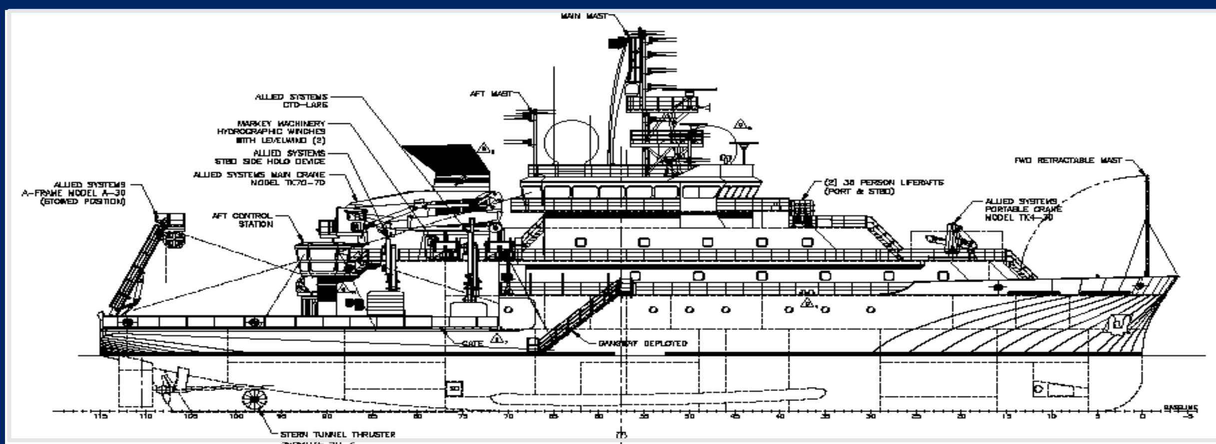
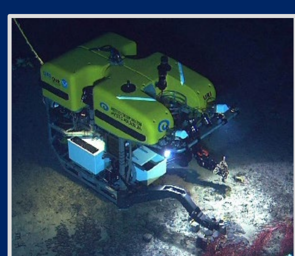
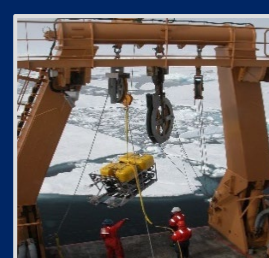
OMAO Draft
Programmatic Environmental Assessment for Vessel Operations







National Oceanic and Atmospheric Administration
Office *of* Marine & Aviation Operations

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CONTENTS

TABLES:

FIGURES:

ACRONYMS AND ABBREVIATIONS

µg	microgram
µPa	micropascal
°C	degrees Celsius
°F	degrees Fahrenheit
ACHP	Advisory Council on Historic Preservation
ACM	asbestos-containing material
ADF&G	Alaska Department Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AIS	Automatic Identification System
AR	Alaska Region
AR6	Sixth Assessment Report
AUV	Autonomous Underwater Vehicle
BIA	biologically important area
BLS	Bureau of Labor Statistics
BMP	Best Management Practice
BOEM	Bureau of Ocean Energy Management
BSAI	Bering Sea and Aleutian Islands
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
C&S	ceremonial and subsistence
CAA	Clean Air Act
$CaCO_3$	calcium carbonate
CBS	Chukchi/Bering Seas
CDA	Core Distribution Area
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFCs	chlorofluorocarbons
CFR	Code of Federal Regulations
CME	Chief Marine Engineer
COI	Certificates of Inspection
CORA	Chippewa Ottawa Resource Authority
CPR	Cardiopulmonary Resuscitation
CTD	conductivity, temperature, and depth
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DAS	days at sea
dB	decibels
dBA	A-weighted decibels
DMS	Document Management System
DO	dissolved oxygen
DPS	distinct population segments
EA	Environmental Assessment
ECA	Emissions Control Area
ECDIS	Electronic Chart Display and Information System
ECO	Environmental Compliance Officer
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIAPP	Engine International Air Pollution Prevention
EIS	Environmental Impact Statement
EJ	Environmental Justice
ENOW	Economics: National Ocean Watch
ENSO	El Nino Southern Oscillation
EO	Executive Order
EOSL	End of Service Life
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FSV	Fisheries Survey Vessel
ft	feet
FY	Fiscal Year
GAR	Greater Atlantic Region
GDP	gross domestic product
GHGs	Greenhouse Gases
GIS	Geographic Information System
GLIFWC	Great Lakes Indian Fish & Wildlife Commission
GOA	Gulf of Alaska
GOM	Gulf of Maine
GPS	Global Positioning System
GRB	Garbage Record Book
HAB	harmful algal bloom
HAPC	Habitat Areas of Particular Concern
HCFCs	hydrochlorofluorocarbons
HMS	highly migratory species
HVAC	heating, ventilation, and air condition
Hz	hertz
IAPP	International Air Pollution Prevention
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organization
IOPP	International Oil Pollution Prevention
IPCC	Intergovernmental Panel on Climate Change
IPHC	International Pacific Halibut Commission

ISPPC	International Sewage Pollution Prevention Certificate
IUU	illegal, unreported, and unregulated
IWC	International Whaling Commission
kg	kilogram
kHz	kilohertz
km	kilometer
kW	kilowatt
lb.	pounds
LNG	liquefied natural gas
LO	Line Office
LQG	large quantity generator
m	meter
m/s	meters per second
MARPOL	International Convention for the Prevention of Pollution from Ships
MBTA	Migratory Bird Treaty Act
MHK	marine and hydrokinetic
mi	miles
MMP	Marine Minerals Program
MMPA	Marine Mammal Protection Act
MO	Marine Operations
MOC	Marine Operations Center
MOC-A	Marine Operations Center-Atlantic
MOC-P	Marine Operations Center-Pacific
MOC-PI	Marine Operations Center-Pacific Islands
MPA	Marine Protected Area
MPH	miles per hour
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSD	Marine Sanitation Device
MW	megawatts
NAAQS	National Ambient Air Quality Standards
NAO	NOAA Administrative Order
NDZ	No Discharge Zone
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
nm	nautical miles
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NMSA	National Marine Sanctuaries Act
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
NRS	Noise Reference Station
O&G	Oil and Gas
O&M	Operation and Management
OA	Operational Area
OCM	Office for Coastal Management
OCS	outer continental shelf
ODS	ozone-depleting substance
OHA2	Omnibus Essential Fish Habitat Amendment 2
OMAO	Office of Marine and Aviation Operations
ONMS	Office of National Marine Sanctuaries
OPA	Oil Pollution Act of 1990
ORB	Oil Record Book
ORT	Oil Residue Tank
OSHA	Occupational Safety and Health Administration
OTEC	Ocean Thermal Energy Conversion
OTS	Over the Side
OWS	Oily Water Separator
PAH	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	Primary Constituent Element
PEA	Programmatic Environmental Assessment
PEL	Permissible Exposure Limit
PFMC	Pacific Fishery Management Council
pH	concentration of hydrogen ions
PIR	Pacific Islands Region
PM	particulate matter
ppb	parts per billion
PPE	personal protective equipment
PPM	parts per million
PRIA	Pacific Remote Island Area
RCRA	Resource Conservation and Recovery Act
ROV	Remotely Operated Vehicle
RV	Research Vessel
SAMMS	Shipboard Automated Maintenance Management Systems
SER	Southeast Region
SFWL	Ships Force Work List
SHPO	State Historic Preservation Officer
SLEP	Ship Life Extension Program
SOF	Statement of Fact
SOLAS	Safety of Life at Sea
SOP	Standard Operating Procedure
SOPEP	Shipboard Oil Pollution Emergency Plan
SOVC	Statement of Voluntary Compliance
SPL	Sound Pressure Level
SQG	small quantity generators
SSI	Ship Specific Instructions
TCL	Traditional Cultural Landscape
TCP	Traditional Cultural Places/Properties
THPO	Tribal Historic Preservation Officer
U.S.	United States
U.S.C.	United States Code
UAS	Uncrewed Aircraft System
ULSD	ultra-low sulfur diesel
UMS	Uncrewed Marine System

UNOLS	University-National Oceanographic Laboratory System
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
USV	Uncrewed Surface Vehicle
UV	ultraviolet radiation
UxS	Uncrewed Systems
VGP	Vessel General Permit
VHF	very high frequency
V-PASS	Vessel Prioritization, Allocation and Scheduling System
VRP	Vessel Response Plan
VSQG	very small quantity generators
WCR	West Coast Region

EXECUTIVE SUMMARY

INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) Office of Marine and Aviation Operations (OMAO) has prepared this Draft Programmatic Environmental Assessment (PEA) to analyze the potential environmental impacts associated with OMAO's vessel operations in United States (U.S.) marine, coastal, and freshwaters, and in areas outside of U.S. jurisdiction. OMAO operates, manages, and maintains NOAA's fleet of research and survey ships, small boats, and an Uncrewed Systems Operation Center at mission-readiness levels in support of NOAA's at-sea observational requirements. NOAA's at-sea mission objectives provide products and services that are vital to safe navigation, commerce, environmental stewardship, and socioeconomic security. This Draft PEA analyzes the environmental impacts of OMAO's vessel operations while the NOAA ships are underway (i.e., when ships are either moving in open water or secured to a specific location in open water), during which time OMAO conducts training, testing, calibration, and troubleshooting of vessel equipment and instruments in preparation for use by other NOAA Line Offices (LOs) or organizations outside of NOAA.

The Proposed Action evaluated in this Draft PEA is to continue OMAO vessel operations over a 15-year timeframe from 2023 to 2038 as the NOAA fleet is modernized by updating vessels in the existing fleet and replacing aging vessels with new vessels built specifically to support NOAA missions. NOAA has developed an integrated approach for fleet modernization that involves building new ships, making significant maintenance investments to extend the service life of existing NOAA ships, and increasing the utilization of the NOAA fleet. Specific plans for vessel improvements, and new vessel design and construction are evolving based on developing mission needs, technology advancements, and funding availability; therefore, this Draft PEA analyzes a range of fleet improvements that may be implemented over the next 15 years.

This Draft PEA evaluates three alternatives: 1) the No Action Alternative (Alternative A), under which OMAO would continue to use the current NOAA fleet to conduct activities to support NOAA's primary mission activities of oceanographic assessment and management of living marine resources; charting and hydrographic surveying; oceanographic monitoring, research and modeling; and emergency response; 2) Alternative B, under which OMAO would seek to reliably and consistently sustain and improve NOAA's at-sea data collection capability and provide the infrastructure necessary to meet mission requirements now and in the future by implementing a phased approach to long-term modernization of the NOAA fleet and fleet management best practices ; and 3) Alternative C, which would encompass all measures undertaken in Alternative B, as well as additional measures reflecting a 20 percent increase in funding relative to Alternative B. The Draft PEA has been prepared to: 1) inform OMAO and the public on the physical, biological, economic, and social impacts of vessel operations; and 2) assist OMAO in deciding how to execute its vessel operations program over the next fifteen years.

This Draft PEA 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 Code of Federal Regulations [CFR] Parts 1500-1508 (1978)); NOAA's Policy and Procedures for Compliance with the National Environmental Policy Act and Related Authorities (NOAA Administrative Order [NAO] 216-6A and Companion Manual for NAO 216-6A), and other relevant federal and state laws and regulations. While revised CEQ regulations implementing NEPA became effective on September 14, 2020 (40 CFR § 1506.13), OMAO prepared this Draft PEA using the 1978 CEQ regulations because this environmental review was an ongoing action as of September 14,

2020. NOAA's Office of General Counsel, Oceans and Coasts Section, issued a memorandum on December 12, 2017 recommending that OMAO scope and prepare a focused programmatic review of vessel activities (McCoy and Bregman, 2017). A first draft of the PEA was developed as of February 21, 2020.

PUBLIC INVOLVEMENT

Because of the wide geographic scope of the Proposed Action, OMAO is publishing a Notice of Availability (NOA) of the Draft PEA in the *Federal Register*. The NOA advises other federal and state agencies, territories, tribal governments, local governments, private parties, and the public of the Proposed Action, provides information on the nature of the analysis, and invites input on the Draft PEA. OMAO is sending letters via email or U.S. mail to federally recognized tribes to announce the publication of the Draft PEA and invite comment.

The Draft PEA is available for review on the OMAO website at http://omao.noaa.gov/noaa-vessel-operations-draft-pea. The 41-day public comment period for the Draft PEA will close on January 31, 2024. Written comments may be submitted by one of the following methods:

- E-mail: omaoenvironmental.compliance@noaa.gov

- U.S. Mail: Please direct written comments to:
  Hannah Staley, Sea Grant Fellow
  Office of Marine and Aviation Operations
  National Oceanic and Atmospheric Administration
  1315 East-West Highway
  Silver Spring, MD 20910

COORDINATION WITH OTHER AGENCIES

OMAO is coordinating with several federal and state agencies as part of this NEPA process. OMAO is coordinating with the National Marine Fisheries Service (NMFS), which 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]). OMAO is also coordinating with the U.S. Fish and Wildlife Service (USFWS), which has legal jurisdiction over certain marine mammal species (including manatees, walruses, polar bears, and sea otters), 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]). The Office of National Marine Sanctuaries has legal jurisdiction under the National Marine Sanctuaries Act (NMSA) over activities in national marine sanctuaries, all of which are included in the action area; however, no activities included in the Proposed Action would occur in sanctuaries, and no activities are likely to destroy, cause the loss of, or injure sanctuary resources, so no consultation is needed. In the event that OMAO does conduct any activities in sanctuaries, then OMAO would undergo the relevant consultation and documentation process.

OMAO does not anticipate any impacts to historic properties as a result of the Proposed Action. In the future, if any OMAO activities are found to have the potential to affect historic properties, then OMAO would perform a Section 106 consultation before conducting those activities. OMAO will also coordinate with coastal states and territories regarding use of this document to inform federal consistency review pursuant to Section 307 of the Coastal Zone Management Act.

PURPOSE AND NEED STATEMENT

The purpose of the Proposed Action is to ensure that NOAA's current and future fleet is maintained and operated in a manner that is safe, environmentally compliant, and allows NOAA to fulfill its at-sea mission objectives and data collection requirements.

The need for the Proposed Action is to maintain uninterrupted operational fleet capabilities to support NOAA scientific data collection in marine, coastal, and freshwater environments. OMAO needs to continue to operate the NOAA fleet to maintain it at mission-readiness levels; however, almost half of NOAA's ships will exceed their design service life during the timeframe of this Draft PEA. If NOAA does not invest in modernizing its fleet, it will not be able to produce the high quality, comprehensive data that are essential for NOAA products and services needed to protect lives and property, generate billions of dollars in American commerce and international trade each year, support stewardship of ecosystem resources, and facilitate research on ocean and atmospheric processes. In order to continue OMAO's vessel operations, NOAA needs to modernize its fleet. NOAA's vessels must be environmentally-compliant and adaptable to provide the infrastructure and capabilities necessary to meet NOAA mission requirements now and in the future.

PROPOSED ACTION AND ALTERNATIVES

Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Under Alternative A, OMAO would continue to use the current NOAA fleet to conduct activities to support NOAA's primary mission activities of oceanographic assessment and management of living marine resources; charting and hydrographic surveying; and oceanographic monitoring, research, and modeling. This would include vessel movement; anchoring; waste handling and discharge operations; vessel repair and maintenance; equipment testing, calibration, training, and troubleshooting; uncrewed marine system operations; uncrewed aircraft operations; small boat operations; and over the side (OTS) handling. Additionally, OMAO is constructing two oceanographic research vessels that are expected to come on-line by 2025 and two new charting and mapping vessels that are expected to come online in 2027 and 2028. Under Alternative A, OMAO would provide a maximum annual capacity of 3,568 operational days at sea (DAS) for scientific projects. This alternative reflects the ships, technology, equipment, fleet utilization, scope, and methods currently in use by OMAO. OMAO would continue to operate NOAA's fleet of survey and research ships until the end of their service life.

Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

OMAO seeks to reliably and consistently sustain and improve NOAA's at-sea data collection capability and provide the infrastructure necessary to meet mission requirements now and in the future. Alternative B therefore consists of a phased approach to implementing measures for long-term modernization of the NOAA fleet and fleet management best practices. In addition to continuing the OMAO vessel operation activities with the current NOAA fleet and building two new oceanographic research vessels and two new charting and mapping vessels, additional measures adopted under Alternative B in the next 15 years would include:

- Designing and constructing up to four additional ships needed to replace vessels that would reach the end of their design service life between 2023 and 2038;

- Extending the service life of aging NOAA ships;
- Increasing NOAA Fleet utilization; and
- Integrating new technology.

Full utilization of the NOAA fleet under Alternative B could provide 4,138 annual operational DAS, which is 570 DAS (or 14 percent) more than Alternative A.

Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B. In addition to implementing the measures under Alternative B (i.e., executing long-term modernization of the NOAA fleet and continuing the current OMAO vessel operations with optimization of the current fleet), OMAO would adopt the following additional measures in the next 15 years under Alternative C:

- Designing and constructing two new ships in addition to those that would be added to the NOAA fleet under Alternative B;
- Increasing the number of uncrewed systems integrated into new ships that would be added to the NOAA fleet;
- Shortening the timeframe of fleet improvement activities;
- Extending the service life of aging NOAA ships;
- Implementing greening techniques proposed for the new ships across the existing current fleet over a shortened timeframe;
- Shortening of the timeframe to improve the OMAO small boat fleet; and
- Purchasing or developing technology to enable more efficient scheduling of vessels, equipment, and personnel to maximize crew productivity and enhance overall fleet performance by increasing DAS.

Full utilization of the NOAA fleet under Alternative C could provide 4,873 annual operational DAS, which is 735 DAS (or 12 percent) more than Alternative B.

ENVIRONMENTAL CONSEQUENCES

Table ES-1 presents a summary of the assessed environmental consequences associated with Alternatives A, B, and C for the resources analyzed in the Draft PEA. 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, moderate, and insignificant. 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.

Table ES-1. Summary Comparison of Impacts

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
Air Quality	Impacts to air quality from diesel air emissions under Alternative A would be adverse and negligible to minor. Impacts to air quality from incinerator air emissions under Alternative A would be adverse and negligible to minor. Impacts to air quality from ozone depleting substances under Alternative A would be adverse and negligible to minor. Overall, impacts to air quality under Alternative A would be adverse, negligible to minor, and insignificant.	Impacts of Alternative B to air quality would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional days at sea (DAS), the deployment of new ships and integration of new and greener technology would likely reduce some impacts. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to air quality under Alternative B would be adverse, negligible to minor, and insignificant.	Impacts of Alternative C to air quality would be similar to those that would occur under Alternatives A and B. Overall, impacts to air quality under Alternative C would be adverse, negligible to minor, and insignificant.
Water Quality	Impacts to water quality from fuels, chemicals, and other contaminants under Alternative A would be adverse and minor to moderate. Impacts to water quality from wastewater under Alternative A	Impacts of Alternative B to water quality would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the	Impacts of Alternative C to water quality would be similar to those that would occur under Alternatives A and B. Overall, impacts to water quality under Alternative C would be

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	would be adverse and minor to moderate. Impacts to water quality from marine debris under Alternative A would be adverse and minor to moderate. Impacts to water quality from increases in sedimentation and/or turbidity under Alternative A would be adverse and negligible to minor. Although the effects of impact causing factors on water quality range from negligible to moderate, moderate impacts could occur in the rare event of an accidental discharge or spill of fuels, chemicals, wastewater, marine debris, or some other contaminants. Overall, impacts to water quality under Alternative A would be adverse, negligible to moderate, and insignificant.	deployment of new ships and integration of new and greener technology would likely reduce some impacts. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to water quality under Alternative B would be adverse, negligible to moderate, and insignificant.	adverse, negligible to moderate, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
Acoustic Resources	Impacts to the acoustic environment from airborne sound under Alternative A would be adverse and minor. Impacts to the acoustic environment from underwater sound under Alternative A would be adverse and minor. Overall, impacts to the acoustic environment from underwater sound under Alternative A would be adverse, minor, and insignificant.	Impacts of Alternative B to the acoustic environment would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the deployment of new ships with greener technology that would likely incorporate quieter designs would likely reduce some impacts to the airborne and underwater acoustic environments. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to the acoustic environment under Alternative B would be adverse, minor, and insignificant.	Impacts of Alternative C to the acoustic environment would be similar to those that would occur under Alternatives A and B. Overall, impacts to the acoustic environment under Alternative C would be adverse, minor, and insignificant.
Habitats	Impacts to habitats from increased sedimentation, turbidity, and chemical contaminants; and from increased ambient sound under Alternative A would be adverse and negligible to minor.	Impacts of Alternative B to 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 habitats under Alternative B would not cause long-term changes in the	Impacts of Alternative C to habitats would be similar to those that would occur under Alternatives A and B. Overall, impacts to habitats under Alternative C would be adverse, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	Impacts to habitats from activities involving physical disturbance to bottom substrate and from facilitated dispersal of invasive species under Alternative A would be adverse and minor. Impacts to habitats from impacts to the water column under Alternative A would be adverse and negligible. Overall, impacts to habitat under Alternative A would be adverse, minor, and insignificant.	availability of space, shelter, cover, or nutrients necessary for dependent species and would not substantially increase or differ in intensity as compared to Alternative A. Overall, impacts to habitats under Alternative B would be adverse, minor, and insignificant.	
Biological Resources - Marine Mammals	Impacts to marine mammals (cetaceans, pinnipeds, sirenians, and fissipeds) from increased ambient sound levels under Alternative A would be adverse and minor. Impacts to marine mammals from vessel presence and movement of equipment in the water under Alternative A would be adverse and minor. Impacts to marine mammals from accidental leakage or spillage of oil,	Impacts of Alternative B to 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 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. The impacts would not substantially increase in intensity as they would be distributed	Impacts of Alternative C to marine mammals would be similar to those that would occur under Alternatives A and B. Overall, impacts to marine mammals under Alternative C would be adverse, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	fuel, and chemicals under Alternative A would be adverse and negligible to minor. Impacts to marine mammals from trash and debris under Alternative A would 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 polar bears are disturbed at denning sites or if polar bear-human interactions occur, the impacts could be adverse and moderate. Overall, impacts to marine mammals under Alternative A would be adverse, minor, and insignificant.	across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to marine mammals under Alternative B would be adverse, minor, and insignificant.	
Biological Resources - Sea Turtles	Impacts to sea turtles from increased ambient sound levels under Alternative A would be adverse and negligible.	Impacts of Alternative B to sea turtles 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 of Alternative C to sea turtles throughout the action area would be the same or slightly, but not appreciably, larger than those that would occur under

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	Impacts to sea turtles from vessel presence and movement under Alternative A would be adverse and negligible to minor. Impacts to sea turtles from accidental leakage or spillage of oil, fuel, and chemicals under Alternative A would be adverse and negligible to minor. Impacts to sea turtles from underwater activities under Alternative A would be adverse and negligible to minor. 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, given the protection status afforded to sea turtles by the ESA. Overall, impacts to sea turtles under Alternative A would be adverse, minor, and insignificant.	Impacts to sea turtles resulting from Alternative B would not cause long-term changes in habitat availability and use, sea turtle behavior, or energy expenditures. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to sea turtles under Alternative B would be adverse, minor, and insignificant.	Alternatives A and B for each impact causing factor. Impacts to sea turtles resulting from Alternative C would not cause long-term changes in habitat availability and use, sea turtle behavior, or energy expenditures. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to sea turtles under Alternative C would be adverse, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
Biological Resources - Fish	Impacts to fish from increased ambient sound under Alternative A would be adverse and negligible to minor. Impacts to fish from vessel wake and underwater turbulence under Alternative A would be adverse and negligible to minor. Impacts to fish from accidental leakage or spillage of oil, fuel, and chemicals under Alternative A would be adverse and negligible. In the rare event that an accidental spill was to occur, the impacts would be minor. Impacts to fish from disturbance of the seafloor under Alternative A would be adverse and negligible to minor. Overall, impacts to fish under Alternative A would be adverse, minor, and insignificant.	Impacts of Alternative B to fish would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the deployment of new ships and integration of new and greener technology would likely reduce some impacts. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to fish under Alternative B would be adverse, minor, and insignificant.	Impacts of Alternative C to fish would be similar to those that would occur under Alternatives A and B. Overall, impacts to fish under Alternative C would be adverse, minor, and insignificant.

Biological Resources - Aquatic Macroinvertebrates	Impacts to aquatic macroinvertebrates from increased ambient sound under Alternative A would be adverse and negligible. Impacts to aquatic macroinvertebrates from vessel wake and underwater turbulence under Alternative A would be adverse and negligible to minor. Impacts to aquatic macroinvertebrates from accidental leakage or spillage of oil, fuel, and chemicals under Alternative A would be adverse and negligible. In the rare event that an accidental spill was to occur, the impacts would be minor. Impacts to aquatic macroinvertebrates from disturbance of the seafloor under Alternative A would be adverse and negligible to minor. Overall, impacts to aquatic macroinvertebrates under Alternative A would be adverse, minor, and insignificant.	Impacts of Alternative B to aquatic macroinvertebrates would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the deployment of new ships and integration of new and greener technology would likely reduce some impacts. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to aquatic macroinvertebrates under Alternative B would be adverse, minor, and insignificant.	Impacts of Alternative C to aquatic macroinvertebrates would be similar to those that would occur under Alternatives A and B Overall, impacts to aquatic macroinvertebrates under Alternative C would be adverse, minor, and insignificant.
Biological Resources - Seabirds, Shorebirds, Coastal	Impacts to birds from increased ambient sound levels under	Impacts of Alternative B to birds would be the same or slightly, but not appreciably, larger than those that would occur under	Impacts of Alternative C to birds would be similar to those that

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
Birds, and Waterfowl	Alternative A would be adverse and negligible. Impacts to birds from vessel presence and movement under Alternative A would be adverse and negligible to minor. Impacts to birds from accidental leakage or spillage of oil, fuel, and chemicals under Alternative A would be adverse and minor. In the rare event that an accidental spill was to occur, the impacts would be moderate or greater. Impacts to birds from underwater activities under Alternative A would be adverse and negligible to minor. Overall, impacts to birds under Alternative A would be adverse, minor, and insignificant.	Alternative A for each impact causing factor. Impacts of Alternative B to birds 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. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to birds under Alternative B would be adverse, minor, and insignificant.	would occur under Alternatives A and B. Overall, impacts to birds under Alternative C would be adverse, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
Cultural and Historic Resources	Impacts to cultural and historic resources from physical impacts to submerged cultural and historic under Alternative A would be both adverse and beneficial and negligible. Beneficial impacts would occur if a resource were discovered that led to the identification of a culturally-significant artifact, group of artifacts, or a previously undocumented historic site. Impacts to cultural and historic resources from visual and noise impacts to historic properties from the presence of NOAA vessels under Alternative A would have no impact. Impacts to cultural and historic resources from visual and noise impacts to TCPs and subsistence hunting and fishing areas from the presence of NOAA vessels and operation of active acoustic sources under Alternative A would be adverse and negligible to minor. Overall, impacts to cultural and historical resources under	Impacts of Alternative B to 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. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to cultural and historic resources under Alternative B would be adverse, minor, and insignificant.	Impacts of Alternative C to cultural and historic resources would be similar to those that would occur under Alternatives A and B. Overall, impacts to cultural and historic resources under Alternative C would be adverse, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	Alternative A would be adverse, minor, and insignificant.		
Socioeconomic Resources	Impacts to socioeconomic resources from data acquired by the NOAA fleet under Alternative A would be beneficial and minor to moderate. The impacts would decrease in intensity from moderate at current fleet utilization levels to minor at reduced fleet utilization levels towards the end of the 15-year timeframe of this PEA. The quality and quantity of products and services to society would decrease under Alternative A, resulting in fewer benefits to society across economic sectors. Overall, impacts to socioeconomic resources under Alternative A would be beneficial and moderate.	Impacts of Alternative B to socioeconomic resources would be an incremental increase in effects as compared to Alternative A that would be distributed unevenly among the different types of operations, the five operational areas, and within the 15-year timeframe. The deployment of newer, more technically-advanced ships along with service life extensions to NOAA ships would increase fleet utilization and data collection capabilities as compared to Alternative A. The quality and quantity of products and services would increase under Alternative B, resulting in greater benefits to society across economic sectors as compared to Alternative A. Overall, impacts to socioeconomic resources under Alternative B would be beneficial and moderate.	Impacts of Alternative C to socioeconomic resources would be similar but increase beyond the level anticipated under Alternatives A and B. Overall, impacts to socioeconomic resources under Alternative C would be beneficial and moderate.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
Environmental Justice	Impacts to environmental justice from increased ambient sound levels under Alternative A would be adverse and minor. Impacts to environmental justice from vessel strikes and movement of equipment under Alternative A would be adverse and minor. Impacts to environmental justice from accidental leakage or spillage of oil, fuel, and chemicals under Alternative A would be adverse and minor. Impacts to environmental justice from entanglement with equipment and marine track/debris and ingestion under Alternative A would be adverse and minor. Impacts to environmental justice from the availability of ocean data acquired by the NOAA fleet under Alternative A would be beneficial and minor.	Impacts of Alternative B to 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. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to environmental justice under Alternative B would be both adverse and beneficial, minor, and insignificant.	Impacts of Alternative C to environmental justice would be similar to those that would occur under Alternatives A and B. Overall, impacts to environmental justice under Alternative C would be both adverse and beneficial, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	Overall, impacts to environmental justice under Alternative A would be both adverse and beneficial, minor, and insignificant.		
Hazardous, Universal, and Special Waste	Impacts to hazardous waste under Alternative A would be adverse and negligible to minor. Impacts to hazardous waste from the storage and handling of hazardous waste under Alternative A would be adverse and negligible to minor. In the rare event that an accidental discharge or spill were to occur, the impacts would be minor to moderate. Overall, impacts to hazardous waste under Alternative A would be adverse, negligible to moderate, and insignificant.	Impacts of Alternative B to hazardous waste would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the deployment of new ships and integration of new and greener technology would likely reduce some impacts. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to hazardous waste under Alternative B would be adverse, negligible to moderate, and insignificant.	Impacts of Alternative C to hazardous waste would be similar to those that would occur under Alternatives A and B. Overall, impacts to hazardous waste under Alternative C would be adverse, negligible to moderate, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
Human Health and Safety	Impacts to human health and safety from vessel movement under Alternative A would be adverse and minor. Impacts to human health and safety from distress, safety, and emergency response under Alternative A would be adverse and minor. Impacts to human health and safety from chemical and biological hazards under Alternative A would be adverse and negligible to minor. Impacts to human health and safety from OTS handling, crane, davit, and winch operations under Alternative A would be adverse and minor. Overall, impacts to human health and safety under Alternative A would be adverse, minor, and insignificant.	Impacts of Alternative B to human health and safety would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the introduction of new ships and safer, more standardized technology would likely reduce some impacts. In addition, the types of activities and safety measures would remain the same. Overall, impacts to hazardous waste under Alternative B would be adverse, minor, and insignificant.	Impacts of Alternative C to human health and safety would be similar to those that would occur under Alternatives A and B. While Alternative C would result in greater impacts overall from additional DAS, the introduction of new ships and safer, more standardized technology would likely reduce some impacts. In addition, the types of activities and safety measures would remain the same. Overall, impacts to hazardous waste under Alternative C would be adverse, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
Climate Change	The effect of OMAO vessel operations on climate change under Alternative A would be adverse and negligible. The effect of climate change on OMAO vessel operations under Alternative A would be adverse and negligible to minor. Overall, the effects of both OMAO vessel operations on climate change and climate change on OMAO vessel operations under Alternative A would be adverse, negligible/negligible to minor (respectively), and insignificant.	Impacts of Alternative B as it relates to climate change and OMAO vessel operations would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the deployment of new ships and integration of new and greener technology would likely reduce some impacts. However, it is unknown whether improved efficiency efforts would offset the increase in miles traveled, DAS, and projects. Overall, the effects of both OMAO vessel operations on climate change and climate change on OMAO vessel operations under Alternative B would be adverse, negligible/negligible to minor (respectively), and insignificant.	Impacts of Alternative C as it relates to climate change and OMAO vessel operations would be similar to those that would occur under Alternatives A and B. Overall, the effects of both OMAO vessel operations on climate change and climate change on OMAO vessel operations under Alternative C would be adverse, negligible/negligible to minor (respectively), and insignificant.

1.0 INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) Office of Marine and Aviation Operations (OMAO) has prepared this Draft Programmatic Environmental Assessment (PEA) to analyze the potential environmental impacts associated with OMAO's vessel operations in United States (U.S.) marine, coastal, and fresh waters, and in areas outside of U.S. jurisdiction OMAO operates, manages, and maintains NOAA's fleet of research and survey ships, small boats, and Uncrewed Systems (UxS) Operations Center at mission-readiness levels in support of NOAA's at-sea observational requirements. NOAA's at-sea mission objectives provide products and services that are vital to safe navigation, commerce, environmental stewardship, and socioeconomic security. This Draft PEA analyzes the environmental impacts of OMAO's vessel operations while NOAA ships are underway (i.e., when ships are either moving in open water or secured to a specific location in open water), during which time OMAO conducts training, testing, calibration, and troubleshooting of vessel equipment and instruments in preparation for use by other NOAA Line Offices (LOs) or organizations outside of NOAA. OMAO retains the sole responsibility for complying with all environmental statutes, regulations, and other legal requirements for those vessel operations that are not connected to any mission requirement from another user (Devany, 2014; Friedman, 2017).

The Proposed Action evaluated in this Draft PEA is to continue OMAO vessel operations over a 15-year timeframe from 2023 to 2038 as the NOAA fleet is modernized by updating vessels in the existing fleet and replacing aging vessels with new vessels built specifically to support NOAA missions. Five years after the publication of the Final PEA, OMAO will reevaluate the PEA to determine if the analysis contained therein remains sufficient or if new analysis is required. NOAA has developed an integrated approach for fleet modernization that involves building new ships, making significant maintenance investments to extend the service life of existing NOAA ships, and increasing the utilization of the NOAA fleet (NOAA, 2016; OMAO, 2020a). Specific plans for vessel improvements and new vessel design and construction are evolving based on developing mission needs, technology advancements, and funding availability; therefore, this Draft PEA analyzes a range of fleet improvements that may be implemented over the next 15 years. Fleet modernization is the best way for NOAA to reliably and consistently sustain its current vessel operations in order to collect at-sea data and execute mission objectives.

This Draft PEA 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 Code of Federal Regulations [CFR] Parts 1500-1508 (1978)); NOAA's Policy and Procedures for Compliance with the NEPA and Related Authorities (NOAA Administrative Order [NAO] 216-6A and Companion Manual for NAO 216-6A), and other relevant federal and state laws and regulations. While revised CEQ regulations implementing NEPA became effective on September 14, 2020 (40 CFR § 1506.13), OMAO prepared this Draft PEA using the 1978 CEQ regulations because this environmental review was an ongoing action as of September 14, 2020. NOAA's Office of General Counsel, Oceans and Coasts Section, issued a memorandum on December 12, 2017 recommending that OMAO scope and prepare a focused programmatic review of vessel activities (McCoy and Bregman, 2017). A first draft of the PEA was developed as of February 21, 2020.

This Draft PEA was prepared to determine whether the Proposed Action constitutes a major federal action significantly affecting the quality of the human environment and whether an Environmental Impact Statement (EIS) is required. This Draft PEA discloses the direct, indirect, and cumulative environmental impacts that would result from the two alternatives identified for implementing the Proposed Action, as well as the "No Action" alternative. After the public comment period, OMAO will either issue a Finding of

No Significant Impact (FONSI) presenting the reasons why the agency has concluded that there are no significant environmental impacts projected to occur upon implementation of the Proposed Action or a determination to proceed with the preparation of an EIS.

The CEQ regulations for implementing NEPA state that federal agencies shall, to the fullest extent possible, integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively. Accordingly, NOAA has issued directives regarding the responsibilities of NOAA LOs to ensure compliance with NOAA Trust Resource Statutes, including the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), the National Marine Sanctuaries Act (NMSA), the Magnuson-Stevens Fisheries Conservation and Management Act (MSA), the Coastal Zone Management Act (CZMA), and related statutes (Devany, 2014; Friedman, 2017). Section 1.4 of this Draft PEA provides a description of OMAO's approach for complying with these statutes.

1.1 Purpose and Need

The purpose of the Proposed Action is to ensure that NOAA's current and future fleet is maintained and operated in a manner that is safe, environmentally compliant, and allows NOAA to fulfill its at-sea mission objectives and data collection requirements.

The need for the Proposed Action is to maintain uninterrupted operational fleet capabilities to support NOAA scientific data collection in marine, coastal, and freshwater environments. OMAO needs to continue to operate the NOAA fleet to maintain it at mission-readiness levels; however, almost half of NOAA's ships will exceed their design service life during the timeframe of this Draft PEA (see Section 2.3). If NOAA does not invest in modernizing its fleet, it will not be able to produce the high quality, comprehensive data that are essential for NOAA products and services needed to protect lives and property, generate billions of dollars in American commerce and international trade each year, support stewardship of ecosystem resources, and facilitate research on ocean and atmospheric processes. In order to continue OMAO's vessel operations, NOAA needs to modernize its fleet. NOAA's vessels must be environmentally-compliant, and adaptable to provide the infrastructure and capabilities necessary to meet NOAA mission requirements now and in the future.

1.2 The Mission, Priorities, and Capabilities of OMAO

NOAA's mission is to collect, share, and use scientific information to help the U.S. understand, manage, and protect the 11.6 million square kilometers (km) [3.4 million square nautical miles (nm)] of ocean in the Exclusive Economic Zone (EEZ) and to predict changes in weather, climate, oceans, and coasts. NOAA programs rely on atmospheric, hydrographic, oceanographic, and biological data to fulfill mandates related to public safety, commerce, scientific knowledge, environmental stewardship, and socioeconomic security.

