vessels and cause less disruption. The sound and visual impacts from vessels, equipment, and humans would cause disturbances in their immediate vicinity and would not persist beyond the conclusion of project activities. To minimize adverse impacts to subsistence communities, repeated surveys by NOS in the same area would be avoided. However, due to limited prior exploration in the Alaska region and the 2019 Presidential Memorandum on Ocean Mapping, the number and frequency of cumulative actions mentioned above, particularly surveying and mapping projects, is expected to increase over the next five years. Overall, cumulative impacts of the actions described in Section 4.1 could result in **adverse** and **minor** to **moderate** aggregate, cumulative impacts on EJ communities, depending on the type of activity, seasonal timing, and animal migration. The contribution of the NOS Proposed Action to these adverse, cumulative impacts would be **minor**.

4.2.10.2 Disturbance to Subsistence Activities and Sociocultural Systems from Climate Change

Air emissions under any of the three NOS alternatives would contribute to cumulative effects on climate from greenhouse gas emissions associated with past, present, and reasonably foreseeable actions, particularly related to oil and natural gas development and operation of offshore LNG terminals. In aggregate, these actions would lead to long-term adverse cumulative impacts to environmental justice communities. However, these impacts would result from the overall global climate change phenomenon, since potential air emission impacts from NOS activities are expected to be imperceptible or non-detectable as described in Section 3.15.1. In recent years, Alaska has experienced concerning trends in subsistence harvest activities due to climate change-induced factors such as changes in thickness and extent of sea-ice, increased snowfall, drier summers and falls, and increased storms and coastal erosion. These could adversely affect subsistence harvest patterns by altering traditional hunting locations, impacting subsistence travel, and resulting in resource patterns shift and seasonal availability changes; making access to subsistence resources more difficult (NMFS, 2016d).

Changes in sea-ice could have dramatic impacts on marine mammal migration routes which could impact harvest patterns of subsistence communities and increase the danger of hunting on sea-ice. Thawing of permafrost and melting of sea-ice could result in the habitat loss of important subsistence species. Warmer summers have already started impacting the timing of subsistence hunting. For example, whalers in Kaktovik are accustomed to hunting in August, but now whaling season occurs primarily in September. It is also becoming increasingly difficult to preserve meat during the warmer months. Common hunting and harvesting areas could recede away from the shore, requiring subsistence harvesters to travel farther to harvest subsistence foods at a greater cost in terms of time, fuel, wear and tear on equipment and people, and lost wages.

Shore erosion has become increasingly common in certain Alaskan communities, which delays sea-ice formation, allowing wave action from storms to cause greater damage to the shoreline and change use patterns of local and regional subsistence use areas. As described in Section 4.1.6, the BOEM MMP has several coastal restoration projects that could slow down these impacts in the long-term. Changes to subsistence harvest patterns caused by climate change could also disrupt the social organization in subsistence communities and impact harvest sharing activities. Serious declines in productivity could result in stresses within a community or between communities, affecting the way of life for the residents (NMFS, 2016d).

Climate change, with resultant loss of summer sea ice and open Northwest Passage and other shipping lanes, will likely attract visitors associated with recreation and tourism industries and encourage increase in commercial shipping along those routes. The addition of vessel traffic, especially cruise ship traffic, local traffic, and cargo ships could impede subsistence harvests, resulting in impacts similar to the ones described in detail in Section 4.2.10.1.

As mentioned in Section 4.2.4.4, effects of climate change may include changes to the water temperatures and increased acidification of the ocean caused by dissolved carbon dioxide. These changes are expected to continue over the reasonably foreseeable future and would contribute to changes in the population and distribution of fishery resources harvested by subsistence communities. While the dynamics of climate change and the potential magnitude and timing of its effects are poorly understood, it is expected that rising temperatures and increase in ocean acidification would disrupt subsistence harvest patterns by decreasing the fish species available for harvest, disrupting the seasonality of harvest activities and locations of fishing areas, and inducing stress within or between communities by adversely impacting subsistence resource sharing activities.

Overall, climate change could lead to changes in diversity, abundance, and distribution of traditional subsistence resources and harvest patterns, leading to long-term impacts on the availability of some subsistence resources. This could potentially threaten indigenous lifestyle and subsistence practices (NMFS, 2016d). These impacts would occur regardless of the chosen alternative and could result in **adverse** and **moderate** to **major** impacts on EJ communities. The contribution of the NOS Proposed Action to these adverse, cumulative, climate-change related impacts on EJ communities would be **negligible**.

4.2.10.3 Contamination of Subsistence Resources

Subsistence resources are currently stressed due to accidental leakage or spillage of oil, fuel, and chemicals and the unintentional disposal of trash and debris, though NOS does not contribute to these actions (see Section 3.15). Such events associated with any of the past, present, or reasonably foreseeable actions mentioned above, particularly offshore and OCS oil and natural gas development, construction and operation of offshore LNG terminals, and commercial fishing would further stress subsistence resources. While not technically considered a cumulative impact to environmental justice communities, the additional stress that could occur to subsistence resources is noteworthy and is therefore described below.

Contaminated resources, or those perceived to be contaminated, from an accidental oil, fuel, or chemical leak or spill could make subsistence resources unavailable or undesirable for use (BOEM, 2015b). For example, contamination from oil/chemical spills would render the affected subsistence resource unsafe to eat. If the skin or fur of the animal is coated with oil, that pelt would no longer be desirable to be made into coats and other handicrafts. Spill cleanup operations could result in the closure of harvesting areas until cleanup is complete. Any impacts to known archaeological or cultural sites from spill events would also result in adverse impacts to EJ communities in the affected region; these impacts are discussed further in Section 4.2.8 (BOEM, 2016).

Contaminated, or perceived contaminated, resources from marine debris could also render subsistence resources undesirable for consumption if plastics and other marine debris are found in whales and other marine species. Contaminants present in small quantities may be deemed harmless, but may accumulate and have serious, long-term, and ongoing health consequences for subsistence communities and the species they rely on for subsistence (MMS, 2007). Plastic debris could adsorb and concentrate potentially damaging toxic compounds from sea water, further contaminating subsistence resources (Gregory, 2009). Additionally, entanglement in commercial fishing debris such as trawl net webbing, plastic packing straps, ropes, and monofilament line could cause drowning, death from injury, starvation, and/or general debilitation of subsistence resources, making them less available to, or more difficult to harvest by subsistence hunters and fishers (NMFS, 2016d).

Minority and low-income fishing communities, like the Louisiana Vietnamese fisherfolk community in the Gulf of Mexico region, would be particularly sensitive to any oil spill and related fishery closures. Further stress to the condition of fisheries in the region would interrupt access to subsistence-based activities and resources (BOEM, 2012). Similarly, in the North Slope region in Alaska, the contamination of waters with fuel, oil, antifreeze, and other chemicals from military and oil and gas development activities in the mid- to late-20th century period resulted in the avoidance of these sites by subsistence harvesters and disrupted subsistence harvest patterns by impacting several acres of subsistence species habitat (BOEM, 2015b). Aggregate cumulative impacts would be considered **moderately adverse** and the contribution of the NOS Proposed Action to these adverse cumulative effects would be **negligible**.

4.2.10.4 New Mapping and Charting Information

Surveying and mapping activities under any of the three NOS alternatives would contribute to cumulative impacts from other surveying and mapping efforts in the action area associated with any of the past, present, or reasonably foreseeable actions mentioned above. In aggregate, these actions would lead to long-term beneficial cumulative impacts to environmental justice communities. The availability of new and updated charts, maps, and data would result in safer navigation, availability of better forecasts of weather and storm surge events that affect local communities, and historic wrecks. However, the availability of such information about previously uncharted areas, or regions that have not been recently surveyed, particularly the Alaska Region, would elicit interest that could result in additional projects in the area, such as greater surveying and mapping efforts and oil and gas exploration and development, which would have the same adverse impacts on EJ communities as those described in detail above. The overall cumulative impacts to subsistence activities from the availability of new mapping and charting information would be **beneficial**, long-term and **minor**, and the contribution of the NOS Proposed Action would also be beneficial, long-term, and **minor**.

4.2.10.5 Conclusion

When considered in tandem with activities associated with the NOS Proposed Action, other surveying and mapping efforts in the action area, offshore oil and natural gas development, offshore renewable energy development, climate change, commercial shipping and recreational boating, assessment and extraction of marine minerals, offshore carbon storage resource assessments, construction and operation of offshore LNG terminals, national defense and homeland security activities, construction of new submarine telecommunication cable infrastructure, commercial and recreational fishing, and coastal development would create adverse and beneficial cumulative impacts to EJ communities.

Adverse impacts would occur through a potential decrease in the total annual subsistence catch numbers of a species hunted by low-income or minority communities, or increase in the time required and distance traveled to harvest the same amount compared to previous years in which NOS surveying and mapping activities did not occur, or both (due to sound and visual disturbances generated by vessels, equipment and humans, climate change, and commercial and recreational fishing); reduced availability of fish, other marine species, or coral reefs important to subsistence cultures (due to IUU fishing); and contamination of subsistence resources (due to accidental spills of oil, fuel, chemicals, and/or marine debris). Beneficial impacts would occur through the availability of new mapping and surveying data and would result in safer navigation and more accurate weather forecasts for subsistence harvesters.

These past, present, and reasonably foreseeable future actions are expected to result in insignificant impacts to EJ communities. Overall, the adverse cumulative impacts of all actions described in Section 4.1 affecting the ability of EJ communities to secure subsistence resources are **minor** to **moderate**. The beneficial cumulative impacts from those actions resulting in higher quality data pertaining to hunting/fishing resources, navigation, and weather conditions are **minor**. These impacts would therefore be insignificant.

Cumulative impacts from any of the alternatives in combination with the cumulative effects scenario could potentially be considered either synergistic or additive depending on the timing, location of activities and impacts, and the communities impacted. Synergistic impacts could result if any activities or actions occur in close spatial or temporal proximity within the study area. Similarly, additive cumulative impacts to EJ communities could occur if activities or actions are conducted sequentially within adjacent areas of the study area. Although the exact timing and location of projects have not been finalized and are subject to change, the Southeast and Alaska regions contain the largest proportion of total miles of vessel movement in the EEZ (Section 2.4.1) and relatively high levels of marine oil and gas development. Therefore, synergistic or additive cumulative impacts are most likely to occur in either of these regions. For example, cumulative, adverse impacts would be synergistic and additive if activities producing sound and visual disturbances under the Proposed Action, oil and gas exploration in the Alaska region and the increased surveying and mapping associated with offshore and OCS oil and natural gas development, commercial shipping in the Northwest Passage, as well as other actions including the operation and presence of vessels, equipment, and humans take place at the same time in the Alaska region. Impacts to subsistence hunting or fishing patterns that affect the availability and/or the quality of subsistence resources, community sociocultural practices and systems would be synergistic and additive. Additive beneficial impacts would occur in terms of better information pertaining to hunting/fishing resources, navigation, and weather conditions. The NOS Proposed Action would contribute to and have the potential to increase these cumulative impacts, but their relative contribution would be **negligible** as compared to the aggregate contributions of other cumulative actions because the NOS impacts would be temporary or short-term, would be confined to the immediate vicinity of project areas, and would be small as compared to impacts from all other cumulative actions. These impacts would occur regardless of the chosen alternative since projects under each alternative would be composed of similar activities and take place in the same geographic areas and timeframes; however, Alternatives B and C would be expected to have slightly higher cumulative impacts because these alternatives include more projects, activities, and nautical miles traveled than Alternative A.

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7.0 GLOSSARY

95% Exposure Range: The horizontal range that includes 95 percent of animat (simulated animal) closest points of approach (CPAs) that exceed a given impact threshold.

Abiotic: Non-living part of the ecosystem such as air, water, and substrates.

Accuracy: The degree to which measurements or models reflect the actual value or condition of the subject being measured or characterized.

Acoustic Impedance: Ratio of sound pressure to sound volume.

Action Area: The geographic location where the NOS Proposed Action would occur. It includes rivers, states' offshore waters, the United States (U.S.) territorial sea, the contiguous zone, U.S. portions of the Great Lakes, the U.S. Exclusive Economic Zone, and coastal and riparian lands.

Active Sonar: A type of Sound Navigation and Ranging (sonar) that detects objects by creating a sound pulse that is transmitted through the water, reflects off a target object, and returns in the form of an echo to be detected.

Additive Cumulative Effect: An impact on a resource which is the sum of the individual impacts on that resource.

Adverse Impacts: Effects which are negative and harmful for the analyzed resource; and cause a change that moves the resource away from a desired condition or detracts from its appearance or condition.

Algal Flat: An assemblage of cyanobacteria (i.e., blue-green algae) or other photosynthetic microorganisms forming a dense flat mass, especially on or within the surface layer of an aquatic sediment.

Alkali Flat: Dried-out lake beds adjacent to coasts containing high salt concentrations.

Alkali lake: A saline water body containing large amounts of sodium and potassium carbonates in solution as well as sodium chloride, commonly found in arid regions.

Amphipod: An order of crustaceans, resembling shrimp, with no carapace (i.e., hard upper shell) and ranging from 1 to 340 millimeters (mm) in length, comprising both marine and freshwater forms. Amphipods are detritivores (i.e., feed on dead organic material) or scavengers.

Amplitude: Magnitude of the largest departure from its equilibrium value of an acoustic variable. High amplitude corresponds to high intensity.

Anadromous: A general category of fish, such as the salmon, which hatch in fresh water, spend most of their lives in the salt water of the ocean, and then return to fresh water to spawn.

Angling: Recreational fishing with hook and line.

Animat: Computer simulated animals used in behavioral research and modeling.

Annelid: Macroinvertebrate phylum consisting of segmented worms, including polychaetes (e.g., bristle worms).

Aquaculture: The artificial breeding, rearing, and harvesting of fish, shellfish, plants, algae, and other organisms in all types of water environments.

Aquatic Macroinvertebrate: Small organisms that have no internal skeletal system and live part or all of their lives in water; they are visible without the aid of a microscope.

Archipelago: Area that contains a chain or group of islands scattered in lakes, rivers, or the ocean.

Area of Potential Effect (APE): The geographic location within which a physical undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking.

Arribada: The synchronized, large-scale nesting on sandy beaches of some species of sea turtle (e.g., Kemp's ridley and olive ridley).

Arthropod: Phylum consisting of macroinvertebrate animals with exoskeletons, including (in marine habitats) crustaceans such as lobsters, crabs, shrimp, as well as amphipods, barnacles, and copepods.

Astrolabe: A historic scientific instrument used for reckoning time and for observational purposes.

Atoll: A ring-shaped coral reef, island, or series of islets.

Audiogram: A chart that shows the results of a hearing test.

Auditory Masking: The reduction in an animal's ability to perceive, recognize, or decode biologically relevant sounds because of interfering sounds.

Automatic Identification System (AIS): A shipboard broadcast system that acts like a transponder and uniquely identifies ships and vessels, using radio or satellite transceivers.

A-weighting Function: A mathematical curve that takes into account the average sensitivity of the human ear to sound frequency. A-weighting is used to convert a physical quantity of acoustic pressure (in decibels [dB]) to a value that better quantifies how loud a noise is perceived by humans. Corresponds to M-weighting functions for marine mammals.

Back-reef Habitat: Shallow lagoon between a barrier reef and the shoreline, often including small patches of corals, sand plains, and seagrass beds; waters in this habitat are typically warmer than outside the reef because of shallow depth, reduced water circulation, and shelter from wave action. Salinity may fluctuate because of variable freshwater inflow.

Backscatter: The scattering of particles or radiation, such as sound waves, by the atoms of the medium through which they pass, in the backward direction.

Bait Cup (also known as grinding hole): Small depressions ground into bedrock.

Baleen: The apparatus inside the mouths of toothless whales, upon which they rely to filter food from the sea.

Ballast Water: Fresh or salt water, sometimes containing sediments, held in tanks and cargo holds of ships to increase stability and maneuverability during transit.

Bank Reef: Reef that is built upward from the seafloor by non-photosynthetic coral.

Barotrauma: Injury from excessive water pressure.

Barrier Reef: A coral reef roughly parallel to a shore and separated from it by a lagoon or channel of deep water.

Bathymetry: The depths and shapes of underwater terrain, or submarine topography.