OMAO supports NOAA's at-sea missions and long-term goals by administering a wide range of research and survey vessels with various capabilities. Larger oceanographic vessels are able to explore the world's deepest oceans, while smaller vessels are responsible for charting the nation's coastal waters. Many of these vessels fulfill multiple missions and are equipped with specialized gear and scientific instrumentation to allow for extensive and diverse data collection capabilities. Some of these capabilities include collecting at-sea data, conducting in situ research; and providing educational outreach, technical assistance, software assistance, disaster response, and research stewardship. Day-to-day operations and activities of the fleet range from hydrographic, ecosystems, and fisheries surveys to weather and atmospheric research. These vessels also provide support for emergency response efforts during disasters and unpredictable events. NOAA LOs, and organizations outside of NOAA such as other U.S. government agencies, academia, state and local governments, communities, and businesses rely on this information for a variety of reasons, including to keep U.S. ports open to maritime commerce, understand biogeochemical changes to the planet, monitor the health of fish stocks, and make important economic and policy decisions.

In order to fulfill NOAA's missions of science, service, and stewardship, OMAO operates, manages, and maintains NOAA's fleet of vessels and NOAA's UxS Operations Center, of which only Uncrewed Marine Systems (UMS), which include Autonomous Underwater Vehicles (AUV), Uncrewed Surface Vehicles (USV), Remotely Operated Vehicles (ROVs), and Uncrewed Aircraft Systems (UAS) deployed directly from NOAA vessels are considered in this Draft PEA. OMAO maintains these vessels, equipment, and systems at mission-readiness levels, facilitating all of NOAA's at-sea missions and data collection requirements. **Figure 1.2-1** shows the primary Operational Areas (OAs) for NOAA vessel activity (collectively referred to as the "action area"). The missions designated within the action area are the focus of this Draft PEA. Operations and transits occurring in areas outside of U.S. jurisdiction are also covered by this Draft PEA, but they represent only a small portion of all OMAO activity. Section 2.1.2 further discusses the geographic scope covered by this Draft PEA.

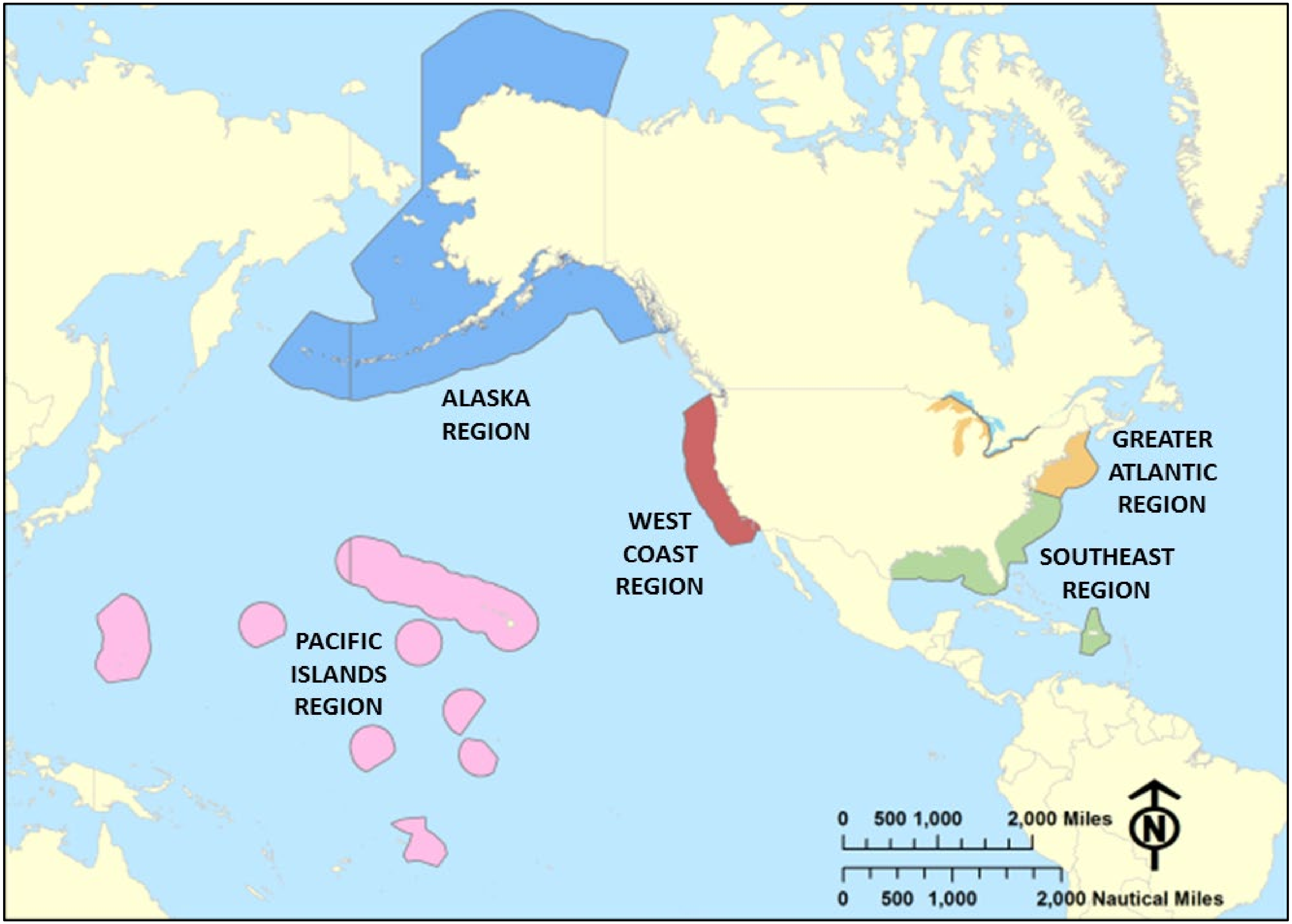


Figure 1.2-1. Primary Operational Areas for NOAA Vessel Activity

1.2.1 OMAO Primary Mission Support

OMAO supports NOAA's primary missions of charting and hydrographic surveying; assessments and management of living marine resources; oceanographic monitoring, research, and modeling; and emergency response, along with corresponding at-sea requirements, as outlined in **Table 1.2-1** and detailed below.

Table 1.2-1. Primary Missions and At-Sea Requirements

Primary Mission	At-Sea Required Capability
Charting and Hydrographic Surveying	Navigation, Observations, and Positioning
	Coastal Science and Assessment
Assessment and Management of Living Marine Resources	Protected Resources Science and Management
	Fisheries Science and Management
	Habitat Conservation and Restoration
Oceanographic Monitoring, Research, and Modeling	Climate Research
	Weather and Air Chemistry Research
	Ocean, Coastal, and Great Lakes Research
Emergency Response	Assessment and Support for Natural and Human-made Disasters

Charting and Hydrographic Surveying: This mission supports safe navigation, management of coastal and ocean resources, restoration and response for emergencies and natural disasters, and technical assistance for coastal zone management. Data collected by the NOAA fleet in support of these missions have significant economic and societal benefits.

> **Navigation, Observations, and Positioning** – Nautical charts are tools used by all sectors of the maritime industry (recreational, commercial, and military) for safe navigation in waterways and coastal areas. Ocean currents, littoral movement of sand, silt transport and deposition from rivers, passage of storms, tectonic activity, and impacts from commercial shipping and recreational uses result in changes to bathymetry that degrade the accuracy of nautical charts. Ongoing surveys are required to keep charts accurate and navigation safe.

> **Coastal Science and Assessment** – These activities gather data for tsunami modeling, storm surge predictions, sanctuary management, ocean exploration, Essential Fish Habitat (EFH) mapping and characterization, and submerged cultural resources management. Accurate underwater mapping of coastal areas is critical for planning and emergency management.

Assessment and Management of Living Marine Resources: NOAA is responsible for the stewardship of the nation's ocean resources and habitats. Timely, geographically-driven, and capabilities-dependent access to the sea supports the sustainability and economic value of fisheries; promotes resiliency of fishing communities and working waterfronts; protects and recovers threatened and endangered species; and maintains and restores healthy coastal habitats for living marine resources. NOAA uses at-sea data to identify, characterize, monitor, and evaluate living marine resources and their surrounding ecosystems through physical, chemical, and biological observations.

> **Protected Resources Science and Management** – Accurate assessments of threatened and endangered marine and anadromous species and the ecosystems that sustain them provide

important information to the communities that value and depend on them. Measurement and prediction of resource abundance, distribution, habitat requirements and related ecosystem components of protected resources directly impact quotas (catch or harvest limits) for commercial and recreational fishery stocks, commercial shipping lanes, and resource conservation efforts.

Fisheries Science and Management – Accurate, complete, and timely fishery related surveys are directly linked to commercial and recreational fishery stock quotas. A reduction in data collection from surveys would result in less precise stock assessments leading to more conservative catch limits, fewer fish to market and economic losses to commercial fishermen and industries across the nation.

Habitat Conservation and Restoration – These activities protect and restore habitat to sustain commercial and recreational fisheries, recover protected species, and maintain resilient coastal ecosystems and communities. Habitat conservation and restoration directly impacts commercial and recreational fishery quotas, the communities that rely on sustained stocks, and the downstream industries fueled by fish and seafood landings.

Oceanographic Monitoring, Research and Modeling: NOAA conducts oceanographic research that increases knowledge of climate, weather, oceans, and coasts. Oceanographic monitoring, research and modeling contribute to accurate weather forecasts, enable communities to plan for and respond to climate events such as drought, and enhance the protection and management of the nation's coastal and ocean resources. Weather data collected by NOAA vessels using weather buoys, drifters and over-the-side and hull mounted instrumentation are directly fed into weather models, forecasts and oceanographic circulation models.

Climate Research – NOAA vessel data are fundamental to sustaining atmospheric and oceanic observations and research; understanding and predicting ocean and climate variability and change; and incorporating research into information and products. Data collected by NOAA vessels directly feeds into global models that forecast precipitation and extreme weather events (tropical cyclones, tornadoes, blizzards). Advancements resulting from the repeatable and complex data collected by NOAA vessels directly lead to improved forecasts and forecasting capabilities.

Weather and Air Chemistry Research – Data collected by NOAA vessels support research and accurate, timely warnings and forecasts of high-impact weather events. Vessel data are fed directly into El Niño and La Niña weather forecasts, which are essential to provide timely and accurate notification for safety of lives and property, emergency management, and economic planning.

Ocean, Coastal, and Great Lakes Research – These activities investigate ocean, coastal and Great Lakes habitats and resources to help manage and understand fisheries; conserve and restore the nation's coasts; and build a stronger economy. For example, data collected by NOAA vessels are used to predict and respond to harmful algae blooms, a significant threat to coastal regions. Data to predict, understand, minimize and properly respond to harmful algae blooms are critical for the economic viability and health of coastal communities.

Emergency Response: NOAA vessels respond to natural and human-made disasters. The data collected by NOAA vessels are used by federal, state, and local agencies to minimize environmental and economic impacts of oil and chemical spills, vessel groundings, hazardous waste releases and national security events. NOAA emergency response services include surveying major commercial ports in direct support of the U.S. Coast Guard (USCG) following storm passage to ensure channels are free from debris, shoaling and/or other navigational hazards. Hydrographic data collected by NOAA vessels directly influence USCG Captains of the Port in their decisions to re-open ports to commercial traffic. Additionally, NOAA's hydrographic assets assist in locating sunken vessels that may be an environmental or navigational threat. NOAA vessels also assist in modeling oil spill trajectories, cleaning up shorelines, identifying sensitive resources, and managing information. In the event that a distress signal is sent out by another vessel or by the USCG, NOAA vessels in the vicinity are obligated to respond to those calls for aid as expeditiously as is feasible. The multi-disciplinary capabilities of the NOAA fleet provide a highly adaptable and responsive national asset in the greatest times of need.

1.2.2 NOAA Fleet Capabilities

The ships comprising NOAA's Fiscal Year (FY) 2023 Fleet are a mix of purpose-built and converted U.S. Navy ships. Some of the ships acquired from the U.S. Navy, including the *Gordon Gunter*, *Nancy Foster*, *Okeanos Explorer*, *Oscar Elton Sette,* and *Thomas Jefferson,* were adapted to perform NOAA activities. The remaining ships were constructed specifically to support NOAA missions. The ships vary in age and size, and they are generally categorized by their primary capabilities, such as oceanographic research, charting and mapping, and fisheries/coastal science. The four categories of NOAA ships are described below, and details of the ships in the FY 2023 fleet are presented in **Table 1.2-2**.

- **Oceanographic Research Vessels** – These are large, high endurance vessels used for deep water oceanography. They have configurable laboratories and mapping equipment. These ships have the capability to conduct all at-sea data collection activities for climate research, weather and air chemistry, and ocean, coastal, and Great Lakes research.

- **Charting and Mapping Vessels** – These are large, high endurance vessels used to gather hydrographic data and make navigational products. The have specialized capabilities for deploying small craft, including both crewed and uncrewed platforms and they have configurable laboratories, and ship-based mapping equipment. These ships have the capability to collect data for charting and surveying in deep and shallow water areas, as well as producing hydrographic, benthic habitat, and water column geospatial products.

- **Fisheries/Coastal Science (Medium Endurance)** – These are smaller, limited endurance vessels that can be at sea for up to 20 days. They have configurable laboratories, ship-based mapping equipment, and trawl capabilities. These ships have the capability to conduct near-shore, shallow-draft, limited range, trawl-based data collection activities.

- **Fisheries/Coastal Science (High Endurance)** – These vessels, also known as Fisheries Survey Vessels (FSVs), are larger than the medium endurance vessels and have significantly longer endurance. They have configurable laboratories, ship-based mapping equipment, and trawl capabilities. These vessels have the capability to collect at-sea data to develop fishery stock assessments.

Appendix A provides detailed descriptions of the mission capabilities of each ship.

Table 1.2-2. FY2023 Ships in the NOAA Fleet

NOAA Ships*	Length (m/ft)	Primary Capabilities**	Launch Year	Age (years)
Oregon II	52/170	Fisheries/Coastal Science (Medium Endurance)	1967	56
Rainier	70/231	Charting and Mapping	1967	56
Fairweather	70/231	Charting and Mapping	1967	56
Oscar Elton Sette	68/224	Fisheries/Coastal Science (Medium Endurance)	1987	36
Okeanos Explorer	68/224	Oceanographic Research	1988	35
Gordon Gunter	68/224	Fisheries/Coastal Science (Medium Endurance)	1989	34
Nancy Foster	57/187	Fisheries/Coastal Science (Medium Endurance)	1990	33
Thomas Jefferson	63/208	Charting and Mapping	1991	32
Ronald H. Brown	84/274	Oceanographic Research	1996	27
Oscar Dyson	64/209	Fisheries/Coastal Science (High Endurance)	2003	20
Henry B. Bigelow	64/209	Fisheries/Coastal Science (High Endurance)	2005	18
Pisces	64/209	Fisheries/Coastal Science (High Endurance)	2007	16
Bell M. Shimada	64/209	Fisheries/Coastal Science (High Endurance)	2008	15
Ferdinand R. Hassler	38/124	Fisheries/Coastal Science (Medium Endurance)	2009	14
Reuben Lasker	64/209	Fisheries/Coastal Science (High Endurance)	2012	11

*Ships are listed from oldest to newest according to launch year.

**Any NOAA ship can provide emergency response in the event of a natural or human-made disaster.

NOAA ships maintain a broad array of equipment, systems, and facilities to support vessel operations and scientific activities while at sea. Ship deck equipment, including winches, davits, cranes, and articulating frames (A-frames), is used to facilitate repairs, bring food stores and equipment onboard, or offload trash. This equipment also supports scientific activities such as water column and seafloor sampling, ecosystem monitoring, and acoustic and bathymetric mapping. Ship systems such as echo sounders and side-scan sonars help scientists explore and map the sea floor, while mission systems such as trawl nets, grab samplers, and sediment corers allow scientists to collect and analyze the different physical, chemical, and biological components of the ocean, as shown in **Figure 1.2-2**. ROVs and UxS enable scientists to explore the ocean and collect data from the safety of the ship. Wet laboratories are equipped with sophisticated analytical equipment, ample chemical storage, and extensive work spaces for scientists to conduct their research. Real-time data processing often provides input into cruise execution, enabling scientists to make adjustments to mapping or sampling plans.

NOAA ships acquire a wide range of oceanographic, atmospheric, hydrographic, fisheries assessment, ecosystem, and habitat data in direct support of resource management and monitoring programs. Most ships are multipurpose and are able to conduct a number of research activities during a single deployment. This versatility enables NOAA ships to maximize NOAA's data collection abilities. Some ships also have specialized capabilities, such as deploying and recovering AUVs, recovering long sediment and rock cores, or operating at high latitudes in the Arctic and Antarctic oceans. FSVs have been acoustically quieted in accordance with low radiated noise standards defined by the International Council for Exploration of the Seas.

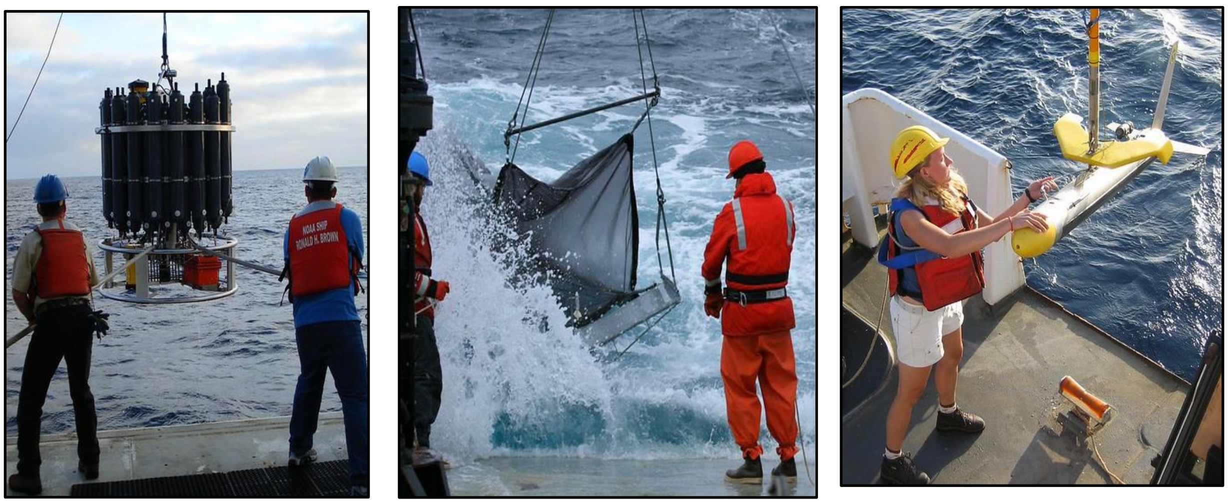


Figure 1.2-2. NOAA Ship Capabilities Including Data Collection (Left), Fisheries Surveys (Center), and Acoustic Mapping (Right)

New technologies will increase and/or improve at-sea scientific capabilities and enable smaller ships to perform expanded mission profiles. Uncrewed assets such as USVs, AUVs ROVs, and gliders will not prevent the need to go to sea, but can extend and expand data collection at temporal and spatial scales beyond current ship-based capabilities. High-bandwidth communication with tele-presence, or virtual participation, allows broader participation by individuals who cannot otherwise go to sea due to physical or ship berthing limitations. These types of technologies will also allow expanded simultaneous multi-mission operations.

1.2.3 NOAA Fleet Officers and Crew

NOAA vessels operate under the command of NOAA Commissioned Officers, also known as NOAA Corps Officers. These officers operate NOAA's vessels, fly aircraft, manage research projects, conduct diving operations, and serve in staff positions throughout NOAA. They are professionals trained in engineering, earth sciences, oceanography, meteorology, fisheries science, or other related disciplines. The combination of commissioned service and scientific expertise makes these officers uniquely capable to lead some of NOAA's most important initiatives.

Vessels can also be operated under a USCG-licensed Civilian Mate and/or Master. The remainder of the vessel's crew are USCG-licensed engineering officers and civilian professional mariners including licensed masters, mates, and engineers, and unlicensed members of the engine, steward, and deck departments. Survey and electronic technicians operate and/or maintain the vessel's mission, communication, and navigation equipment. These professional mariners are essential to provide the specialized skills and technical expertise to successfully complete NOAA's at-sea missions. Appendix B describes NOAA's Marine Operation Centers, which function as homeports and support centers for NOAA's ships, officers, and crews.

1.2.4 Modernization of the NOAA Fleet

As described in Section 1.2.2, ships in the NOAA fleet range in age from 11- to 56-years old. NOAA recognizes the need to modernize the fleet in order to meet the current and future at-sea needs of NOAA projects while maintaining environmentally-compliant operations. NOAA has developed an integrated approach for fleet modernization that would involve building new ships specifically designed to support multiple NOAA missions, making significant maintenance investments to extend the service life of existing NOAA ships, and increasing the utilization of the NOAA fleet (NOAA, 2016; OMAO, 2020a). Specific plans for vessel improvements and new vessel design are evolving based on at-sea requirements, technology advancements, and funding availability. This Draft PEA analyzes a range of fleet improvements that may be implemented over the next 15 years to encompass future decisions on fleet modernization.

NOAA's long-term strategy for modernization of its fleet is to design and construct new ships to replace ships that will meet the end of their service lives in the coming years. The timeline to analyze requirements, design, and build a ship is eight to ten years; therefore, it is critical that NOAA simultaneously proceed with near-term strategies to address the loss of capabilities over the next few years. Near-term strategies include integration of new environmentally-friendly technologies into existing ships, upgrades to ship infrastructure and data collection capabilities, and the implementation of fleet management strategies to maximize use of the existing NOAA fleet and mitigate the anticipated loss of NOAA ships that reach the end of their service life over the next decade.

The future NOAA fleet will consist of four vessel types (see Section 1.2.2). Each vessel will incorporate the latest technologies during construction and accommodate new technologies as they become available, including advanced systems and greener technologies to maintain environmentally-compliant operations. Basic ship systems will be standardized as much as possible across the fleet to reduce operation and maintenance costs. Two new oceanographic research ships are currently under construction and are expected to be completed in 2025. The contracts for two new charting and mapping ships were awarded in the summer of 2023,and the ships are expected to be completed in 2027 and 2028.

The Proposed Action evaluated in this Draft PEA is to continue OMAO vessel operations over a 15-year timeframe from 2023 to 2038 as the NOAA fleet is modernized by updating vessels in the existing fleet and replacing aging vessels with new vessels built specifically to support NOAA missions. Through the combination of near-term ship upgrades, long-term ship replacement, and improved fleet utilization, NOAA will address the purpose and need of the Proposed Action to continue uninterrupted operational capabilities to fulfill its at-sea mission objectives and data collection requirements, and to maintain environmentally-compliant operations now and in the future by implementing greener technologies.

1.3 PROGRAMMATIC SCOPE

CEQ guidance on the effective use of programmatic NEPA reviews states that a 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). This CEQ guidance also provides that "agencies may prepare a single NEPA document to support both programmatic and project-specific proposals."

OMAO determined that a programmatic approach was appropriate for the Proposed Action because OMAO conducts a suite of similar agency actions associated with vessel operations throughout U.S. waters, the EEZ, and in areas outside of U.S. jurisdiction. Using this programmatic approach, this Draft PEA analyzes the general environmental impacts on the natural and physical environment associated with OMAO fleet activities in support of NOAA's primary missions (see Section 1.2.1). The analysis will be used to inform NOAA and OMAO leadership and the public on the environmental impacts before a decision is made on how to execute future fleet activities.

1.3.1 Subsequent Action-Specific Consideration of Environmental Impacts

The PEA provides a programmatic analysis of the environmental effects of OMAO's anticipated vessel operations throughout the action area for the next 15 years, including modernization of the NOAA fleet. This Draft PEA is also intended to support tiered, project-level decision-making. The PEA will serve as the basis for tiering future NEPA reviews of actions and activities that are needed to continue operations but that fall outside the scope of this analysis. Under NEPA, tiering refers to employing a broad overarching NEPA document to support environmental analyses for subsequent actions that are narrower in scope (40 CFR § 1508.28 (1978)). As new OMAO activities become sufficiently well-defined and proposed, and their potential environmental consequences are better understood, specific impacts will be evaluated as necessary. An action not included in this PEA may need to be captured in a project-level, tiered NEPA review. For example, although the PEA does not cover the environmental effects from the NOAA LO's use of the fleet during a project, the PEA may, if appropriate, be incorporated by reference into joint environmental compliance documents prepared by the user and OMAO. In addition, tiering may be used for documenting coverage of future activity within the scope of the existing analysis; preparing site-specific Environmental Assessments (EAs) relying on and incorporating analysis in the PEA; and preparing an EIS if significant impacts outside the scope of the PEA analysis may result from site-specific actions.

Some proposed activities will require further project-specific EAs and compliance with additional consultation, approval, or permitting requirements. The analysis provided by this PEA is intended to support and integrate site-specific NEPA analysis and compliance with the ESA, MMPA, MSA, NMSA, CZMA, and other applicable statutes, while acknowledging that specific activities may require development of more focused and refined analysis. With the exception of at-sea activities covered under embarked project permits, at-sea activities under this PEA involve only incidental interactions with protected species, such as marine mammals and threatened and endangered species, but not intentional interactions with those species. OMAO does not anticipate direct take of protected species as a result of the Proposed Action.

1.4 Environmental Compliance Considerations and Coordination with Other Agencies

OMAO is committed to public transparency and working with federal, state, local, and tribal partners to minimize environmental impacts from OMAO vessel operations. To that end, OMAO follows all statutes and regulations during its at-sea operations and integrates other planning and environmental review procedures required by law or by agency practice to ensure environmentally-compliant operations. Although state and local statutes and regulations (particularly procedural requirements such as permitting) are not typically binding on federal agencies, as stated in NAO 216-17A, Section 2.02: "It is NOAA policy for all personnel and affiliates to conduct their activities in a manner that complies with all applicable environmental requirements and to cooperate with federal agencies, including the U.S. Environmental Protection Agency (EPA), as well as state, interstate, and local agencies in the prevention, control, and abatement of environmental pollution.)" It is NOAA's intent to comply with substantive state and local requirements to the maximum extent practicable.

OMAO's environmental compliance policies for at-sea operations are informed by the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78), which is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. MARPOL requirements address prevention of pollution by oil (Annex I), by noxious liquid substances in bulk (Annex II), by harmful substances carried by sea in packaged form (Annex III), by sewage from ships (Annex IV), by garbage from ships (Annex V), and prevention of air pollution from ships (Annex VI). The U.S. is a party to Annexes I, II, III, V, and VI. Although NOAA vessels are exempt from many MARPOL requirements, NOAA vessels are subject to the requirements of MARPOL Annex V under the U.S. law implementing the MARPOL Convention: the Act to Prevent Pollution from Ships (APPS; 33 U.S.C. § 1902). Further, APPS requires federal agencies to "prescribe standards applicable to ships excluded from this Act … for which they are responsible," which "shall ensure, so far as is reasonable and practicable without impairing the operations or operational capabilities of such ships, that such ships act in a manner consistent with the MARPOL Protocol" (33 U.S.C. § 1902(i)). Consistent with this mandate, OMAO Policy 0251 requires NOAA's vessels to comply with USCG regulations for oceanographic research vessels at 46 CFR Subchapter U through OMAO Policy 0251 and other policies and procedures, described in more detail in Chapter 3. OMAO voluntarily complies with many requirements of Annexes I, IV, and VI.

Other major components of OMAO's environmental compliance are the Clean Water Act (CWA) and the Clean Air Act (CAA). Under the CWA, the U.S. EPA established the National Pollutant Discharge Elimination System (NPDES) Vessel General Permit (VGP), which provides coverage nationwide for discharges incidental to the normal operation of commercial vessels greater than 24 meters (m) (79 feet [ft]) in length. Under the CAA, along with the mandates established in MARPOL Annex VI, U.S. flagged ships and non-U.S. flagged ships operating in U.S. waters must adhere to engine-based and fuel-based standards to limit air pollutants contained in ship exhaust, in addition to prohibiting the deliberate emission of ozone-depleting substances (ODS) and regulating incinerator emissions. Also, 33 CFR § 151 covers the regulations for those vessels carrying oil, noxious liquid substances, garbage, municipal or commercial waste, and ballast water, and addresses oil pollution, ballast, solid waste, spills, etc. All NOAA ships abide by these laws and regulations, which are discussed further in Sections 3.3 and 3.4.

1.4.1 Applicable Environmental Statutes

In accordance with CEQ regulations for implementing NEPA, federal agencies shall, to the fullest extent possible, integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively. To this end, OMAO is addressing compliance with the laws appearing in **Table 1.4-1** concurrently with preparation of this Draft PEA. **Table 1.4-1** includes a description of the applicability of each statute to OMAO activities and OMAO's approach for consultation with the responsible agency.

Table 1.4-1. Regulatory Requirements Addressed Concurrently with the OMAO Draft PEA

Statute	Overview	Responsible Agencies	Compliance Focus	OMAO Compliance Approach
National Environmental Policy Act (NEPA)	Requires United States (U.S.) federal agencies to evaluate potential environmental effects by preparing an environmental evaluation of any major planned federal action affecting the human environment and promotes public awareness of potential impacts.	Council on Environmental Quality (CEQ), Lead federal agencies (e.g., National Oceanic and Atmospheric Administration [NOAA] and Office of Marine and Aviation Operations [OMAO]); U.S. Environmental Protection Agency (EPA)	Environmental impacts of the Proposed Action on resources in the action area	Preparation of Programmatic Environmental Assessment (PEA)
Endangered Species Act (ESA)	Provides for the conservation of endangered and threatened species of fish, wildlife, and plants throughout all or a significant portion of their range, and the conservation of the ecosystems upon which they depend. Administered jointly by National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS).	NMFS Office of Protected Resources (OPR); USFWS	Actions that may adversely affect threatened or endangered species, or any designated critical habitat	OMAO is currently preparing a Biological Assessment (BA) and pursuing informal consultation.
Marine Mammal Protection Act (MMPA)	Prohibits the take of marine mammals in U.S. waters and by U.S. citizens on the high seas and the importation of marine mammals and marine mammal products into the U.S. Allows, upon request, the "incidental," but not intentional, take of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing).	NMFS OPR; USFWS	Actions that may result in the take of any marine mammal	OMAO is coordinating with NMFS OPR regarding its approach to compliance with the MMPA. OMAO will document its compliance with the MMPA prior to concluding this NEPA process.

Statute	Overview	Responsible Agencies	Compliance Focus	OMAO Compliance Approach
Magnuson-Stevens Fishery Conservation and Management Act (MSA), Essential Fish Habitat (EFH)	Authorizes the U.S. to manage fishery resources in an area from a state's territorial sea (extending 5.5km [3 nm] from shore) to 370 km [200 nm] off its coast (termed as the Exclusive Economic Zone [EEZ]). Includes 10 national standards to promote domestic commercial and recreational fishing under sound conservation and management principles, and provide for the preparation and implementation of fishery management plans (FMPs).	NMFS Office of Habitat Conservation (OHC)	Actions that may adversely affect EFH identified in FMPs	OMAO will initiate consultation with NMFS upon completion of the Draft PEA.
Migratory Bird Treaty Act (MBTA)	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.	USFWS	Actions that may result in death, injury, or take, and other actions that may adversely affect migratory birds and their habitat	The Proposed Action would not result in take of migratory birds, so no consultation is required. OMAO has considered impacts to migratory birds in Section 3.7 of this Draft PEA.

Statute	Overview	Responsible Agencies	Compliance Focus	OMAO Compliance Approach
National Marine Sanctuaries Act (NMSA)	Authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or aesthetic qualities as national marine sanctuaries. Section 304(d) of the NMSA requires interagency consultation between the Office of National Marine Sanctuaries (ONMS) and federal agencies taking actions that are "likely to destroy, cause the loss of, or injure a sanctuary resource".	National Ocean Service (NOS); ONMS	Actions that may adversely affect (destroy, cause the loss of, or injure) any sanctuary resource; actions that may adversely impact resources of a National Marine Sanctuary or Marine National Monument	No activities included in the Proposed Action would occur in sanctuaries, and no activities outside of sanctuaries are likely to destroy, cause the loss of, or injure sanctuary resources, so no consultation is needed. In the event that OMAO does conduct any activities in sanctuaries, then OMAO would consider whether such an activity meets the standard for consultation under the NMSA Section 304(d) and document the process.
National Historic Preservation Act (NHPA)	Primary federal statute addressing the management of historic properties. 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.	Advisory Council on Historic Preservation (ACHP); SHPOs; THPOs	Actions that may adversely affect historic properties	OMAO does not anticipate any impacts to historic properties as a result of the Proposed Action. In the future, if any OMAO activities are found to have the potential to affect historic properties, then OMAO would perform a Section 106 consultation

Statute	Overview	Responsible Agencies	Compliance Focus	OMAO Compliance Approach
				before conducting those activities.
Coastal Zone Management Act (CZMA)	Encourages and assists states in developing coastal management programs. Requires any federal activity affecting the land or water use or natural resources of a state's coastal zone to be consistent with that state's approved coastal management program.	NOS Office for Coastal Management (OCM); State Coastal Zone Management Offices	Actions that may adversely affect any land, water use, or natural resources of the coastal zone	OMAO is pursuing a nationwide consistency determination which will be initiated following publication of the Draft PEA.

1.4.2 Executive Orders (EOs)

Compliance with the EOs listed in **Table 1.4-2** has been considered in the preparation of this PEA as shown:

Table 1.4-2. Executive Orders (EOs) Considered in Preparation of the OMAO Draft PEA

Executive Order	Overview	OMAO Compliance Approach
EO 12114, Environmental Effects Abroad of Major Federal Actions	Addresses proposed actions, or impacts thereof, that occur outside the U.S., its territories and possessions, U.S. territorial seas, or which may affect resources not subject to the management authority of the U.S.	NOAA vessels may transit through areas outside of U.S. jurisdiction (Section 2.1.2.2); activities performed in areas outside of U.S. jurisdiction would be limited and impacts beyond the U.S. EEZ would be similar to impacts within the EEZ (Chapter 3).
EO 13158, Marine Protected Areas (MPA)	Addresses proposed actions that may affect natural or cultural resources of an MPA.	The impact of OMAO operations on individual MPAs and resources within MPAs would be the same as the impacts on the resources within the applicable geographic region evaluated in this PEA (Chapter 3).
EO 13089, Coral Reef Protection	Develops and implements a comprehensive program of research and mapping to inventory, monitor, and identify the major causes and consequences of degradation of coral reef ecosystems.	For more information see Aquatic Macroinvertebrates (Section 3.7.1.4).
EO 13112, Invasive Species	Prevents the introduction of invasive species and provides for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.	For more information on invasive species see Habitats (Section 3.6), Aquatic Macroinvertebrates (Section 3.7.1.4), and Essential Fish Habitat (Section 3.6.1.5).
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds	Directs federal agencies that take actions that either directly or indirectly affect migratory birds to develop a Memorandum of Understanding (MOU), and to work with the USFWS and other federal agencies, to promote the conservation of migratory bird populations.	For more information on birds see Seabirds, Shorebirds and Coastal Birds, and Waterfowl (Section 3.7.1.5).

Executive Order	Overview	OMAO Compliance Approach
EO 13175, Consultation and Coordination with Indian Tribal Governments	Ensures that all executive departments and agencies consult with Indian Tribes and respect tribal sovereignty as they develop policy on issues that impact Indian communities.	OMAO has invited tribes to comment on the Draft PEA. For more information on the consideration of tribal resources see Cultural and Historic Resources (Section 3.8) and Environmental Justice (Section 3.10).
EO 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations	Addresses disproportionately high and adverse human health or environmental effects to minority and low-income populations.	For more information see Environmental Justice (Section 3.10).
EO 14096, Revitalizing Our Nation's Commitment to Environmental Justice for All	Seeks to deepen the "whole-of-government" approach to Environmental Justice (EJ) by fully integrating the consideration of unserved and overburdened communities and populations into all aspects of federal agency planning and delivery of services.	For more information see Environmental Justice (Section 3.10).
EO 13693, Planning for Federal Sustainability in the Next Decade	Requires federal agencies to improve environmental and energy efficiency and sustainability, including reducing greenhouse gas emissions, fleet performance, energy conservation, solid waste diversion, and pollution prevention.	The preparation of the PEA will enable OMAO to more meaningfully and efficiently consider the environmental effects of vessel operations. For more information on how Alternatives B and C would adopt new techniques and technologies to encourage greater program efficiencies see Chapter 2, Sections 2.4 and 2.5.
EO 14008, Tackling the Climate Crisis at Home and Abroad	Places the climate crisis at the forefront of U.S. foreign policy and national security planning, and builds upon the Paris Agreement's three overarching objectives: a safe global temperature, increased climate resilience, and financial flows aligned with a pathway toward low greenhouse gas emissions and climate-resilient development.	For more information on climate change see Section 3.13, Climate Change, and cumulative effects on the environment (Sections 4.1.5 and 4.2).

1.5 PUBLIC INVOLVEMENT

NEPA requires agencies to involve relevant federal agencies, state and local agencies, tribes, applicants, and the public to the extent practicable when preparing EAs. Public participation promotes transparency, facilitates better decision-making, and helps federal agencies identify data gaps and sources of potential concern regarding the environmental impacts of a proposed action. Stakeholders such as state, tribal, and local governments; the public (both private citizens and non-governmental organizations); and other agencies have a critical role in helping OMAO understand the environmental impacts of the Proposed Action and alternatives.

Because of the wide geographic scope of the Proposed Action, OMAO is publishing a Notice of Availability (NOA) of the Draft PEA in the *Federal Register*. The NOA advises other federal and state agencies, territories, tribal governments, local governments, private parties, and the public of the Proposed Action, provides information on the nature of the analysis, and invites their input. OMAO is also sending letters via email or U.S. mail to federally recognized tribes to announce the publication of the Draft PEA and invite comment.

The Draft PEA is available for review on the OMAO website at http://omao.noaa.gov/noaa-vessel-operations-draft-pea. The 41-day public comment period for the Draft PEA will close on January 31, 2024. Written comments may be submitted by one of the following methods:

- E-mail: omaoenvironmental.compliance@noaa.gov
- U.S. Mail: Please direct written comments to:

  Hannah Staley, Sea Grant Fellow
  Office of Marine and Aviation Operations
  National Oceanic and Atmospheric Administration
  1315 East-West Highway
  Silver Spring, MD 20910

2.0 DESCRIPTION OF THE PROPOSED ACTION AND THE ALTERNATIVES

This chapter describes the Proposed Action and the alternatives that address the purpose and need for the action. The Proposed Action of this Draft Programmatic Environmental Assessment (PEA) is to continue Office of Marine and Aviation Operations (OMAO) vessel operations as the National Oceanic and Atmospheric Administration (NOAA) fleet is upgraded and modernized.