Bathypelagic: Zone of the open ocean that extends from a depth of 1,000 to 4,000 meters (m) beneath the surface, with little or no sunlight present in the ecosystem. Above lies the mesopelagic zone; below the abyssopelagic zone.

Beach Nourishment: Process by which sediment, usually sand, lost through longshore drift or erosion is artificially replaced with sediment from other sources.

Beneficial Impacts: Effects which are positive and supportive for the analyzed resource. A beneficial impact constitutes a positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.

Benthic: Relating to or occurring at the bottom of a body of water or in the depths of the ocean.

Benthos: The flora and fauna found on the bottom, or in the bottom sediments, of a sea, lake, or other body of water.

Best Management Practice (BMP): An action or a combination of actions, that is determined to be an effective and practicable means of preventing or reducing adverse impacts to a resource.

Bicarbonate: A salt of carbonic acid containing the ion HCO_3^-.

Bilge: Area on the outer surface of a ship's hull where the bottom curves to meet the vertical sides. The bilge of a ship or boat is the part of the hull that would rest on the ground if the vessel were unsupported by water.

Bilge Water: Water that is generated by various activities involved in keeping a ship running while at sea. It collects in the hull of a vessel and contains industrial fluids from machinery spaces, internal drainage systems, sludge tanks, and various other sources.

Bioaccumulation: Over time, the buildup of ingested substances, typically heavy metals, pesticides, or toxins, in the tissues of a living organism. This occurs when an organism absorbs a substance at a rate faster than that at which the substance is lost or eliminated.

Biodiversity: The variety and variability of life on Earth. Biodiversity is typically a measure of variation at the genetic, species, and ecosystem level. Terrestrial biodiversity is usually greater near the equator, which is the result of the warm climate and high primary productivity, and lower in polar regions.

Biologically Important Area (BIA): Spatially defined locations where aggregations of individuals of cetaceans display biologically important behaviors which are region-, species-, and time-specific.

Bioluminescence: Light produced by a chemical reaction within a living organism; occurs widely in marine vertebrates and invertebrates.

Biosphere: Layer of the Earth where life exists.

Biotic: Relating to or resulting from living things, especially in their ecological relations.

Bivalve: Aquatic mollusk with two hinged shells, such as oysters, clams, mussels, and scallops.

Bleaching (of coral): Under conditions of thermal stress, the process of expelling the algae (zooxanthellae) living in the tissues of coral polyps, causing the corals to turn completely white; bleaching for an extended period of time can lead to mortality of the coral polyps and hence the coral reef.

Blubber: The thick layer of fat under the skin of marine mammals, such as seals, whales, and walruses.

Bluff: Steep shoreline slope formed in sediment (i.e., loose material such as clay, sand, and gravel) that has three feet or more of vertical elevation just above the high tide line.

Brachiopod: Phylum consisting of marine macroinvertebrates with hard “valves” or shells on their upper and lower surfaces.

Brackish: Water with salinity levels higher than fresh water but lower than sea water (salt water).

Breaching (for whales): Leaping above the water.

Broadband: Data transmission using a wide range of frequencies.

Broadband Sound: Vibrations with a combination of many frequencies distributed over a wide section of the audible range; as opposed to narrowband sound.

Bryozoan: Macroinvertebrate phylum consisting of moss animals or sea mats.

Bycatch: Fish or shellfish caught unintentionally or inadvertently while pursuing other target species.

Capital: Human-created assets that can enhance one's power to perform economically useful work.

Carbon Geosequestration: Depositing and storing carbon in a reservoir beneath the Earth's surface.

Catadromous: A general category describing fish, such as eels, that live in fresh water and migrate to salt water to spawn.

Cavitation: A phenomenon in which rapid changes of pressure in a liquid lead to the formation of small vapor-filled cavities (i.e., bubbles) in places where the pressure is relatively low.

Cephalopod: Active predatory mollusk of the large class Cephalopoda, such as an octopus or squid.

Cetacean: Completely aquatic marine mammals such as whales, dolphins, and porpoises; they feed, mate, calve, and suckle their young in the water.

Chartered Vessel: Vessels that are owned and/or operated by a private firm and are operating under an NOS contract.

Cilia: Microscopic hair-like structures on the surface of certain cells that either cause currents in the surrounding fluid, or, in some protozoans and other small organisms, provide propulsion.

Closest Point of Approach (CPA): Term used in modeling the level of sound exposure of marine mammals to an underwater sound source; refers to the closest horizontal distance of animats from a sound source.

Cnidaria: Phylum of macroinvertebrate marine fauna including jellyfish, sea anemones, and corals.

Coastal Birds: Birds which occupy coastal habitats, such as shorebirds, pelicans, terns, gulls, and some waterfowl and wading birds.

Community: Group or association of populations of two or more different species occupying the same ecosystem.

Conservative Estimate: Use of assumptions in analysis methodologies that result in larger impacts on the environment.

Conspecific: Animals or plants belonging to the same species.

Consumer Surplus: The value of goods in excess of the costs of acquisition.

Contiguous Zone: A band of water extending farther from the outer edge of the territorial sea to up to 24 nautical miles (nm) (44.4 kilometers [km]) from the baseline. The zone established by the United States under Article 24 of the Convention on the Territorial Sea and the Contiguous Zone, as published in the June 1, 1972 issue of the *Federal Register*.

Continental Shelf: The area of sea bed around a large landmass where the sea is relatively shallow compared with the open ocean.

Continental Slope: The deepening sea floor out from the continental shelf (see definition above) edge to the upper limit of the continental rise, or the point where there is a general decrease in steepness.

Continuous Sound: Vibration that is present at all times in a relevant time window.

Copepod: Small aquatic crustaceans that are one of the most numerous macroinvertebrates in aquatic communities. They inhabit a wide range of salinities, from fresh water to hypersaline conditions.

Coral Polyps: Sessile macroinvertebrates of the class Anthoza that typically form and live in large colonies known as coral reefs, which constitute some of the most biodiverse communities on Earth.

Corallite: Skeleton of an individual coral polyp.

Core: Samples that preserve surface and subsurface sediment layers.

Countervailing Cumulative Effect: Where the net adverse impact is less than the sum of the individual impacts.

Critical Habitat: Specific geographic area, as formally designated by the U.S. Fish and Wildlife Service or National Marine Fisheries Service under the Endangered Species Act (ESA), that contains features essential to the conservation of an endangered or threatened species and that may require special management and protection. May also include areas that are not currently occupied by the species but will be needed for its recovery.

Cryopelagic: Relating to the underside of an oceanic ice layer or the water immediately below the ice surface.

Cultural Landscape: A geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person, or exhibiting other cultural or aesthetic values.

Cumulative Actions: Past, present, and reasonably foreseeable future activities that are addressed in the cumulative effects analysis because their environmental effects may combine or interact with the effects of the Proposed Action.

Cumulative Impacts: Effects on the environment from the incremental effect of the Proposed Action when added to other past, present, and reasonably foreseeable future actions.

Cumulative Sound Exposure Level (SEL): A measure of energy that takes into account both received level and duration of exposure; total combined sound energy to which an animal has been exposed over time.

Datum: A coordinate system and a set of reference points used for locating places on the Earth. Datums are used in navigation and surveying by cartographers, surveyors, and navigation systems to translate positions indicated on maps to their real position on Earth.

De minimis: Referring to environmental impacts so minimal as to merit disregard.

De-ballast: Exchange of ballast water (see definition above) in open ocean waters (for vessels that have ballast tanks).

Decidecade Band: A logarithmic frequency interval equal to one tenth of a decade (i.e., a unit for measuring ratios on a logarithmic scale, with one decade corresponding to a ratio of 10 between two numbers); it is approximately equal to one third of an octave.

Delphinid: Oceanic dolphin belonging to the family Delphinidae.

Demand: The desire of purchasers, consumers, clients, employers, etc., for a particular commodity, service, or other item.

Demersal: Relating to or near the ocean bottom, typically in reference to fish species such as cod, haddock, and flatfish (e.g., halibut) that live on or near the sea floor.

Deoxygenation: A decrease in dissolved oxygen concentration in fresh or saltwater habitats.

Depleted (under the MMPA): Status of a species under the Marine Mammal Protection Act (MMPA) when its population falls below the optimum sustainable population level.