When preparing an Environmental Assessment (EA), decision makers must consider and analyze the impacts of a reasonable range of alternatives to the Proposed Action. The alternatives considered comprise a reasonable range of approaches to meet the purpose and need for the action, including a "No Action" alternative. OMAO has determined that to be reasonable for the purposes of this Draft PEA, an alternative must meet four criteria:

- 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, OMAO identified two action alternatives (Alternatives B and C) that meet the stated purpose and need of the proposed federal action and thus have been analyzed in detail in this Draft PEA. These alternatives are based on varying assumptions about future funding amounts and are presented in Sections 2.4 and 2.5. OMAO also analyzed a "No Action" alternative (Alternative A) that allows OMAO leadership and the public to compare the potential impacts of the action alternatives with the effects that would occur if OMAO continued vessel operations at current levels (i.e., the status quo). The No Action Alternative is presented in Section 2.3. OMAO did not identify any other alternatives that meet the purpose and need.

2.1 SCOPE OF THE ANALYSIS

In this Draft PEA, scope refers to the range of activities that are covered under this document as well as the geographic and temporal range of the Proposed Action and the alternatives. Geographic scope is the spatial extent of the areas potentially affected by the Proposed Action and the alternatives. Temporal scope is the timeframe over which the Proposed Action and the alternatives are evaluated. OMAO determined the scope of this document on the basis of the current extent of OMAO vessel operations and the ability to reliably predict the future level of activity. Activities that occur outside the parameters outlined below were not considered in the analysis.

2.1.1 Scope of OMAO Activities

This Draft PEA covers only those OMAO routine vessel operations that occur when the NOAA vessel is underway (i.e., when it is either moving in open water or is secured in a specific location in open water) and not operating under project instructions from another NOAA Line Office (LO) or organization outside of NOAA. During these operations (described in detail in Section 2.2), the responsibilities of meeting NEPA requirements fall to OMAO alone:

- Vessel movement;
- Anchoring;
- Waste handling and discharge operations;

- Vessel repair and maintenance;
- Equipment testing, calibration, training, and troubleshooting;
- Uncrewed Marine Systems (UMS) and Uncrewed Aircraft System (UAS) operations;
- Small boat operations; and
- Over the Side (OTS) handling.

Although not in the scope of this Draft PEA, OMAO will continue to follow all environmental compliance regulations at all ports and shoreside facilities.

OMAO also conducts distress, safety, and emergency response operations in situations where a vessel requires OMAO's immediate assistance in matters of crew, vessel, or public safety. This includes actions on behalf of the NOAA vessel itself in situations in which the safety and stability of the vessel or the crew and passengers are in distress. OMAO's response to such incidents is guided by the provisions under the International Convention for the Safety of Life at Sea (SOLAS). For ship distress calls, a vessel in need of assistance sends out a distress signal via VHF channel 16 and provides information such as the vessel's location, the nature of distress, and the kind of assistance required. The nearest vessel's CO or Master responds by transiting to the distress location and providing the necessary personnel and equipment (USCG, No Date-b). If OMAO is conducting vessel operations while underway and a ship sends out a distress signal, OMAO would respond if it is the closest vessel, based on a decision by the CO following USCG consultation in most instances. To prepare for these situations, OMAO conducts drills and training as required by law, including, but not limited to, man overboard, abandon ship, and fire situations. Safety drills and training have little to no environmental consequences and, therefore, are not addressed further in this Draft PEA.

For emergency response situations such as a hurricane or major oil spill, the entity having jurisdiction over that operating area such as the U.S. Coast Guard or U.S. Navy is responsible for granting authorization for assistance. NOAA vessels provide data collection capabilities to assist the affected entity in its response and recovery efforts. The data collection that occurs in response to these emergency situations is performed while under the project instructions of another NOAA LO or organization outside of NOAA and is not covered by this PEA.

NOAA vessels involved in fisheries surveys use bottom, mid, and surface level trawl nets or longlines. The operation of trawl nets and longlines to perform fisheries surveys, including performance and acceptance testing, calibration, training, and troubleshooting, is conducted while under project instructions from another NOAA LO or organization outside of NOAA and, therefore, is not covered under this PEA.

OMAO vessel operations include deployment of small boats (referred to as "attached" small boats) and other vehicles that are launched and operated directly from NOAA ships. This Draft PEA does not cover the Small Boat Program, OMAO aviation operations, or any other land-based launch or operation of small boats, vehicles, or other vessels. In addition, this Draft PEA does not cover other NOAA programs, such as the Diving Program or Aviation Safety Program or the use of charters or expanding partnerships. These other OMAO operations are expected to be addressed in future NEPA documents. Shipbuilding and decommissioning are also not covered under this Draft PEA.

This Draft PEA does not cover project execution by users other than OMAO when onboard a NOAA vessel, including NOAA LOs or organizations outside of NOAA. When OMAO vessels are deployed in support of NOAA LOs or organizations outside of NOAA, the associated at-sea operations are covered under the project instructions issued by the responsible NOAA LO or outside organization, as well as their requisite licenses, scientific research permits, and NEPA compliance. All scientific permits and safety protocols are the responsibility of the project's principal investigator for coverage of project operations for the duration of the project.

The OMAO vessel operation activities analyzed in this Draft PEA are shown in **Table 2.1-1** and described in detail in Section 2.2.

Table 2.1-1. OMAO Vessel Operations Covered by this PEA

OMAO Vessel Activity	YES[1] Covered by this PEA	NO[2] Not Covered by this PEA
Vessel Movement	▪ Vessel movement while operating outside of project instructions from another NOAA LO or organization outside of NOAA as deemed necessary by OMAO personnel, including vessel movement to and from ports, project areas, or locations used to conduct drills, equipment testing, calibration, training, and troubleshooting, and other OMAO operations. ▪ Vessel movement to conduct drills and trainings facilitated by OMAO personnel.	▪ Vessel movement while operating under project instructions from another NOAA LO or organization outside of NOAA, including vessel movement to and from a project area if specified in the project instructions from another NOAA LO or organization outside of NOAA.
Anchoring	▪ Anchoring during OMAO vessel operations, such as drills, equipment testing, calibration, training, and troubleshooting. ▪ Anchoring while under project instructions from another NOAA LO or organization outside of NOAA as deemed necessary by OMAO personnel, such as to ensure the safety of the vessel.	▪ Anchoring while under project instructions from another NOAA LO or organization outside of NOAA, including anchoring in specific locations or situations for scientific project purposes.
Waste Handling and Discharges	▪ Management of waste products and discharges that are generated from operation and maintenance activities onboard NOAA vessels. ▪ Response to spills generated from operation and maintenance activities onboard NOAA ships.	▪ Management of waste products and discharges from wet laboratory activities performed while under project instructions from another NOAA LO or organization outside of NOAA. ▪ Management, removal, and disposal of chemicals or other hazardous materials brought onboard by another NOAA LO or organization outside of NOAA. ▪ Response to spills generated from scientific project activities while under project instructions from another NOAA LO or organization outside of NOAA.

OMAO Vessel Activity	YES[1] Covered by this PEA	NO[2] Not Covered by this PEA
Vessel Repair and Maintenance	▪ Repair and maintenance activities for NOAA vessels, equipment, and gear performed while underway.	▪ Repair and maintenance activities for equipment brought onboard by another NOAA LO or organization outside of NOAA.
Active Acoustic Systems Operations	▪ Operation of navigational depth sounders for safety (excluding multibeam echo sounders, side scan sonar, and other data collection systems). ▪ Operation of acoustic systems beyond those for safety of navigation (including multibeam echo sounders, single beam echosounders, acoustic Doppler current profilers (ADCPs) and side-scan sonars) for OMAO vessel operation purposes only, such as performance and acceptance testing, calibration, training, and troubleshooting following repairs or drydock.	▪ Conducting hydrographic or fisheries surveys using active acoustic equipment (single beam and multibeam echo sounders, side-scan sonar, ADCPs) while under project instructions from another NOAA LO or organization outside of NOAA, including data collection, performance and acceptance testing, calibration, training, and troubleshooting.
Other Sensors and Data Collection Systems Operations	▪ Operation of conductivity, temperature, and depth (CTD) sensor, hydrophone, thermosalinograph, magnetometer, drop/towed camera, and meteorological sensors for OMAO purposes only, such as performance and acceptance testing, calibration, training, and troubleshooting. ▪ Operation of grab sampler, sediment corer, and seawater collection equipment for OMAO purposes only, such as performance and acceptance testing, calibration, training, and troubleshooting.	▪ Use of non-acoustic systems to conduct oceanographic research or to collect scientific data including data on water quality, habitats, marine mammals, fish, and climate effects while under project instructions from another NOAA LO or organization outside of NOAA; also including performance and acceptance testing, calibration, training, and troubleshooting while under project instructions. ▪ Collecting scientific data on seafloor sediment and seawater while under project instructions from another NOAA LO or organization outside of NOAA; also including performance and acceptance testing, calibration, training, and troubleshooting while under project instructions.

OMAO Vessel Activity	YES[1] Covered by this PEA	NO[2] Not Covered by this PEA
Uncrewed Marine Systems (UMS) Operations	▪ Launch and recovery of UMS from NOAA ships while underway for equipment testing, calibration, training, or troubleshooting. ▪ Operation of UMS other than Remotely Operated Vehicles (ROVs) from NOAA ships while underway for performance and acceptance testing, calibration, training, and troubleshooting.	▪ Testing, training, and troubleshooting of ROVs, which is only performed by project personnel while under project instructions from another NOAA LO or organization outside of NOAA. ▪ Operation of ROVs or UMS while under project instructions from another NOAA LO or organization outside of NOAA.
Uncrewed Aircraft Systems (UAS) Operations	▪ Launch and recovery of UAS from NOAA ships while underway for equipment testing, calibration, training, and troubleshooting. ▪ Operation of UAS from NOAA ships while underway for performance and acceptance testing, calibration, training, and troubleshooting.	▪ Operation of ship-based UAS while under project instructions from another NOAA LO or organization outside of NOAA.
Small Boat Operations	▪ Launch, operation, and recovery of attached small boats from NOAA ships while underway for equipment testing, calibration, training, troubleshooting, and personnel transfer. ▪ Performance and acceptance testing, calibration, training, and troubleshooting of attached small boat equipment, such as hydrographic equipment.	▪ Operation of attached small boats while under project instructions from another NOAA LO or organization outside of NOAA.
Over the Side (OTS) Handling, Crane, Davit, and Winch Operations	▪ Operation of winches, cranes, davits, frames, and other such deck equipment for data collection, equipment testing, calibration, training, and troubleshooting including lowering and positioning CTDs, cameras, magnetometers, ROVs, and small boats.	▪ Operation of equipment brought onboard by another NOAA LO or organization outside of NOAA.

[1] The PEA covers all underway OMAO vessel operations except for specific activities that are covered under project instructions provided by a NOAA LO or other organization outside of NOAA (such as another government agency) related to fulfilling the responsible party's at-sea data collection requirements. Vessel operations that occur in port are not covered by this PEA.

[2] The activities listed should be covered under project instructions provided by the responsible party in accordance with the responsible party's environmental compliance protocols.

2.1.2 Geographic Scope

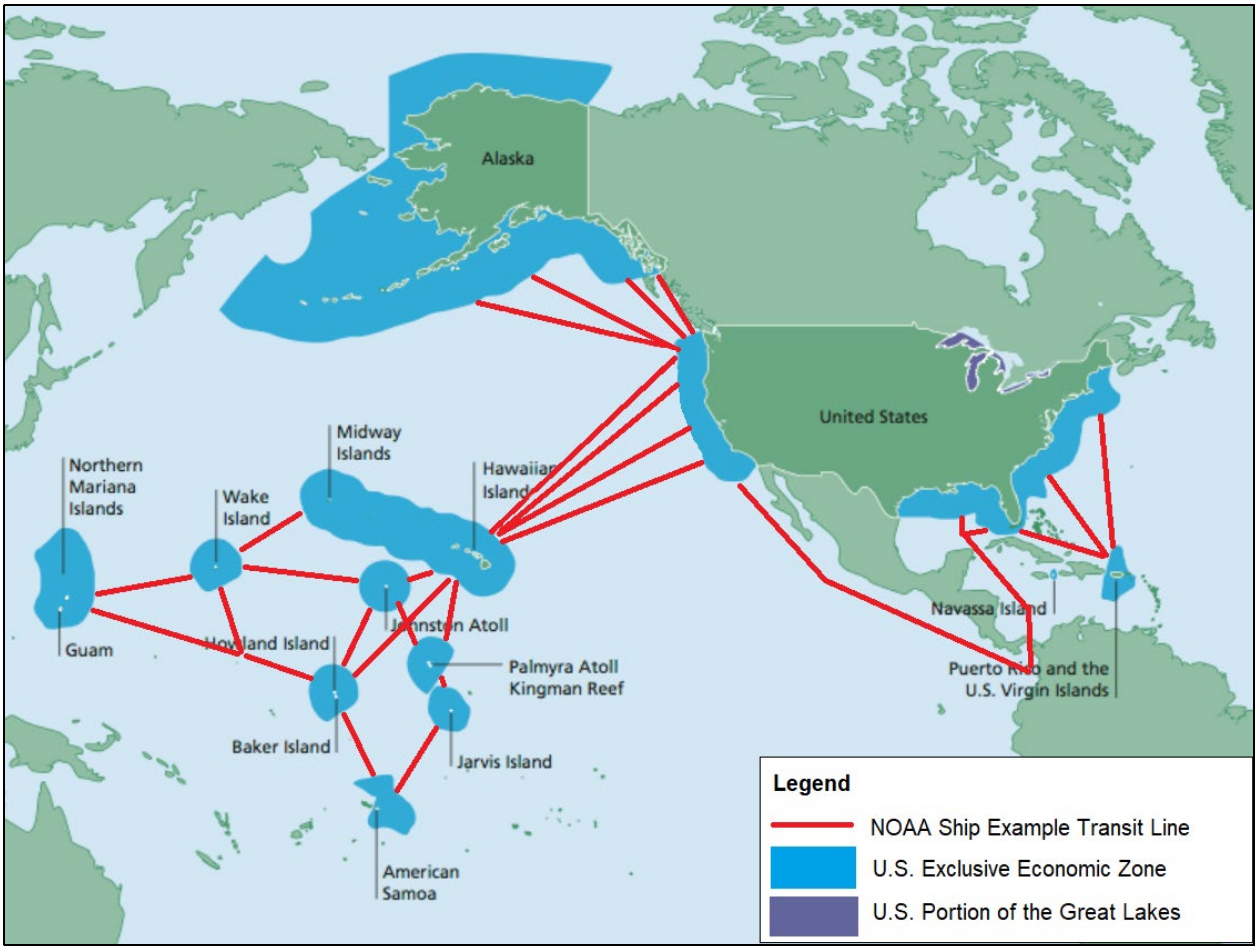
This Draft PEA encompasses OMAO operation of NOAA vessels in United States (U.S.) waters. This includes the oceans from the U.S. baseline, also known as the territorial sea baseline, to the limits of the U.S. Exclusive Economic Zone (EEZ) (370 kilometers (km) [200 nautical miles (nm)]) and the U.S. portions of the Great Lakes. The geographic scope extends to the international maritime boundaries with Canada and Mexico. This document also considers OMAO's operations in areas outside of U.S. jurisdiction.

2.1.2.1 Activities in U.S. Waters

U.S. waters for this Draft PEA include the U.S. EEZ and internal waters where OMAO activities occur. Within the EEZ, the U.S. territorial sea extends 22 km (12 nm) from the U.S. baseline and includes 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 U.S. exercises sovereignty. The contiguous zone extends 22 km (12 nm) from the territorial sea. Internal waters refer to waters from the U.S. baseline landward, including the U.S. portions of the Great Lakes and other large rivers, lakes, and tidewaters in which OMAO operates NOAA vessels.

The geographic scope (or action area) of this Draft PEA is shown in **Figures 1.2-1** and **2.1-1**. The action area is organized and analyzed by OMAO Operational Areas (OAs). The OAs are:

- Greater Atlantic Region-- includes the U.S. portions of the Great Lakes, New England, and the mid-Atlantic;
- 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;
- West Coast Region-- includes coastal California, Oregon, and Washington;
- Alaska Region-- includes Alaskan waters and the Arctic; and
- Pacific Islands Region-- includes Hawai'i and territories of the U.S. only.



Note: The transit lines depicted are examples and are not the only routes that NOAA ships would take.

Figure 2.1-1. Geographic Scope of the Draft PEA

2.1.2.2 Activities in Areas Outside of U.S. Jurisdiction

NOAA vessels also operate in areas beyond the U.S. EEZ and beyond any foreign nation's EEZ while transiting between ports, between project locations, and between a port and a project location. Vessel operations performed by OMAO in these areas outside of U.S. jurisdiction only comprise vessel transits, routine repair and maintenance of the vessels, and mandatory SOLAS training exercises. It is conceivable that OMAO would need to test and/or calibrate equipment when transiting in an area outside of U.S. jurisdiction; however, this would not be a planned exercise and would only occur due to unforeseen or unexpected circumstances. Example transit lines are shown in **Figure 2.1-1** to illustrate the general areas for routes that NOAA vessels could take when transiting in waters outside of U.S. jurisdiction.

2.1.3 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 with longer time intervals. Changes in spending levels, the environment, the data needs of the public, technologies, and field methods available to OMAO can all modify the environmental effects. Based on OMAO's experience with these factors, this Draft PEA analyzes vessel operation activities for a time period of 15 years, from 2023 to 2038. For the purposes of this Draft PEA, vessel operations could take place at any time of year.

Five years after the publication of the Final PEA, OMAO will reevaluate the PEA to determine if the analysis contained therein remains sufficient or if new analysis is required. If necessary, this new analysis may take the form of a supplemental PEA, a new PEA, or more extensive project-level analysis.

2.2 ACTIVITIES COMMON TO ALL ALTERNATIVES

Under all alternatives, OMAO would continue to perform vessel movement; anchoring; waste handling and discharge operations; vessel repair and maintenance; equipment testing, calibration, training, and troubleshooting; UMS operations; small boat operations; and OTS handling. These activities assist NOAA's LOs and organizations outside of NOAA in gathering accurate and timely data on the nature and condition of the marine and coastal environment. The subsections below describe the activities that are common to all alternatives.

The following sections describe in detail all OMAO vessel operations shown in **Table 2.1-1** above. Vessel operations conducted solely as part of scientific projects are discussed in a limited capacity for some activities in order to provide context for OMAO's vessel operations.

2.2.1 Vessel Movement

Vessel movement refers to NOAA vessels navigating to and from ports, project areas, or locations to conduct drills, equipment testing, calibration, training, troubleshooting, and other OMAO vessel operations. This document analyzes the environmental impact of all vessel movement undertaken or funded by OMAO, including any movement deemed necessary by the vessel's Master or Commanding Officer (CO), such as to ensure the safety of the vessel, its crew, and the public. It does not include vessel movement while under project instructions from another NOAA LO or an organization outside of NOAA. **Table 2.2-1** presents annual vessel miles of vessel transit attributable to OMAO for the October 2021 to September 2022 field season based on the best available data. As shown in **Table 2.2-1**, vessel miles attributable to OMAO-only transits account for approximately 9.7 percent of total miles traveled by the NOAA Fleet. While transits primarily occur in U.S. navigable waters, they may occasionally take place in areas outside of U.S. jurisdiction.

Table 2.2-1. Vessel Transit Miles for the 2021-2022 Field Season

OMAO Operational Area	Miles of Vessel Transit (nm)*
Greater Atlantic	1,189.00
Southeast	15,712.60
West Coast	9,207.65
Alaska	2,326.10
Pacific Islands	386.97
International Transits	74.83
Total Miles Attributable to OMAO	**28,897.15**
Total Miles of Transit for the Fleet	**297,467.36**

The speed at which a vessel moves depends on the size of its propulsion system and may vary by location, but it is typically lower than 12 knots for the ships in the NOAA fleet. Vessel movement may occur at night. Based upon comparison with 2019 global positioning system (GPS) data collected from Automatic

Identification System (AIS) transponders onboard commercial vessels, OMAO estimates that vessels used for its activities account for a negligible proportion of U.S. vessel traffic.[1]

Navigation and communication systems are integrated into the bridge of the vessel and used by NOAA Corps officers or licensed mates to chart a course to reach their destination. NOAA vessels are typically equipped with the following types of navigational and communication systems:

- **Radar Systems:** Marine radars are equipment used in the identification, tracking, and positioning of vessels for safe navigation. NOAA vessels employ two types of radar systems for navigational purposes: X-band and S-band radars. X-band radars operate at high frequencies (about 8 to 12 gigahertz [GHz]) and are used to obtain a sharper image and higher resolution of the target whereas S-band radars use lower frequencies (about 2 to 4 GHz) and are used for specialized purposes, such as to detect targets across larger distances through heavy weather conditions such as rain or fog (Marine Insight, 2021a; Microwaves & RF, 2017).
- **GPS and Differential GPS (DGPS):** GPS is a satellite-based navigation system that provides a fast and accurate method to determine the vessel position, speed, and its course (GPS.GOV, 2021). The GPS data are embedded within the AIS transmission, which is an automated tracking system for the identification of vessels in the vicinity. AIS is a broadcast transponder system that primarily operates at two very high frequency (VHF) channels: AIS 1 (161.975 megahertz [MHz]) and AIS 2 (162.025 MHz) (Marine Insight, 2022; USCG, No Date-a).
    - DGPS is an enhancement to the basic GPS signal and provides higher precision and increased safety during maritime operations in its coverage areas compared to the standard GPS signal (GPS.GOV, 2021).
- **Gyro Compass:** A gyro compass is a type of non-magnetic gyroscope that is used on vessels to detect the direction of true (geographic) north, as opposed to magnetic north (Marine Insight, 2021b). The gyroscope employs a rapidly-spinning disc and the earth's rotation to seek out true north and is used to determine the vessel's heading.
- **Deepwater and Shallow Navigational Echo Sounders:** Echo sounders are sonar (sound navigation and ranging) systems, typically mounted on the vessel's hull to measure water depth and aid in navigational safety. Echo sounders emit sound pulses and measure depth by recording the time it takes for the pulse to reach the seafloor and return to the ship. (DOSITS, No Date-a). NOAA vessels use navigational echo sounders that operate at shallow depths between 0 to 500 meters (m) (1,640 feet [ft]) and at a frequency of 18 kilohertz (kHz) to 300 kHz. Operation of echo sounders at deepwater depths greater than 500 m (1,640 ft) results in loss of accuracy.
- **Electronic Chart Display and Information System (ECDIS):** ECDIS is an electronic navigational chart system that NOAA uses as its primary charting product. The system uses GPS capabilities to accurately pinpoint navigational points (Marine Insight, 2021c) and improves navigational safety as it reduces the navigator's workload by decreasing reliance on more cumbersome paper charts. ECDIS also enables efficient planning and monitoring of navigational routes.

[1] Compared to 2019 AIS data for commercial vessels, vessel miles attributable to OMAO while not under project instructions from another entity account for 0.01 percent of all nautical miles traveled within the U.S. EEZ. However, because AIS transponders are not required for recreational vessels, OMAO vessel miles likely represent less than 0.01 percent of total vessel use within the EEZ.

- **Starlink:** All vessels in the NOAA fleet are now equipped with Starlink, a broadband satellite internet system that provide high-speed internet in most locations where OMAO operations occur.

OMAO personnel conduct a variety of operations to ensure that the vessel functions effectively while in motion. These operations include waste disposal, vessel repair and maintenance, OTS operations, and testing and calibration of equipment. OMAO also conducts drills and training for all its crewmembers for the development, advancement, and retention of required skills, such as fire drills, abandon ship drills, man overboard training, spill response training, and safety training.

2.2.2 Anchoring

Anchoring refers to the lowering of one or two anchors from the bow or stern of the vessel into the open water to secure the vessel in a specific location. NOAA ships use a system of hydraulic pumps to deploy and recover anchor chains. When operating under OMAO command, ships may anchor to perform OMAO vessel operations, such as drills and training, equipment testing, calibration, troubleshooting, or vessel repair and maintenance. While the choice of anchoring location is at the discretion of the ship's CO or Master, the anchor location is selected based on bottom type, depth, protection from seas and wind, and proximity to where vessel operations are to be conducted. 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. OMAO does not anchor in known areas of coral, hard bottom, seagrass, or abalone critical habitat, except in an emergency situation. For vessel movement spanning multiple days or while under project instructions from another NOAA LO or an organization outside of NOAA, a ship may need to anchor to avoid adverse weather or in the unlikely event of an equipment malfunction.

2.2.3 Waste Handling and Discharges

OMAO is responsible for the management of waste products and discharges generated during OMAO's routine vessel operations or while under project instructions from another NOAA LO or organization outside of NOAA. These activities are described in the subsections below. OMAO is not responsible for the management of waste products and discharges from wet laboratory activities performed while under project instructions from another NOAA LO or organization outside of NOAA. OMAO is also not responsible for the management, removal, and disposal of chemicals or other hazardous materials brought onboard by another NOAA LO or organization outside of NOAA.

2.2.3.1 Hazardous, Universal, and Special Waste Management

Hazardous wastes are substances defined by their quantity, concentration, or physical, chemical, or toxic characteristics that may present a danger to public health and welfare or the environment when released into the environment (40 CFR § 261.3). Potentially hazardous wastes managed by OMAO personnel include chemical wastes generated from maintenance activities such as cleaning, painting, and equipment lubrication; medical waste; and toxic substances such as asbestos-containing materials.

OMAO also manages universal waste, including batteries, pesticides, mercury-containing equipment, lamps, and aerosol cans (40 CFR § 273); and wastes designated as special wastes by OMAO because they require special management for disposal, such as oily rags and absorbents, fuel and oil filters, waste or used oil, antifreeze, and cooking oil. OMAO has procedures in place to ensure proper management, storage, and disposal of potentially hazardous, universal, or special wastes that are generated onboard NOAA vessels. These wastes are retained and appropriately stored on the ship until a time when they can be properly disposed of at shoreside waste collection facilities. These wastes are never discharged overboard.

2.2.3.2 Solid Waste Management

Management, storage, and disposal of solid waste generated during OMAO's vessel operations is conducted in accordance with the Solid Waste Management Plan that each ship is required to develop and maintain. The solid waste generated on the ship is sorted into the following categories: plastic, recyclables, non-food waste (dry trash), food waste, and incinerator ash. If the waste is not sorted, it is handled and logged according to the rules that address the most restricted component of the waste stream (i.e., plastic mixed with dry trash must be handled as plastic). OMAO personnel follow the USCG's standard requirement of posting placards summarizing disposal restrictions in prominent locations where solid wastes are managed, processed, and stored.

Plastics are recycled when possible; when that is not possible, they may be processed in an incinerator or transferred to shoreside facilities for disposal. Recyclables such as aluminum cans, glass, and paper are generally stored in recycling bins. Dry trash is either stored in bins or processed in an incinerator. Overboard discharge of plastics, recyclables, and dry trash does not occur; these wastes are instead transferred to shoreside facilities for disposal once the ship is moored alongside a dock.

Food scraps are stored in a manner that does not cause pest problems or offensive odor until they are discharged. Some ships are equipped with macerators that help in breaking down the food waste for ease of discharge. On ships equipped with an incinerator, food waste may on occasion be incinerated.

When reasonably feasible, operation of the incinerator is restricted to areas as far from human settlement as possible. Overboard discharge of incinerator ash is prohibited; it is retained for shoreside disposal. NOAA ships that are not equipped with incinerators may instead employ garbage grinders, macerators, or compactors for solid waste management. Per the guidelines provided in Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL), OMAO does not incinerate the following substances: polychlorinated biphenyls (PCBs); garbage containing more than a trace of heavy metals; refined petroleum products containing halogen compounds; polyvinyl chloride (PVCs) unless the incinerator is approved by the USCG/International Maritime Organization (IMO) for that use; exhaust gas cleaning residues; batteries and electronics; cans containing compressed gas or propellants such as spray paint and hair spray (For domestic regulations, see: 46 CFR § 63.25-9 - Incinerators. For international regulations, see: Annex VI- Regulations for the Prevention of Air Pollution from Ships; Chapter 3 - Requirements for control of emissions from ships; Regulation 16 - Shipboard incineration).

All waste discharges and/or waste transfers are recorded in the Garbage Record Book. This logbook is required to comply with revised MARPOL 73/78, Annex V as amended by Resolution MEPC.201(62) and with USCG Garbage Pollution Regulations in 33 Code of Federal Regulations (CFR) Part 151.

2.2.3.3 Wastewater Management

All NOAA ships and some attached small boats are equipped with Marine Sanitation Devices (MSDs) to receive, retain, and treat sewage generated onboard. Sewage, also referred to as black water, consists of any drainage water from toilets and urinals that contains human waste. Greywater consists of drainage water from other vessel functions, such as showers, kitchens, bathroom sinks, dishwashers, laundry, washbasins, and interior deck drains. OMAO has procedures in place to ensure proper management, storage, treatment, and disposal of greywater and sewage. The National Pollutant Discharge Elimination

System (NPDES) Vessel General Permit (VGP) program regulates the discharge of greywater from NOAA vessels to the environment incidental to normal vessel operations within 3 nm (5.6 km) of U.S. shores and in federally protected waters. Though the NPDES VGP program does not regulate the discharge of sewage, OMAO ensures that its sewage disposal operations are in compliance with all relevant federal and international regulations. Greywater and sewage may either be discharged overboard, depending on the distance of the vessel from the shore, or may be retained and transferred for treatment at shoreside sewage reception facilities.

2.2.3.4 Deck and Equipment Washdown Water Management

Deck and equipment washdown water includes wastewater generated from washdown of the deck and rinsing of small boats and equipment such as cranes, winches, davits, anchors, etc. Deck and equipment are rinsed with freshwater or an environmentally safe all-purpose cleaner, and the residual wastewater is discharged directly overboard through the scuppers on the side of the ship. The nature of the cleaner and the quantity of water used for washdown help dilute pollutants in the wastewater to a very minimal concentration. When possible, decks are washed down beyond 3 nm from shore to reduce impact to nearshore areas.

2.2.3.5 Oily Material Management

Oily materials and mixtures are generated onboard NOAA vessels as a part of routine vessel operations. Bilge water collects in the lowest part of the ship, also known as the bilge, and can contain a mixture of sea water, oil, sludge, or other chemicals. Oily residues and sludges may be generated from equipment and machinery during normal operations. OMAO has procedures to store, treat, discharge, and dispose of oily mixtures generated onboard. Designated tanks are maintained on NOAA ships to collect and store oily mixtures. All ships maintain an Oily Water Separator (OWS), which treats oily bilge water, reduces its oil content to under 15 parts per million (ppm), and allows the effluent to be discharged. OMAO is required by law to maintain an operational OWS on each ship; each time the system is turned on, it is recorded in the Oil Record Book. Oily mixtures that cannot be treated through the OWS are retained in their tanks and disposed of at a shoreside facility.

2.2.3.6 Ballast Water Management

OMAO routinely manages ballast water, defined as fresh or saltwater stored in tanks used to enhance control, trim, stability, and overall safety of ships. All NOAA ships carrying fresh or saltwater ballast maintain records of all ballast operations. The ballast tank(s) on a ship is(are) filled or emptied depending on the stability requirements for weight distribution on the ship. Ballasting on a ship is managed through openings located below the water line, typically at the lowermost portion of the ship's hull. The openings are connected to a ballast system through piping and dedicated ballast pumps. De-ballasting most commonly occurs prior to fueling operations.

There are four general methods for how a NOAA ship complies with ballast water laws: 1) a ballast water treatment system, 2) Public Water System (PWS) ballast, 3) no discharge of ballast, and 4) exemptions from ballast water regulations. The *Oscar Dyson*, *Oscar Elton Sette*, *Ronald H. Brown*, and *Okeanos Explorer* are equipped with ballast water treatment systems that enable the ships to take on seawater as ballast and discharge it after the seawater has been treated through the system. The two new oceanographic research ships expected to be completed in 2025 and the two new charting and mapping ships expected to be completed in 2027 and 2028 will also have ballast water treatment systems. The *Oregon II*, *Henry B. Bigelow*, *Bell M. Shimada*, *Reuben Lasker*, *Gordon Gunter*, and *Thomas Jefferson* use

PWS water, or potable water, as ballast. These ships can discharge their ballast anywhere according to the regulations. The *Rainier*, *Fairweather*, and *Nancy Foster* do not discharge ballast; their ballast tanks could be filled with solid Ballast-Crete™ or equivalent, antifreeze and water, lead ingots bound with straps, or some combination of these. The *Ferdinand R. Hassler* is exempt from ballasting requirements due to the ship's small size. OMAO follows all required environmental compliance procedures during the loading and discharge of ballast water and maintains all appropriate reporting and record keeping documents.

2.2.3.7 Spill Response

In addition to managing waste products generated during routine OMAO vessel operations, OMAO also manages accidental spills of fuel, chemicals, and other contaminants that may occur from the following: tank overflow during fueling operations, fuel transfer operations, pipe leaks due to structural failure, accidental spills of hazardous chemicals (e.g., paints, oils, lubricants, and cleaning chemicals) used for vessel and equipment repair and maintenance, or unintentional discharge of sewage, bilge water, or ballast water into the surrounding environment due to damage to the vessel or its equipment. OMAO follows the policy and guidance provided in the Vessel Response Plan and Shipboard Oil Pollution Emergency Plan (VRP/SOPEP) to manage accidental spills of oils, hazardous materials, and marine pollutants. OMAO routinely performs preventative maintenance to avoid leaks and spills.

In the event of accidental spills during OMAO's routine operations, the CO's or Master's first responsibility is to ensure the safety of the crew and the vessel. A Spill Response Team, consisting of a team lead and at least five trained individuals, supports spill response and cleanup efforts using equipment such as absorbent pads, spill buckets, waste containers, emulsifiers, and oil resistant gloves. Members of this team are required to wear personal protective equipment (PPE) while conducting cleanup activities. All spills are recorded by OMAO and reported to the Marine Operation Center (MOC), the OMAO Safety and Environmental Compliance Division (SECD), and the USCG National Response Center (NRC). To ensure spill preparedness in the event of such emergencies, drills and training for the crew are regularly conducted and spill cleanup equipment is properly maintained.

2.2.4 Vessel Repair and Maintenance

Regular and adequate repair and maintenance of the NOAA fleet allows the vessels to support NOAA's multi-mission requirements and activities described in Section 1.2.1, ensuring that an appropriate level of vessel readiness is maintained and that the ships operate in a safe manner. OMAO uses the Shipboard Automated Maintenance Management System (SAMMS) software to assist shipboard and shoreside personnel in managing maintenance and repair needs of its fleet. The information in SAMMS ensures the effective and efficient scheduling of resources and prioritization of repair and maintenance to keep the vessels mission-capable. During the COVID-19 pandemic in 2020 when vessel usage was greatly reduced, OMAO was able to address deferred maintenance for the fleet. Repair and maintenance are a priority in OMAO budgeting and planning.

Repair and maintenance activities that cannot be performed while at sea are performed when the ship is alongside a pier. The OMAO Safety Management System complemented by comprehensive checklists and standard operating procedures provides guidance for underway maintenance activities to minimize the environmental impact. Some repair and maintenance activities commonly conducted by OMAO personnel while underway and the associated practices to reduce environmental impact include:

- Preparation and painting of vessel surfaces – OMAO uses environmentally friendly materials and takes precautions to prevent spillage or leakage into the sea;
- Lubrication of OMAO machines, equipment, and gear – Lubricants are chosen based on their minimal environmental footprint and any excess or waste is managed responsibly; and
- Repair and maintenance of ship systems, such as generators, boilers, cooling systems, and engines, as needed – These systems are maintained in a manner that prioritized the environment, ensuring any emissions or discharges comply with relevant standards.

2.2.5 Active Acoustic Systems Operations

While underway, OMAO may operate acoustic equipment for OMAO vessel operations such as performance and acceptance testing, calibrating, training, and troubleshooting to ensure the smooth operation of these systems. Active acoustic systems include those used for safety and navigation, such as deepwater and shallow navigational echo sounders (described in Section 2.2.1) and those for uses other than navigational safety, such as multibeam echo sounders or side-scan sonar, as described below. These systems are tested and calibrated following repairs or drydock to ensure the systems are working properly.

Echo Sounder

Echo sounders (also referred to as sonars) installed on or mounted to NOAA vessels are one of the most common categories of active acoustics used in ocean navigation, remote sensing, and ocean and habitat mapping.

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 seafloor, but also potentially objects in the water column) and reflect back to the echo sounder's receiver. By measuring the amount of time for the sound to return from the seafloor 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 sonar systems.

Single beam echo sounders transmit one focused acoustic beam, typically directly below the vessel. Sub-bottom profilers are a specific subtype of single beam echo sounder, designed to penetrate seafloor sediments and reveal subsurface 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 seafloor and reflect back to the vessel when it encounters different types of sediments and rock. Single beam systems, 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. Multibeam systems are the most commonly employed echo sounders for mapping the seafloor, as they allow for "full bottom coverage" of the area of interest. Many multibeam systems are capable of recording data on acoustic backscatter – the intensity of the acoustic return - along with the range. Multibeam backscatter is intensity data collected from multibeam systems that can be processed to create low-resolution imagery. Backscatter data is processed 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.

Side-scan sonars (sometimes referred to as "imaging sonars") are a specialized system for detecting objects on the seafloor that typically use fans of acoustic energy directed down and to the side of the sensor platform. In a side scan, the transmitted energy is formed into the shape of a fan that sweeps the seafloor 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 seafloor or ocean bottom. 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 as seen in **Figure 2.2-1**.

Figure 2.2-1. Side-scan Deployment from NOAA Ship *Thomas Jefferson*

Different echo sounders are designed to produce sound at different frequencies. For the purpose of testing, calibrating, training, and troubleshooting, single beam echo sounders on NOAA vessels can range from 0.5 kHz up to 200 kHz or more. Multibeam echo sounders on NOAA vessels typically range from 12 kHz up to 900 kHz or more. Side-scan sonars on NOAA vessels typically range from 300 kHz to 1600 kHz.

High-frequency echo sounders generally provide higher precision than low-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. Low-frequency echo sounders, by comparison, are typically used in deeper water. The source level of these echo sounders can range as high as 247 decibels (dB) re: 1 microPascal (μPa) at 1 m.

Acoustic Doppler Current Profiler

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. NOAA ships are equipped with hull mounted ADCPs. The ADCPs on NOAA vessels operate at a frequency range of 75-1,200 kHz for the purpose of testing, calibrating, training, and troubleshooting and are moderate in terms of source levels (< 160-180 dB re: 1 µPa m).

2.2.6 Other Sensors and Data Collection Systems Operations

While underway, OMAO may operate other sensors and data collection equipment for vessel operation purposes such as performance and acceptance testing, calibrating, training, and troubleshooting to ensure the smooth operation of these systems and safe navigation of the ship. Such systems operated by OMAO are described below:

Conductivity, Temperature, and Depth Sensor

A conductivity, temperature, and depth (CTD) sensor is a package of electronic instruments that measures the conductivity, temperature, and depth of water. A CTD's primary function is to record variations in the conductivity and temperature of the water column as it changes relative to depth, which can also help to calculate salinity, density, and depth at the sampling location (NOAA, No Date-a). Often, CTDs are attached to a much larger metal frame called a rosette (as seen in **Figure 2.2-2**), which may hold water-sampling bottles, called Niskin bottles, used to collect water at different depths, as well as other sensors that can measure additional physical or chemical properties (NOAA, No Date-a). 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. OMAO's CTD-related operations do not typically require the use of Niskin bottles, only deployment of the equipment to verify all sensors and connections are operational and collecting data as necessary. Most CTD systems have an acoustic altimeter to measure distance from the sea floor. OMAO deploys and retrieves CTDs using deck equipment such as cranes, davits (a small crane onboard a ship), or winches.

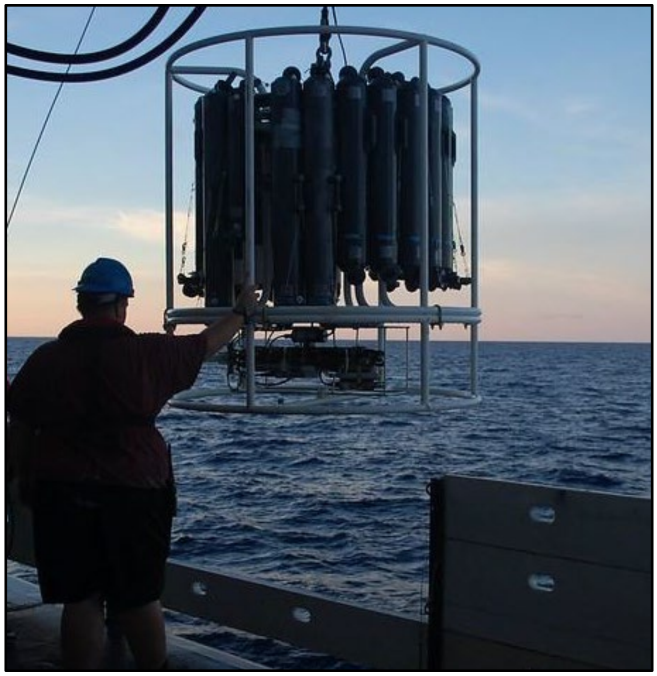


Figure 2.2-2. CTD Attached to a Rosette Deployed at Sunset from NOAA Ship *Pisces*

Hydrophone

A hydrophone is an underwater microphone designed to detect, record, and listen to underwater sound waves from either natural sources or active acoustic systems for monitoring and research purposes. Hydrophones are passive systems that emit no sound. Passive listening systems are often integrated into the housing of the ADCPs. OMAO operates these instruments only for testing, calibrating, training, and troubleshooting and deploys/recovers them using cranes, davits, or winches.

Thermosalinograph

A thermosalinograph is an automated Sea Surface Temperature (SST) and Sea Surface Salinity (SSS) measurement system taking measurements from onboard a ship using a water intake. A conductivity cell and a thermistor cell provide conductivity and temperature measurements. Salinity can be derived from the temperature and pressure at a particular location within the water column (NOAA, No Date-b). OMAO operates these instruments only for testing, calibration, training, and troubleshooting and deploys/recovers them using cranes, davits, or winches. There are currently 14 ships in the fleet with installed thermosalinograph systems.

Magnetometers

A magnetometer is a passive instrument that measures changes in the Earth's magnetic field. Magnetometers are launched from ships or small boats and lowered on a cable using a power winch or by hand using a line. Magnetometers are tethered at all times and are operated at approximately 1 m (3 ft) above the seafloor usually on predetermined transects. The total time of equipment submersion varies by project, but typically occurs on the scale of hours. OMAO operates these instruments only for testing, calibrating, training, and troubleshooting purposes; in these cases, the submersion time is shorter than when OMAO operates magnetometers under instructions from other LOs or organizations.

Meteorology Sensors

Meteorology sensors are instruments used to understand and measure parameters associated with climate and weather, such as wind speed and direction, relative humidity, precipitation, barometric pressure, and solar radiation. NOAA ships are also equipped with other instruments, such as wind birds, hygrometers, and barometers for the in-situ measurement of climate and weather-related parameters. OMAO operates these instruments for safe navigation, testing, calibrating, training, and troubleshooting purposes.

Drop/Towed Cameras

Drop/towed cameras are used for the delineation and identification of seafloor habitats (i.e., ground truthing) through visual observations. Drop/towed cameras are launched from ships or small boats and lowered on a cable using a power winch or by hand using a line. Drop/towed cameras are tethered at all times and are operated at approximately 1 m (3 ft) above the seafloor usually on predetermined transects. The total time of equipment submersion varies by project, but typically occurs on the scale of hours. OMAO only operates drop/towed cameras for equipment testing, calibrating, training, and troubleshooting.

Bottom Grab Samples and Sediment Corers

OMAO deploys bottom grab samplers and sediment corers for the purposes of performance and acceptance testing of equipment, calibration, training, and troubleshooting. Collection of seafloor sediment samples involves lowering a grab sampler at a rate of about 1 m per second (3 ft per second) through the water column to the seafloor. Samples are taken using a clamshell bottom snapper (15 cm by 15 cm [6 in by 6 in]) or similar type of grab sampler or sediment corer to collect the top layer of sediment (approximately the first 5 cm (2 in) of sediment). The sampling depths are limited by the capabilities of the spring-loaded mechanism relying on the apparatus's weight as it is deployed directly to the bottom. The sampler's apparatus is deployed with its buckets spread open in a locked position. When the sampler comes in contact with the bottom, the weight of the sampler triggers the spring-loaded mechanism to release, which snaps the buckets shut to collect the sediment and prevent sample washout. Corers such as box corers work in a similar manner, but are able to collect undisturbed samples from various sediment types.

2.2.7 Uncrewed Marine Systems Operations

Uncrewed Marine Systems (UMS) are used to carry and operate scientific instruments. Uncrewed Systems (UxS) operate with various levels of autonomy and include Uncrewed Underwater Vehicles (UUVs – sometimes referred to as Autonomous Underwater Vehicles/AUVs), Uncrewed Surface Vehicles (USVs, sometimes referred to as Autonomous Surface Vehicles/ASVs), ROVs, and Gliders. These systems use a variety of propulsion sources, including diesel, diesel/electric, battery, solar, buoyancy-driven, wave-driven, and wave-gliding propulsion systems. OMAO conducts testing and calibration of these UMS.

USVs often look similar to boats, ranging in size from the 1.8-m (6-ft) Teledyne Z-Boat to the 7.7-m (25-ft) Exail DriX. UUVs 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, or larger systems requiring winches or other deployment equipment, such as the 5.5-m (18-ft) REMUS-600. OMAO is only responsible for launching and recovering ROVs and UxS from NOAA ships (as seen in **Figure 2.2-3**).

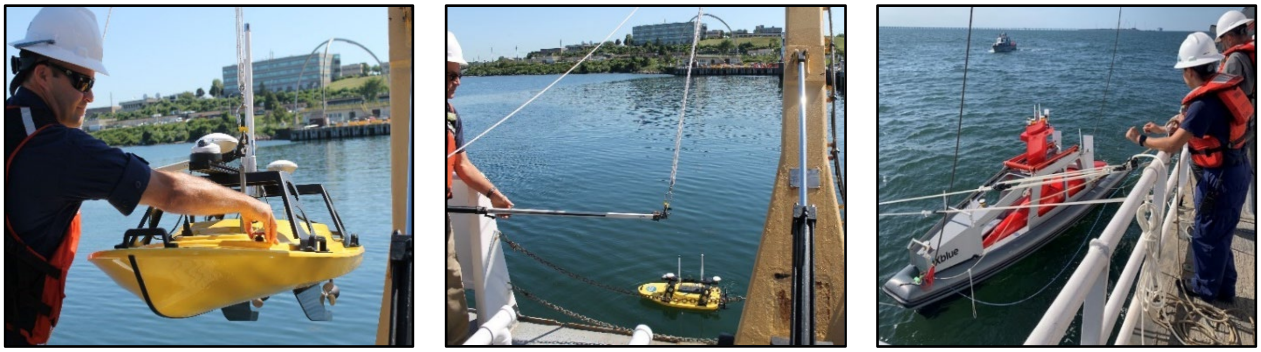


Figure 2.2-3. Launching of USVs, Z-Boat (left, center) and DriX (right), from the NOAA Ship *Thomas Jefferson*

2.2.8 Uncrewed Aircraft Systems Operations

Uncrewed aircraft systems (UAS) refer to uncrewed aircraft and the auxiliary equipment (including payloads, sensors, and communication) required for pilots to safely and efficiently operate within national airspace. Uncrewed aircraft are aircraft that are operated without the possibility of direct human intervention from within or on the aircraft (Public Law 112-95, Section 331[8]). UAS can also be referred to as drones and do not have a human pilot onboard. This PEA only covers UAS launched directly from NOAA's vessels (marine-based UAS).

NOAA's LOs use UAS for mission support, including hydrographic surveying; acoustic fish stock assessment; collection of data needed for management of commercial fisheries and conservation and recovery of protected species; making critical environmental observations; and weather forecasting. NOAA uses UAS to meet different operational requirements currently not met by crewed aircraft, thereby reducing overall cost and personnel risk. OMAO currently owns, maintains, and operates 20 UAS of the total 152 UAS assets owned by NOAA. **Table 2.2-2** shows the categories, classes, and weights of uncrewed aircraft managed by NOAA.

Table 2.2-2. Characteristics of UAS* assets owned and operated by NOAA

<table>
<tr><th>UAS Category</th><th>Max Gross Takeoff Weight (pounds [lb.])</th><th>Normal Operating Altitude (ft)</th><th>Speed (knots)</th><th>Examples of UAS in this category (not all inclusive)</th></tr>
<tr><td>Group 1**</td><td>0 – 20</td><td><1,200 AGL</td><td><100</td><td>Puma, MD4-1000, APH-22</td></tr>
<tr><td>Group 2</td><td>21 – 55</td><td><3,500 AGL</td><td rowspan="2"><250</td><td>ScanEagle, Silver Fox, Aerosonde</td></tr>
<tr><td>Group 3</td><td><1320</td><td rowspan="2"><18,000 MSL</td><td>Shadow, Integrator, Viking</td></tr>
<tr><td>Group 4</td><td rowspan="2">>1320</td><td rowspan="2">Any Airspeed</td><td>Predator A/B, Gray Eagle</td></tr>
<tr><td>Group 5</td><td>>18,000 MSL</td><td>Predator B, Global Hawk, BAMS</td></tr>
</table>

*Uncrewed aircraft typically emit sound in the range of 60 to 150 hertz (Hz) (Intaratep et al., 2016; Christiansen et al., 2016).

**UAS currently deployed from vessels by OMAO are included in Group 1.

Source: OMAO, 2017a; AGL refers to above ground level; MSL refers to mean sea level.

OMAO is responsible for deploying and recovering uncrewed aircraft from NOAA ships while underway for performance and acceptance testing, calibration, training, and troubleshooting. These OMAO activities with uncrewed aircraft would last from a minimum of a few minutes to at most one hour in any given location. Calibration and testing are conducted at lower altitudes close to the operator (approximately 15 m [50 ft]) to test the functionality of sensors and navigation after transport to the ship; they also fly briefly to operational altitude to make sure the UAS can achieve that height. Additionally, it is important to note that testing and training flights are never conducted near or over protected species. All UAS currently operated by OMAO fall under Group 1 categorization. Examples of marine-based UAS managed by OMAO include Phantom 4, Autel Evo II, Skydio 2, Mavic, Puma, and Solo. OMAO-managed aircraft utilize battery-powered motors. Certain NOAA ships will be equipped with UAS assets to help accomplish missions over the next 15 years.

2.2.9 Small Boat Operations

NOAA ships carry different types of attached small boats. Attached small boats are deployable components of the larger ship and are launched and recovered directly from the ship via davits or similar equipment as seen in **Figure 2.2-4**. Attached small boats range in size from about 4.5 to 9 m (15 to 30 ft), can reach speeds up to 25 to 30 knots, and can carry between two and six passengers. Each NOAA ship is required to carry at least one SOLAS-approved rescue boat for man-overboard situations or other emergencies. Based on their capabilities and geographic limitations, some ships carry specialized small boats, such as survey launches, work boats, and Rigid Hull Inflatable Boats (RHIB) to help execute their mission(s). For example, hydrographic survey launches are equipped with active acoustic systems that can collect hydrographic data in areas that may be inaccessible to the larger ships. Appendix A lists the full inventory of attached small boats carried onboard each NOAA ship.

Figure 2.2-4. Small Boat Launch from NOAA Ship *Thomas Jefferson*

This Draft PEA covers the launch, operation, and recovery of attached small boats from NOAA ships while underway for equipment testing, calibration, training, troubleshooting, and personnel transfer. This Draft PEA also covers performance and acceptance testing, calibration, training, and troubleshooting of attached small boat equipment, such as hydrographic equipment. This Draft PEA does not include operation of attached small boats while under project instructions from another NOAA LO or organization outside of NOAA. It also does not cover the operations or activities of the NOAA Small Boat Program or any small boat launched or recovered from land.

2.2.10 Over the Side, Crane, Davit, and Winch Operations

Over the Side (OTS) operations refer to the deployment, positioning, and recovery of equipment such as CTDs, cameras, magnetometers, ROVs, and small boats over the side of the ship. OMAO performs OTS operations for testing, calibrating, training, or troubleshooting purposes. Generally, OTS operations are conducted using cranes, davits, winches, and A-frames. Deck equipment is also used for other purposes, such as to bring food and scientific equipment onboard, move heavy equipment around the ship, and for the removal of trash and recyclable bins from the vessel. Deck equipment used for OTS and other vessel operations is powered by electric or hydraulic systems.

2.3 ALTERNATIVE A: NO ACTION – CONTINUE VESSEL OPERATIONS WITH CURRENT NOAA FLEET

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, OMAO would continue to use the current NOAA fleet to conduct the activities listed in Section 2.2 to support NOAA's primary mission activities of oceanographic assessment and management of living marine resources; charting and hydrographic surveying; and oceanographic monitoring, research and modeling. This would include vessel movement; anchoring; waste handling and discharge operations; vessel repair and maintenance; equipment testing, calibration, training, and troubleshooting; UMS operations; UAS operations; small boat operations; and OTS handling. Additionally, OMAO is constructing two oceanographic research vessels that are expected to come online in 2025 and awarded contracts in July 2023 for two new charting and mapping vessels that are expected to come online in 2027 and 2028 for a total of four new ships under Alternative A (see Appendix A for ship specifications).

Construction of new ships, in conjunction with new technology such as UxS, is the best long-term strategy for sustaining NOAA's ability to provide the at-sea data collection essential to meet its legally mandated responsibilities and allow retention of core capabilities in each mission area. New ships would include UxS and new small boats that would be interchangeable among all of the new ships in the fleet. New ships would be integrated with greener technologies, including some or all of the measures listed below:

- Increased storage for treated waste/wastewater (greywater, sewage, macerated food waste, and trash) onboard to minimize movement to or from waste discharge zones. Currently, the macerators and MSDs on the ships can only hold raw waste/sewage and untreated wastewater;
- OWSs and MSDs to minimize discharge of pollutants in open waters;
- Ballast water treatment systems;
- Generators that comply with the U.S. Environmental Protection Agency's (EPA's) Tier IV standards. Tier IV generators emit lower levels of particulate matter, nitrogen oxides (NOx), and other harmful pollutants into the environment;
- Centrifugal-type OWSs instead of the coalescer-type OWSs that are used in the current fleet;
- Aluminum corrosion prevention and cathodic protection systems for ship hulls instead of the more toxic zinc system used in the current ships;
- Increased implementation of energy efficiency measures, such as the use of lithium batteries to power the ships' hotel mode and certain propulsion operations; and
- Refrigerants and fire suppression systems that do not use ozone-depleting substances (ODSs).

Under Alternative A, OMAO would provide capacity to conduct a maximum of 3,568 operational days at sea (DAS) for scientific projects.

As ships reach the end of their usable life, NOAA plans to withdraw the older ships from service. The ships currently operating within the fleet were launched between the years 1967 and 2012, and the average ship age in the fleet is almost 30 years. **Table 2.3-1** shows the most updated estimate of End of Service Life (EOSL) ranges for the current NOAA fleet based on the Material Condition Assessments conducted by OMAO.

Table 2.3-1. Anticipated End of Service Life for the Current NOAA Fleet (in years)

NOAA Ship	Anticipated Range of End of Service Life
Oregon II	2022 - 2030
Oscar Elton Sette	2025 - 2029
Fairweather	2026 - 2030
Rainier	2026 - 2030
Okeanos Explorer	2027 - 2031
Gordon Gunter	2030 - 2034
Thomas Jefferson	2034 - 2037
Oscar Dyson	2036 - 2039
Ferdinand R. Hassler	2039 - 2041
Henry B. Bigelow	2039 - 2042
Nancy Foster	2039 - 2042
Pisces	2042 - 2045
Ronald H. Brown	2042 - 2043
Bell M. Shimada	2045 - 2048
Reuben Lasker	2050 - 2053

This alternative reflects the ships, technology, equipment, fleet utilization, scope, and methods currently in use by OMAO. OMAO would continue to operate NOAA's fleet of survey and research ships until the end of their service life. It would continue to support projects undertaken by other NOAA LOs or organizations outside of NOAA at the current level of activity, for as long as the fleet capacity allows. This alternative also analyzes impacts from the additional "greening" techniques that are currently being implemented across the NOAA fleet, which include goals for fuel efficiency and emissions reductions. These techniques include operating at the most fuel-efficient speed possible, keeping the hull and propeller clean, and minimizing generator use to the extent practicable.

2.4 Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

OMAO seeks to reliably and consistently sustain and improve NOAA's at-sea data collection capability and provide the infrastructure necessary to meet mission requirements now and in the future. Alternative B therefore consists of a phased approach to implementing measures for long-term modernization of the NOAA fleet and fleet management best practices. The size of the NOAA fleet will fluctuate during the modernization period as the timing of new ships coming online may not correspond to the timing of older ships being retired. Overall, fleet modernization under Alternative B is expected to result in a NOAA fleet of similar size to the current fleet but with newer, more efficient technologies and more efficient utilization resulting in the capability to provide more DAS than the No Action Alternative.

In addition to continuing the OMAO vessel operation activities described in Section 2.2 with the current NOAA fleet and building two new oceanographic research and two new charting and mapping vessels, additional measures adopted under Alternative B in the next 15 years would include:

1. **Design and construction of up to four additional ships needed to replace vessels that would reach the end of their design service life between 2023 and 2038**

    - The additional four new ships would be medium endurance fisheries/coastal science vessels;
    - Construction of new ships, in conjunction with new technology such as UxS, is the best long-term strategy for sustaining NOAA's ability to provide the at-sea data collection essential to meet its legally mandated responsibilities and allow retention of core capabilities in each mission area;
    - New ships would include UxS and new small boats that would be interchangeable among all of the new ships in the fleet; and
    - Specific plans for vessel improvements and new vessel design are evolving based on developing mission needs, technology advancements, and funding availability.

2. **Extend service life of aging fleet**

    - Material condition assessment surveys would be performed on all ships to determine the loss of current capabilities as ships retire. These assessments would also provide important information for future maintenance investments, such as design service life extensions, repairs, and corrective maintenance;
    - NOAA's ships can also undergo mid-life repairs that extend the design service life of the ships. Extending the design service life of aging ships in the current NOAA fleet would involve three primary levels of maintenance:
        - Corrective maintenance and prevention would make the most severely deteriorated major ship systems more reliable;
        - Repairs to extend overhauls and/or replace major systems to provide greater overall reliability and improve the suite of mission equipment. This may include implementing major system upgrades to increase operational duration in coastal waters, such as converting tanks to potable water tanks, greywater, and sewage; upgrading the mapping instrumentation suite; and upgrading the navigation suite; and
        - Design service life extensions that would allow approximately 15 years of operation beyond the end of design service life. Extending the design life of a ship only addresses specific ship infrastructure and instrumentation components. These may include upgrades to the heating, ventilation, and air condition (HVAC) system, replacement of the sanitary and potable water piping system, and reconfiguration of ship space.

OMAO has planned mid-life repairs for six NOAA ships: *Ronald H. Brown, Oscar Dyson*, *Henry B. Bigelow*, *Pisces*, *Bell M. Shimada*, and *Reuben Lasker*. The Ship Life Extension Program (SLEP) for these six ships is expected to begin in FY 2023 and last for nearly a decade. Each ship would be drydocked for nearly a year while the repairs take place; ships would not be available for project work during this time. The SLEP ship system upgrades and modifications are expected to extend each ship's design service life by 20 years.

As ships reach the end of their usable life, NOAA plans to withdraw the older ships from service. The ships currently operating within the fleet were launched between the years 1967 and 2012, and the average ship age in the fleet is almost 30 years. As an increasing number of ships approach the end of their design service life, generally spanning 50 years, periodic repair and maintenance activities, along with mid-life repairs and service extensions, are crucial for the reliable operation of NOAA's fleet.

3. Increase NOAA Fleet Utilization

- Analysis indicates that full utilization of the NOAA fleet under Alternative B could provide 4,138 annual operational DAS, which is 570 DAS (or 14 percent) more than Alternative A;
- The increase in fleet utilization would be implemented in a phased approach; and
- This strategy would increase the immediate capacity of each vessel, but is only a short-term strategy for older vessels.

4. Integrate New Technology

- Technology integration is critical to both near-term improvement and long-term modernization of the NOAA fleet;
- OMAO would consider the implementation of relevant data collection technologies and vessel infrastructure advancements that could increase the efficiency and effectiveness of at-sea time:
    - Updated data collection technology, such as instrumentation/sensors and UxS, would improve the quality and quantity of products and services that the agency can provide;
    - Advancements in ship infrastructure would include improvements to mechanical control systems and system efficiencies to improve safety and create equipment standardization throughout the fleet; and
    - Available infrastructure advancements in ship automation would improve fuel efficiency and fuel consumption.
- New ships would be integrated with greener technologies, including some or all of the measures listed below:
    - Increased storage for treated waste/wastewater (greywater, sewage, macerated food waste, and trash) onboard to minimize movement to or from waste discharge zones; Currently, the macerators and MSDs on the ships can only hold raw waste/sewage and untreated wastewater;
    - OWSs and MSDs to minimize discharge of pollutants in open waters;
    - Ballast water treatment systems;
    - Generators that comply with the EPA's Tier IV standards. Tier IV generators emit lower levels of particulate matter, NOx, and other harmful pollutants into the environment;
    - Centrifugal-type OWSs instead of the coalescer-type OWSs that are used in the current fleet;

- Aluminum corrosion prevention and cathodic protection systems for ship hulls instead of the more toxic zinc system used in the current ships;
- Increased implementation of energy efficiency measures, such as the use of lithium batteries to power the ships' hotel mode and certain propulsion operations; and
- Refrigerants and fire suppression systems that do not use ozone-depleting substances (ODSs).

2.5 Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B. In addition to implementing the measures outlined in Section 2.4 under Alternative B (i.e., executing long-term modernization of the NOAA fleet and continuing the current OMAO vessel operations with optimization of the current fleet), OMAO would adopt the following additional measures in the next 15 years under Alternative C:

1. **Design and construction of two new ships in addition to those that would be added to the NOAA fleet under Alternative B**
    - Under Alternative C, OMAO would add two additional medium endurance fisheries/coastal science ships to the fleet to further enhance NOAA's ability to provide at-sea data collection essential to meet its legally mandated responsibilities and allow retention of core capabilities; and
    - OMAO's analysis indicates that full utilization of the NOAA fleet under Alternative C could provide 4,873 annual operational DAS, which is 735 DAS (or 12 percent) more than Alternative B.
2. **Increasing the number of UxS integrated into new ships that would be added to the NOAA fleet**
    - Incorporation of additional UxS into new ships under Alternative C would further extend NOAA's data collection capabilities.
3. **Shortening the timeframe of fleet improvement activities**
    - Under Alternative C, increased funding would facilitate the expedited solicitation of ship design and construction contracts, enabling NOAA to induct the new vessels into the fleet sooner than anticipated under Alternative B.
4. **Extend service life of aging NOAA ships**
    - As under Alternative B, OMAO would implement mid-life repairs under SLEP for the *Ronald H Brown, Oscar Dyson*, *Henry Bigelow*, *Pisces*, *Bell M. Shimada*, and *Reuben Lasker*, which would extend their design service life by 20 years.
5. **Greening techniques proposed for the new ships would also be implemented across the current fleet over a shortened timeframe. These measures include:**
    - Increase in storage for treated waste/wastewater (greywater, sewage, macerated food waste, and trash) onboard to minimize the ship's movement to or from waste discharge zones. Currently, the macerators and MSDs on the ships can only hold raw waste/sewage and untreated wastewater;

- Installation of new OWSs and MSDs onboard the current NOAA fleet to increase the treatment efficiency of the wastewater generated onboard the ships;
- Replacement of the current generators on the ships with generators that comply with EPA's Tier IV standards;
- Replacement of the existing coalescer-type OWSs with the more robust centrifugal models for improved operational reliability;
- Replacement of the existing zinc corrosion prevention and cathodic protection system for ship hulls with the less toxic aluminum system;
- Development and implementation of energy efficiency practices across the fleet, such as reinforcing training of vessel operators to maximize fuel efficiency, and the use of energy storage systems to offset excess fuel consumption during transitory periods of high demands from the ships' hotel loads and various other operations;
- Complete phase out of ODSs used across the current fleet, including substances such as refrigerants and certain types of fire suppressants, and use of environmentally friendly lubricants and oils in systems where there is a potential for discharge to the marine environment; and
- Introduction of dedicated stowage for recyclable waste items.

6. **Shortening of the timeframe to improve the OMAO small boat fleet.**
    - Improvements could include use of fuel sources other than gasoline, earlier replacement of aging small boats, and implementation of innovative construction technologies and/or innovative emissions reduction technologies/techniques to reduce environmental impacts of the fleet as such technologies are developed and become available.
7. **Purchasing or developing technology to enable more efficient scheduling of vessels, equipment, and personnel to maximize crew productivity and enhance overall fleet performance by increasing DAS.**
    - Currently, all NOAA LOs submit their ship time requests via the online NOAA Vessel Prioritization, Allocation and Scheduling System (V-PASS). Upon undergoing several rounds of review, verification, and approval at the NOAA LO and MOC level, the NOAA LOs submit their completed project prioritization lists for the upcoming Fiscal Year (FY) to OMAO via the OMAO Scheduler. The current configuration of the V-PASS system does not allow users to seamlessly interact with its features, making it difficult to utilize the ship scheduling process; and
    - Under Alternative C, improvements would be made to the V-PASS system to streamline the process of scheduling assets, including ships, small boats, UMS, equipment (acoustic equipment, data collection equipment, etc.), and personnel to enable efficient allocation of and subsequent increase in DAS and ensure maximum utilization of these assets across NOAA.

The size of the NOAA Fleet would fluctuate during the modernization period as the timing of new ships coming online may not correspond to the timing of older ships being retired. Overall, fleet modernization under Alternative C is expected to result in a NOAA Fleet of similar size to the current fleet but with newer, more efficient technologies and more efficient utilization resulting in the capability to provide more DAS than Alternative B.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Chapter 3 describes the current environment for resources that may be affected by Alternative A (No Action – Continue Vessel Operations with Current National Oceanic and Atmospheric Administration [NOAA] Fleet), Alternative B (Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities), and Alternative C (Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support), and the potential environmental consequences associated with the alternatives.

Sections 3.3 through 3.13 discuss the resources analyzed. The resources analyzed are:

- Air Quality;
- Water Quality;
- Acoustic Environment;
- Habitats;
- Biological Resources;
- Cultural and Historic Resources;
- Socioeconomic Resources;
- Environmental Justice;
- Hazardous, Universal, and Special Waste;
- Human Health and Safety; and
- Climate Change.

Section 3.14 presents a comparison of the environmental consequences for Alternatives A, B, and C.

3.1 AFFECTED ENVIRONMENT METHODOLOGY

The affected environment summarizes the current physical, biological, social, and economic environments of the "action area". The action area for the Office of Marine and Aviation Operations (OMAO) vessel operations encompasses United States (U.S.) waters, including the oceans from the U.S. baseline to the limits of the U.S. Exclusive Economic Zone (EEZ) (generally 370 kilometers [km] [200 nautical miles {nm}] from shore). The action area includes the entirety of Lake Michigan-Huron and U.S. waters of the other Great Lakes, and extends to the international maritime boundaries with Canada and Mexico. This document also considers OMAO's vessel operations in seas areas outside of U.S. jurisdiction. 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 type (i.e., 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. 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) Parts 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 § 1508.8(a) (1978)).

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 § 1508.8(b) (1978)).

For example, the ability of sea water to sustain aquatic life may become temporarily impaired in the event of an accidental fuel or hazardous materials spill. This is a direct impact. 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 Draft PEA 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.

In addition, this Draft PEA evaluates the cumulative impacts of the Proposed Action. Cumulative impacts are defined at 40 CFR § 1508.7 (1978) as:

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 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. 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. See Chapter 4 for a complete discussion of 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 Draft PEA, OMAO developed significance criteria by defining the context (sphere of influence), duration (how long), and intensity (how much) of potential impacts.

3.2.2.1 Context

Context means that the significance of an action must be analyzed in several settings such as society as a whole (human, national), the affected region, the affected interests, and the locality. Context is the setting within which an impact is analyzed and is defined as:

- Regional – Impacts would affect the resource on a regional level, extending well past the immediate vicinity of the NOAA vessel. The extent of regional impacts depends on the impact causing factor and whether the vessel is stationary or moving when the impact occurs.
- Localized – Impacts would affect the resource in the immediate vicinity of the vessel.

3.2.2.2 Duration

Impacts are also expressed in terms of duration. In addition to the definitions below, impacts could be continuous (i.e., constant) or intermittent (i.e., recurring or periodic). Continuous and intermittent impacts could occur temporarily or in the short or long term.

- Permanent – Impacts would last indefinitely.
- Long-term – Impacts would likely last for several months or longer.
- Short-term – Impacts would likely extend beyond the time of vessel operations but would not last more than several days to several weeks.
- Temporary – Impacts would occur only during the time that vessel operations are being conducted, lasting up to several hours.

3.2.2.3 Intensity

Intensity refers to the severity of impact, or the degree to which a resource would be beneficially or adversely affected by an action. Four impact descriptors are used to categorize the intensity of impacts: negligible, minor, moderate, and major as defined in **Table 3.2-1**. Also shown in **Table 3.2-1** are the significance conclusions associated with each intensity category.

Table 3.2-1. Impact Intensity Descriptors for Characterizing Environmental Consequences

Intensity of Impact	Intensity Descriptor	Significance Conclusion
Negligible	Minimal impact on the resource would occur; any change that might occur would be barely perceptible and would not be easily measurable.	Insignificant
Minor	Change in a resource would occur, but no substantial resource impact would result; the change in the resource would be detectable but would not alter the condition or appearance of the resource.	Insignificant
Moderate	Noticeable change in a resource would occur and this change would alter the condition or appearance of the resource; the integrity of the resource would remain intact.	Insignificant
Major	Substantial impact or change in a resource would occur that is easily defined and highly noticeable and that measurably alters the condition or appearance of the resource; the integrity of the resource may not remain intact.	Significant

3.2.3 Best Management Practices

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(h), 1502.14(f) (1978). In conjunction with preparation of this PEA, OMAO has developed a list of Best Management Practices (BMPs) which are presented in Appendix C and are included in the environmental consequences analyses as applicable. To reduce or minimize the potential impact of OMAO activities on endangered and threatened species, marine mammals, critical habitat, and Essential Fish Habitat (EFH), OMAO requires that all Commands and offices incorporate and employ Best Management Practices (BMPs) for all at-sea activities when practicable. All applicable BMPs must be communicated to vessel crews and support personnel and employed as appropriate for the specific at-sea activities being conducted.

3.3 Air Quality

This section describes the affected environment for air quality and analyzes the effects of OMAO vessel operations on measurable air quality conditions encountered throughout the action area, which is the area of analysis for air quality.

3.3.1 Affected Environment

Air quality is the measure of the atmospheric concentration of defined pollutants in a specific area. An air pollutant can be any substance in the air that can cause harm to humans or the environment. Pollutant emission sources can be natural, including smoke from wildfires, dust, and wind erosion, or human-made, including emissions from vehicles, industrial operations, agriculture, or construction sites, dust from unpaved roads, or smoke from human-caused wildfires. With the exception of carbon dioxide, air quality issues over the oceans tend to be most serious close to the coast, where concentrated human and industrial development introduces pollutants to the ambient air. In open water areas, air quality is typically expected to be good since pollutant emissions are mostly limited to ships and offshore drilling locations.

Addressing air quality in the area of analysis is a two-fold process consisting of an assessment of air quality conditions to acknowledge the state of this resource, and an assessment of all relevant environmental compliance regulations and applicable OMAO policies and procedures. It should be noted that air quality issues may be discussed in other sections of this Draft PEA as they specifically relate to other affected resources such as biological and socioeconomic resources.

3.3.1.1 Air Quality Assessment

This section describes air quality conditions as presented by the U.S. Environmental Protection Agency's (EPA) annual report, Our Nation's Air, which is representative of air quality conditions along coastal areas. The report follows the National Ambient Air Quality Standards (NAAQS) and summarizes the nation's air quality status.

The Clean Air Act (CAA) requires the EPA to establish NAAQSs (40 CFR Part 50) for six principal pollutants that can be harmful to public health and the environment. These six principal pollutants include ground-level ozone (O_3), particulate matter (PM), carbon monoxide (CO), lead (Pb), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2). The CAA identifies two types of NAAQS: primary standards that provide public health protection, including protecting the health of "sensitive" populations such as children and elderly; and secondary standards that provide public welfare protection, such as protection for animals, crops, vegetation, and buildings (EPA, 2023a). These air quality standards are summarized in **Table 3.3-1**.

Table 3.3-1. National Ambient Air Quality Standards

Pollutant		Type (Primary or Secondary)	Averaging Time	Level*	Form
CO		Primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Pb		Primary and Secondary	Rolling 3-month average	0.5 µg/m^3	Not to be exceeded
NO_2		Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary and Secondary	1 year	53 ppb	Annual Mean
O_3		Primary and Secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
PM**	$PM_{2.5}$	Primary	1 year	12.0 µg/m^3	Annual mean, averaged over 3 years
		Secondary	1 year	15.0 µg/m^3	Annual mean, averaged over 3 years

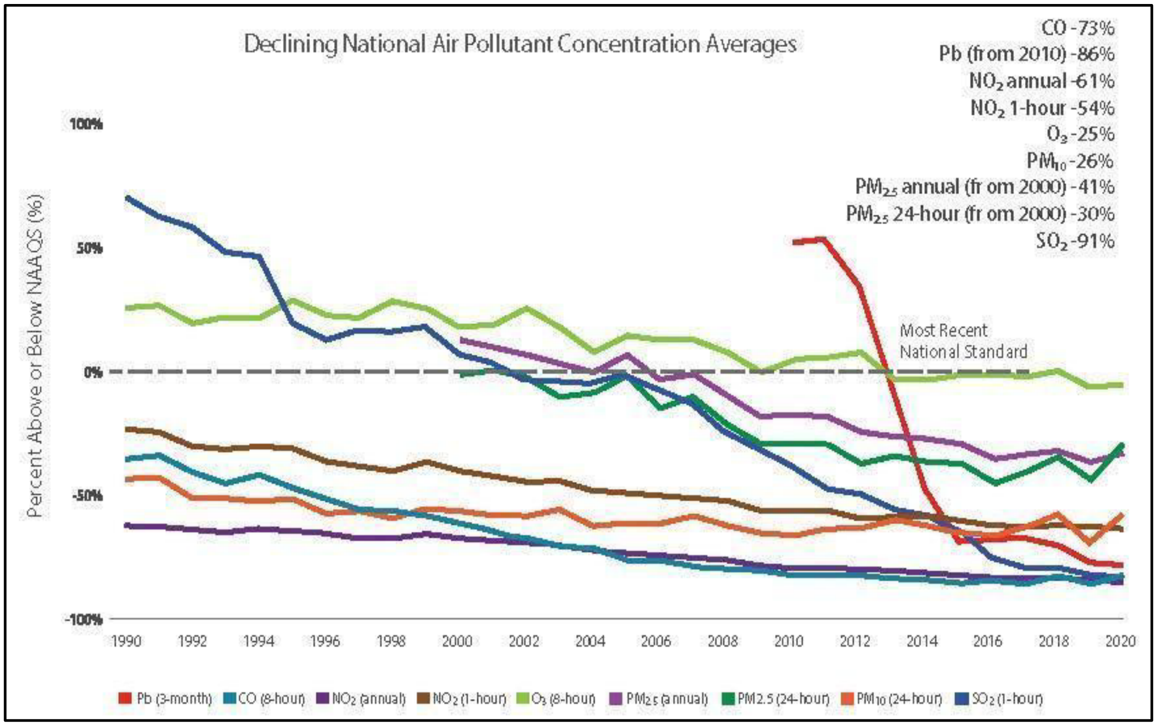
Pollutant		Type (Primary or Secondary)	Averaging Time	Level*	Form
		Primary and Secondary	24 hours	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	Primary and Secondary	24 hours	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
SO_2		Primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Source: EPA, 2023a

*Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (μg/m3).