Depredation: The act of preying upon, such as the killing of adult birds and offspring by natural predators.

Designed Cultural Landscape: A setting that includes purposefully planned views or vistas.

Detritus: In aquatic ecosystems, refers to dead particulate organic material, as opposed to dissolved organic material. It usually includes the remains or fragments of dead organisms as well as fecal material, and often hosts communities of microorganisms that both colonize and decompose it.

Diadromous: A general category describing fish that spend portions of their life cycles partially in fresh water and partially in salt water, including both anadromous and catadromous fish.

Direct effect: Impact caused by an action that occurs at the same time and place.

Distinct Population Segment (DPS): A vertebrate population (i.e., a group of potentially interbreeding organisms in the same species in a given locality) or group of populations that is discrete from other populations of the species and significant in relation to the entire species.

Doppler Shift: Relative change in the frequency of sounds emitted by approaching or receding sound sources.

Downwelling: A process where surface water is forced downwards, where it may deliver oxygen to deeper waters, increasing dissolved oxygen concentrations in the depths.

Dredge: Remove sediment from the sea bed, lake bed, river bed, or the bottom of artificial waterways, typically done to increase or restore water depth for the transit of vessels or to restore the volume of water in lakes filling in with sediments.

Duty Cycle: The fraction or percentage of time that a source is 'on' in a relevant time window (e.g., a source transmitting for two hours per day has a duty cycle of 2/24 = 0.08 = 8 percent).

Echinoderm: Member of a phylum of marine macroinvertebrates; the adults are recognizable by their radial symmetry, including sea stars, sea urchins, sea cucumbers, sand dollars, and crinoids.

Echolocation: The use of sound waves and echoes to determine where objects are in space, used both in air (by bats) and water (by marine mammals).

Economic Sector: Components of the economy which are distinct from each other.

Ecosystem: A system of biotic (i.e., living) and abiotic (i.e., non-living) components that interact with each other and function together as a unit.

Effects Determination: Process employed under the ESA to formally conclude whether actions may affect listed species or designated critical habitat.

Electric Load Planning: The process of forecasting the demand for electricity of a community and adjusting the generation and transmission of electricity accordingly.

Electrophysiological Studies: Investigations which stimulate the flow of ions into tissue in order to deduce the functional capabilities of anatomical structures.

Endangered: A species is considered endangered under the ESA if it is in danger of extinction throughout all or a significant portion of its range.

Endemic: Native and restricted to a certain place, often referring to a species confined to a given locale.

Energy Source Level: In acoustics, defined as the intensity of the radiated sound at a distance of 1 meter from the source, where intensity is the amount of sound power transmitted through a unit area in a specified direction. Source level is given as a relative intensity measured in decibels.

Ensonify: To fill with sound, for example, a given volume of water of a given shape and configuration.

Environmental Justice: A condition under which no population bears a disproportionate share of negative environmental consequences resulting from industrial, municipal, and commercial operations or from the execution of federal, state, and local services, laws, regulations, and policies.

Epipelagic: The part of the ocean where there is enough sunlight for algae to utilize photosynthesis; this zone reaches from the sea surface down to approximately 200 m (650 feet).

Episodic Erosion: The shore and backshore adjustment that results from short-duration, high-intensity meteorologic and oceanic storm events. This type of event response results in shore adjustment and occurs during a single storm or during a series of closely spaced storm events within a storm season.

Escarpment: An area of ground surface at which elevation changes suddenly. It usually refers to a cliff, precipice, or steep slope.

Essential Fish Habitat: Those waters and substrate necessary for fish for spawning, breeding, feeding, or growth to maturity, as designated by the National Marine Fisheries Service.

Eutrophication: Excessive richness of nutrients (e.g., nitrates and phosphates) in a lake or other body of water, frequently due to runoff from the land, which causes a dense growth of plant life (e.g., algal blooms) and death of aquatic animal life from lack of oxygen when the algae die en masse and decompose.

Evolutionarily Significant Unit (ESU): A population of organisms considered distinct for the purposes of conservation action; may be a species, subspecies, race, population, or stock, such as a stock of salmon associated with a particular river.

Exclusive Economic Zone (EEZ): Area of the sea where the U.S. and other coastal nations have jurisdiction over natural resources. The U.S. EEZ extends no more than 200 nautical miles from the territorial sea baseline and is adjacent to the 12 nautical mile territorial sea of the U.S., including the Commonwealth of Puerto Rico, Guam, American Samoa, the U.S. Virgin Islands, the Commonwealth of the Northern Mariana Islands, and any other territory or possession over which the United States exercises sovereignty.

Exoskeleton: A rigid, external supportive covering of an animal, such as an arthropod.

Federal Subsistence Priority: Subsistence (see definition below) uses by rural residents of Alaska are accorded priority by the federal government over non-subsistence uses, commercial or sport.

Federally Recognized Tribes: An American Indian or Alaska Native tribal entity that is recognized as having a government-to-government relationship with the U.S., with the responsibilities, powers, limitations, and obligations attached to that designation, and is eligible for funding and services from the Bureau of Indian Affairs. See 86 FR 7554, updated by 86 FR 18552, for the full list of 574 federally recognized tribes.

Feeding Area: Areas and months within which a particular species or population selectively eats. These may either be found consistently in space and time, or may be associated with ephemeral features that are less predictable but can be delineated and are generally located within a larger identifiable area.

Filter Feeder: Animals that eat by moving water through a structure that acts as a sieve, straining suspended matter and food particles or prey from the water.

Fissiped: Members of the taxonomic order Carnivora, having toes separated to the base, including sea otters and polar bears.

Fishery Management Councils (FMC): Eight regional bodies composed of knowledgeable people with a stake in fishery management, established under the Magnuson-Stevens Fishery Conservation and Management Act, to develop regional Fishery Management Plans and responsibly manage fish and shellfish species in waters within the U.S. EEZ.

Fishing Community: A social or economic group whose members reside in a specific location and share a common dependency on commercial, recreational, or subsistence fishing or on directly related fisheries dependent services and industries (e.g., boatyards, ice suppliers, tackle shops).

Fishing Lure: Artificial fishing bait designed to attract a fish's attention and instigate a bite so as to impale the fish on a hook; one or more hooks are often hidden within the lure.

Fjord: A long, deep, narrow body of water that reaches far inland and is bordered by steep mountains; in the continental United States, they are found only in Alaska.

Fledging Period: The stage in a flying animal's life between hatching or birth and becoming capable of flight.

Fledgling: A young bird which has developed wing feathers that are large and strong enough for flight.

Floe: A layer of floating ice on the surface of a water body; distinct from icebergs, which have calved from tidewater glaciers and have more vertical structure.

Flume: A narrow channel conveying water.

Fore Reef: The outside part of a reef (see definition below) seaward of the reef edge facing the open sea.

Fourier Transform: Algorithm that decomposes functions depending on space or time into functions depending on spatial or temporal frequency. Used to compute the spectral (frequency) content of a signal.

Frequency: Rate of oscillation of a sound wave as the number of cycles per second: f [unit is Hz: Hertz]; 1 Hz = $1/s$ $[\text{second}]$; higher-frequency sounds are perceived as higher-pitched to the observer. Animal species are able to perceive sounds within given frequency ranges that vary from species to species. Sounds below or above that frequency range cannot be heard or detected by that species.

Fringing Reef: One of the three main types of coral reef (see definition below). It is distinguished from the other main types, barrier reefs and atolls, in that it has either an entirely shallow backreef zone (i.e., lagoon) or none at all. Grows seaward directly from the shore and forms a border along the shoreline and surrounding islands.

Frontal Zone: The transition area, sometimes amounting to a discontinuity, that separates adjacent air masses.

Fusiform: Tapering at both ends; spindle-shaped.

Gastropod: Mollusks of the class Gastropoda, having a head with eyes and feelers and a muscular foot on the underside of its body with which it moves. Most gastropods are aquatic in both fresh and salt water, but some have evolved to live on land, such as some snails and slugs; may have a univalve shell or none.

Geological and Geophysical (G&G) Surveys: Conducted to obtain data for oil and gas exploration and production; uses high-intensity active acoustic sources that penetrate the surface of the sea floor.