**The subscripts for particulate matter refer to a maximum particle size of 2.5 microns or 10 microns.

Our Nation's Air reports the concentration of air pollutants on a national scale and compares the results as a percentage above or below the NAAQS, as illustrated in **Figure 3.3-1**. The report focuses on the six principal pollutants as outlined by NAAQS and presents national air quality data in a variety of forms, such as long-term trends, emission sources, economic growth, nonattainment areas, visibility, etc. (EPA, 2020). The report's summary presents a broad baseline of the condition of the nation's air quality. Air pollutants are displayed according to the unit of measurement and the averaging time that pertain to the standards for that pollutant. Most pollutants display long-term trends dating back to 1990, while others start in later years, such as $PM_{2.5}$ in 2000 and Pb in 2010.



Source: EPA, 2020

Figure 3.3-1. Long-term Air Pollution Trends Compared Against NAAQS

Overall, the concentrations of air pollutants on a national scale have dropped significantly since 1990, despite increases of air pollutants associated with fires, carbon monoxide, and particle pollution. All air pollutant parameters analyzed in this report show negative long-term trends over the last few decades and had concentrations below their respective NAAQS in 2020:

1) **Carbon monoxide**: The NAAQS for carbon monoxide is 9 ppm averaged over an 8-hour period. In 2020, carbon monoxide levels were well below the National Standard. National air quality shows a strong long-term decreasing trend, falling 73 percent below 1990 levels.

2) **Lead**: The NAAQS for lead is 0.5 µg/m^3 over a 3-month period. In 2020, lead concentrations were below the National Standard. National air quality shows a steep long-term decreasing trend, falling 86 percent below 2010 levels.

3) **Nitrogen dioxide**: Nitrogen dioxide is analyzed on both a 1-hour and annual basis. The 1-hour NAAQS for NO_2 is 100 ppb, while the annual standard is 53 ppb. In 2020, both parameters were well below the National Standard. National air quality shows both parameters having moderate long-term decreasing trends, with the 1-hour and annual parameters falling 54 percent and 61 percent, respectively, compared to 1990 concentrations.

4) **Ozone**: The NAAQS for ozone is 0.070 ppm averaged over an 8-hour period. In 2020, ozone levels were just below the National Standard. National air quality shows a weak, but decreasing long-term trend in ozone, falling 25 percent compared to 1990 levels.

5) **Particulate matter**: Particulate matter is analyzed as $PM_{2.5}$ on a 24-hour basis, $PM_{2.5}$ on an annual basis, and PM_{10} on a 24-hour basis. The NAAQSs for each parameter are 35 µg/m^3, 12.0-15.0 µg/m^3, and 150 µg/m^3, respectively. It is unclear whether Our Nation's Air used the primary or secondary level standard for $PM_{2.5}$ on an annual basis; therefore, a range between 12.0-15.0

μg/m^3 is provided. In 2020, all three parameters were below the National Standard. $PM_{2.5}$ and PM_{10} on a 24-hour basis exhibited a recent upward trend from 2019-2020, but both parameters are still well below the National Standard. National air quality shows all three particulate matter parameters with decreasing long-term trends, falling 30 percent, 41 percent, and 26 percent, respectively, compared to 2000 levels for $PM_{2.5}$ and 1990 levels for PM_{10}.

6) **Sulfur dioxide**: Sulfur dioxide is analyzed on an hourly basis, and has a NAAQS of 75 ppb. In 2020, concentrations for SO_2 were well below the National Standard. National air quality shows the strongest long-term decrease in concentration among the parameters analyzed, falling 91 percent compared to 1990 levels.

3.3.1.2 Regulatory Framework

During OMAO vessel operations, NOAA vessels would traverse across open ocean, along coastal zones, and into ports and harbors. Any OMAO vessel operation that utilizes the vessel's main engines or emergency diesel generators would generate emissions that could affect air quality. Emissions from incinerators onboard select NOAA ships could also affect air quality, in addition to any ozone-depleting substances (ODSs) carried onboard. NOAA vessels are required to abide by all laws and regulations to limit their potential impact to air quality. Therefore, this section discusses applicable federal regulations along with OMAO's environmental compliance framework.

3.3.1.2.1 Federal Regulations

The regulatory framework that establishes minimum acceptable air quality standards for NOAA vessels is derived from the International Convention for Prevention of Pollution from Ships, or Marine Pollution (MARPOL) 73/78. MARPOL was developed through the International Maritime Organization (IMO) and consists of six Annexes, each targeting a different form of marine pollution from ships. Annex VI specifically addresses air pollution from ocean-going ships, and was implemented in the U.S. through the Act to Prevent Pollution from Ships (APPS), 33 U.S.C. §§ 1901-1905. It acts as a set of procedural standards to limit the main air pollutants contained in ship exhaust gas, including sulfur oxides (So_x) and nitrous oxides (NO_x). It requires the use of fuel with lower sulfur content, prohibits deliberate emissions of ODS, and regulates shipboard incineration. The requirements comprise both engine-based and fuel-based standards and apply to both U.S. flagged ships wherever located and to non-U.S. flagged ships operating in U.S. waters. All stipulations apply to vessels operating in U.S. waters, including those within 200 nautical miles (nm) of the North American coast, also known as Emission Control Areas (ECAs) (EPA, 2022a). ECAs are areas of stringent international emission standards as designated by IMO, and the North American ECAs includes waters adjacent to the Pacific Coast (including southeastern Alaska), the Atlantic and Gulf coasts, and the eight main Hawai'ian Islands extending up to 200 nm from coasts of the U.S. (EPA, 2010). Ship operators must maintain records on board regarding their compliance with the emission standards, fuel requirements, and other provisions of Annex VI (EPA, 2022a). Under APPS and the terms of MARPOL itself, government ships on exclusively non-commercial service are exempt from the requirements of MARPOL Annex VI (33 U.S.C. § 1902(b)); however, through the policies and procedures discussed below, OMAO voluntarily complies with Annex VI. A summary of MARPOL Annex VI requirements is provided in **Table 3.3-2**.

Table 3.3-2. MARPOL Annex VI - Summary of Requirements

Regulation	Requirements and Applicability	Comments
6 – Certification	▪ **Ships delivered after 19 May 2005** must hold an International Air Pollution Prevention (IAPP)[1] certificate and one Engine International Air Pollution Prevention (EIAPP) certificate for each diesel engine of 130 kilowatt (kW) or more upon its delivery. ▪ **Ships delivered between 1 January 2000 and 19 May 2005** must hold an IAPP certificate and one EIAPP certificate for each diesel engine of 130 kW or more at the first scheduled drydocking survey after 19 May 2005, but not later than 19 May 2008. ▪ **Ships delivered before 1 January 2000** must hold an IAPP certificate at the first scheduled drydocking survey after 19 May 2005, but not later than 19 May 2008.	For ships delivered before 1 January 2000, if a diesel engine undergoes or has undergone a major conversion after 1 January 2000, the engine must hold an EIAPP certificate. See Section 3.3.1.2.2.2 for more information on IAPP certificates for NOAA ships under MARPOL Annex VI.
12 – ODS	▪ New installations containing ODS are prohibited on all ships. ▪ Deliberate emission of ODS during operation, maintenance, repair is prohibited.	New installations containing hydrochlorofluorocarbons (HCFCs) are permitted until 1 January 2020.
13 – NO_x emissions	▪ **Ships delivered after 19 May 2005** – Every diesel engine of 130 kW or more must be supplied with an EIAPP certificate and a Technical File. This requirement is applicable upon ship's delivery. ▪ **Ships delivered between 1 January 2000 and 19 May 2005** – The above requirement is applicable at the first scheduled drydocking survey after 19 May 2005, but not later than 19 May 2008. ▪ **Ships delivered before 1 January 2000** – These ships do not need to comply with this regulation unless its diesel engines have undergone a major conversion after 1 January 2000, in which case the regulation applies at the first scheduled drydocking survey after 19 May 2005, but not later than 19 May 2008.	Engine major conversion includes: ▪ Engine replacement by a new engine built on/after 1 January 2000; ▪ Substantial modification that could increase the level of NO_x emission; and ▪ Maximum continuous rating (output) increases by more than 10%.

Regulation	Requirements and Applicability	Comments
14 – SO_x emissions	▪ The sulfur content of any fuel used on board shall not exceed 0.50% (max % by weight). ▪ In SO_x ECAs, the sulfur content shall not exceed 0.10%, or the ship must be provided with an approved exhaust gas cleaning system. ▪ Before entering SO_x ECAs, fuel systems with sulfur content exceeding 0.10% must be fully flushed and fuel change over parameters recorded.	The Baltic Sea, the North Sea, and all of North America, including Hawai'i, have established ECAs.
16 – Shipboard incineration	▪ Shipboard incinerators installed **on/after 1 January 2000** are to be Type Approved against provisions of Resolution MEPC.76 (40). ▪ An operating manual shall be provided and personnel responsible for the operation of incinerator shall be trained. ▪ Incineration of certain substances is prohibited (cargo residues, polychlorinated biphenyls (PCBs), garbage containing traces of heavy metals, etc.).	Incineration of PCBs is prohibited except in incinerators designed specifically to incinerate PCBs in addition to having an IMO Type Approval certificate as per MEPC.59 (33) or MEPC.76 (40).
18 – Fuel quality	▪ Fuel used on board shall be blends of hydrocarbons derived from petroleum refining, free from inorganic acids, and shall not include any added substance or chemical waste. ▪ Bunker delivery notes shall be kept onboard for a period of 3 years after fuel delivery. ▪ Bunker delivery notes shall be accompanied by a sample of the delivered fuel. The sample is kept onboard until the fuel is substantially consumed but for not less than 12 months.	Guidelines for the sampling are given in Resolution MEPC.96 (47).

Source: VeriSTAR, No Date; IMO, No Date

[1] IAPP Certificate issued by USCG.

3.3.1.2.2 OMAO Air Quality Environmental Compliance

OMAO catalogs its policies, procedures, instructions, and other relevant information within its Document Management System (DMS). This system provides an internal regulatory framework that OMAO must abide by in order to remain in compliance with applicable laws. Within the DMS, OMAO maintains policies and procedures to provide instruction and support to manage air emissions generated aboard each ship. Every NOAA ship is responsible for incorporating OMAO policies and procedures into Ship Specific Instructions (SSI) based on the ship's operational capabilities. In this way, all OMAO vessel operations are held to the same standard in terms of environmental compliance, but with a tailored approach to the individual ship.

The policies and procedures that govern emissions from OMAO vessels in general are discussed below. These are incorporated into the SSI for each ship as appropriate.

3.3.1.2.2.1 Engine International Air Pollution Prevention (EIAPP) Certificate

An EIAPP certificate is the internationally-accepted documentation that a specific engine meets the international NOx emission limits for diesel engines set forth in Annex VI. The following diesel engines are required to be certified to the Annex VI NOx limits as evidenced by an EIAPP certificate: any engine above 130 kW that is installed on a ship constructed on or after January 1, 2000, or any engine above 130 kW installed on a ship if the engine has undergone a major conversion on or after January 1, 2000 as described in **Table 3.3-2**. Each engine must be accompanied by a Technical File, which is a document prepared by the engine manufacturer containing information needed to inspect the engine to verify compliance, and a Record Book of Engine Parameters, which is a document for recording all parameter changes, including components and engine settings that may influence NOx emissions (EPA, 2009).

Engine manufacturers provide EIAPPs for engines installed after January 1, 2000. This documentation is maintained onboard NOAA ships with engines newer than January 2000. All main engines and generators operate according to their technical manuals, which establishes the required ratio of oxygen to nitrogen in order to manage and limit NOx emissions. While some lower-tier engines can improve their efficiency and reduce emissions through engine upgrade kits, this is not an option for all engines. Older engines on NOAA ships may not have upgrade kits available, and major overhauls to ship infrastructure may not be practical because the ships are nearing the end of their expected service life; therefore, engine upgrade options for most NOAA ships are fairly limited.

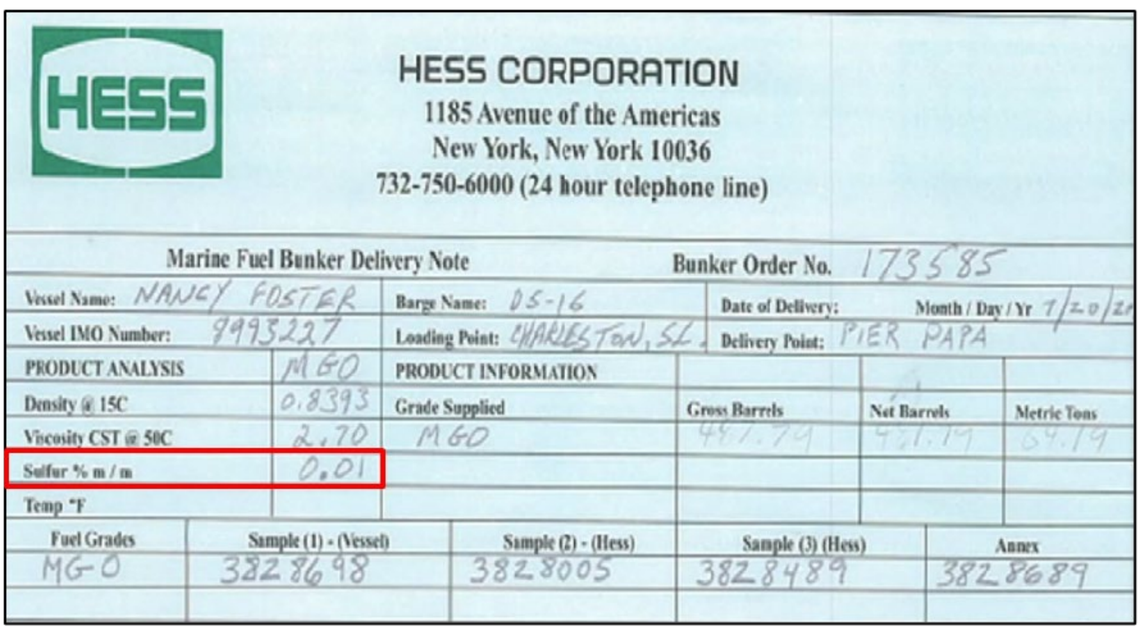
3.3.1.2.2.2 International Air Pollution Prevention (IAPP) Certificate

An IAPP certificate provides the documentation that details how each ship fully complies with the applicable requirements of Annex VI. An IAPP certificate is only required for ships at or above 400 gross tons and engaging in international voyages to ports or offshore terminals under the jurisdiction of a party to Annex VI (Christensen, 2009). The certificate and its supporting documents list the following information: any ODSs carried onboard; all marine diesel engines carried onboard and information regarding compliance with NOx regulations; information regarding compliance with SO_x and particulate matter regulations, specifically the sulfur content of the fuel while operating within an ECA; and information regarding the installation and compliance of all shipboard incinerators. Ships with diesel engines above 130 kW are still required to obtain an EIAPP certificate even if they do not obtain an IAPP certificate.

The USCG issues Certificates of Inspection (COI) to certain U.S. flagged vessels to ensure that the vessel and its equipment are in compliance with the laws and regulations applicable to that vessel. During the initial inspection, materials, workmanship, and conditions of all parts of the vessel and its machinery and equipment may be checked to determine if the vessel is operational and serviceable. COIs enable ships to attain other certifications, such as IAPPs. However, most of NOAA's ships were not designed and built to the COI standard, which makes it very difficult to attain COIs and other certifications. *Reuben Lasker* and *Ferdinand R. Hassler* are the only two ships in the NOAA fleet that possess COIs. *Reuben Lasker* was issued an IAPP certificate because it travels internationally; *Ferdinand R. Hassler* was not issued an IAPP certificate because it does not travel internationally. While all other NOAA ships do not possess IAPP certificates because they are not COI ships, all ships comply with USCG and IMO air pollution prevention requirements, and fleet inspection teams continue to conduct inspections against all relevant standards.

3.3.1.2.2.3 Diesel Fuel

OMAO Procedure 'Oil Transfer' establishes the requirements for oil transfers to, from, and within NOAA ships, and applies to all ships with a tank capacity of 250 barrels (10,500 gallons) or more. This procedure mandates the specifications and instructions pertaining to the required sulfur content of diesel fuel to be used by NOAA ships in order limit the pollutants contained in ship exhaust gas, including SO_x and NO_x. Per IMO 2020, sulfur content in fuels must be limited to 0.50 percent, or 5,000 ppm of sulfur. However, further restrictions exist in the North American ECA, where diesel fuel must contain less than or equal to 0.10 percent, or 1,000 ppm of sulfur (IMO, No Date). This information is typically documented on the marine fuel bunker delivery note, as shown in **Figure 3.3-2**. NOAA ships always burn low sulfur diesel, which contains between 15 and 500 ppm sulfur, but frequently burn ultra-low sulfur diesel (ULSD), which contains less than or equal to 15 ppm sulfur. The sulfur content of purchased fuel aboard NOAA ships must be documented in the Oil Record Book (ORB) (OMAO, 2020b).


HESS CORPORATION
1185 Avenue of the Americas
New York, New York 10036
732-750-6000 (24 hour telephone line)

Marine Fuel Bunker Delivery Note — Bunker Order No. 173585

Vessel Name: NANCY FOSTER — Barge Name: DS-16 — Date of Delivery: Month / Day / Yr 7/20/2[illegible]
Vessel IMO Number: 9993227 — Loading Point: CHARLESTON, SC — Delivery Point: PIER PAPA

PRODUCT ANALYSIS	MGO	PRODUCT INFORMATION			
Density @ 15C	0.8393	Grade Supplied	Gross Barrels	Net Barrels	Metric Tons
Viscosity CST @ 50C	2.70	MGO	457.79	451.14	64.19
Sulfur % m / m	0.01				
Temp °F					

Fuel Grades	Sample (1) - (Vessel)	Sample (2) - (Hess)	Sample (3) (Hess)	Annex
MGO	3828698	3828005	3828489	3828689

Figure 3.3-2. Marine Fuel Bunker Note Detailing Sulfur Content (red box)

Further specifications may be required by state regulations. For example, diesel fuel burned within 24 nm of California coasts is required to be ULSD and contain less than or equal to 15 ppm sulfur. California also requires an agreement with an Oil Spill Response/Recovery Organization for fueling. Any ships unable to procure the correct sulfur-content fuel must reduce the quantity to the minimum, locate a source for the correct sulfur-content fuel at their next fueling location, and notify the Chief, Environmental Management Branch (EMB). Furthermore, all bunkering operations for diesel fuel must be recorded in the ORB, including marine fuel bunker delivery notes, purchasing documents including fuel supplier's receipts (when available), and analysis of fuel/fuel reports indicating sulfur content (OMAO, 2020b).

3.3.1.2.2.4 Ozone Depleting Substances

OMAO Procedure 'Management of Shipboard Ozone Depleting Substances and Refrigerants' ensures compliance with ODS regulations, including those required by the IAPP certificate. This procedure also provides recommendations for managing non-ODS refrigerants. The ship's CO is responsible for ensuring an inventory of all ODS onboard is maintained. If there are no ODS onboard the ship, the CO must sign a memo certifying this fact and submit it to the Marine Operations Center (MOC) Environmental Compliance Officer (ECO); the memo must be maintained onboard the ship and made available to inspectors and surveyors (OMAO, 2012).

Identification

Ozone in the stratosphere protects the earth from the penetration of harmful short-wavelength ultraviolet (UVB) solar radiation. Ozone absorbs UVB and only allows a small amount to reach the earth's surface. ODSs that are released into earth's atmosphere can interact with and destroy the ozone layer (EPA, 2001). These substances include chlorofluorocarbons (CFCs), HCFCs, halons, methyl bromide, carbon tetrachloride, and methyl chloroform, which can be found in refrigeration and fire suppression systems (OMAO, 2012). Without the filtering action of the ozone layer, more of the sun's harmful UV-B solar radiation would penetrate the atmosphere and reach the earth's surface. This could lead to increased incidences of certain skin cancers and cataracts, as well as other human health and environmental consequences (EPA, 2001).

Management and Recordkeeping

The installation of equipment containing ODSs (including CFCs, halons, and some chlorinated compounds) was prohibited after May 2005, except HCFCs which were permitted until January 2020. The continued use of existing equipment using ODSs is permitted; ODSs do not need to be removed or replaced proactively. The deliberate discharge of ODSs and non-ODS refrigerants during maintenance, repair, operation, or disposal is prohibited. ODSs, non-ODS refrigerants, and equipment containing such chemicals must be disposed of only at appropriate reception facilities (OMAO, 2012).

The ODS Log Book must be maintained aboard each ship, and must include at a minimum: ODS Equipment List, ODS and Refrigerant Usage Log, Section 608 Refrigerant Technician Certificates, and service reports from contractors servicing ODS-containing equipment. These records must be maintained for all rechargeable systems containing ODSs. ODS-containing systems that are permanently sealed equipment with no charging connections or removable components are not subject to this recordkeeping requirement. Refrigeration leak detection must be practiced and recorded in the ODS Usage Log, including checking relief valves, rupture disks, and condensers (OMAO, 2012).

3.3.1.2.2.5 Shipboard Incinerators

OMAO Procedure 'Shipboard Solid Waste Management' details the SSI for each ship to develop their own solid waste management plan. It addresses management, storage, and disposal of shipboard-generated solid wastes and provides the minimum requirements for the condition and use of shipboard incinerators.

These include incinerators that were installed before March 1998 which do not need to be USCG approved, and incinerators installed after 1998 that must be USCG approved. It specifies the procedures for separating, processing, sorting, and storing trash before incineration, including the location and duration of storage for trash waiting to be processed. Plastics may be processed in the incinerator if indicated in the incinerator equipment manual; however, recycling is the preferred option. Certain substances are prohibited from incineration, and placards listing all prohibited substances must be posted in plain view where the incinerator is operated, as illustrated by **Figure 3.3-3** (OMAO, 2013a).

THE FOLLOWING ITEMS ARE PROHIBITED FROM INCINERATION

- POLYCHLORINATED BIPHENYLS (PCBs)
- GARBAGE CONTAINING MORE THAN A TRACE OF HEAVY METALS
- REFINED PETROLEUM PRODUCTS CONTAINING HALOGEN COMPOUNDS
- POLYVINYL CHLORIDE (PVCs)- UNLESS INCINERATOR IS APPROVED BY USCG/IMO FOR THAT USE
- EXHAUST GAS CLEANING RESIDUES
- BATTERIES AND ELECTRONICS
- CANS CONTAINING COMPRESSED GAS OR PROPELLANTS SUCH AS SPRAY PAINT, HAIR SPRAY, ETC.

Figure 3.3-3. Incinerator Placard Listing Substances Prohibited from Incineration

Each ship's solid waste management plan SSI must also include procedures for managing the incinerator, including roles and procedures for operating the incinerator, distance from land, permission from the bridge, training, etc. When operating the incinerator, ships are encouraged to restrict operation to beyond 12 nm of shore and as far from human settlement as possible. In-port incinerator operations are prohibited except for required testing, inspections, and maintenance. All maintenance and operations must follow the manufacturer's instructions, and safety and operation instructions must be posted in plain view where the incinerator is operated, including the prohibited substances placard as illustrated by **Figure 3.3-3**. All incinerator ash is stored aboard, discarded ashore, and logged in the Garbage Record Book (GRB) (OMAO, 2013a).

3.3.1.2.2.6 Greenhouse Gas Emissions

Greenhouse gases (GHGs) are gases that trap heat in the atmosphere and include carbon dioxide, methane, nitrous oxide, and fluorinated gases, among other gases. Fuel combustion is one of the main sources of carbon dioxide and nitrous oxide in the atmosphere, while methane emissions can come from natural gas and petroleum systems. Fluorinated gases are sometimes used as a substitute for ODS; while they are emitted in much smaller quantities, they are potent GHGs because they trap substantially more heat than carbon dioxide (EPA, 2023d) (see Section 3.13 Climate Change for further discussion).

OMAO Procedure 'Ship Energy Efficiency Management Plan (SEEMP)' details the SSI for each ship to develop management measures and practices to improve energy efficiency in their operations and control their greenhouse gas emissions. This procedure requires each ship to list their engine equipment and other emission sources (e.g., main engines, generators, bow/stern thrusters, incinerator, etc.), energy sources (e.g., diesel fuel), and energy consumption rates at different speeds and levels of intensity to identify which activities are the most fuel/energy intensive. **Figure 3.3-4** provides an example of how intensity levels affect fuel consumption. The ship's fuel consumption below ten knots is about 40 gallons; however, as the ship accelerates past ten knots, fuel consumption increases at a drastically higher rate. By identifying which levels of activities are the most energy intensive, ships can create effective energy efficiency objectives and curb their greenhouse gas emissions. Some energy efficiency objectives could include optimizing propulsion and generator load; reducing hotel load; and planning the voyage, mission, and operations to promote efficiency (OMAO, 2022).

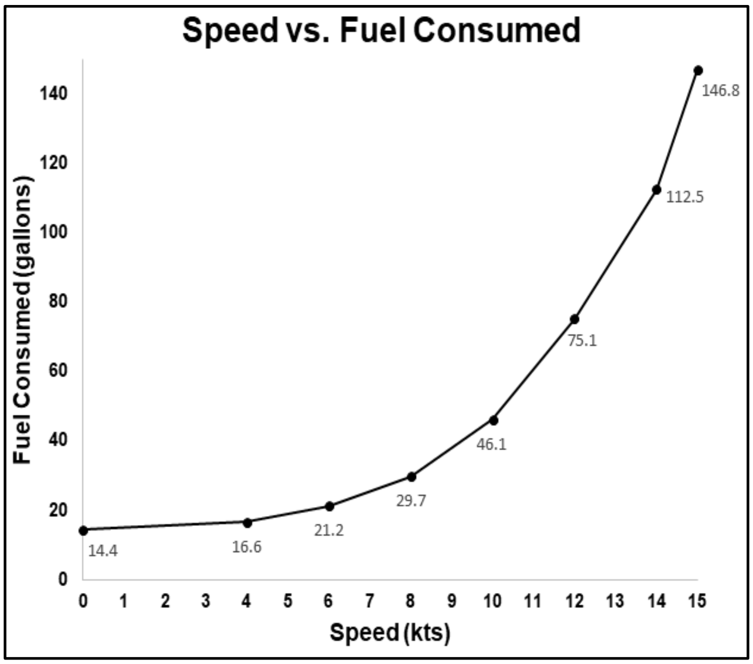


Figure 3.3-4. How Ship Speed Affects Fuel Consumption

3.3.2 Environmental Consequences

The following sections identify and evaluate potential impacts to air quality occurring in the action area under Alternatives A, B, and C.

Activities described in **Table 2.1-1** and in Section 2.2 that occur during OMAO vessel operations and could impact air quality in the action area include vessel movement; waste handling and discharges; vessel repair and maintenance; UMS operations; and small boat operations.

Impacts on air quality are not expected from anchoring; active acoustic systems operations; operation of other sensors and data collection systems; uncrewed aircraft systems (UAS) operations; and over the side (OTS) handling, crane, davit, and winch operations and these activities are not discussed further in this section.

OMAO operations could impact air quality in the action area through: (1) diesel engine and generator emissions (e.g., from vessel movements, UMS operations, and small boat operations); (2) incinerator emissions (e.g., from waste handling and discharges); and (3) ODSs (e.g., from vessel repair and maintenance).

3.3.2.1 Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Under Alternative A, OMAO vessel operations using the current NOAA fleet would continue across all five operational areas over the 15-year timeframe of the PEA. In addition, OMAO is constructing two oceanographic research vessels that are expected to come online by 2025 and is constructing two new charting and mapping vessels that are expected to come online in 2027 and 2028 for a total of four new ships under Alternative A. OMAO would provide a maximum annual capacity of 3,568 operational days at sea (DAS) for scientific projects. Alternative A would also feature "greening" techniques to minimize air quality impacts throughout the fleet, such as energy efficiency efforts.

3.3.2.1.1 Diesel Engine and Generator Emissions

Vessel movement, UMS operations, and small boat operations under Alternative A would generate emissions that could potentially affect air quality.

OMAO operations rely on diesel fuel to power the main engines and emergency diesel generators of NOAA vessels. Diesel fuel is combusted to generate power for vessel movement, UMS operations, and small boat operations, and the release of diesel fuel combustion emissions into the atmosphere could potentially degrade air quality. Engines are assigned EPA Tiers to indicate the level of air emissions generated, with pre-Tier and Tier 0 being least efficient at limiting air emissions and Tier IV being most efficient. Most NOAA vessels maintain EPA Tier 0 to II engines; NOAA Ship *Nancy Foster* is the only ship in the fleet to operate Tier III engines. The new vessels would be built with the cleanest-burning engines available, Tier IV. Small boats, or launches, are also diesel powered. The use of diesel as a power source for UMS is limited to certain uncrewed surface vehicles (USVs), such as Drix or C-worker, which use diesel as their primary power source. Diesel emissions from these activities would vary based on the duration of operations, fuel type, engine type, and engine efficiency.

Diesel engine and generator emissions generated by NOAA vessels could contribute to air pollution and affect air quality. The amount of sulfur in diesel fuel is directly linked to the amount of pollution produced when the fuel is burned in an engine. Pollution from diesel exhaust includes soot or particulate matter; nitrous oxides which contribute to the production of ground-level ozone, or smog; hydrocarbons; carbon monoxide; and other hazardous air pollutants (HAPs) and air toxins (EPA, 2023bb). Most of these pollutants are included in EPA's NAAQS due to their propensity to degrade air quality and cause harmful effects to human health and the environment. Particulate matter can be comprised of larger particles that can be seen as soot or smoke, or as fine particles (MD DOE, No Date). Nitrous oxides contain varying amounts of nitrogen and oxygen that are highly reactive; nitrogen dioxide along with other particles in the air can create a reddish-brown smog that can be potentially toxic (MD DOE, No Date; UCAR, 2023a). Hydrocarbons are chemical compounds that contain hydrogen and carbon and include many toxic compounds that cause cancer and other adverse health effects. Hydrocarbons can also react with nitrous oxides in the presence of sunlight to form ground-level ozone, or smog. Carbon monoxide is a colorless, odorless, poisonous gas produced by the incomplete burning of solid, liquid, or gaseous fuels (MD DOE, No Date). Sulfur oxides are pollutants that can irritate the human respiratory system and can combine with water droplets in the air to form acid rain (UCAR, 2023b). Carbon dioxide also enters the atmosphere from the burning of fossil fuels and remains a main contributor to greenhouse gases in Earth's atmosphere (MD DOE, No Date).

In order to minimize the potential impacts to air quality from diesel fuel combustion emissions, all NOAA vessels are required to abide by all policies, procedures, and regulations related to diesel fuel. This includes OMAO Procedure 'Oil Transfer' which describes the requirements for the maximum sulfur content used in diesel fuel onboard NOAA ships and all proper recordkeeping and reporting procedures (OMAO, 2020b). MARPOL, Annex VI, requires that the amount of sulfur in diesel fuel be limited to 0.50 percent or 5,000 ppm outside of designated ECAs and limited to 0.10 percent or 1,000 ppm within designated ECAs. NOAA ships always burn low sulfur diesel, which contains between 15 and 500 ppm sulfur, but frequently burn ULSD, which contains less than or equal to 15 ppm sulfur. This greatly limits not only the sulfur content, but the amount of other air pollutants emitted during diesel fuel combustion. All main engines and generators are operated according to their technical manuals, which establish the required ratio of oxygen to nitrogen in order to manage and limit nitrous oxide emissions. Operators would perform daily pre-work equipment inspections for cleanliness and leaks. All heavy equipment operations would be postponed or halted should a leak be detected, and would not proceed until the leak was repaired and equipment cleaned. In addition, NOAA vessels required to maintain air pollution prevention certificates, such as the EIAPP certificate and the IAPP certificate would continue to do so based on the vessel's capabilities and specifications (see Section 3.3.1). These documents reflect compliance with MARPOL regarding sulfur content in diesel fuel; nitrous oxides, sulfur oxides, and particulate material emission regulations; any ODSs carried onboard; and shipboard incinerators. While engine upgrade kits are not available for most NOAA vessels, some may receive engine replacements in the near future. NOAA Ship *Ronald H. Brown's* Tier 0 generators are scheduled to be replaced with Tier III generators during its midlife overhaul. Although NOAA vessels must burn fuel in order to operate, following the policies, procedures, and regulations helps to limit emissions. Alternative A would also feature "greening" techniques that would improve energy efficiency, which would be in addition to OMAO Procedure 'Ship Energy Efficiency Management Plan', which outlines the process for each ship's operations to become more energy efficient and reduce its greenhouse gas emissions. Alternative A's four new builds would include Tier IV engines, which would generate fewer emissions than lower tier engines.

Air emissions from NOAA vessels would be temporary and ephemeral as they would occur primarily over the ocean and would dissipate rapidly. NOAA vessels would be expected to contribute an extremely minimal amount of diesel fuel combustion emissions compared to overall vessel activity in the action area, which covers a very wide geographic range. NOAA ships range in size from 124 feet to 274 feet, with small boats or launches ranging in size from 15 feet to 30 feet. Alternatively, ocean-going vessels and other ship traffic such as tankers, cargo ships, container ships, and cruise ships generally vary in size from several hundred feet to over a thousand feet, with the size of the worldwide fleet greatly outnumbering the size of the NOAA fleet. In comparison, this would render any diesel fuel combustion emissions from NOAA vessels as a nearly undetectable fraction of overall emissions.

Under Alternative A, vessel movement, UMS operations, and small boat operations would generate emissions from diesel fuel combustion that could potentially affect air quality. All NOAA vessels are required to abide by all policies, procedures, and regulations discussed above that are related to diesel fuel content and emissions, in addition to voluntary compliance with MARPOL Annex VI. Impacts beyond the U.S. Economic Exclusive Zone (EEZ) while vessels are transiting would be similar to those within the EEZ. Therefore, the impacts from the generation of diesel emissions would be adverse, **negligible** to **minor**, **temporary**, **localized** or **regional**, if the vessel is moving, and therefore **insignificant**.

3.3.2.1.2 Incinerator Emissions

Waste handling and discharges under Alternative A would generate incinerator emissions that could potentially affect air quality.

Incineration of shipboard wastes would generate emissions. The emissions and their effects would vary based on the type and amount of incinerated waste and the distance incineration occurs from shore. Waste handling and discharges could potentially degrade air quality if prohibited products are incinerated. Some NOAA ships have shipboard incinerators to reduce the volume of waste generated onboard. Collected waste items could include but are not limited to paper products, food-contaminated containers, incidental plastics, oil or sludge (if approved), cooking oil, and oily rags, containers, filters, and other oil-soaked materials. Incineration would generate incinerator ash, which would be contained onboard for storage and shoreside disposal. The potential impacts from incinerator ash are also discussed in Section 3.4.2 (Water Quality). Particles smaller than a micrometer in size are vented up a separate exhaust pipe within the smokestack as incinerator emissions and could contain toxic heavy metals such as lead, cadmium, and arsenic; however, materials that contain more than traces of heavy metals are prohibited from incineration. Refined petroleum products containing halogen compounds are also prohibited from incineration. Nitrogen and sulfur oxides could also be present in incinerator emissions; however, the concentrations emitted are likely to be orders of magnitude lower compared to emissions from the ship's engines (National Academies, 1996). Organic compounds such as dioxins could be formed through the combustion process during the incineration of commercial, municipal, wood, or oil waste. Dioxins are a group of toxic chemical compounds that are extremely persistent in the environment and break down very slowly (EPA, 2023c).

In order to minimize the potential impacts to air quality from incinerator emissions, all NOAA vessels using an incinerator are required to abide by the policies, procedures, and regulations related to incinerator usage. This includes OMAO Procedure 'Shipboard Solid Waste Management' which provides the requirements for the operation, maintenance, and recordkeeping of shipboard incinerators. All shipboard incinerators are type approved and must follow the original equipment manufacturer's instructions regarding operation and functioning, especially alarms and safety shutdowns. Operators would perform daily pre-work equipment inspections for cleanliness and leaks. All incineration would be postponed or halted should a leak be detected, and would not proceed until the leak was repaired. At-sea incinerator operation should be restricted to beyond 12 nm from shore, when possible, and as far from human settlement as possible. Each vessel displays a Discharge Matrix authorizing use of the incinerator based on distance from shore. When operating the incinerator, ships are encouraged to restrict operation to beyond 12 nm from shore and secure or minimize operation within 12 nm from shore. All vessels are strictly prohibited from incinerator operation unless permission is obtained from the bridge. All incinerator ash must be stored aboard and discarded ashore. Furthermore, certain substances are strictly prohibited from incineration and a placard stating the prohibited substances must be posted in plain view where the incinerator is operated, consistent with MARPOL, Annex VI (OMAO, 2013a). Therefore, while some NOAA vessels would generate incinerator emissions, those vessels would abide by all policies, procedures, and regulations to minimize the potential impacts from incinerator emissions. Incineration would occur at a distance away from shore to reduce the likelihood of emissions affecting air quality in coastal communities. In addition, incinerator emissions from NOAA ships represent a very minute fraction as compared to overall air emissions from all other vessel activity in the ocean.

Under Alternative A, waste handling and discharges would generate incinerator emissions that could potentially affect air quality. All NOAA vessels equipped with incinerators are required to abide by all policies, procedures, and regulations related to operation and maintenance. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. Therefore, the impacts from the generation of incinerator emissions would be adverse, **negligible** to **minor**, **temporary**, **localized** or **regional** if the ship is moving, and therefore **insignificant**.

3.3.2.1.3 Ozone Depleting Substances

Vessel repair and maintenance could release ODS that could potentially affect air quality.

ODS are compounds that contribute to stratospheric ozone depletion. ODS use on NOAA vessels is limited to halon fire suppression systems or refrigeration or HVAC systems that use CFCs such as R-12 or HCFCs such as R-22 Halons are very effective fire and explosive suppression agents that are electrically non-conductive and leave no residue; this makes them extremely valuable for certain applications and situations (EPA, 2001). CFCs and HCFSs are ozone-depleting substances and potent greenhouse gases that were widely used in air conditioners and refrigerators for over 30 years up until the mid-1990s (EPA, 2022b). Some older systems and equipment onboard the aging fleet may still contain ODS. Vessel repair and maintenance could potentially degrade air quality if any ODS were leaked or spilled from older systems and equipment during servicing or operation.

In order to minimize the potential impacts from ODS to air quality, the NOAA fleet is required to abide by all policies, procedures, and regulations related to ODS. This includes OMAO Procedure 'Management of Shipboard Ozone Depleting Substances and Refrigerants' which describes the requirements to maintain compliance with ODS regulations, including those required by the IAPP certificate (OMAO, 2020b). After March 2005, the installation of equipment containing ODS including CFCs and halons was no longer authorized onboard NOAA vessels; HCFCs were no longer permitted after January 2020. The continued use of existing equipment containing ODS is still permitted, but all maintenance, repair, replacement, disposal, and recordkeeping procedures must be followed. Any personnel involved in maintenance of air conditioning and refrigeration systems must possess an EPA Section 608 Technician Certification, and all ODS and non-ODS refrigerants must be retained and stored during all maintenance and repair activities. Intentional venting of refrigerants does not occur (OMAO, 2012). Accidental leaks or discharge of ODS are infrequent events. Operators perform daily pre-work equipment inspections for leaks. Leaks are promptly repaired. Furthermore, a list of ODS equipment and the usage of ODS and refrigerants must be maintained in the ODS Log Book, in addition to being listed on each ship's IAPP certificate, as necessary. Therefore, while some NOAA vessels may continue to carry equipment that contains ODS, release of ODS to the environment during routine operations is unlikely to occur. Any accidental leak or discharge of ODS would be considered minimal compared to the wide geographic range of the action area.

Five of the 15 ships currently in the NOAA fleet still have a halon fire suppression system on board, primarily in areas with a higher risk of fire such as the main engine room. Discharge of a halon fire suppression system could occur during an OMAO response to a fire. However, such an event would be unlikely to occur and limited to only those five ships.

Under Alternative A, vessel repair and maintenance could involve an ODS release that could potentially affect air quality. However, the NOAA fleet is required to abide by all policies, procedures, and regulations related to ODS. Impacts beyond the U.S. EEZ while vessels are transiting or conducting routine vessel repair and maintenance would be similar to those within the EEZ. Therefore, the impacts from ODS would be adverse, **negligible** to **minor**, **temporary**, **local** or **regional** if the ship is moving, and therefore **insignificant**.

3.3.2.1.4 Conclusion

Under Alternative A, OMAO would continue to use the current NOAA fleet to conduct operations to support NOAA's primary mission activities. OMAO would continue to operate NOAA's fleet of survey and research ships until they reached the end of service life. Almost half the ships in the NOAA fleet would exceed their design service life by 2038; however, two new ships would come online in 2025 with two more ships projected to come online in 2027 and 2028. The fleet would provide a maximum annual capacity of 3,568 DAS for scientific projects. Alternative A would also include engine upgrades to some NOAA ships and "greening" techniques to minimize air quality impacts throughout the fleet, such as energy efficiency efforts. Furthermore, all ships would abide by the Shipboard Energy Efficiency Management Plan to make their operations more energy efficient and control their greenhouse gas emissions. Since the effects of impact causing factors on air quality throughout the action area range from negligible to minor, the overall impact of Alternative A on air quality would be adverse, **negligible** to **minor**, **temporary**, **regional** or **localized** depending on whether the vessel is stationary or moving, and therefore **insignificant**.

3.3.2.2 Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

OMAO operations under Alternative B would take place in the same operational areas and timeframes as under Alternative A; however, under Alternative B, OMAO would construct up to eight new ships (four as in Alternative A, plus four additional ships) to replace ships that would reach the end of their design service life, extend the service life of aging ships through maintenance and mid-life repairs for six ships, increase fleet utilization with up to 4,138 DAS (approximately 570 more DAS annually than under Alternative A), and integrate new and greener technology as described in Section 2.4. As such, effects under Alternative B would incrementally increase from those of Alternative A but would not differ fundamentally in type.

Impacts from OMAO operations on air quality through diesel fuel combustion emissions, incinerator emissions, and the release of ODS would occur under Alternative B from the same activities as those under Alternative A. Although the number of DAS would be greater under Alternative B than under Alternative A, the additional 570 DAS (implemented in a phased approach) would be distributed across the five operational areas. While the increase of these 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 intensity of the impacts. Additionally, replacing aging ships with new ships and integrating new and greener technology would likely reduce some impacts. Ship-specific infrastructure upgrades and advancements to extend the life of the current fleet would improve fuel consumption and reduce associated emissions during vessel movements and vessel repair and maintenance. The new vessels would be delivered with greener technologies with reduced emissions, including EPA Tier IV engines that emit lower levels of particulate matter, nitrous oxides, and other harmful pollutants; refrigerant and fire suppression systems that do not use ODS; and lithium batteries to power the ship's hotel mode and certain propulsion operations. All new builds would be delivered with COIs that would be kept up to date onboard each vessel. Furthermore, six NOAA Ships, including *Ronald H. Brown, Oscar Dyson*, *Henry B. Bigelow*, *Pisces*, *Bell M. Shimada*, and *Reuben Lasker*, would undergo midlife repairs that would replace or upgrade their engines, thereby reducing emissions.

Impacts of Alternative B on air quality throughout the action area would be similar to those discussed above under Alternative A for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be lower due to the introduction of new ships and improved technology. Overall, impacts on air quality under Alternative B would be adverse, **negligible** to

minor, **temporary**, **regional** or **localized** depending on whether the vessel is stationary or moving, and therefore **insignificant**.

3.3.2.3 Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

OMAO operations under Alternative C would implement the same measures as under Alternative B and take place in the same operational areas and timeframe as under Alternatives A and B; however, Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B with additional measures including maximizing crew productivity and enhancing overall fleet performance by increasing DAS by approximately 735 additional days, construction of two new ships in addition to those under Alternative B, increasing the number and use of uncrewed systems integrated into vessels, and shortening the timeframe for fleet improvement activities, implementation of greening techniques, and improvements to the small boat fleet as discussed in Section 2.5. As such, effects under Alternative C would incrementally increase from those of Alternatives A and B but would not differ fundamentally in type.

Impacts from OMAO operations to air quality from diesel fuel combustion emissions, incinerator emissions, and the release of ODS would occur under Alternative C from the same activities as those under Alternatives A and B. Along with the greater number of DAS under Alternative C as compared to Alternatives A and B, there would be greater impacts overall; however, the associated impact-causing factors would not be concentrated enough in any given area to substantially increase the intensity of the impacts as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Furthermore, benefits would be introduced at an accelerated rate from the proposed measures under Alternative B with the increased funding under Alternative C. New ships would enter the fleet sooner than anticipated, in addition to two new ships to replace aging ships as compared to Alternative B (i.e., a total of ten new ships), and new greening techniques and small boat improvements for the current fleet would occur over a shortened timeframe. Therefore, similar to Alternative B, these measures would reduce overall emissions, including EPA Tier IV engines that emit lower levels of particulate matter, nitrous oxides, and other harmful pollutants; refrigerant and fire suppression systems that do not use ODS; and lithium batteries to power the ship's hotel mode and certain propulsion operations, over a shortened timeframe compared to Alternative B.

Impacts of Alternative C on air quality throughout the action area would be similar to those discussed above under Alternatives A and B for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be lower due to the increase in greening measures and technology improvements. Overall, impacts on air quality under Alternative C would be adverse, **negligible** to **minor**, **temporary**, **regional** or **localized** depending on whether the vessel is stationary or moving, and therefore **insignificant**.

3.4 Water Quality

This section describes the affected environment for water quality and assesses OMAO vessel operations as they pertain to water quality conditions encountered throughout the action area, which is the area of analysis for water quality.

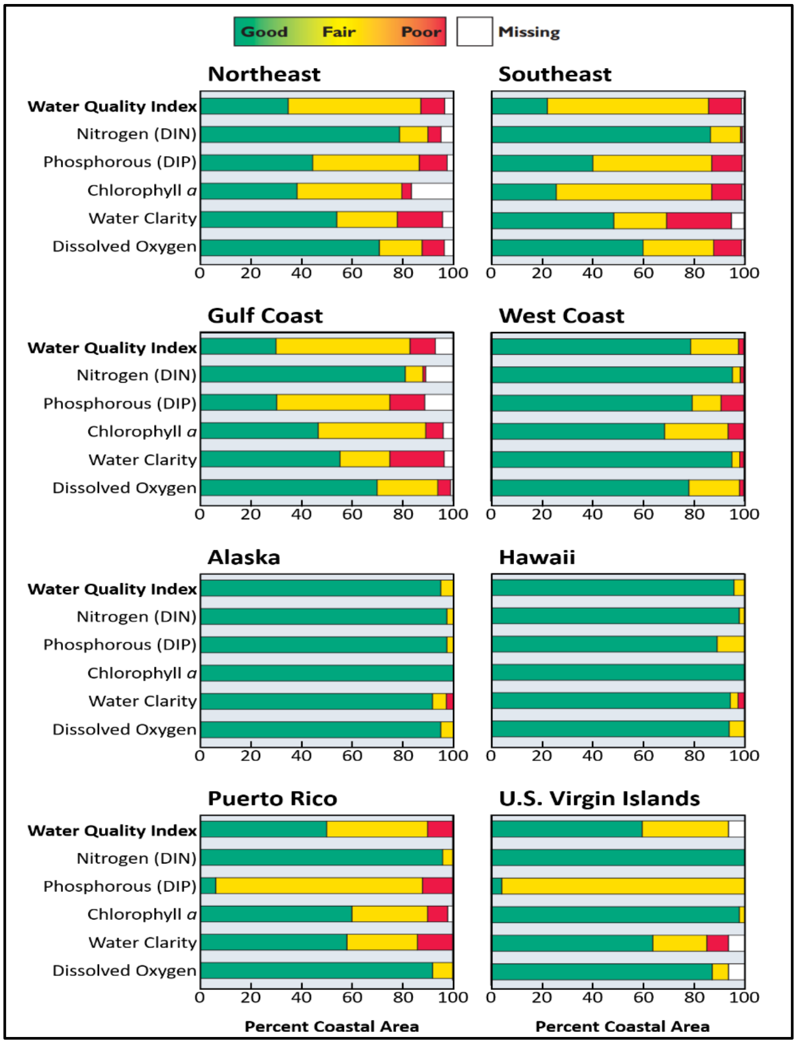
3.4.1 Affected Environment

Water quality refers to the suitability of water for a particular use based on the selected physical, chemical, and biological characteristics (USGS, No Date-b). The uses of water are universal, as all life on Earth requires water for existence, and many abiotic factors rely on water for physical or chemical processes. The types of water, such as fresh, estuarine, and marine, the conditions of quality, such as physical, chemical, and biological parameters, and the levels of regulation, such as federal, state, or local, vary widely across the area of analysis.

Addressing water quality in the area of analysis is a two-fold process consisting of an assessment of water quality conditions to acknowledge the state of these water resources, and an assessment of all relevant environmental compliance regulations and applicable OMAO policies and procedures. It should also be noted that water quality is discussed in other sections of this Draft PEA as it specifically relates to aspects of the environment, such as biological resources and socioeconomic resources.

3.4.1.1 Water Quality Assessment

This section describes water quality conditions in the action area as presented by the National Coastal Conditions Report IV (EPA, 2012). The EPA has performed regular assessments of ecological conditions that include assessments of water quality, typically presented as indices with parameters such as nitrogen, phosphorous, dissolved oxygen (DO), water clarity, and chlorophyll *a* (i.e., a form of chlorophyll used in photosynthesis). The National Coastal Conditions Report IV (EPA, 2012) contains some of the most recent national evaluations of water quality. The 2012 assessment examined several available data sets collected from 2003 to 2006 from different agencies and areas of the country. The report summarized the findings and presented a broad baseline picture of the condition of the nation's water resources. The findings are graphically presented in **Figure 3.4-1**, followed by a summary discussion of the findings by region (geographic regions generally correspond with OMAO Operational Areas).



Source: EPA, 2012

Figure 3.4-1. Regional Water Quality Conditions from 2003 - 2006

3.4.1.1.1 Greater Atlantic Region

The Northeast coast refers to the coastal and estuarine waters from Maine through Virginia, including Cape Cod, Narragansett Bay, Long Island Sound, the Delaware Estuary, and the Chesapeake Bay. For overall water quality, this region was rated as good to fair. Phosphorus, chlorophyll *a*, DO, and water clarity were all rated as fair, while nitrogen was rated as good. Water quality followed a strong gradient along the Northeast Coast. Good conditions were found in well-mixed, open estuaries towards the north around Acadia, Maine, while fair conditions were more likely in the poorly flushed, high developed estuaries moving southward from New York into Virginia. (EPA, 2012).

The Great Lakes region refers to open waters and nearshore coastal waters of the Great Lakes, which are defined as having a depth of 20 meters (m) (66 feet [ft]) or less. Overall water quality in this region was rated as fair. Phosphorus was rated as poor, water clarity was rated as good to fair, and DO was rated as good. Increased phosphorus loading has been related to nonpoint sources such as stormwater runoff, which can decrease water clarity via propagation of algal blooms and consumption of DO upon their decay. Eutrophic conditions have also been noted in the coastal waters of Lake Erie, likely a result of zebra and quagga mussels consuming plankton, increasing water clarity, and creating a competitive advantage for certain algal species (e.g., *Cladophora*) (EPA, 2012).

3.4.1.1.2 Southeast Region

The Southeast coast extends from Virginia to Florida and contains key resources such as North Carolina's Outer Banks, the Albemarle-Pamlico Estuarine System, Indian River Lagoon, Biscayne Bay, and shipping ports in Miami and Jacksonville, FL, Savannah, GA, and Charleston, SC. Overall, this region's water quality was rated as fair. Phosphorus, chlorophyll *a*, and DO were rated as fair, while nitrogen was rated as good and water clarity was rated as poor. Between 1980 and 2006, the coastal counties of the Southeast Coast have had a population increase from 7.2 million to nearly 13 million people. This has likely provided human-induced stress, including increases to urbanization and development, stormwater runoff, and water pollution in some areas of the region (EPA, 2012).

The Gulf of Mexico coastline spans from the Texas-Mexico border all the way east to Florida Bay. This area includes over 750 estuaries, bays, wetlands, and sub-estuary systems that are associated with larger estuaries. The overall water quality rating for the Gulf Coast was fair. Nitrogen was rated as good, but phosphorus was rated as fair. Chlorophyll *a* and water clarity were both rated as fair, while DO was rated as good. It should be noted that the Gulf of Mexico is the second-largest area of oxygen-depleted waters in the world. The zone occurs in waters on the Louisiana shelf to the west of the Mississippi River Delta and is hypothesized to be caused by water column stratification driven by weather, river flow, and decomposition of organic matter in bottom waters (EPA, 2012).

Puerto Rico is the smallest island of the Greater Antilles. It is a densely populated island with estuarine areas that are heavily developed. Overall water quality for Puerto Rico was rated from good to fair. Nitrogen was rated as good, while phosphorus was rated as fair. Chlorophyll *a* and DO were both rated as good, and water clarity was rated as fair (EPA, 2012).

The U.S. Virgin Islands consist of the islands of St. John, St. Thomas, and St. Croix. From 1980 to 2006, the population of these islands increased 12 percent from 98,000 to 110,000, with a population density of 613 persons per square mile (mi^2). The overall water quality for the U.S. Virgin Islands was rated as good. Nitrogen was rated as good, while phosphorus was rated as fair. Chlorophyll *a*, water clarity, and DO were all rated as good (EPA, 2012).

3.4.1.1.3 West Coast Region

The West coast extends from the Washington-Canada border south to the Mexican border. It comprises more than 410 estuaries and bays, including three large estuarine systems – the San Francisco Estuary, Columbia River, and Puget Sound (including the Strait of Juan de Fuca). The overall water quality rating for the West Coast region was rated as good. Nitrogen, phosphorus, chlorophyll *a*, water clarity, and DO were all rated as good. Higher chlorophyll *a* concentrations in the outer coastal estuaries of Washington and Oregon may have been the result of natural upwelling that occurs along that section of the coastline and not the result of anthropogenic inputs (EPA, 2012).

3.4.1.1.4 Alaska Region

Alaska's southeastern coastline is home to hundreds of bays, estuaries, coves, fjords, and other coastal features, including the Gulf of Alaska (GOA). Unlike other U.S. regions, Alaska's main threat to water quality comes from climate change and resource development, such as oil, gas, and mineral reserves.

Overall, water quality for Southeastern Alaska was rated as good. Nitrogen, phosphorus, chlorophyll *a*, water clarity, and DO were all rated as good. DO and water clarity were rated as fair in a few areas, but naturally occurring conditions were believed to have caused those results, such as glacial silt input from nearby glaciers or river systems draining glaciated watersheds (EPA, 2012).

3.4.1.1.5 Pacific Islands Region

Hawai'i's coastal waters represent less than 1 percent of the coastal ocean area around the Hawai'ian Islands and are best developed on the older islands. Pearl Harbor is the largest remaining Hawai'ian estuary (22 mi^2), while most other Hawai'ian estuaries occupy less than 0.5 mi^2. The remaining estuarine waters are channelized conduits that rapidly transport stormwater runoff to the sea. Overall, Hawai'i's water quality index was rated as good. Nitrogen, phosphorus, chlorophyll *a*, water clarity, and DO were all rated as good. Hawai'i has steeply sloped coastal watersheds and high seasonal rainfall, so land use changes due to increases in population and economic growth that result in increased runoff are of great concern for water quality in coastal areas (EPA, 2012).

American Samoa is the southernmost U.S. territory. The combined land area of American Samoa is approximately 77 mi^2, including five volcanic high islands and two atolls. The overall water quality for American Samoa was rated as good. Nitrogen, phosphorus, chlorophyll *a*, water clarity, and DO were all rated as good (EPA, 2012).

The Island of Guam is the westernmost point of the U.S. It has relatively small estuaries and coastal embayments, along with larger marine bays, such as the deepwater lagoon of Apra Harbor. Overall, Guam's water quality was rated as good. Nitrogen was rated as good, but high concentrations were found near Apra Harbor, likely from urbanized development runoff. Phosphorus was rated as fair, and while it cannot be fully determined, high concentrations near bays and harbors could have been the result of nearby aquaculture ponds. Chlorophyll *a*, water clarity, and DO were all rated as good (EPA, 2012).

3.4.1.2 Regulatory Framework

While performing OMAO vessel operations, NOAA ships and other vessels move into and out of areas of potentially sensitive waters within many federal, state, and local regulatory jurisdictions. Many of these jurisdictions have developed water quality standards that reflect both the individual water quality of their respective systems and the needs of their water resources (e.g., recreation, fishing, drinking water, etc.). Therefore, this section discusses federal, state, and local (protected waters) regulations to understand their requirements. In addition, this section also discusses OMAO's Environmental Compliance framework to demonstrate how vessel operations comply with all applicable regulations.

3.4.1.2.1 Federal Regulations

The federal regulatory framework that establishes minimum water quality requirements is derived from international standards relevant for ships, specifically MARPOL 73/78. MARPOL contains six Annexes, each targeting a different form of marine pollution from ships (USCG, No Date-c). **Table 3.4-1** summarizes each applicable Annex, or section within MARPOL 73/78, by water pollution source, title, whether the U.S. is a party, and implementing legislation, law and/or regulations, and applicable U.S. Coast Guard (USCG) guidance. OMAO voluntarily complies with many requirements of Annexes I and IV and NOAA vessels are subject to Annex V. A brief discussion of each Annex and applicable U.S. regulations follows the table.

Table 3.4-1. MARPOL Annexes Related to Water Pollution

Annex	Pollution Source	Title	US Party*	Implementation Legislation/ Regulations/Guidance
I	Oil	Regulations for the Prevention of Pollution by Oil	Yes	▪ APPS (33 United States Code [U.S.C.] Section [§] 1901 – 1912) ▪ Oil Pollution Act (OPA) (33 U.S.C. 2701 – 2761) ▪ 33 Code of Federal Regulations (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
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 Part 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 – 1915 ▪ 33 CFR Part 151 ▪ Marine Safety Manual, Vol. II

Source: USCG, No Date-c

* Indicates whether the U.S. has agreed to comply with the Annex.

Annex I addresses oil pollution prevention and has been incorporated into U.S. law by APPS and the 1990 OPA. Requirements include oily waste discharge limitations, oily-water separating equipment, machinery space bilges, as well as Shipboard Oil Pollution Emergency Plans (SOPEP) (USCG, No Date-d). Ships that are equal to or above 400 gross tons and engage in international voyages to ports and terminals under the jurisdiction of other parties to MARPOL 73/78 must carry a valid International Oil Pollution Prevention (IOPP) Certificate (Cornell Law School, No Date-a), which verifies that the vessel is in compliance with the requirements of Annex I and that any required equipment is on board and operational. Annex I also requires each vessel to maintain an ORB to record all oil transfers and discharges (USCG, No Date-d).

Annex IV addresses sewage discharges from vessels. The U.S. is not party to Annex IV, and thus is not bound to the Annex's provisions. The U.S. maintains a separate suite of regulations under the CWA that provides a statutory framework under which the EPA and the USCG regulate sewage discharges from vessels. The CWA defines discharge of a pollutant as "any addition of a pollutant to navigable waters from any point source, and any addition of a pollutant to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft" (33 U.S.C. 1362(12)). A point source is "any discernible, confined and discrete conveyance" and includes a vessel or other floating craft (33 U.S.C. 1362(14). The CWA generally prohibits the discharge of any pollutant from a point source unless authorized by a permit issued under the CWA (33 U.S.C. 1311). In 2013, the EPA issued the National Pollution Discharge Elimination System (NPDES) Vessel General Permit (VGP), which provided NPDES permit coverage nationwide for discharges incidental to the normal operation of commercial vessels greater than 24 m (79 ft) in length (EPA, 2023f). The Vessel Incidental Discharge Act (VIDA) (Title IX of the Frank LoBiodo Coast Guard Authorization Act of 2018, Pub. L. 115-282) requires EPA to develop new standards of performance for commercial vessel incidental discharges and the USCG to develop corresponding implementing regulations. On October 26, 2020, EPA published a Notice of Proposed Rulemaking for rules to implement VIDA (85 FR 67818); however, the VGP will remain in effect until EPA finalizes its rulemaking and until the USCG develops corresponding implementing regulations.

MARPOL Annex IV requires ships that are equal to or greater than 400 gross tons and engage in international voyages to have a valid International Sewage Pollution Prevention Certificate (ISPPC) issued by its flag Administration or by a recognized organization acting on behalf of the flag Administration. Since the U.S. is not party to Annex IV, U.S. vessels that engage in international voyages with sewage systems in compliance with Annex IV may be eligible to receive a Statement of Voluntary Compliance (SOVC). This certificate takes the place of the ISPPC and is issued to U.S. vessels by the USCG to demonstrate voluntary compliance with MARPOL Annex IV (Salerno, 2009).

Annex V addresses ship-generated garbage and aims to reduce the amount of garbage (both plastics and other wastes, such as food scraps and general trash) that ships generate. It has been incorporated into U.S. law APPS, as amended by the Marine Plastic Pollution Research and Control Act (Pub. L. 100-220). Unlike MARPOL Annex I, APPS provides that non-commercial government vessels not operated by the USCG or the Department of Defense must comply with Annex V at 33 CFR Part 151. Garbage is broadly defined as nearly any kind of waste generated during a ship's normal operations. It requires adequate waste reception facilities at U.S. ports, that manned ships of certain sizes display pollution prevention placards, for certain ships to develop waste management plans, and that certain manned ships maintain waste disposal records. It also implements a general ban on dumping plastics and synthetics into the marine environment anywhere in the world, designates areas where dumping some types of garbage is prohibited, and sets conditions where dumping of other types of garbage is allowed at sea (USCG, 2017).

A USCG COI is issued to certain U.S. flagged vessels to ensure that the vessel and its equipment are in compliance with the laws and regulations applicable to that vessel. During the initial inspection, materials, workmanship, and conditions of all parts of the vessel and its machinery and equipment may be checked to determine if the vessel is operational and serviceable. COIs enable ships to attain other certifications, such as IOPPs, ISPPCs, SOVCs, etc. However, most of NOAA's ships were not designed and built to the COI standard, which makes it very difficult to attain COIs and other certifications. The only two ships in the fleet that possess COIs are *Reuben Lasker* and *Ferdinand R. Hassler*. Regardless, all NOAA ships comply with USCG and IMO pollution prevention requirements, and fleet inspection teams continue to conduct inspections against all relevant standards.

3.4.1.2.2 State and Local Regulations

The following states maintain specific regulations that pertain to vessel discharges within their respective state's waters: Alaska, California, Connecticut, Hawai'I, Maine, New Hampshire, New York, Rhode Island, and Washington. NOAA ships and other vessels must abide by these regulations while within each state's waters as part of their NPDES VGP. State-specific regulations can be found in Appendix D. In addition, a list of local protected waters is also listed in Appendix D.

3.4.1.2.3 OMAO Water Quality Environmental Compliance

OMAO has created a DMS to enhance fleet standardization and ensure current and accurate documentation is maintained for all OMAO activities. The DMS includes administrative and operational standard operating procedures, policies, SSI, and other relevant information. This system provides an internal regulatory framework that allows OMAO to remain in compliance with applicable federal, state, and local laws. Furthermore, each NOAA ship is responsible for developing their own SSI per OMAO policy or procedure as it pertains to each ship's capabilities. In this way, all OMAO vessel operations are held to the same standard in terms of environmental compliance, but with a tailored approach to the individual ship.

Within the DMS, NOAA ships and other vessels maintain a NPDES VGP, which regulates discharges and provides instructions to manage water pollution streams. OMAO Procedure 'National Pollutant Discharge Elimination System Vessel General Permit Compliance Procedures' provides the minimum requirements to obtain and maintain the NPDES 2013 VGP. The NPDES VGP program controls water pollution by regulating vessel discharges to the environment incidental to normal vessel operations within 3 nm of U.S. shores and in federally protected waters. The permit states that all crew members involved in NPDES compliance must be trained in the requirements of the permits (OMAO, 2013b).

OMAO Procedure 'National Pollution Discharge Elimination System Vessel General Permit Ship-Specific Instruction, Attachment A' identifies all discharges that pertain to the ship and the rules and regulations set forth to best manage each discharge. The Commanding Officer (CO) of each NOAA ship must ensure that a shipboard ECO is designated. The ECO must establish and maintain the NPDES VGP SSI, which lists the operational discharge, the permit reference, the Ship-Specific Best Management Practices (BMPs) that demonstrates how compliance will be managed aboard the ship, the Responsible Parties for each BMP, and the required recordkeeping associated with each operational discharge (OMAO, 2013c). The ECO must also complete inspections, conduct trainings, and maintain record keeping requirements per each ship's NPDES VGP SSI (OMAO, 2013b). Each NPDES VGP operational discharge is discussed as it pertains to OMAO vessel activities in the sections below.

In addition, a Discharge Matrix, as seen in the example provided in **Figure 3.4-2**, is a requirement for all NOAA ships. These matrices are displayed on the bridge and in engineering spaces and govern discharge requirements based on the ship's distance from shore and in accordance with the applicable regulations of those waters. Each ship must maintain a ship specific version based on its operational and treatment capabilities, and its operating area. It is important to note that all discharges onboard NOAA ships are prohibited unless permission is obtained from the bridge.

DISCHARGE	MOST EVERYWHERE			
	≤1NM	1-3NM	3-12NM	> 12NM
BLACKWATER[2] (RAW SEWAGE)	SECURED	SECURED	SECURED	AUTHORIZED (OOD notates deck log)
MSD[2]	select: SECURED/ MINIMIZE[2] (OOD notates deck log)	select: SECURED/ MINIMIZE[2] (OOD notates deck log)	AUTHORIZED (OOD notates deck log)	AUTHORIZED (OOD notates deck log)
GRAYWATER	select: SECURED/ MINIMIZE[5] (log in GW log)	select: SECURED/ MINIMIZE[5] (log in GW log)	AUTHORIZED	AUTHORIZED
WET GARBAGE (FOOD WASTE)	SECURED	SECURED	MACERATED[4] (log in GRB)	AUTHORIZED[4] (log in GRB)
INCINERATOR	select: SECURED/ MINIMIZE[5] (log trash in GRB; log waste oil in ORB & GRB)	select: SECURED/ MINIMIZE[5] (log trash in GRB; log waste oil in ORB & GRB)	select: SECURED/ MINIMIZE[5] (log trash in GRB; log waste oil in ORB & GRB)	AUTHORIZED (log trash in GRB; log waste oil in ORB & GRB)
OWS	SECURED[3]	select: SECURED/ MINIMIZE[5] (log in ORB)	AUTHORIZED (log in ORB)	AUTHORIZED (log in ORB)

[1] Ships must maintain a ship-specific version of this matrix. Select the appropriate verbiage & color according to SSIs, for any discharges that appear as orange crosshatch (contact MO ECO for guidance). Include regulations specific to unique areas at right (i.e., Wide Caribbean Special Area; Papahanaumokuakea; routinely visited sanctuaries; etc.).

[2] Blackwater (raw sewage) & Marine Sanitation Device discharge is prohibited in all No Discharge Zones (NDZ).

[3] Oily Water Separator (OWS) discharge w/in 1nm requires permission from CO and is made for safety & essential function only; safety reasons must be documented in the ORB as "I" entry.

[4] Ships operating in GOMex and Caribbean must follow Wider Caribbean Special Area for garbage: secure discharge <12n & macerate prior to >12nm.

[5] Ship must select appropriate verbiage & color (green, orange, red) based on ship-specific instructions for MSD, GW, INCINERATOR, AND OWS (contact MO ECO for assistance).

Figure 3.4-2. Discharge Restrictions[1] for NOAA Ships

General OMAO procedures and the corresponding vessel operational activities include: 1) oil transfers due to vessel movements and small boat operations, 2) shipboard solid waste management due to generation of dry waste, recyclables, food waste, and incinerator ash, 3) shipboard wastewater management due to generation of greywater and sewage, 4) oily material management (including bilge water) due to generation of oily materials, and 5) shipboard automated maintenance management systems (SAMMS) due to vessel repair and maintenance activities. All permits, procedures, and policies related to these activities and the associated water discharges are discussed below.

3.4.1.2.3.1 Oil Transfers

Oil transfers occur as part of OMAO vessel operations and are generally addressed in each ship's NPDES VGP SSI as the operational discharge 'Fuel Spills/Overflows'. It provides specific best management instructions for general fueling procedures, including small boats. Crews responsible in both ship and small boat fueling operations must be trained to avoid spills caused by human error or improper use of equipment. Additionally, all small boats operate in full environmental compliance with federal, state, and NOAA requirements by abiding by the 'NOAA Small Boat Standards and Procedures Manual', which provides instruction for oil management (NOAA, 2018a). Furthermore, all NOAA vessels must follow NPDES State Rules concerning oily materials while within each state's respective jurisdiction (see Appendix D) (OMAO, 2013c).

OMAO Procedure 'Oil Transfer' (Attachments A – D) establishes the requirements for oil transfers to, from, and within NOAA ships, and applies to all ships with a fuel oil capacity of 250 barrels (10,500 gallons) or more. The SSI includes oil transfer procedures and fueling billet duties (Attachment A), the ship's fueling billet list (Attachment B), an example of a generic fueling plan (Attachment C), and an example of an internal transfer checklist (Attachment D). Each ship must maintain an Oil Transfer binder, which contains a printed copy of their SSI along with any required diagrams, and is kept on the ship's bridge, the Chief Marine Engineer's (CME) room, and in the engineering spaces. All oil transfer operations outlined in the SSI must be followed, and all officers and crew members performing an essential role during fueling operations must be trained and familiar with the SSI. All bunkering operations for fuel oil and bulk lubricating oil must be recorded in the ORB. Booming is not mandatory for NOAA ships except in certain situations, such as when it is required by federal, state, or local regulations, when it is a routinely implemented best practice or a condition for fueling at a facility, when conditions of the transfer or sensitivity of the environment call for additional protective measures, or when the Center CO directly requests it (OMAO, 2020b). A boom is a floating barrier used to contain marine spills and protect the environment; pre-booming is the deployment of that device before an oil transfer occurs. This is demonstrated in **Figure 3.4-3**, where a boom (seen in yellow) encircles a ship in order to contain any oil spills should they occur.

Source: WA DOE, No Date

Figure 3.4-3. Booming: deployment of a floating barrier (seen in yellow) to contain marine spills and protect the environment

In the event of an oil, hazardous substance, or marine pollutant spill, all crew members will take appropriate action to minimize the effects of the spill. OMAO Procedure 'Shipboard Oil Pollution Emergency Plan & Non-Tank Vessel Response Plan (VRP)' provides policy and guidance to all NOAA ships and other vessels regarding oil pollution emergency planning and response, in accordance with MARPOL 73/78, Annex I and 33 CFR Part 155 Subpart J. 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 (OMAO, 2017b).

Reuben Lasker and *Ferdinand R. Hassler* are the only two ships in the NOAA fleet that possess COIs. *Reuben Lasker* was issued an IOPP because it travels internationally; *Ferdinand R. Hassler* was not issued an IOPP because it does not travel internationally. While all other NOAA ships do not possess IOPPs because they are not COI ships, all ships comply with USCG and IMO oil pollution prevention requirements, and fleet inspection teams continue to conduct inspections against all relevant standards.

3.4.1.2.3.2 Shipboard Solid Waste Management

Shipboard solid waste is generated aboard NOAA ships and other vessels as dry waste, recyclables, food waste, and incinerator ash, and is generally addressed in each ship's NPDES VGP SSI as the operational discharge 'Materials Storage'. It specifies best management instructions to limit the exposure of onboard materials, including garbage. Additionally, all small boats operate in full environmental compliance with federal, state, and NOAA requirements by abiding by the 'NOAA Small Boat Standards and Procedures

Manual' (NOAA, 2018a). Furthermore, all NOAA vessels must follow NPDES State Rules concerning solid waste while within each state's respective jurisdiction (see Appendix D) (OMAO, 2013c).

OMAO Procedure 'Shipboard Solid Waste Management' provides the template for NOAA ships to develop the SSI for a solid waste management plan. The plan addresses management, storage, and disposal of shipboard-generated solid waste including food waste, trash and garbage, dunnage and bulk packaging items, all plastic and synthetic materials, and incinerator ash, in order to ensure compliance with federal laws. The plan establishes each ship's procedure to sort, store, and manage solid waste, maintain and operate waste processing equipment, and train all personnel involved (OMAO, 2013a).

Sorting and Storing

Solid waste is categorized by the different waste streams produced onboard NOAA ships: plastic, recyclables, incinerator ash, non-food waste (dry trash), and food waste. Solid waste must be sorted, processed, and stored based on which specific waste stream it is categorized as, and storage bins must meet the proper requirements for each waste stream. Solid waste placards summarizing disposal restrictions are required by USCG. **Figure 3.4-4** illustrates a solid waste placard used aboard NOAA ships. They are posted in prominent locations where solid wastes are managed, processed, and stored, including the bridge, engine room operating station, the galley, main deck common areas, and solid waste processing and storage areas (OMAO, 2013c).

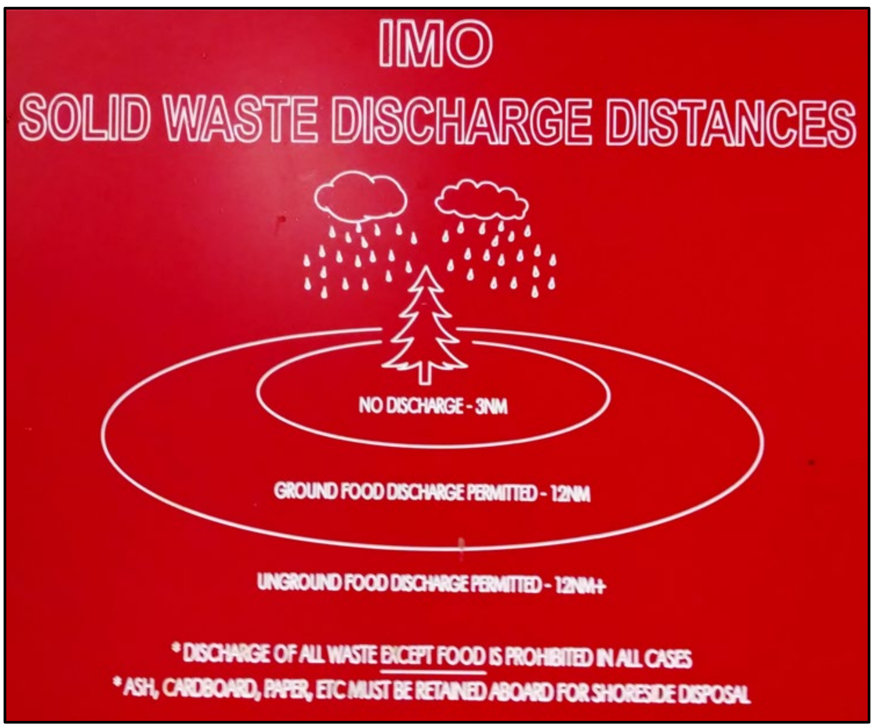


Figure 3.4-4. Solid Waste Placard Used Onboard NOAA Ships

Processing

Garbage grinders, macerators, compactors, and incinerators are some of the equipment used aboard NOAA ships for management of solid waste. Plastics may be processed in the incinerator if indicated in the equipment manual, but recycling is the preferred option for plastics. Certain substances are prohibited from incinerator use, and placards listing all prohibited substances must be posted in plain view where the incinerator is operated, as illustrated by **Figure 3.4-5**. Operation of incinerators is minimized within 12 nm, fully authorized beyond 12 nm, and must be operated as far from human settlement as possible. All incinerator ash must be stored onboard and discarded ashore (OMAO, 2013d).