Gill Net: A fishing mesh which is hung vertically so that fish get trapped in it by their gills (i.e., the respiratory organs of fish).

Gross Domestic Product (GDP): The total value of goods produced and services provided in a country during one year.

Ground Truthing: To directly confirm, or validate by direct observation, information or data that was derived indirectly.

Gyre: A large system of rotating ocean currents.

Habitat: The natural environment of an organism; a place possessing the features and resources needed to promote the life and growth of an organism or a species.

Habitat Areas of Particular Concern (HAPC): A designation that encompasses discrete subsets of Essential Fish Habitat; high-priority locales for conservation, management, or research because they are rare, sensitive, stressed by development, or important to ecosystem function.

Habitat Occupancy: The presence of a given species within a habitat area.

Hard Bottom: Refers to exposed rock underneath a waterbody but includes other substrata such as coral and artificial structures.

Hatchling: A young bird that has recently emerged from its egg and is typically still nest-bound.

Haul Out: To come out of the water to spend time on land; practiced in particular by certain pinnipeds.

Head-of-tide: The inland limit of water affected by the rise and fall of sea levels.

Headwaters: The inland source from which a river originates within a basin or watershed; often refers to adjacent lands as well as waters within the upper reaches of a river basin.

Hearing Threshold: The minimum sound level, measured in decibels that an animal can hear within a specified frequency band.

Hearing Threshold Shifts: Changes in the hearing range of an organism due to exposure to high intensity sounds.

Highly Migratory Species (HMS): Fish that travel long distances and often cross domestic and international boundaries. These pelagic fish live in the open ocean, although they may spend part of their life cycle in nearshore waters.

High Resolution Geophysical (HRG) Survey: A type of geological and geophysical survey that uses sound waves that are reflected off submerged structures to collect data on conditions both at the sea floor and the shallow subsurface.

High Tide Line: The intersection of the land with the water's surface at the maximum height reached by a rising tide.

Historic Property: Any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretory of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties and also includes properties of traditional religious and cultural importance to an Indian tribe or Hawaiian organization and that meet the National Register criteria.

Homing Propensity: Tendency to return to the locations where a species originated.

Hydrocarbon: A compound of hydrogen and carbon, such as any of those which are the chief components of coal, petroleum, and natural gas (i.e., the fossil fuels).

Hydrography: The measurement and description of the physical features of oceans, seas, coastal areas, lakes, and rivers, as well as the prediction of their change over time, for the primary purpose of safety of navigation and in support of all other marine activities.

Hypoxia: Refers to low or depleted dissolved oxygen in a body of water.

Ice Seals: Four species of seals found in the Arctic – bearded, ringed, spotted, and ribbon – which are collectively called ice seals because of their association with sea ice for feeding, resting, and pupping.

Illegal, Unreported, and Unregulated (IUU) Fishing: Fishing activities that violate both national and international fishing regulations.

Immunocompetency or Immunocompetence: The ability of the body or of an organism to respond to illness.

Impulsive Sound: Sounds that are typically transient, brief (less than 1 second), broadband, and consist of high peak sound pressure (i.e., the decibel level of the maximum instantaneous acoustic pressure in a stated frequency band) with rapid rise time and rapid decay.

Indirect Effect: Environmental impact that is caused by the action and occurs later in time or is farther removed in distance but is still reasonably foreseeable. Indirect effects also include "induced changes" in the human and natural environments.

Insolation: Sunlight or incoming solar radiation.

Intermittent Sound: A sound that is periodically present, in contrast to one that is constant or continuous.

Intertidal Zone: Area where the ocean meets the land between high and low tides.

Inverse Fourier Transform: A mathematical algorithm that converts a space or time signal to a signal of the frequency domain; converting spatial or temporal data into the frequency domain data. It computes the time-domain signal, h(t), from the spectral components H(t).

Invertebrate: Animal lacking a backbone.

Irretrievable Impact: Losses to or effects on natural resources that are lost for a period of time, but not permanently.

Irreversible Impact: Losses to or effects on natural resources from use or depletion of nonrenewable resources, such as fossil fuels or cultural resources, or to factors such as soil productivity that are renewable only over long periods of time.

Isopleth: Lines or curves on a map of equal values; contour lines on a topographic map depicting ground surfaces of the same elevation are an example of isopleths.

Karigi: Special houses used for performing ritual ceremonies by Alaska Natives.

Knot (unit): A unit of speed equal to one nautical mile per hour, exactly 1.852 kilometers per hour (km/h) (approximately 1.15078 miles per hour [mph] or 0.514 meters per second [m/s]).

Krill: Small, planktonic, shrimp-like crustaceans of the open oceans that are eaten by a number of marine animals, notably the baleen whales; they have been described as "essentially the fuel that runs the engine of the Earth's marine ecosystems."

Lagoon: A shallow body of water that may have an opening to a larger body of water but is also protected from it by a sandbar or coral reef; often brackish when near the sea.

Launch: A small boat that is deployed into the water directly from a ship.

Lentic: Inhabiting or situated in still fresh water, such as the waters of a lake.

Level A Harassment: Any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild.

Level B Harassment: Any act of pursuit, torment or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing a disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.

Lidar: Acronym for Light Detection And Ranging. A remote sensing technology that uses light in the form of a pulsed laser to measure ranges (i.e., distances) to a target.

Liquefied Natural Gas (LNG): A form of natural gas (i.e., a naturally occurring hydrocarbon gas mixture consisting primarily of methane) that has been cooled down so that it has a reduced volume and behaves as a liquid.

Lithic: Of the nature of or relating to stone; in archaeology, it refers to any stone that has been used or beat on by humans.

Lombard Effect: A phenomenon in which speakers increase their vocal production to communicate in noisy environments.

Low-income Population: Group of individuals living in geographic proximity to one another, or a geographically dispersed or transient (i.e., migrant) group of individuals that have household incomes at or below the designated "low-income" threshold or the designated federal poverty level.

Macroalgae: Large marine algae, often living attached in dense beds, such as kelp and seaweed.

Macrohabitat: An extensive habitat presenting considerable variation of the environment, containing a variety of ecological niches, and supporting a large number and variety of complex flora and fauna.

Macroinvertebrate: An animal lacking a backbone that can be seen without the aid of a microscope and captured by a 500--micrometer (μm) net or sieve. This includes arthropods (e.g., insects, mites, scuds and crayfish), mollusks (e.g., snails, limpets, mussels and clams), annelids (e.g., segmented worms), nematodes (e.g., roundworms), and platyhelminthes (e.g., flatworms).

Mangrove: A tree or shrub that grows in chiefly tropical coastal swamps that are flooded at high tide, typically with numerous tangled roots above ground and forming dense thickets.

Markov Chain: A mathematical system that transitions from one state to another according to certain probabilistic rules. Its defining characteristic is that no matter how the process reached its present state, the possible future states are fixed. They are used to model randomness in biological and economic systems.

Marine Hydrokinetic Technologies (MHK): The use of movement or temperature gradients of water to generate electricity in the ocean.

Marine Seismic Survey: A type of geological and geophysical survey that uses a variety of acoustic sources to image sediment and rock deep below the sea floor.

Maritime Heritage: The study of our past, both recent and ancient, in the context of the marine environment; study of the history of vessels, trade, transport, seaports, migration, navies, and sea battles, among other topics.

Marsh: A type of wetland which is dominated by grasses and other herbaceous plants; may be freshwater, brackish, or saltwater, and may be located inland or along the coast.

Masking: The effect of an acoustic source interfering with the reception and detection of an acoustic signal of biological importance to a receiver.

Mechanical Wave: A wave, such as sound, that is not capable of transmitting its energy through a vacuum. They require a medium in order to propagate their energy from one location to another.

Melon (as in Odontocetes): A globular fatty organ in certain whale species that gives shape to the domed forehead, focuses and modulates the animal’s vocalizations, and acts as a sound lens; it is a key organ involved in communication and echolocation.

Merchantman: A merchant or trading ship that transports cargo or carries passengers for hire.

Mesopelagic: Also known as the middle open ocean, this zone stretches from the bottom of the epipelagic down to the point where sunlight cannot reach. The deep end of this zone is approximately 1,000 m (3,300 feet) deep.