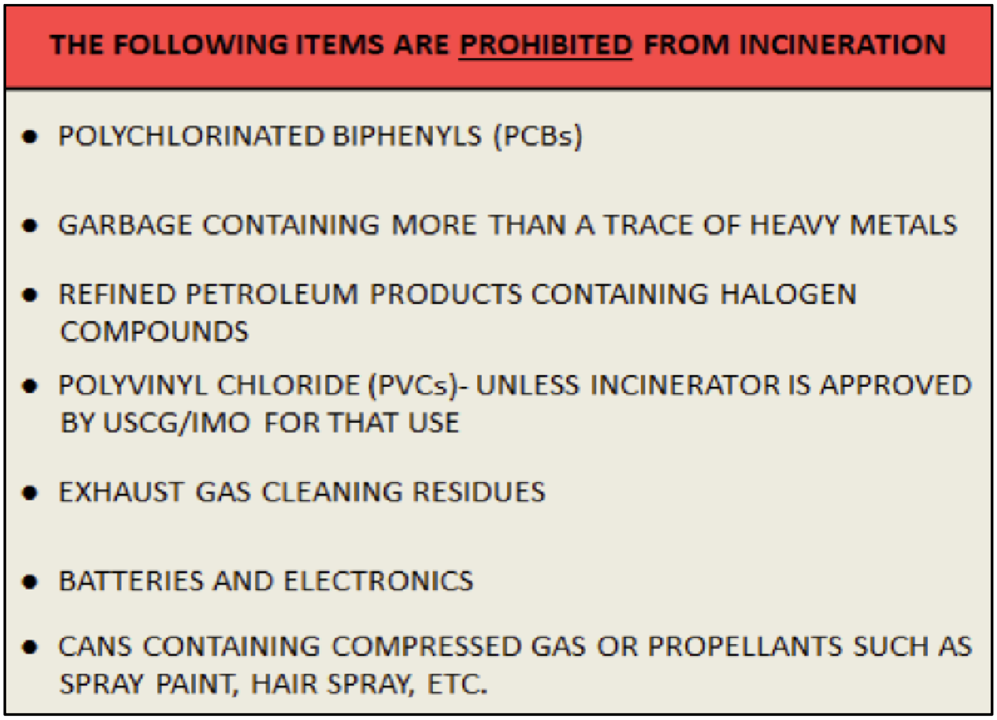


Figure 3.4-5. Incinerator Placard Listing Substances Prohibited from Incineration

Discharging and Disposal

Nearly all solid wastes are prohibited from discharge while underway. Plastics, recyclables, incinerator ash, and dry trash are all prohibited from overboard discharge. These waste streams must be secured onboard for shoreside disposal. The first shoreside transfer of each of these waste streams must be logged in the GRB. Each ship must maintain a ship specific Discharge Matrix, as shown in **Figure 3.4-2**, which dictates the authorization of incinerator use and the discharge of food waste based on distance from shore. The incinerator is authorized beyond 12 nm (or operated <12 nm for testing, inspection, or maintenance); all incinerator ash must be secured, logged in the GRB, and the waste oil logged in the GRB and ORB. All food waste must be secured within 3 nm of shore. Food waste that is ground (or macerated) to 25 millimeters (mm) (one inch) or less may be discharged beyond 3 nm of shore. All food waste may be discharged beyond 12 nm of shore. All food discharges must be logged in the GRB (OMAO, 2013d).

3.4.1.2.3.3 Shipboard Wastewater Management

Shipboard wastewater is generated aboard NOAA ships and other vessels as sewage, also known as black water, and greywater, and is generally addressed in each ship's NPDES VGP SSI as the operational discharge 'Greywater or Greywater Mixed with Sewage'. Each ship's SSI provides best management instructions for greywater discharge based on each ship's distance from shore. If greywater is mixed with sewage, discharges must comply with both this procedure and OMAO Procedure 'Shipboard Wastewater Management'. Additionally, all small boats operate in full environmental compliance with federal, state, and NOAA requirements by abiding by the 'NOAA Small Boat Standards and Procedures Manual', which provides instruction for wastewater management (NOAA, 2018a). Furthermore, all NOAA vessels must follow NPDES State Rules concerning wastewater discharges while within each state's respective jurisdiction (see Appendix D) (OMAO, 2013c).

OMAO Procedure 'Shipboard Wastewater Management' provides the requirements to develop the SSI to maintain compliance with wastewater regulations, including discharge of treated and untreated sewage and greywater. Each ship's SSI is unique to that ship's capabilities, and outlines the responsibilities related to wastewater management, including maintenance and proper function of the MSD, communication regarding ship location and discharge restrictions, crew member roles, trainings, and record keeping (OMAO, 2016).

NOAA ships with COIs may attain a SOVC, which serves as the U.S. voluntary compliance documentation to MARPOL Annex VI in lieu of an ISPPC. *Reuben Lasker* and *Ferdinand R. Hassler* are the only two ships in the NOAA fleet that possess COIs, and both possess a SOVC. A few ships in the fleet have successfully obtained a Statement of Fact (SOF) which can also take the place of a SOVC. Regardless of the presence of certificates, all NOAA ships comply with USCG and IMO sewage management requirements, and fleet inspection teams continue to conduct inspections against all relevant standards.

Wastewater Treatment System Requirements

Each ship's SSI must describe its sewage treatment system, including details on the type of MSD used. All 15 NOAA ships maintain MSDs: 13 have a Type II and two have a Type III. A Type II MSD is an onboard treatment device that uses biological or aerobic digestion to treat waste, and can discharge the waste after treatment. A Type III MSD is a holding tank or similar device that prevents the overboard discharge of treated or untreated sewage (BoatUS, 2023). The MSD must be operating properly and maintained according to the requirements of the original equipment manufacturer. Ships operating within 12 nm of shore or within federally protected waters must maintain a properly functioning MSD Type II or III (OMAO, 2016).

Procedures for Wastewater Discharges

Any wastewater discharge must receive approval from the bridge before discharging while underway. Each ship must maintain a ship specific Discharge Matrix, as shown in **Figure 3.4-2**, which shows wastewater discharge restrictions/requirements based on distance from shore. Raw, untreated sewage cannot be discharged within 12 nm of shore and must be secured. Raw sewage can be discharged greater than 12 nm of shore and outside of National Marine Sanctuaries and Marine National Monuments while underway and must be documented in the Deck Log. Raw sewage that was treated through a Type II MSD (also referred to as MSD in the Discharge Matrix) can be discharged anywhere outside No Discharge Zones, National Marine Sanctuaries, or Marine National Monuments. However, it is recommended that these discharges are minimal and secured when possible while the ship is within 3 nm of shore. MSD discharges are authorized when a ship is beyond 3 nm of shore. Any MSD discharge must be documented in the Deck Log. Each ship's NPDES VGP SSI contains greywater regulations for discharges and recording requirements in the Greywater Discharge Log within 3 nm of shore. As such, ships are prohibited from discharging greywater within 3 nm of shore if the ship still has available storage capacity. If a ship discharges greywater within 3 nm of shore, it is required to record those discharges in the Greywater Discharge Log. Greywater discharge is authorized beyond 3 nm of shore, and no record keeping is required.

When alongside, NOAA ships must use sewage reception facilities if available, and be careful not to transfer any pollutant that could damage or interfere with a treatment facility system. MSD or greywater discharge into U.S. waters while alongside is allowed if the ship has no storage capacity, unless it is prohibited by law or condition of the port of entry. All options must be considered before alongside discharge, such as transfer of wastewater to a truck or barge. Ships scheduled to be in foreign waters must ensure compliance with local Marine Protected Areas (MPAs) and foreign no discharge zones to determine another country's discharge regulations and prohibitions (OMAO, 2016).

Accidental release or spillage of greywater, sewage, or treated sewage must follow the procedure laid out in each ship's SSI. If untreated sewage is discharged within 12 nm or greywater within 3 nm or unintentional discharge in a prohibited area occurs, a Corrective Action Assessment must be completed and submitted within 24 hours. All other cleanup instructions must be followed as they are laid out in each ship's procedure (OMAO, 2016).

3.4.1.2.3.4 Oily Material Management

Oily mixtures are generated aboard NOAA ships and other vessels, including oil residue, sludge, and bilge water, and are generally addressed in each ship's NPDES VGP SSI as the operational discharge 'Bilgewater'. Each ship's NPDES VGP SSI also provides instructions to manage other operational discharges related to oily mixtures, including 'Materials Storage', 'Discharge of Oil, Including Oily Mixtures', Oil to Seawater Interfaces', and 'Non-Oily Machinery Wastewater'. Each operational discharge contains best management instructions to help manage these substances. Additionally, all small boats operate in full environmental compliance with federal, state, and NOAA requirements by abiding by the 'NOAA Small Boat Standards and Procedures Manual', which provides instruction for oily materials management (NOAA, 2018a). Furthermore, all NOAA vessels must follow NPDES State Rules concerning oily materials while within each state's respective jurisdiction (see Appendix D). (OMAO, 2013c).

Many ships include 'oily material management' requirements in their Chief Marine Engineer's Standing Orders. Ships may also use the draft OMAO Procedure 'Oily Material Management Plan' to establish the requirements for oily waste transfers for all NOAA ships. The purpose of this draft guidance is to meet the requirements for the control and management of oily materials, and to establish minimum procedures for the shipboard management of oily waste and oily materials, including oil residue, sludge, and bilge water.

Oily Water Separator

Operation and maintenance of each ship's Oily Water Separator (OWS) is specific to each ship. In general, the OWS works most efficiently when processing bilge water with a low oil content. The OWS ensures that the effluent being discharged through the system has an oil content of under 15 ppm. It is essential that the OWS remains operational, as required by law. Each time the OWS is turned on for operation, it must be recorded in the ORB. If the OWS is not operational, the ship must immediately correct the problem. To continue underway operations, a formal mitigation plan is required and the ship must receive written approval by the Deputy Director of OMAO following review by legal counsel. Oil removed from the OWS must be transferred to the Oil Residue Tank (ORT) for disposal onshore, or incinerated onboard. All records of maintenance and testing of the OWS must be retained in the SAMMS, and any failure or repair must be recorded in the ORB. If any oil residue, sludge, or bilge water becomes contaminated by anything other than routine sources, such as Aqueous Film Forming Foam (AFFF), solvents, antifreeze, dispersants, or other hazardous substances, it cannot be processed through the OWS (OMAO, No Date-a), and must be disposed of ashore (see Section 3.11 Hazardous Waste).

Storage and Labeling

Oil from outside machinery spaces, such as launches, small boats, cranes, hydraulics, etc., or cooking oils may be collected and transferred to the ORT, which holds oil residue and sludge produced during normal operations. Incinerator Sludge Tanks (IST) provide the holding capacity for the sludge to be incinerated. Bilgewater Holding Tanks (BHT) collect untreated oily bilge water prior to discharge, transfer, or disposal. All tanks must be labeled to reflect tank names in a manner consistent with MARPOL Annex I, tank names must be recorded in the ORB, and ships must sound and record tanks weekly. Oil filters and other oil-soaked materials must be kept in a manner which minimizes risk of fire, such as within a steel drum with a metal lid (OMAO, No Date-a). Further details on storage and handling of oil filters, oil-soaked materials, and other potentially hazardous materials are discussed in Section 3.11 Hazardous Waste.

Disposal

The CME may develop instructions for transferring liquid oily waste from the ship to shore. Machinery oil transferred to shore must be recorded in the ORB and accompanied with a receipt. Cooking oil may be collected and transferred directly to shore in lieu of transferring to the ORT for disposal; collection and transfers occurring in this manner must be recorded in the GRB. Incineration of oil or sludge must be recorded in the ORB. Oil-soaked materials and used oil filters are considered special waste, and must be disposed of either to a hauler or to a Marine Operations (MO) facility via a Waste Classification Form, as described in Section 3.11 Hazardous Waste, and logged into the GRB. Incineration of oil-soaked materials and oil filters must be done in accordance with each ship's Garbage Management Plan and recorded in the GRB. Incineration of cooking oil requires an entry in the GRB; if it was placed in the ORT then incinerated, an entry in the ORB is required instead (OMAO, No Date-a).

Discharge

Each ship must maintain a ship-specific Discharge Matrix, as shown in **Figure 3.4-2**, which shows OWS discharge restrictions based on distance from shore. Each ship's NPDES VGP SSI contains OWS regulations for discharges and record requirements within 3 nm of shore. Discharges through the OWS within 1 nm from shore are prohibited. Ships must minimize the amount of OWS discharged between 1 and 3 nm of shore, and only discharge if storage capacity will be exceeded and while the ship is making way. Ships are authorized to discharge OWS outside of 3 nm or within special areas if all conditions within their permit are met. If any of these conditions are not met, the ship is prohibited from discharging OWS overboard. Discharges are prohibited if water quality standards are violated or cause a noticeable change to the water's surface or the shoreline. All authorized discharges must be logged in the ORB, and all spills must be addressed and reported in accordance with the ship's SOPEP (Section 3.4.1.2.3.1) (OMAO, No Date-a).

3.4.1.2.3.5 Shipboard Automated Maintenance Management System (SAAMS)

Shipboard maintenance aboard NOAA ships that could result in a discharge generally consists of deck restoration activities, including but not limited to chipping and grinding, sanding, painting, and machine lubrication, and also includes larger repairs as necessary. These activities are generally addressed in each ship's NPDES VGP SSI as the operational discharges 'Deck Washdown and Runoff and Above Water Line Hull Cleaning' and 'Firemain Systems'. Each operational discharge contains best management instructions to help manage these substances. Additionally, all NOAA vessels must follow NPDES State Rules concerning waste discharges while within each state's respective jurisdiction (see Appendix D) (OMAO, 2013c).

OMAO Procedure 'SAMMS: Maintenance, Modification, and Repair' provides direction for the scheduling, submitting, managing, and documenting of all shipboard maintenance, modification, and repair actions, and submitting those requests within the SAMMS program. This provides a single repository for all actions that can be accessed by ships or shore-side personnel. Each ship's CME is responsible for the operation and maintenance of the SAMMS system onboard their respective ship. The CME shall ensure that all repairs, modifications, and scheduled and unscheduled maintenance actions are properly entered into the SAMMS Machinery History Module, along with an accurate list of spare parts within the SAMMS spare parts module. If any Work Requests (WR) require shoreside assistance, materials, technical support, labor, or funding, the CME is also responsible for converting those requests to Voyage Repair Requests (VRR). If a ship does not require off-ship assistance, the CME is responsible for converting those requests to Ships Force Work Lists (SFWLs). The SFWL items are assigned to the appropriate department, and each department head is notified that a new SFWL item has been created. Personnel who complete any SFWL item assigned to their department must provide applicable cost, manpower expended, and other pertinent data; the CME must provide the same information for all Engineering Department SFWLs completed (OMAO, 2011).

3.4.2 Environmental Consequences

The following sections identify and evaluate potential impacts to water quality occurring in the action area under Alternatives A, B, and C.

Activities described in **Table 2.1-1** and in Section 2.2 that occur during OMAO vessel operations and could impact water quality in the action area include vessel movement; anchoring; waste handling and discharges; vessel repair and maintenance; other sensors and data collection systems operations; UxS or UMS operations; small boat operations, and OTS handling, crane, davit, and winch operations. The impact causing factors for these activities include fuels, chemicals, and other contaminants; wastewater; marine debris; and increased sedimentation and/or turbidity.

Impacts on water quality from active acoustic systems operations and UAS operations are not expected to occur and are not discussed further in this section.

Note that use of the term "sea floor" below also includes lake and river bottoms where OMAO vessel operations could occur.

3.4.2.1 Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Under Alternative A, OMAO vessel operations using the current NOAA fleet would continue across all five operational areas over the 15-year period. In addition, OMAO is constructing two oceanographic research vessels that are expected to come online by 2025 and two new charting and mapping vessels that are expected to come online in 2027 and 2028 for a total of four new ships under Alternative A. OMAO would provide a maximum annual capacity of 3,568 operational DAS for scientific projects.

3.4.2.1.1 Fuels, Chemicals, and Other Contaminants

Vessel movement, waste handling and discharges, vessel repair and maintenance, UMS operations, small boat operations, and OTS handling, crane, davit, and winch operations would generate or utilize fuels, chemicals, and other contaminants that could result in the unauthorized discharge or accidental leakage or spillage of these substances that would potentially affect water quality.

Fuels, chemicals, and other potential water contaminants are a necessary part of OMAO vessel operations due to various activities that require the use of these substances or generate them as waste. Most are oil-based substances and could potentially degrade water quality if an accidental leak, spill, or unauthorized discharge occurred during an activity such as vessel movement, vessel repair and maintenance, UMS operations, or small boat operations. NOAA vessels use diesel generators to generate power for operations. Small boats, or launches, are also diesel powered and are refueled directly from the ship. Some UMS use diesel as the primary or secondary power source for their operations. There is a possibility of accidental leaks or spill of fuels, oils, or other contaminants during oil transfers or fuel bunkering evolutions. Oils and chemicals in the forms of lubricants, grease, paints, and other substances are used to power, repair, and maintain machinery and equipment onboard. These contaminants could end up in the aquatic environment through general usage even if proper application, storage, and disposal procedures are followed. In addition, waste handling and discharges could also potentially degrade water quality if an issue arises during the process of storage, treatment, disposal, and discharge for generated waste substances. Spill response may be required to address any accidental spill or leakage. Fuels, chemicals, and other contaminants can become waste products in the form of filters, rags, residues, sludges, or bilge water during the previously mentioned activities. Waste waiting to be treated through an OWS or transported shoreside is held in various storage tanks depending on the type of waste. NOAA vessels generate washdown water that contains residues from rinsing the decks, small boats, and equipment. These surfaces are regularly scrubbed with an environmentally safe cleaner that can be discharged directly overboard. Bilge water can also be treated through the OWS before being discharged overboard or transferred to a holding tank. Waste that has been treated through an OWS can be discharged at an appropriate distance from shore (3 nm or beyond) due to dilution and dispersion.

In the event that fuels, chemicals, and other contaminants were to be accidentally discharged, leaked, or spilled into the surrounding water, the substances could have adverse impacts to water quality. These impacts depend largely on the density and chemical characteristics of the substance, the size of the spill, and the amount of time it takes to clean the spill. Lighter, less dense contaminants, such as gasoline, diesel, and light crude oils, would float on the water's surface and typically evaporate after a few days (NOAA, 2020a). During that time, the impact to water quality would be caused by creating a sheen on the water's surface that blocks sunlight from reaching photosynthetic organisms (SDWF, No Date). These organisms affect water quality conditions including dissolved oxygen levels, pH, and nutrient availability – all of which could fluctuate with changing light availability. Some bacteria have the ability to break down different components of oil over time (SDWF, No Date); however, the bacterial decomposition process would consume dissolved oxygen and alter the availability of nutrients in the water column, affecting water quality conditions, thereby impacting photosynthetic organisms. Heavier, more dense contaminants found in some oils could sink below the water's surface and affect water quality conditions throughout the water column. Both light and heavy contaminants could introduce toxic chemicals into the water column, such as polycyclic aromatic hydrocarbons (PAHs), which can persist in the environment for many years (NOAA, 2022b). Toxicity impacts would vary based on the chemical makeup of the substance and how its makeup changes over time as it is physically broken down and weathered in water (NOAA, 2020a). The potential adverse impacts from fuels, chemicals, and other contaminants as hazardous substances are also discussed in Section 3.11.2 (Hazardous Waste). A spill of larger volume would be expected to have a greater impact compared to a smaller volume spill; however, this would also depend on the density and chemical composition of the substance, the distance of the spill from shore, and the time it takes for the spill to be cleaned up.

In order to properly manage fuels, chemicals, and other contaminants and prevent or minimize the unauthorized discharge or accidental leakage or spillage of these substances, all NOAA vessels are required to comply with all OMAO policies and procedures. This includes all procedures related to transferring oily substances or bunkering fuel onto ships, specifically OMAO Procedure 'Oil Transfers' and Attachments A – D which describes the requirements for oil transfers to, from, and within NOAA ships. These instructions are specific to each ship, guide the step-by-step process of bringing oily substances onboard NOAA ships, and include record keeping and reporting requirements and spill response instructions (OMAO, 2020b). Management of bilge water, oily waste, and other contaminants are also covered by OMAO procedures. Each ship must also abide by its NPDES VGP SSI, which indicates the responsible party, management practices, and related recordkeeping for oily substance management (OMAO, 2013c). Furthermore, consistent with MARPOL 73/78, each NOAA ship must abide by the SOPEP/VRP, which establishes the procedure for responding to an accidental discharge or spill of oil, hazardous substances, or marine pollutants. The plan includes general duties of crew members to ensure spill-response readiness and maintain compliance, such as the designation of a vessel spill response team and team leader, clean-up equipment, spill disposal procedures, training and reporting, and shipboard drills (OMAO, 2017b). Booming consists of the deployment of floating devices on the water's surface to corral marine spills should one occur; OMAO practices booming as required by federal, state, or local law or in circumstances that necessitate its use (see Section 3.4.1.2.3.1). OMAO would store appropriate materials onboard to contain and clean potential spills, and operators would perform daily pre-work equipment inspections for cleanliness and leaks. All NOAA ships must also maintain a ship-specific Discharge Matrix and follow all OWS discharge restrictions based on distance from shore. All ships are strictly prohibited from discharging any OWS discharge unless permission is obtained from the bridge. Lastly, small boats must follow oily water management guidance provided by the NOAA Small Boat Standards and Procedures Manual (NOAA, 2018a). Therefore, while NOAA vessels would generate or utilize fuel, chemicals, or other contaminants, all activities involving these substances would be required to follow the proper regulations and procedures to prevent or minimize any adverse impacts to water quality. The OMAO policies and procedures for the generation, storage, handling, and transfer or disposal of fuels, chemicals, and other contaminants that are listed as hazardous are also discussed in Section 3.11.2 (Hazardous Waste).

There are 15 ships in the current fleet, ranging in size from 124 feet to 274 feet, with small boats or launches ranging in size from 15 feet to 30 feet. As the largest ship in the fleet, NOAA Ship *Ronald H. Brown* maintains an onboard fuel storage capacity of 267,412 gallons, oil residue tank capacity of 3,909 gallons, and bilgewater holding tank capacity of 5,078 gallons for a total capacity of 275,073 gallons of oily substances. By comparison, commercial cargo vessels have a capacity of about 1.5 to 4.5 million gallons of oil depending on the size of the ship (NOAA, 2023b); smaller oil tankers have a capacity of about 26 million gallons of oil and large crude carriers have a capacity of over 260 million gallons of oil (International Chamber of Shipping, No Date). Any spill that could potentially occur would be much smaller compared to potential spills caused by tankers, commercial cargo vessels, and other large ocean-transiting vessels. OMAO vessel operations represent an extremely small fraction of overall vessel activity in the action area, which covers a very wide geographic area, as OMAO vessel movements do not constitute a large portion of the total miles traveled by the NOAA fleet (see Section 2.2.1). As discussed above, OMAO has protocols and procedures in place to avoid spills from vessels, and when they occur, they are cleaned up as quickly as possible.

Under Alternative A, vessel movement, waste handling and discharges, vessel repair and maintenance, UMS operations, and small boat operations would generate and utilize fuels, chemicals, or other contaminants that could result in the unauthorized discharge or accidental leakage or spillage of these substances that would potentially affect water quality. All NOAA vessels carry comparably smaller volumes of these substances and are required to abide by all policies, procedures, and regulations related to the use, transfer, storage, and management of fuels, chemicals, and contaminants, including the SOPEP/VRP and NPDES VGP. Impacts beyond the U.S. EEZ while vessels are transiting or conducting routine vessel repair and maintenance would be similar to those within the EEZ. Therefore, in the event that an accidental discharge or spill were to occur, the impacts from the unauthorized discharge would be adverse, **minor** to **moderate**, **temporary** to **short term**, **local** or **regional** if the vessel is moving, and therefore **insignificant**.

3.4.2.1.2 Wastewater

Vessel waste handling and discharges and small boat operations could result in the unauthorized discharge or accidental leakage or spillage of wastewater that would potentially affect water quality.

Wastewater generated aboard NOAA vessels includes sewage and greywater. Sewage, also known as black water, refers to wastewater that comes from toilets and urinals and contains human waste, while greywater refers to any wastewater that comes from other vessel hotel functions, such as showers, kitchens, and bathroom sinks. Waste handling and discharges could potentially degrade water quality if an unauthorized discharge or an accidental spill or leak of wastewater were to occur. This could happen if proper waste handling procedures were not followed and a discharge of wastewater (e.g., untreated sewage, treated sewage, or greywater) were to occur at a distance from shore that was not authorized.

The amount of wastewater generated, the storage capacities, and the treatment systems onboard NOAA vessels vary based on the size of the vessel and complement capacity. The range for the number of persons onboard is based on berthing availability. NOAA Ship *Rainier* can embark with 64 personnel onboard. Alternatively, NOAA Ship *Ferdinand R. Hassler* can embark with 14 personnel onboard. (Appendix A, Vessel Profiles). These accommodations dictate the amount of wastewater likely to be generated during vessel operations and the storage, treatment, disposal, and discharge capabilities ships would require onboard, such as USCG-approved Type II or III MSDs. In addition, all small boat operations could also affect water quality if proper waste handling procedures are not followed and an unauthorized discharge or an accidental spill or leak were to occur. Small boats with installed toilet facilities must have an operable MSD onboard. Small boats under 65 feet are permitted to use a USCG-approved Type I, II, or III MSD (NOAA, 2018a).

In the event that wastewater was accidentally discharged, leaked, or spilled into the surrounding water, the wastewater could cause adverse impacts to water quality depending on the type of wastewater, the distance from shore, the size of the spill, and the amount of time it takes to clean the spill. Raw sewage could contain a wide variety of harmful microorganisms including bacteria, fungi, parasites, and viruses (DHSS, 2014). These pathogens degrade water quality by causing infections and illness in the immediate vicinity of the vessel, that could range from mild to severe. Sewage can also contain debris or other trash washed down toilets, including organic material, dissolved organic material, and nutrients in the forms of nitrogen and phosphorus. Organic materials, dissolved organic materials, and nutrients could affect water quality conditions such as dissolved oxygen, pH, and nutrient availability (Lehigh University, No Date). While greywater can still contain pathogens, chemicals, detergents, debris, and other contaminants which could cause similar water quality impacts, it would likely contain lower levels of contaminants, and impacts would vary based on the source and contents of the greywater. A spill of larger volume would also be expected to have a greater impact compared to a smaller volume spill; however, this would also depend on the type of wastewater, the time it takes for the spill to be cleaned up, and the distance of the spill from shore, as further distances from shore generally allow for the discharge of untreated sewage (> 12 nm), treated sewage (3-12 nm or beyond), and greywater (3-12 nm or beyond) due to dilution and dispersion.

In order to properly manage wastewater and prevent or minimize the unauthorized discharge or accidental leakage or spillage of wastewater, NOAA vessels comply with all OMAO policies and procedures, specifically OMAO Procedure 'Shipboard Wastewater Management' which describes each vessel's wastewater treatment system, procedures for wastewater discharges, MSD maintenance responsibilities, training, and recordkeeping. Each NOAA vessel operates and maintains either a USCG-approved Type II or III MSD to treat and store wastewater, and all MSDs must be operating properly and tested to ensure compliance with each Type's standards (NOAA 2018; OMAO, 2016). Each vessel must also abide by its NPDES VGP SSI, which indicates the responsible party, management practices, and related recordkeeping for greywater or greywater mixed with sewage (NOAA, 2018a; OMAO, 2013b). Operators would perform daily pre-work equipment inspections for cleanliness and leaks. All heavy equipment operations would be postponed or halted should a leak be detected, and will not proceed until the leak is repaired and equipment cleaned. OMAO would also use minimally-toxic, biodegradable, phosphate-free cleaners across the fleet, when operating within 3 nm. All NOAA vessels must maintain a ship-specific Discharge Matrix, and follow all raw sewage, MSD (treated sewage), and greywater discharge restrictions based on distance from shore. Wastewater discharge is strictly prohibited unless permission is granted by the bridge. Therefore, while NOAA vessels would generate wastewater under Alternative A, each vessel would be in compliance with all regulations, policies, and procedures related to wastewater management, treatment, and discharge to prevent or minimize any adverse impacts to water quality.

NOAA vessels would likely not carry enough wastewater to cause a considerable spill, in the event that one does occur. There are 15 ships in the fleet, ranging in size from 124 feet to 274 feet, with small boats or launches ranging in size from 15 feet to 30 feet. As the largest ship in the fleet, NOAA Ship *Ronald H. Brown* maintains an onboard untreated sewage tank storage capacity of 5,151 gallons which contains all the commingled wastewater (including greywater and sewage) onboard the ship. The ship has a berthing capacity for 60 embarked personnel (Appendix A, Vessel Profiles). By comparison, an average-sized cruise ship can carry 3,000 passengers and crew and produce 30,000 gallons of sewage and 255,000 gallons of greywater per day (Cranor, 2003). Therefore, while NOAA vessels would store wastewater onboard, considerable spills are not expected to occur due to the comparably smaller size, tank capacities, and number of personnel onboard. Furthermore, any accidental spill that were to occur would be considered minimal given that OMAO vessel operations represent an extremely small fraction of overall vessel activity in the action area, which covers a very wide geographic range, and as OMAO vessel movements do not constitute a large portion of the total miles traveled by the NOAA fleet (see Section 2.2.1).

Under Alternative A, waste handling and discharges and small boat operations would generate wastewater that could result in the unauthorized discharge or accidental leakage or spillage of wastewater that would potentially affect water quality. However, all NOAA vessels would generate and store small volumes of wastewater and are required to abide by OMAO's policies, procedures, and regulations related to the management, treatment, and discharge of wastewater, including the NPDES VGP. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. Therefore, in the event that an accidental discharge or spill were to occur, the impacts from the unauthorized discharge would be adverse, **minor** to **moderate**, **temporary** or **short term**, **local** or **regional** if the vessel is moving, and therefore **insignificant**.

3.4.2.1.3 Marine Debris

Waste handling and discharges, vessel repair and maintenance, other sensors and data collection systems operations, UMS operations, and small boat operations would generate solid waste that could result in the unauthorized discharge of marine debris that would potentially affect water quality.

Marine debris is solid waste that is directly or indirectly, intentionally or unintentionally, disposed of or abandoned in the marine environment (NOAA, No Date-c). For this analysis, marine debris also includes solid waste debris from NOAA vessels that end up in freshwater environments, such as the Great Lakes and major rivers. Solid waste generated onboard NOAA ships includes plastic, recyclables, food waste, non-food waste such as dry trash, and incinerator ash. The generation of trash, recyclables, food waste, and other solid debris is a general function of vessel operations, as crew members, scientists, and other personnel consume food and utilize products as a part of their daily lives during voyages. This can also include supplies, tools, gear, equipment, or other items onboard ships that get discarded as trash during vessel repair and maintenance. Furthermore, equipment, instruments, or other gear that are utilized during other sensors and data collection systems operations, UMS operations, and small boat operations could potentially become marine debris if they are inadvertently lost overboard. Many of these deployable pieces of equipment are attached by cables, lines, tethers, or other extensions that could become detached and inaccessible for retrieval.

The amount of solid waste generated, the storage capacities, and the management systems vary based on the size of the ship and complement capacity. The range for the number of persons onboard is based on berthing availability. NOAA Ship *Rainier* has berthing capacity for 64 personnel. Alternatively, NOAA Ship *Ferdinand R. Hassler* has berthing capacity for 14 personnel (Appendix A, Mission Capabilities of NOAA Ships). While most ships have garbage grinders, macerators, or compactors, some ships also have an incinerator used to process and manage solid waste. Incinerator ash must be managed and stored before it is discarded ashore; improperly securing incinerator ash could result in an accidental and unauthorized discharge.

Waste handling and discharges could potentially degrade water quality if an unauthorized or accidental discharge of solid waste were to occur. This could happen if proper waste handling procedures were not followed. In the rare event that solid waste was accidentally discharged into the surrounding water, the marine debris could have adverse impacts to water quality that would ultimately depend on the type of solid waste, the time it takes for the discharge to be cleaned up, and the size of the discharge. Marine debris can cause a number of different impacts to water quality that primarily revolve around its physical and chemical properties. Floating or sinking garbage, trash, detached or lost equipment, or other marine debris generally degrades water quality by its physical presence; it could affect water quality conditions by blocking sunlight from reaching photosynthetic organisms, and it could become entangled, be ingested by, or otherwise endanger marine life and is aesthetically displeasing.

Water quality can also be affected by the chemical properties of marine debris. This effect is more common in plastics due to the composition of polymers, derived from petroleum-based chemicals. Additional chemicals like plasticizers, flame retardants, and pigments are used in the production process to create specific properties in the final product (EPA, 2023f). As plastics persist in the environment, they can either leach these chemicals into the water, or attract and hold onto other pollutants that are already in the water, thereby becoming a vector for water pollution. Over time, plastics can be weathered down and broken down into smaller pieces by a combination of sunlight, wind, waves, and other physical forces. These fragmented pieces of plastic are known as microplastics, which are plastic pieces or fibers smaller than 5 mm. Other types of marine debris could similarly break down over time and further degrade water quality as smaller sizes allow for easier dispersion and more evenly mixed debris throughout the water column. Microplastics and other fragmented marine debris can also be more easily ingested by marine life, even microscopic zooplankton and small fish (NOAA, 2023a). Incinerators are approved for different solid wastes based on their type, such as plastics, oils, sludges, and other solid wastes; therefore, incinerator ash could carry a variety of toxic properties that could degrade water quality. Adverse impacts from incinerator ash are also discussed in Section 3.3.2 (Air Quality). The impact of an accidental discharge could vary based on the type of marine debris, the volume of the discharge, the time it takes for the discharge to be cleaned up, and the distance from shore that the discharge occurs. Macerated or unmacerated food waste are permitted to be discharged at an appropriate distance from shore (3-12 nm and > 12 nm, respectively) due to dilution and dispersion.

In order to properly manage solid waste and prevent or minimize the unauthorized discharge of marine debris, NOAA vessels are required to comply with all OMAO policies and procedures. This includes procedures related to solid waste, specifically OMAO Procedure 'Shipboard Solid Waste Management', which addresses the management, storage, and disposal of all shipboard-generated solid waste. This plan is specific to each vessel. It provides instructions for proper collecting, sorting, storage, and disposal of solid wastes, the display requirements for USCG-mandated solid waste placards which summarize disposal restrictions, and required record keeping. The plan also provides operational instructions for the waste processing equipment, including garbage grinders, macerators, compactors, and incinerators. Incinerator usage is recommended beyond 12 nm from shore, but all ash is required to be contained and stored for shoreside disposal (OMAO, 2013c). OMAO would store appropriate materials onboard to contain and clean potential discharges, and all materials and equipment placed in the water will be free of pollutants. Each vessel must also abide by the NPDES VGP SSI, which indicates the responsible party, management practices, and related recordkeeping for solid waste management (NOAA, 2018a; OMAO, 2013b). Each NOAA vessel maintains a ship-specific Discharge Matrix, and follows all food waste (or macerated food waste) discharge restrictions based on distance from shore. Discharge of plastics, recyclables, dry trash, and incinerator ash is strictly prohibited. All vessels are strictly prohibited from discharging any solid waste, with the exception of food waste, unless permission is granted by the bridge. Furthermore, as OMAO is only responsible for testing, calibrating, and training with the equipment onboard, OMAO has the discretion to select areas and durations of equipment use, reducing the likelihood for deployable equipment used during other sensors and data collection systems operations, UMS operations, and small boat operations to inadvertently become marine debris. Therefore, while NOAA vessels would generate solid waste, each vessel would be in compliance with all OMAO regulations, policies, and procedures related to solid waste management, storage, disposal, and discharge to prevent or minimize any adverse impacts to water quality.

NOAA vessels would likely not generate or carry enough solid waste to cause a considerable discharge, in the event that one does occur. There are 15 ships in the fleet, ranging in size from 124 feet to 274 feet, with small boats or launches ranging in size from 15 feet to 30 feet. As the largest ship in the fleet, NOAA Ship *Ronald H. Brown* has a berthing capacity of 60 embarked personnel. By comparison, an average-sized cruise ship can carry 3,000 passengers and crew and produce 50 tons of garbage and solid waste (Bureau of Transportation Statistics, 2017). Therefore, while NOAA vessels would generate and store solid waste onboard, considerable discharges are not expected to occur due to the comparably smaller size, tank capacities, and limited number of personnel onboard. Furthermore, any accidental discharge that were to occur would be considered minimal given that OMAO vessel operations represent an extremely small fraction of overall vessel activity in the action area, which covers a very wide geographic range, and as

OMAO vessel movements do not constitute a large portion of the total miles traveled by the NOAA fleet (see Section 2.2.1).

Under Alternative A, waste handling and discharges, vessel repair and maintenance, other sensors and data collection systems operations, UMS operations, and small boat operations would generate solid waste that could result in the unauthorized discharge of marine debris that would potentially affect water quality. All NOAA vessels abide by all policies, procedures, and regulations related to the storage, management, disposal, and discharge of solid waste, including the Shipboard Solid Waste Management plan and the NPDES VGP. Impacts beyond the U.S. EEZ while vessels are transiting or conducting routine vessel repair and maintenance would be similar to those within the EEZ. Therefore, in the event that an accidental discharge was to occur, the impacts would be adverse, **minor** to **moderate**, **short term** to **long term**, **local** or **regional** if the vessel is moving, and therefore **insignificant**.

3.4.2.1.4 Increase in Sedimentation and/or Turbidity

Vessel movement, anchoring, waste handling and discharges, other sensors and data collection systems operations (specifically grab samplers and sediment corers), UMS operations, and small boat operations could increase sedimentation and/or turbidity and potentially affect water quality.