Metapopulation: Consists of a group of spatially separated populations of the same species which interact at some level. Among certain marine fish species, for example, populations may be spatially separated and independent, but spatial overlap occurs during breeding periods, allowing for gene flow between the distinct populations.

Midden: An old dump for domestic waste which may consist of animal bone, human excrement, botanical material, mollusk shells, sherds, lithics, and other artifacts and ecofacts associated with past human occupation.

Midwater: Mesopelagic and bathypelagic (see definitions above) zones of the open ocean.

Migratory Corridor: Areas and seasons within which a substantial portion of a species or population is known to migrate; for aquatic species the corridor is typically delimited on one or both sides by land or ice.

Minimum Population Estimate: An estimate of the number of animals in a stock that:

(A) is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information; and

(B) provides reasonable assurance that the stock size is equal to or greater than the estimate.

Minority Population: A population in which the percentage of minorities exceeds 50 percent or is substantially higher than the percentage of minorities in the general population or other appropriate unit of geographic analysis.

Mollusk: Phylum of macroinvertebrates including gastropods (e.g., sea snails, whelks, limpets, abalone), bivalves (e.g., clams, mussels, oysters, scallops), cephalopods (e.g., squid, octopus), and chitins.

Molt: The process of shedding feathers, fur, or skin that will be replaced by a new growth.

Motile: Capable of self-powered motion.

Muktuk/maktak: Fried whale blubber.

M-weighting Function: Sound frequency weighting function for marine mammals based on a literature review of their physiological and behavioral responses to anthropogenic sound. Applied in a similar way as A-weighting for noise level assessments for humans (see definition for A-weighting function).

Mysticete: A taxonomic suborder of cetaceans; whales that have two blowholes and baleen plates instead of teeth.

Nacelle: Housing for the generator, gearbox, and other parts of a wind turbine.

National Register of Historic Places (NRHP): The official list of the nation's historic places worthy of preservation. Authorized by the National Historic Preservation Act of 1966, the National Park Service's NRHP is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect America's historic and archeological resources.

National Wildlife Refuge: A designation for protected areas that are managed by the U.S. Fish and Wildlife Service. These public lands and waters are set aside to conserve America's wild animals and plants.

Neritic: Relating to or denoting the shallow part of the sea near a coast and overlying the continental shelf.

Nesting: The process of building or occupying a nest (i.e., a structure built by certain animals to hold eggs, offspring, and, oftentimes, the animal itself).

Noise: An undesirable sound, one that interferes with communication, is intense enough to damage hearing, or is otherwise intrusive or objectionable to certain living organisms, including humans.

Non-impulsive Sound: Sounds that can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent, and typically do not have a high peak sound pressure with rapid rise/decay time as impulsive sounds do.

Nursery Area: A location, usually offering plentiful food and some level of protection from predation, in which the juveniles of a marine species undergo growth and development.

Nutrient Cycling: Movement of organic and inorganic materials through different components of a cell, community, or ecosystem, which can be cycled and reutilized by some of these components.

Ocean Acidification: The process in which the acidity, a measure of hydrogen ion concentration (pH), of seawater increases as a result of absorbing carbon dioxide (CO_2).

Ocean Economy: Economic activity which indirectly or directly uses the ocean (or Great Lakes) as an input. It consists of six sectors: marine construction; living resources; offshore mineral extraction; ship and boat building; tourism and recreation; and marine transportation.

Ocean Thermal Energy Conversion (OTEC): A process or technology to power a turbine to produce electricity by harnessing the temperature differences (i.e., thermal gradients) between ocean surface waters and deep ocean waters.

Octave: A series of eight notes occupying the interval between, and including, two notes, one having twice or half the frequency of vibration of the other.

Odobenid: Organisms belonging to the family Odobenidae. The only living species is the walrus.

Odontocete: A taxonomic suborder of cetaceans; whales that have teeth (e.g., the orca) and one opening at their blowhole.

Offshore Waters: Marine waters outside the territorial boundaries of a state.

Ordnance: Military supplies including weapons, ammunition, combat vehicles, and maintenance tools and equipment.

Ostracod: A class of crustaceans that has several pairs of legs and a body made up of sections that are covered in a hard outer shell.

Otariid: Eared seals. This family includes sea lions and fur seals.

Otolith: Also known as "earstones", they are hard, calcium carbonate structures located directly behind the brain of bony fishes; involved in sensing gravity and movement. Alternating bands develop over time that can be read like tree rings to determine a specimen's age, which is important information in managing the sustainable harvest of fish stocks.

Overwintering: The process of organisms adapting to and surviving winter conditions, such as freezing temperatures, ice, snow, and less available food.

Pack Ice: Any area of detached sea ice (i.e., ice formed by freezing of sea water) that is not land fast; it is mobile by virtue of not being attached to the shoreline or something else.

Palustrine: Relating to a system of inland freshwater wetlands, such as marshes, swamps, and lake shores, and characterized by the presence of trees, shrubs, or emergent vegetation.

Passband: Frequency bands obtained by splitting a spectrum into 1 Hz wide bands.

Passive Sonar: A method for detecting acoustic signals in an underwater environment, usually the ocean. The difference between passive and active sonar is that a passive sonar system emits no signals; instead, its purpose is to detect the acoustic signals emanating from external sources.

Patch Reef: Small, isolated reefs (see definition below) that grow up from the open bottom of the island platform or continental shelf. They usually occur between fringing reefs and barrier reefs.

Peak Pressure: The maximum value reached by sound pressure (see definition below); referred to as the Lpeak or sometimes Lpk.

Peak-to-peak Sound Pressure: The difference between the maximum and minimum instantaneous sound pressure (see definition below), possibly filtered in a stated frequency band, attained by an impulsive sound, *p(t).*

Pelagic: Relating to, living in, or found on the open sea, away from land, where water is deep; oceanic.

Permanent Threshold Shift (PTS): Permanent elevation in hearing threshold with physical damage to the sound receptors in the ear lasting indefinitely; in some cases, there can be total or partial deafness, whereas in other cases the animal has an impaired ability to hear sounds in specific frequency ranges.

Period (as related to sound): Duration of 1 cycle: $T = 1/f$ [s], where T = time period to complete one cycle of an oscillation, f = frequency, and s = second. It is related to wavelength by $T=\lambda/v$, where, λ = wavelength (lambda), and v = velocity.

Petroglyphs: Prehistoric rock carvings.

Phocid: Earless seals or "true seals" that can be identified by their lack of external ear flaps.

Photic Zone: Part of a body of water where enough light penetrates for photosynthesis to occur in phytoplankton.

Photosynthesis: Process by which green plants, algae, diatoms, and certain forms of bacteria (e.g., cyanobacteria) manufacture the carbohydrate glucose ($C_6H_{12}O_6$) from carbon dioxide and water, using energy captured from sunlight by chlorophyll, and releasing excess oxygen as a byproduct.

Phylum (p. phyla): Major taxonomic category that ranks just above class and just below kingdom (as in plant, animal, and fungus kingdoms) in the taxonomic hierarchy; it classifies organisms by their fundamental body plan.

Physiology: The normal functions of living organisms and their anatomical structures.

Phytoplankton: Microscopic organisms that live in both saltwater and freshwater aquatic environments; like all green plants, they contain the pigment chlorophyll to convert sunlight via the process of photosynthesis into carbohydrates (i.e., food, organic matter, and chemical energy); phytoplankton are critically important in aquatic ecosystems and form the base of the aquatic food web or pyramid.

Pillbox: Small concrete forts used by armies as outposts or guard posts.

Pinger: Underwater signaling device or locator beacon; they have short-duration chirp signals in the 10 s of kHz range at moderate source levels (160-180 dB re: 1 micropascal [µPa] @ 1 m).

Pinniped: Marine mammals that include the true seals, eared seals, sea lions, and walruses.

Piscivorous: Referring to organisms that primarily eat fish.

Planktivorous: Referring to organisms that primarily consume small invertebrates (e.g., plankton such as krill, zooplankton).

Plankton: Organisms, including both plants and animals (i.e., autotrophs and heterotrophs), that drift in water in the oceans, seas, rivers, and lakes.

Plunge Diving: A seabird foraging technique that involves rapidly diving into deep waters while in flight in order to hunt for prey; practiced by gannets and boobies, among other species.

Pod: A social group of whales.

Population: Group of individual organisms of the same plant, animal, or microorganism species capable of interbreeding and occupying the same geographic area or ecosystem; or, the size (i.e., number of individuals) in any given population; members of a given population are typically more closely related to one another genetically than to individuals of other populations within the same species.

Potential Biological Removal (PBR) Level: Defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population.

Porifera: Macroinvertebrate animal phylum composed of sponges.

Precision: The degree to which separate measurements or models of the same subject are close in value.

Precocial: Offspring requiring lower levels of parental care.

Primary Constituent Element (PCE): The physical and biological features of a habitat that a species needs to survive and reproduce. Used in definitions of designated critical habitat.

Producer Surplus: The value of a good or service in excess of the costs of production.

Programmatic: Describes any broad or high-level National Environmental Policy Act (NEPA) review; it is not limited to a NEPA review for a particular project. Programmatic NEPA reviews assess the general environmental impacts of proposed policies, plans, programs, or suites of projects for which subsequent actions will be implemented either based on the Programmatic Environmental Assessment or Programmatic Environmental Impact Statement, or based on subsequent NEPA reviews tiered from the programmatic review (e.g., a site- or project- specific document).

Project Cargo: Large, heavy, high value or critical pieces of equipment for a project.

Propagation Loss: Reduction in sound pressure level (SPL) between two designated locations in a sound transmission system, one location often being at a reference location from the source. Also known as propagation transmission loss.

Propagules: Any material that functions in growing an organism to the next stage in its life cycle, such as by dispersal. The propagule is usually distinct in form from the parent organism.

Propeller Singing: The resonance between the local natural frequency of the propeller blade tip and the vortex shedding frequency at trailing edge of the blade. Propeller singing creates very intensive levels of radiated noise.

Protected Species: An animal or plant which it is forbidden by federal law to harm or destroy, e.g., endangered species.

Pseudofeces: Mucous-coated grit expelled by filter-feeding gastropod mollusks, distinct from actual feces.

Pulse (as related to sound): A single segment of a periodic signal that consists of (potentially) repeating segments with defined beginning and end points and is, typically, short in duration. Pulses are not necessarily impulsive.

Pulse Length: For impulsive (pulsed) sound (e.g., airguns, pile driving), the pulse length is often taken as the 90 percent pulse energy duration T90%, which is the time between the 5 percent and 95 percent points on the cumulative energy curve.

P-wave: Also called primary waves, these are mechanical waves that are longitudinal in nature.

Received Level: Amount of sound energy actually reaching a receiver such as a modeled animal; the greater the transmission loss, the lower the received sound level at any given location.

Red Tide: A common term used for harmful algal blooms, which can be dangerous to people and deadly for fish due to potent neurotoxins released by the dinoflagellate *Karenia brevis*.

Reef: A ridge of jagged rock, coral, or sand just above or below the surface of the sea.

Reef Crest: The highest (i.e., most shallow) part of the reef which lies between the shoreward, protected back reef zone and the outer fore reef zone (see definitions above).

Reef Flat: Occupies the inshore side of the bank reef (see definition above). This consists of broken coral skeletons and coralline algae and excludes most other organisms due to the inhospitable, heavy surf that often characterizes this area.

Reef Slope: Area of high coral cover and moderate to low wave energy on the fringing reef.

Reproductive Area: Locations and seasons within which a particular species or population selectively mates, gives birth, or is found with neonates or other sensitive age classes.

Reserved Right: The doctrine that holds that Native Americans retain all rights not explicitly revoked in treaties or other legislation.

Rise Time: The amount of time it takes for a signal to change from static pressure to high pressure.

Rookery: Large, clustered nesting colony, generally of gregarious seabirds, wading birds, and pinnipeds.

Salp: Semi-transparent barrel-shaped marine animals that move through the water by contracting bands of muscles which ring the body. They belong to the subphylum Tunicata, a group of marine macroinvertebrates also known as sea squirts.

Salt Marsh: Coastal wetlands that are flooded and drained by salt water moved by the tides; the soil may be composed of deep mud and peat.

Sandbar: Along the seashore, a ridge of sand or coarse sediment connected to the shoreline or resting offshore that is submerged or partially exposed; generally narrow and straight and formed by the breaking of waves moving material from the shoreline.

Sandflat: A flat, marshy, or barren tract of land that is alternately covered and uncovered by the tide and consisting of unconsolidated sediment mostly of mud and sand.

Sea floor: The solid surface underlying a sea or ocean.

Seabirds: Birds which spend much of their lives at sea foraging over pelagic habitat (i.e., open sea), often thousands of kilometers from their nesting grounds.

Seamount: Undersea mountains formed by volcanic activity.

Sediment: A naturally occurring material that is broken down by processes of weathering and erosion and subsequently transported by the action of wind, water, or ice or by the force of gravity.

Seine Net: A large mesh with sinkers on one edge and floats on the other that hangs vertically in the water and is used to enclose and catch fish when its ends are pulled together or are drawn ashore.

Semelparous: Organisms that die after spawning only once, such as Pacific salmonids.

Sessile: Non-mobile, or attached, organisms such as adult coral polyps.

Shelf Break: The point of the first major change in gradient at the outermost edge of the continental shelf (see definition above); its depth, distance from shore, and configuration are highly variable.

Shoal: A shallow place in a river, sea, or other body of water caused by a submerged bank or bar of sand or other unconsolidated material deposited on the substrate

Shorebirds: A distinct taxonomic subset of coastal birds, such as sandpipers, plovers, sanderlings, and godwits which forage on sandy shores at the water’s edge.

Sirenian: An order of fully aquatic, herbivorous mammals that inhabit swamps, rivers, estuaries, marine wetlands, and coastal marine waters. Sirenians currently comprise the families Dugongidae (e.g., the dugong) and Trichechidae (e.g., manatees) with a total of four species.

Social Surplus: The value of a good or service in excess of the costs of acquisition or production.

Sonar: A technique that uses sound propagation to navigate (e.g., submarines), communicate with, or detect objects on or under the surface of the water, such as other vessels.

Sound: Vibrations that travel through the air or water and can be heard when they reach a person's or animal's ear.

Sound Exposure Level (SEL): The time-integral of the squared acoustic pressure over a duration (*T*).

Sound Pressure Level (SPL): The root-mean-square (rms) pressure level in a stated frequency band over a specified time window (T; s).

Source Level: Amount of sound radiated by a sound source, defined as the intensity of the radiated sound at a distance of 1 meter from the source, where intensity is the amount of sound power transmitted through a unit area in a specified direction. Source level is stated as a relative intensity in decibels (dB). In underwater sound, decibels are referenced to a pressure of 1 µPa; thus, sound level is reported in units of dB re 1 µPa @ 1 m.

South Pacific Gyre: A distinct area of the Earth's system of rotating ocean currents bounded by the equator to the north, Australia to the west, the Antarctic Circumpolar Current to the south, and South America to the east.

Spawn: The mass of eggs deposited by fishes, amphibians, mollusks, crustaceans, etc.; the release or deposit of eggs.

Species: The most basic unit in the hierarchical system of taxonomy, a group of organisms that can and do reproduce with one another in nature and produce offspring that are fertile.

Spectral Density: The distribution of a sound's power with frequency is described by the sound's spectrum. The sound spectrum can be split into a series of adjacent frequency bands with a width of 1 Hz (called passbands), which yields the power spectral density of the sound.

Speed: The distance travelled per unit time $c = \lambda/T = \lambda \times f$ where c = the speed of sound [m/s], f = frequency (Hz), λ = wavelength (m), and $T =$ time (s).

Spermaceti: The solid wax found in the head cavity of the sperm whale.

Spherical Spreading Loss: With regard to spherical sound waves emitted by a point source, refers to that portion of the transmission loss due to the divergence, that is, spreading, of sound waves in accordance with a system's configuration. Also known as divergence loss.

Spur and Groove: Geomorphic feature of many coral reefs, consisting of ridges or "spurs" of coral separated by channels or "grooves"; grooves are often characterized by sediments such as sand or rubble.

State Historic Preservation Office/Officer (SHPO): Entities within each state and U.S. territory that administer the state historic preservation program, a state and National Register of Historic Places Program, a Historic Preservation Fund grant program, a data management program, review and compliance, and other programs. The latter term refers to the individual who directs that office and oversees management of each of its programs.

Statocysts: Sac-like organs with sensory cilia.

Stock: In fisheries, it refers to a particular fish population of a given species that is more or less genetically isolated from other stocks of the same species, such as those associated with a particular river or tributary. For marine mammals, it is a group of individuals of the same species or smaller taxa in a common spatial arrangement that interbreed when mature.

Stranding: The term may refer to any of the following:

- A marine mammal that is on the shore and unable to return to the water under its own power;
- A marine mammal that is on the shore and, although able to return to the water, is in need of apparent medical attention;

- A marine mammal in the water that cannot return to its natural habitat without assistance; or
- A dead marine mammal on the beach or in the water.

Strategic Stock (under the MMPA): Defined by the MMPA as a marine mammal stock:

- For which the level of direct human-caused mortality exceeds the potential biological removal level (see definition above);
- Which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future; or
- Which is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA.

Strike Quota: Under international agreement, refers to the limitation on the number of bowhead whales that may be struck by subsistence hunters, and is the sum total of the whales that are successfully and unsuccessfully landed.

Submarine Canyon: Narrow, steep-sided valleys that cut into continental slopes and continental rises of the oceans. They originate either within continental slopes or on a continental shelf.

Submerged Cultural and Historic resources: Objects found on the sea floor, lake, or river beds with historic, pre-historic, or culturally significant values.

Subsistence: Subsistence uses of wild resources are defined as "noncommercial, customary and traditional uses" for a variety of purposes. These include: Direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of nonedible by-products of fish and wildlife resources taken for personal family consumption; and for the customary trade, barter, or sharing for personal or family consumption.

Substrate: Surface or material on or from which an organism lives, grows, or obtains its nourishment; also, the material or sediments that rest at the bottom of a stream, lake, or ocean.

Subtidal Zone: On a coastline, the area that lies below the intertidal zone (see definition above) and is almost continuously submerged.

Suspension Feeder: Animals that eat particles of organic matter that are suspended in water.

S-wave: Also called secondary waves, these are mechanical waves that are transverse in nature.

Swim Bladder: In fish, gas-filled internal cavity near the ears that deforms with the pressure wave and allows fish to sense the pressure impact of sound.

Taxon (pl. taxa): Units used in the science of biological classification, or taxonomy. A taxonomic group of any rank, such as a species, family, or class.

Taxonomy: Science of naming, describing, and classifying organisms, including all plants, animals, and microorganisms in the biosphere.

Temporary Threshold Shift (TTS): The mildest form of hearing impairment; exposure to loud sound resulting in a non-permanent (i.e., reversible) elevation in hearing threshold, making it more difficult to hear sounds; TTS can last from minutes or hours to days; the magnitude of the TTS depends on the level and duration of the sound exposure, among other considerations.

Territorial Sea: Defined as a belt of coastal waters extending 12-nautical miles from the baseline, usually the low-water line, along the coast.

Tidal Flat: Intertidal, non-vegetated, soft sediment habitats, found between mean high-water and mean low-water spring tide datums and generally located in estuaries and other low energy marine environments.

Thermal Refugium (pl. refugia): A place that serves as a shelter for organisms from adverse temperatures (e.g., in a stream).

Thermocline: Transition layer between warmer mixed water at the ocean's surface and cooler deep water below.

Thicket: Dense groups of corals.

Threatened: A species is considered threatened if it is likely to become an endangered species under the ESA within the foreseeable future.

Tonal Sound: Sounds with discrete frequencies, such as music notes.

Traditional Cultural Places: Also referred to as "Traditional Cultural Properties", TCPs are historic properties that derive their cultural significance from the role the property plays or played in a community's historically rooted beliefs, customs, and practices.

Transducer: Any device that converts one form of energy into a readable signal.

Transmission Loss: A measure, in decibels, of the decrease in sound level between a source and a receiver some distance away. Geometric spreading of acoustic waves is the predominant way by which transmission loss occurs. Transmission loss also happens when the sound is absorbed and scattered by the seawater, and reflected at the water surface and within the seabed. Transmission loss depends on the acoustic properties of the ocean and seabed; its value changes with frequency.

Treaty Tribe: Federally recognized tribe that has retained its right to hunt, fish, and gather under a treaty signed with the federal government.

Tribal Sovereignty: The right of American Indians and Alaska Natives to govern themselves. The U.S. Constitution recognizes Indian tribes as distinct governments and they have, with a few exceptions, the same powers as federal and state governments to regulate their internal affairs.

Trophic Level: The position an organism occupies in a food chain. A food chain is a succession of organisms that eat other organisms and may, in turn, be eaten themselves. The trophic level of an organism is the number of steps it is from the start of the chain.

Tunicate: Macroinvertebrate animal phylum including sea squirts or sea pork.

Tympanum: Membrane, or eardrum, in certain animals.

Umiak: Seal skin boat.

Unavoidable Adverse Impact: Effects on the human environment that would remain even after mitigation measures and BMPs have been applied.

Undertaking: A project, activity, or program funded in whole or in part by a federal agency, including those carried out by or on behalf of a federal agency; those carried out with federal assistance; those requiring a federal permit, license, or approval; and those subject to state or local regulation administered pursuant to a delegation or approval by a federal agency.

Unregulated Fishing: Occurs in areas or for fish stocks for which there are no applicable conservation or management measures and where such fishing activities are conducted in a manner inconsistent with the responsibilities of nation-states for the conservation of living marine resources under international law. Unregulated fishing occurs in marine regions outside the EEZs of nation-states.

Unreported Fishing: Fishing activities that are not reported or are misreported to relevant authorities in contravention of national laws and regulations or reporting procedures of a relevant regional fisheries management organization.

Upwelling: A process in which deep, cold water rises toward the surface. It occurs in the open ocean and along coastlines.

Usual and Accustomed (U&A) Places: Lands adjacent to streams, rivers, or shorelines to which a tribe usually travels or is accustomed to travel for the purpose of taking fish.

Vessel Wake: Waves created by the hull of a ship as it moves through the water. Depending on hull design, speed, vessel weight, and power supply, the wake of a vessel can produce anywhere from a minimal flow of water and rippling chop to swelling waves of significant size.

Vestibular Apparatus: In vertebrates, the structure of the inner ear involved in balance.

Viewshed: A subset of a landscape unit that consists of all the surface areas visible from an observer's viewpoint.

Viscosity: Quantity that describes a fluid's resistance to flow.

Viviparous: Animals that give birth to developed, live young, instead of producing eggs.

Water Column: Conceptual vertical area of water extending from the surface of the ocean, river, or lake to the bottom substrate or sediment. Many physical, chemical, and biological aquatic phenomena are characterized by their relative and/or absolute positions in the water column.

Waterfowl: Birds which spend much of their lives on the water's surface in both freshwater and saltwater environments. Specifically refers to ducks, geese, and swans.

Watershed: An area of land that drains or "sheds" water into a specific watercourse (i.e., a river or stream), such as the Missouri River watershed or the Ohio River watershed.

Wavelength: Spatial distance between two successive 'peaks' in a propagating wave: λ [m]. It is related to sound speed c and frequency f by $\lambda = c/f$.

Weighting Function: In acoustical analysis, a weighting function is used to correlate objective sound level meter measurements with subjective responses to sound in the subject organisms (such as marine mammals) under study.

Whelping: The process of a mammal giving birth, such as female polar bears birthing their cubs.

Willingness to Pay: The amount users are hypothetically willing to pay for goods, services, or information. Commonly used to monetize goods, services, or information without clear market values.

Zero-to-peak Sound Pressure/Peak Sound Pressure: Decibel level of the maximum instantaneous acoustic pressure in a stated frequency band attained by an acoustic pressure signal, *p(t)*.

Zooplankton: A type of heterotrophic (i.e., non-photosynthesizing) plankton that ranges from microscopic organisms to macroinvertebrates such as jellyfish; zooplankton drift or float with marine currents. Zooplankton are heterotrophs (i.e., they cannot produce their own food via photosynthesis) and must obtain their energy by consuming other organisms.

Zooxanthellae: Unicellular, golden-brown algae (e.g., dinoflagellates) that live either in the water column as plankton or symbiotically inside the tissue of other organisms, such as coral polyps.

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