These activities can create physical disturbances in the water column or sea floor or release discharges overboard, potentially causing impacts to sedimentation and/or turbidity. Turbidity is the measure of relative water clarity and can be affected based on the materials found in the water, such as plankton, microorganisms, clays, silts, and other tiny sediments and materials (USGS, No Date-a). As such, increased sedimentation also causes turbidity because resuspended sediments and particles can cloud the water column and decrease water clarity. NOAA vessels and equipment could create turbidity when moving along the water's surface or through the water column. Vessel movements, small boats, or UMS could create wakes, wave action, or other disturbances on the water's surface or within the water column, decreasing water clarity. Similarly, deployable equipment such as anchors, sensors and data collection systems could also decrease water clarity as the equipment moves through the water column and creates cavitation in its wake. Sedimentation and turbidity could also increase when anchors, grab samplers, and sediment corers physically impact bottom substrates and cause sea floor sediments to resuspend in the water column. The extent of the impact on sedimentation and turbidity potentially caused by vessels and equipment would depend on the location and duration of the disturbance. In addition, previously discussed ship discharges such as wastewater or macerated food waste could temporarily cause discoloration and decrease the clarity of the surrounding water.

Increased sedimentation and turbidity could have adverse impacts to water quality that would ultimately depend on the size of the disturbance and its duration. Excessive turbidity can block sunlight needed for photosynthesis by aquatic plants, macroalgae, and phytoplankton, which could potentially lower the overall nutrient availability and affect dissolved oxygen and pH levels. Suspended materials could react with dissolved oxygen in the water column and cause temporary or short-term depletions in dissolved oxygen. Resuspended sediments or newly introduced particles could be attached to pollutants, such as chemicals, metals, or bacteria, which could disperse those pollutants into the environment. Turbidity can also provide food and shelter for pathogens and can sometimes be used as an indicator of potential pollution in a water body (USGS, No Date-a).

Overall, the impact on sedimentation and turbidity by OMAO activities is expected to be minimal. OMAO is only responsible for testing, calibrating, and training with the equipment onboard; therefore, OMAO has the discretion to select areas where they could create the least disturbance. OMAO follows safe navigation and prudent mariner practices, which also help to minimize sedimentation and turbidity. The majority of areas where a ship would cause increased sedimentation and turbidity are at shallow depths that are unsafe due to the ship's draft. Accordingly, vessels, UMS, and small boats would be routed away from these areas to avoid unsafe depths and to prevent stirring up bottom sediments wherever possible. Any small boats operating in shallow water would reduce their speeds and proceed with caution to avoid bottom disturbance. Any wakes, wave action, cavitation, or other disturbances created by vessels or equipment moving along the water's surface or through the water column would dissipate relatively quickly (within seconds or minutes). Bottom sampling and other deployable equipment would be programmed and operated to avoid sea floor disturbance during testing and training. Anchoring would be expected to occur in designated anchorage areas or preferred bottom types, such as sticky mud or sand, and could potentially cause turbidity by resuspending bottom sediments. OMAO would also minimize anchor drag by providing adequate anchor scope. That said, the sedimentation that would likely occur from anchoring and other bottom-disturbing activities would settle back to the sea floor or dissipate with prevailing currents and winds relatively quickly (within seconds or minutes). These bottom disturbing activities would affect a small area, would not happen frequently, and would not occur over a wide geographic area. In addition, all authorized discharges would abide by all the corresponding policies, procedures, and regulations as discussed previously (Section 3.4.2.1.1, 3.4.2.1.2, 3.4.2.1.3). Any discharges that would occur would be in permitted volumes, concentrations, and distances away from shore. Therefore, while OMAO operations may increase sedimentation and turbidity, all NOAA vessels would abide by policies and practices to prevent or minimize any potential impacts to water quality.

Under Alternative A, vessel movement, anchoring, waste handling and discharges, other sensors and data collection systems operations, UMS operations, and small boat operations could increase sedimentation and/or turbidity and potentially affect water quality. All NOAA vessels would abide by policies and practices related to preventing or minimizing sea floor disturbance, sedimentation, and turbidity. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. Therefore, the impacts would be adverse, **negligible** to **minor**, **temporary**, **local** or **regional** if the vessel is moving, and therefore **insignificant**.

3.4.2.1.5 Conclusion

Under Alternative A, OMAO would continue to use the current fleet to conduct operations to support NOAA's primary mission activities. OMAO would continue to operate NOAA's fleet of survey and research ships until they reached the end of service life. Almost half the ships in the NOAA fleet would exceed their design service life by 2038; however, two new ships would come online by 2025 with two more ships projected to come online in 2027 and 2028. Overall, under Alternative A the fleet would provide a maximum annual capacity of 3,568 DAS for scientific projects. Since the effects of impact causing factors on water quality throughout the action area range from negligible to moderate, the overall impact of Alternative A on water quality would be adverse, **negligible** to **moderate**, **temporary** to **long term**, **regional** or **localized** depending on whether the vessel is stationary or moving, and therefore **insignificant**.

3.4.2.2 Alternative B: Vessel Operations with Fleet Recapitalization and Optimizing At-Sea Capabilities

OMAO operations under Alternative B would take place in the same operational areas and timeframes as under Alternative A; however, under Alternative B, OMAO would construct up to eight new ships (four as in Alternative A, plus four additional ships) to replace ships that would reach the end of their design service life, extend the service life of aging ships through maintenance and mid-life repairs for six ships, increase fleet utilization with up to 4,138 DAS (approximately 570 more DAS annually than under Alternative A), and integrate new and greener technology as described in Section 2.4. As such, effects under Alternative B would incrementally increase from those of Alternative A but would not differ fundamentally in type.

Impacts from OMAO operations on water quality through spills of fuels, chemicals, and other contaminants; wastewater discharges; marine debris; and sedimentation and/or turbidity would occur under Alternative B from the same activities as those under Alternative A. Although the number of DAS would be greater under Alternative B than under Alternative A, the additional 570 DAS (implemented in a phased approach) would be distributed across the five operational areas. 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 intensity of the impacts. Additionally, replacing aging ships with new ships and integrating new and greener technology would likely reduce some impacts, including increased storage for treated wastewater, sewage and greywater endurance, OWSs and MSDs to minimize discharge of pollutants in open waters, and deck stowage for recyclable waste items. Energy efficiency measures would also be implemented, such as replacing some of the currently used diesel-powered generators with lithium batteries to power the ship's hotel mode and certain propulsion operations; this could reduce the amount of fuel used during operations and minimize the potential occurrence of accidental spills and discharges. Six NOAA ships including *Ronald H. Brown, Oscar Dyson*, *Henry B. Bigelow*, *Pisces*, *Bell M. Shimada*, and *Reuben Lasker*, would undergo midlife repairs that would replace or upgrade ship infrastructure to improve their functionality, reliability, and efficiency for an additional 20 years beyond their design service life. Therefore, introducing new builds with greener technology and conducting mid-life repairs and other maintenance to extend the service life of aging NOAA ships would minimize and avoid future impacts by reducing less efficient systems and infrastructure throughout the fleet. Furthermore, all new builds would be delivered with COIs that would be kept up to date onboard each vessel. This would demonstrate the new fleet's environmental compliance with applicable laws and regulations, while also enabling the fleet to attain other certificates such as IOPPs, ISPPs, or SOVCs, that further demonstrate environmental compliance with USCG and IMO pollution prevention standards.

Impacts of Alternative B on water quality throughout the action area would be similar to those discussed above under Alternative A for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be lower due to the introduction of new ships and technology. Overall, impacts on water quality under Alternative B would be adverse, **negligible** to **moderate**, **temporary** to **long term**, **regional** or **localized** depending on whether the vessel is stationary or moving, and therefore **insignificant**.

3.4.2.3 Alternative C: Vessel Operations with Fleet Recapitalization and Optimization with Greater Funding Support

OMAO operations under Alternative C would implement the same measures as under Alternative B and take place in the same operational areas and timeframe as under Alternatives A and B; however, Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B with additional measures including maximizing crew productivity and enhancing overall fleet performance by increasing DAS by 735 additional days, construction of two new ships in addition to those under Alternative B, increasing the number and use of uncrewed systems integrated into vessels, and shortening the timeframe for fleet improvement activities, implementation of greening techniques, and improvements to the small boat fleet as discussed in Section 2.5. As such, effects under Alternative C would incrementally increase from those of Alternatives A and B but would not differ fundamentally in type.

Impacts from OMAO operations on water quality through spills of fuels, chemicals, and other contaminants; wastewater discharges; marine debris; and sedimentation and/or turbidity would occur under Alternative C from the same activities as those under Alternatives A and B. Along with the greater number of DAS under Alternative C as compared to Alternatives A and B, there would be greater impacts overall; however, the associated impact causing factors would not be concentrated enough in any given area to substantially increase the intensity of the impacts as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Furthermore, benefits would be introduced at an accelerated rate from the proposed measures under Alternative B with increased funding under Alternative C. New ships would enter the fleet sooner than anticipated under Alternative C, in addition to two new ships to replace aging ships as compared to Alternative B (i.e., a total of ten new ships), and new greening and improvement techniques for the current fleet would occur over a shortened timeframe. Therefore, similar to Alternative B, this would minimize and avoid future impacts from the less efficient systems and infrastructure of older ships by introducing new ships with greener, state-of-the-art technology and conducting mid-life repairs and other maintenance to aging ships over a shortened timeframe compared to Alternative B.

Impacts of Alternative C on water quality throughout the action area would be similar to those discussed above under Alternatives A and B for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be lower due to the greening measures and technology improvements, especially over a shortened timespan. Overall, impacts on water quality under Alternative C would be adverse, **negligible** to **moderate**, **temporary** to **long term**, **regional** or **localized** depending on whether the vessel is stationary or moving, and therefore **insignificant**.

3.5 Acoustic Environment

The acoustic environment refers to the sum of all acoustic resources of a given area and can be described by both the type of sounds present in the area and characteristics of the area itself that affect sound propagation (e.g., underwater versus airborne or urban versus open space). The Affected Environment section briefly reviews the physics of sound and describes the existing airborne and underwater acoustic environment within the action area. The Environmental Consequences section evaluates how the overall acoustic environment in the action area could change as a result of implementing the Proposed Action.

3.5.1 Affected Environment

The area of analysis for evaluating the acoustic environment is the entirety of the action area where OMAO vessel operations would take place. This section first discusses the basic principles of sound needed to understand how sound is characterized, and then it describes the airborne acoustic environment and the underwater acoustic environment present in the action area.

3.5.1.1 Introduction to Sound

In general, sound is a pressure wave that travels through a medium, such as air or water. There are several terms used to characterize sound, including:

- ***Frequency:*** Commonly known as "pitch," frequency is the number of times per second that a sound pressure wave repeats itself. The units of frequency are hertz (Hz). Humans can generally hear sounds with frequencies between 20 Hz and 20,000 Hz. Frequencies above 20,000 Hz are known as ultrasound and frequencies below 20 Hz are known as infrasound (NPS, 2018).

- ***Amplitude:*** Commonly known as the “loudness” of a sound, amplitude is the relative strength of sound waves. Sound Pressure Level (SPL), or sound level, is a means of characterizing the amplitude of a sound and is measured in decibels (dB). The decibel is a relative unit; it compares the sound pressure to a reference pressure. The reference pressure for air is 20 micropascals (µPa) and the reference pressure for water is 1 µPa. Given these different reference pressures, decibels for sounds in air are not equivalent to decibels for sounds in water (DOSITS, No Date-b). For humans, the lower threshold of hearing is 0 dB re 20 µPa at 1 kilohertz (kHz) (NPS, 2018). Decibels are on a logarithmic scale; therefore, each 10-dB increase is a 10-fold increase in sound level, a 20-dB increase is a 100-fold increase in sound level, a 30-dB increase is a 1,000-fold increase in sound level, and so on. In human hearing, a 10-dB increase, however, does not indicate that the sound is perceived as being 10 times louder; humans perceive a 10-dB increase as a doubling of sound loudness (DOSITS, No Date-b).

- ***A-Weighted Sound Level:*** An SPL reported in A-weighted decibels (dBA) has been measured using a filter that deemphasizes the very low and very high frequency components of the sound and gives the greatest weight to the components of sound that fall in the frequency range where most speech information resides; this is similar to how the human ear perceives sound. Therefore, human reactions to sounds given in A-weighted decibels are more predictable than human reactions to sounds given in non-A-weighted decibels (Nguyen and Khoo, 2013; EPA, 1981).

- ***Sound Propagation:*** The distance a sound travels before attenuating (reducing to 0 dB) depends on characteristics of the sound wave and characteristics of the medium. In open air, it is generally accepted that sound levels measured from a point source decrease at a rate of 6 dBA per doubling of distance (FHA, 2017).

Individual sound sources, such as crashing waves or seagull calls, are called acoustic resources. All of the acoustic resources within an area combine to create an acoustic environment. Airborne and underwater acoustic resources that contribute to the acoustic environment can be generally divided into three categories:

1. Natural biological sounds which include sounds produced by wildlife,
2. Natural physical sounds which include sounds produced by the physical environment, and
3. Human-made, or anthropogenic, sounds which include sounds from human activity (NOAA, 2016).

Some human-made sounds are considered to be noise. Noise is defined as unwanted sound, or sound that is inappropriate in the context of a given acoustic environment. Typically, a sound becomes noise when it either interferes with normal activities such as communication, concentration, or sleep or diminishes the general quality of life (EPA, 1981). Which sounds are considered to be noise depends on who hears the sound; the people and wildlife who can hear the acoustic environment are called receptors. Ambient noise level refers to the normal, acceptable, and/or existing noise at a given location (Nguyen and Khoo, 2013).

3.5.1.2 Airborne Acoustic Environment

It is not possible to provide an exhaustive list of all the airborne acoustic resources that could contribute to the acoustic environment in the entire action area; therefore, the airborne acoustic environment is described qualitatively with upper quantitative limits on noise set by noise regulations. Overexposure to noise may result in hearing loss and non-auditory physiological responses, such as stress, and can interfere with communication, concentration, and sleep (EPA, 1981). Examples of commonly encountered airborne sounds and the typical human response are summarized in **Table 3.5-1**.

Table 3.5-1. Human Responses to Common Sounds

Common Sounds	Average Sound Level (dBA)	Typical Human Response
Normal conversation, air conditioner	60	Sounds at this dBA level or less typically do not cause annoyance or hearing damage.
Washing machine, dishwasher	70	Potentially considered annoying.
Gas-powered lawnmowers and leaf blowers	80-85	Damage to hearing possible after 2 hours of exposure.
Loud entertainment venues, such as a rock concert.	105–110	Hearing loss possible in less than 5 minutes
Firecrackers	140–150	Pain and ear injury.

Source: CDC, 2022

The scope of this Draft PEA covers underway vessels; an underway vessel would either be located at sea or nearshore. The acoustic resources and receptors that would be present at sea and nearshore are different. At sea, acoustic resources include natural biological sounds such as sounds produced by birds and above water marine mammals; natural physical sounds such as sounds from rain, lightning, wind, waves, and other weather events or physical phenomena; and anthropogenic sounds such as sounds from ship engines, ship horns, and other ship-related activities and aircraft engines. The receptors who can hear airborne sounds at sea include people on board the vessel and wildlife such as birds, polar bears, and hauled out pinnipeds. Similar to the acoustic resources found at sea, nearshore acoustic resources also include sounds produced by terrestrial wildlife, construction activities, road traffic, recreational activities, and port operations. In addition to people on the NOAA vessel, nearshore receptors include people and wildlife onshore within earshot of the NOAA vessel. The areas where OMAO's activities could be audible to people and wildlife onshore are most likely to occur around port cities where the vessels would be most often transiting towards or away from the pier. In general, the airborne acoustic environment around a port or harbor depends on numerous factors. Noise tends to increase as the size of the port and the number of ships increases. The perceived level of noise is also impacted by meteorological conditions (e.g., wind speed and direction) and the topography of the land around the port which can cause reflections, deflections, diffractions, and absorption that can either attenuate or amplify noise. The largest sources of airborne noise at a port are engine sounds, ventilation/fans, pumps, public address systems, ship horns, compressors, and generators. The most prevalent noise perceived by residents living near a port is caused by low frequency noise (≤ 160 Hz) which is often interpreted as a humming or buzzing noise (Wolfert et al., 2019). For context, an example of a low frequency sound in this range is thunder, which can be heard between 20 to 120 Hz (Vavrek et al., No Date). **Table 3.5-2** below summarizes the acoustic resources and receptors present in the at sea and nearshore airborne acoustic environments.

Table 3.5-2. Overview of Airborne Acoustic Environment

	At Sea Acoustic Environment	Nearshore Acoustic Environment
Acoustic Resources		
Natural Biological Sounds	Sounds produced by birds and above water marine mammals such as polar bears and hauled out pinnipeds	Sounds produced by birds, terrestrial wildlife, and above water marine mammals
Natural Physical Sounds	Sounds from rain, lightning, wind, waves, and other weather events or physical phenomena	Sounds from rain, lightning, wind, waves, and other weather events or physical phenomena
Anthropogenic Sounds	Sounds from ship engines, ship horns, and other ship related activities and aircraft engines	Sounds from the operation of a port/marina, ship engines, ship horns, and other ship related activities and construction activities, road traffic, recreational activities, and aircraft engines
Receptors		
Humans	People on board the vessel	People on board the vessel and people onshore
Wildlife	Birds, polar bears, and hauled out pinnipeds	Birds, terrestrial wildlife, and above water marine mammals such as polar bears and hauled out pinnipeds

3.5.1.2.1 Regulation of Airborne Noise

Airborne noise related to OMAO vessel operations is regulated both at the vessel level and at the community level. Vessel level regulations would be applicable to people onboard the vessel. Occupational noise refers to the expected sounds in a given work environment. The Centers for Disease Control and Prevention (CDC) estimates that 22 million workers are exposed to potentially damaging noise at work each year (OSHA, No Date). The Occupational Safety and Health Administration (OSHA) requires employers to protect personnel from occupational noise generated as a result of conducting project activities (29 CFR § 1910.95). Occupational noise standards require employers to provide protection against the effects of noise exposure when the sound levels exceed those shown in **Table 3.5-3**.

Table 3.5-3. Permissible Occupational Noise Exposures

Duration per Day (hours)	Sound Level (dBA)
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

Source: eCFR, 2023

Community level regulations are applicable to people and wildlife not onboard the vessel, but within earshot of the vessel. Noise that leaves a project site is regulated by local noise ordinances established by state and local governments. Most noise ordinances are specific to a city and address sources such as noise from residences, industries, traffic, and construction. Although, as a federal agency, OMAO does not need to adhere to local ordinances, these ordinances provide a baseline for acceptable community noise.

Local noise ordinances are typically established to protect the well-being of local residents, particularly sensitive receptors to noise. Sensitive receptors considered in this analysis include hospitals, schools, daycare facilities, elderly housing, places of worship, areas designated for nature conservation/preservation, and parks. People at these locations are typically engaging in activities that would be disrupted with the addition of excessive noise. In 2013, the California Department of Transportation sponsored a study to map noise of container terminals at the Port of Los Angeles. The City of Los Angeles municipal code limits noise from construction, industrial, and agricultural machinery to 75 dBA at a distance of 15.2 m (50 ft) from a point source. The normally acceptable community noise levels in Los Angeles for residential areas, parks, schools, hospitals, and other sensitive receptors ranges between 50-70 dBA (Nguyen and Khoo, 2013). Given that a sound in air generally decreases by 6 dBA per doubling of distance, a 75 dBA sound at 15 m (50 ft) (the upper limit of sound permissible by the LA noise ordinance) would attenuate to 50 dBA (a conservative acceptable community noise level) at approximately 271 m (890 ft). Given that the LA noise ordinance is similar to other coastal noise ordinances, using this estimate, receptors approximately 305 m (1,000 ft) away from OMAO activities are considered.

Providing an exhaustive list of local coastal noise regulations and all sensitive receptors within the action area is not possible; therefore, the noise regulations for OMAO's home ports and sensitive receptors within 305 m (1,000 ft) of the port destination are discussed below as representative of coastal community noise levels (not to exceed) for each Operational Area (OA).

3.5.1.2.2 Greater Atlantic Region Sensitive Receptors and Noise Regulations

There are two homeports within the Greater Atlantic Region located in New Castle, New Hampshire and Newport, Rhode Island. OMAO's homeport in New Castle is the University of New Hampshire (UNH) Judd Gregg Marine Research Pier in Portsmouth Harbor. Excessive noise in New Castle, New Hampshire is regulated in Section V of the town's ordinances which only permits excessive construction noise between

7:00 am and 30 minutes before sunset (New Castle, 2014). Within 305 m (1,000 ft) of the UNH Judd Gregg Marine Research Pier is the Fort Constitution Historic Site, Battery Farnsworth historical place, residences, and New Castle Beach.

OMAO's homeport in Newport, Rhode Island is located at the Port of Newport. OMAO is preparing to relocate the NOAA Marine Operations Center-Atlantic (MOC-A) to Newport, Rhode Island from its current location in Norfolk, Virginia. There are several parks within 305 m (1,000 ft) of the Port of Newport and around the Newport Harbor, including Aquidneck Park, King Park, and Fort Adams State Park as well as the Newport Public Library. The area is a mix of commercial and residential spaces. Newport attracts millions of visitors each year, many of whom visit the city on boats through the harbor; this has resulted in an increased number of noise related disturbances and a general increase in concern over noise pollution. In 2011, Newport Harbor had been experiencing an influx of noise complaints from people staying on their boats within the harbor. Noise complaints were generally focused on four sources of noise: generators, unmuffled exhaust systems, loud music and yelling, and mini wind turbines to power boats (Bonjour, 2011). Excessive noise in Newport, Rhode Island is regulated in the Noise Abatement Chapter of the city's code of ordinances. The city enforces limits on acceptable sound levels for different zoning districts during day and night hours, for residential and other noise sensitive areas, the sound limit is 65 dBA during the hours of 7:00 am to 9.59 pm and 55 dBA from 10:00 pm to 6:59 am (The City of Newport RI, 2023).

3.5.1.2.3 Southeast Region Sensitive Receptors and Noise Regulations

OMAO vessels have homeports in three locations in the Southeast Region: Norfolk, Virginia; Charleston, South Carolina; and Pascagoula, Mississippi. Currently, the NOAA MOC-A is located in OMAO's homeport in Norfolk. There is mostly commercial property within 305 m (1,000 ft) of the MOC-A, but there is also the Freemason historic district, a dog park, and a portion of Riverside Park. Noise in Norfolk, Virginia is regulated in Chapter 26 of the city's code and sets limits on sound levels for various land use categories. Between 7:00 am to 10:00 pm, the sound limit for noise sensitive zones is 55 dBA, for residential areas it is 57 dBA, for park and recreational areas it is 67 dBA, for commercial areas it is 67 dBA, and for industrial areas it is 77 dBA (The City of Norfolk, 2023).

OMAO's homeport in Charleston, South Carolina is at the Charleston Marine Support Facility. The properties within 305 m (1,000 ft) of the facility include mostly other federal facilities such as the Federal Law Enforcement Training Center and the Charleston USCG Base. Noise in Charleston, South Carolina is regulated in Chapter 21, Article II of the city's code. The use of loud equipment is only permitted between the hours of 7:00 am and 7:00 pm weekdays and 9:00 am and 7:00 pm on Saturdays (The City of Charleston, 2022).

OMAO's homeport in Pascagoula, Mississippi is the Gulf Marine Support Facility. Within 305 m (1,000 ft) of the facility is a mix of commercial and residential areas. Noise in Pascagoula, Mississippi is regulated in Chapter 54, Article V of the city's code. Noise from heavy equipment, power equipment, or other tools are only permitted between the hours of 6:30 am and 7:00 pm Monday through Saturday (The City of Pascagoula, 2022).

3.5.1.2.4 West Coast Region Sensitive Receptors and Noise Regulations

OMAO has two homeports located in the West Coast Region: Newport, Oregon and San Diego, California. OMAO's homeport in Newport, Oregon is the NOAA Marine Operations Center-Pacific (MOC-P); however, OMAO may relocate MOC-P within the next 15-years. The area 305 m (1,000 ft) around the MOC-P primarily consists of parking lots and a facility for Oregon State University (OSU) Ship Operations. Noise in Newport, Oregon is regulated in Title VIII, Chapter 8 of the city's municipal code. Daytime and nighttime maximum allowable noise limits are set for residential, commercial, and industrial zones. The daytime limit for residential areas is 55 dBA, for commercial areas it is 60 dBA, and for industrial areas it is 70 dB (City of Newport OR, No Date).

OMAO's homeport in San Diego, California is located at the Port of San Diego, California. The port is located in a mostly industrial and commercial area, with Cesar Chavez Park being the only potentially sensitive receptor within 305 m (1,000 ft). Noise in San Diego, California is regulated in Chapter 5, Article 9.5 in the city's municipal code. Between the hours of 7:00 am to 7:00 pm, the acceptable noise level for single family residential areas is 50 dBA, for commercial areas it is 65 dBA, and for industrial areas it is 75 dBA (The City of San Diego, No Date).

3.5.1.2.5 Pacific Island Region Sensitive Receptors and Noise Regulations

OMAO has one homeport located in the Pacific Island Region in Honolulu, Hawai'i at the Marine Operations Center - Pacific Islands (MOC-PI). The MOC-PI is on Ford Island primarily surrounded by other federal facilities; it is adjacent to NOAA's Pacific Islands Regional Office and the Naval Brig at Pearl Harbor (a military prison). Noise in Honolulu, Hawaii is regulated in Section 21-3.100 of the Revised Ordinances of Honolulu which sets different sound levels for different land uses and times. For waterfront industrial districts, the permitted noise ranges from 39 dBA of 8 kHz-sound to 79 dBA of 31.5 Hz-sound (City and County of Honolulu, No Date).

3.5.1.2.6 Alaska Region Sensitive Receptors and Noise Regulations

OMAO has two homeports located in the Alaska Region: Ketchikan, Alaska and Kodiak, Alaska. OMAO's homeport in Ketchikan, Alaska is the Ketchikan, Alaska Port Office. The Ketchikan, Alaska Port Office is primarily surrounded by commercial and industrial space; within 305 m (1,000 ft) is the Bayview Cemetery and Ketchikan USCG Base. Noise in Ketchikan is regulated in Chapter 19.05 of the Ketchikan municipal code. The code restricts the use of any tools or equipment used in construction, drilling, repair, alteration, demolition or excavation work during nighttime hours, but does not have quantitative limits on sound levels (City of Ketchikan, 2023).

The area within 305 m (1,000 ft) of OMAO's homeport in Kodiak, Alaska is all commercial and industrial. Noise in Kodiak, Alaska is specifically regulated for port and harbor facilities in Title 18, Chapter 18.28 of the Kodiak City Code. The code prohibits the operator of a vessel from using any siren, whistle, horn, or other noise producing or noise amplifying device on the vessel in such a manner that disturbs the peace and privacy of other persons in the Kodiak harbor or adjacent areas. This does not apply to emergency signals or sounds required by federal statutes or regulations relating to the navigation of vessels (City of Kodiak, 2023).

3.5.1.3 Underwater Acoustic Environment

Sound underwater is very different from sound in air. Although sounds in air and sounds in water are described using the same metrics, the physical differences between air and water result in the same sound having different speed, pitch, and intensity. In general, sound travels much faster and farther in water (including seawater) than in air because sound travels faster in denser mediums; however, the density of seawater varies with the water's salinity (i.e., salt concentration), temperature, and pressure (pressure increases with water depth because of the increasing weight of the water above). On average, sound travels at about 1,500 m per second (m/s) (3,500 mi per hour [mph]) in seawater compared to 340 m/s (760 mph) in air. Some sounds, particularly low-frequency ones, can travel hundreds of kilometers underwater (DOSITS, No Date-c).

Acoustic resources that together create the underwater acoustic environment vary by location; however, in general, they include natural biological underwater sounds produced by fish, birds, marine mammals, invertebrates, and other animals that produce and use sound underwater to perform various life functions. The characteristics of how sound travels underwater has resulted in sound being an efficient method of communication for marine life. Natural physical underwater sounds include sounds from rain, lightning, wind, waves, the movement and breaking of ice, volcanic eruptions, earthquakes, and other physical phenomena. Anthropogenic underwater sounds include sounds from vessel engines, oil and gas exploration (e.g., seismic airguns), drilling, construction, dredging (e.g., excavating), fishing, sonar, and echo sounders (NOAA, 2016).

3.5.1.3.1 Regulation of Underwater Sound

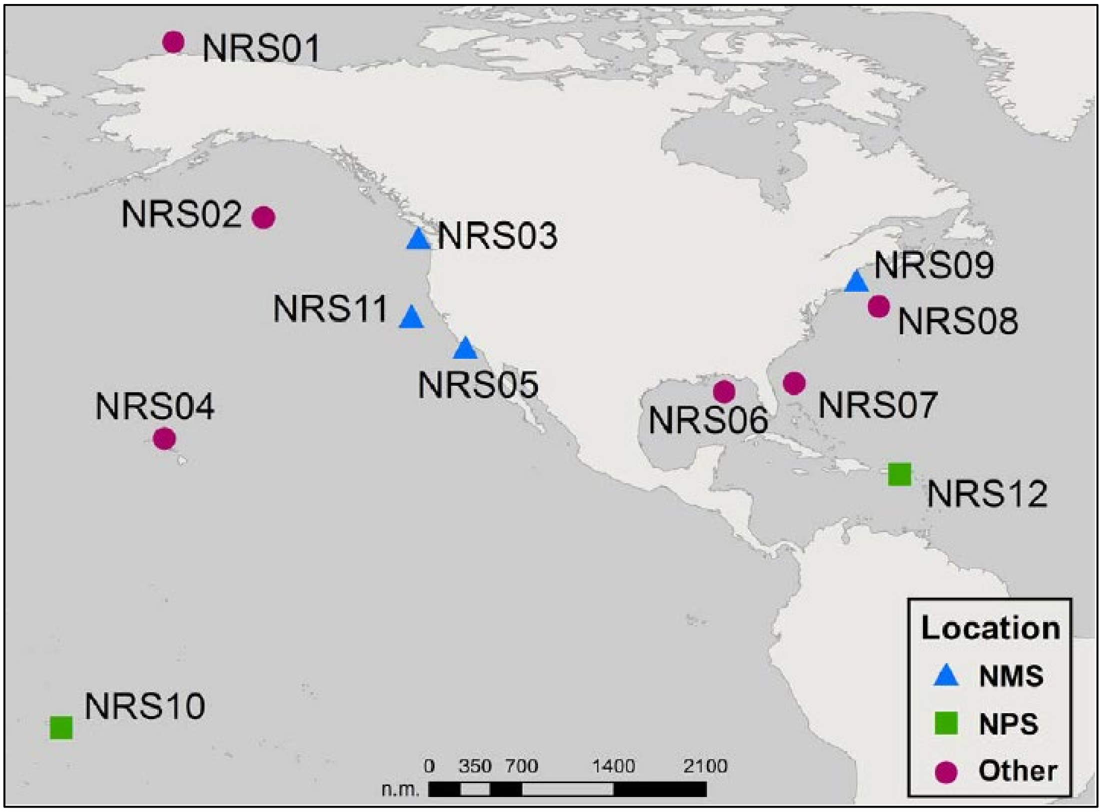
The U.S. does not have any federal statutes or regulations in place that are specifically designed to address underwater sound, and as such, from the effects of underwater sound are typically managed through biological resource-specific regulations, such as the Marine Mammal Protection Act (MMPA), the Endangered Species Act (ESA), the National Marine Sanctuaries Act (NMSA), and the Magnuson-Stevens Fishery Conservation and Management Act (MSA). NOAA cooperated with the IMO to develop voluntary guidelines for reducing underwater sound from commercial shipping (NOAA, 2016). The “Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life” were adopted in April 2014 and provides recommendations for propeller design, hull design, onboard machinery selection considerations, and Operation and Maintenance (O&M) practices to decrease vessel sound (IMO, 2014).

3.5.1.3.2 Underwater Acoustic Resources and Trends

Underwater sound is also of concern both nearshore and at sea; however, there are no noise ordinances to describe acceptable underwater sound levels; instead, the underwater acoustic environment can be described through overall trends and the likely acoustic resources that contribute to and are affected by such trends. Over the past 50 years, the ambient sound in the ocean has increased at both low frequencies (< 1,000 Hz) and mid-frequencies (1-20 kHz). Contributors to anthropogenic ambient sound include commercial shipping, defense-related activities, hydrocarbon exploration and development, research activities, and recreational activities (Hildebrand, No Date).

Thus far, the most comprehensive monitoring of underwater acoustic environments has been primarily done in protected areas managed by NOAA and the National Park Service (NPS), although increasing ocean sound is a problem throughout the U.S. EEZ. The NOAA/NPS Ocean Noise Reference Station (NRS) Network is an array of autonomous passive acoustic recorders in 12 regions in the U.S. EEZ. The 12 stations record data that can be used to develop quantitative baseline levels and multi-year trends in ocean ambient sound surrounding the shoreline/coastline of the continental U.S., Alaska, Hawaii, and island territories. The first NRS in the Alaskan Arctic was deployed in June 2014, and eleven additional stations were added to the network during the following two years. As shown in **Figure 3.5-1**, the stations are located in the Alaskan Arctic (NRS01), GOA (NRS02), Olympic Coast National Marine Sanctuary (NMS) (NRS03), Hawaiian Islands (NRS04), Channel Islands NMS (NRS05), Gulf of Mexico (NRS06), Southeastern continental U.S. (NRS07), Northeastern continental U.S. (NRS08), Stellwagen Bank NMS (NRS09), Tutuila

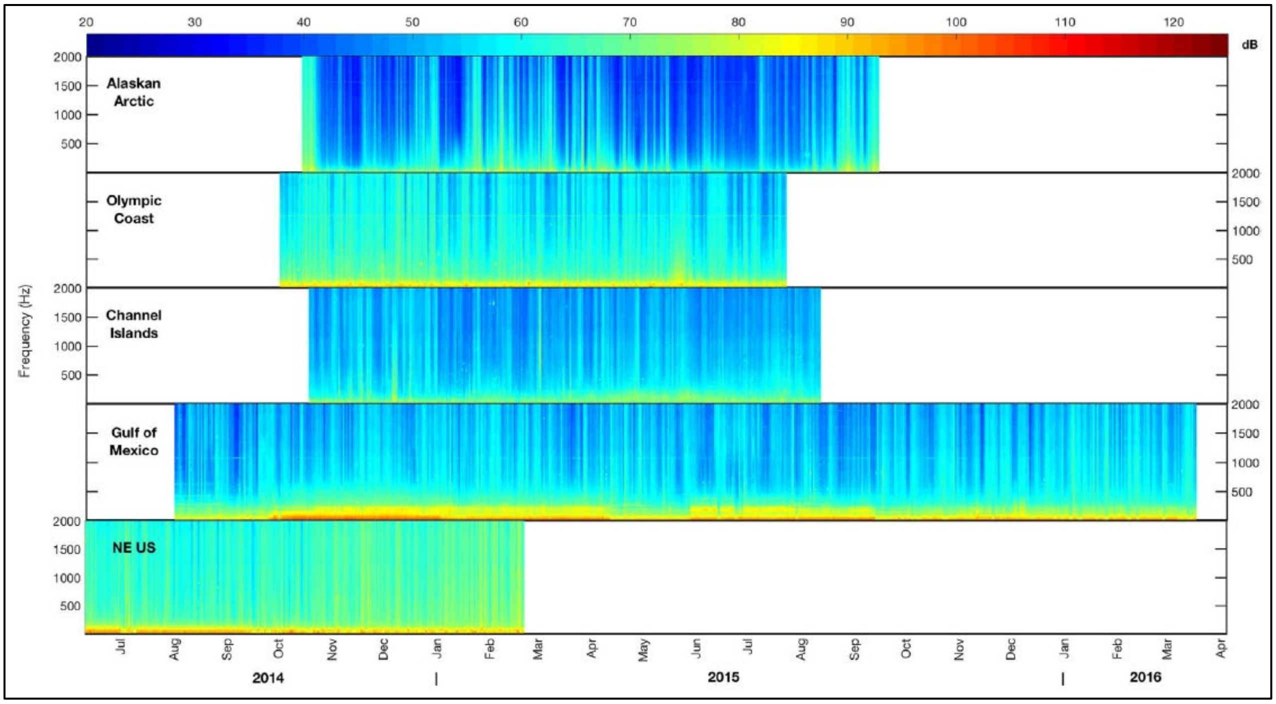
Island (National Park of American Samoa) (NRS10), Cordell Bank Coast NMS (NRS11), and Buck Island Reef National Monument in the U.S. Virgin Islands (NRS12) (Haver et al., 2018).



Source: Haver et al., 2018

Figure 3.5-1. Locations of Noise Reference Stations (NRSs)

Since installation, the stations continuously observe low-frequency underwater sound between 10 Hz and 2,000 Hz to capture anthropogenic, natural biological, and natural physical acoustic resources. Sources of anthropogenic sound in the ocean (e.g., commercial and recreational vessel traffic, naval activities, and fossil fuel exploration/extraction) commonly emit low-frequency signals that propagate over long distances (Haver et al., 2018). The initial investigation of data collected by five of the stations (Alaskan Arctic, Olympic Coast NMS, Channel Islands NMS, Gulf of Mexico, and the Northeast U.S.) demonstrates temporal and geographic variability of 10 Hz to 2000 Hz in ocean ambient sound levels over an eight-month time-period (Haver et al., 2018). These five stations are located in all OAs of the action area except for the Pacific Islands Region. The frequency and sound level in decibels of ocean sound recorded at these stations is illustrated in **Figure 3.5-2**.



Source: Haver et al., 2018

Figure 3.5-2. Ocean Sound Measured by Five Noise Reference Stations (NRSs) Over Time

The sound levels measured at each station shown in Figure 3.5-2 is an aggregate of anthropogenic sound, natural biological sounds, and natural physical sounds. Anthropogenic contributions to the ambient sound levels measured at the five stations likely reflect the proximity to densely populated port cities and local shipping lanes, as well as the sound propagation features of the site (e.g., shallow water or deep water). These factors contribute to the anthropogenic sound levels measured at each station. For example, the stations at Olympic Coast NMS, Channel Islands NMS, Gulf of Mexico, and Northeast U.S. are closer to densely populated port cities compared to the relatively remote station in the Alaskan Arctic. The Channel Islands and Olympic Coast NMS stations record sound from portions of the thousands of large container ships that travel annually across the Pacific to ports along the U.S West Coast, and the Northeast U.S. station records sound from vessels that travel from Europe, Africa, and other points in the North Atlantic to Boston, New York City, and other major Northeast U.S. port cities. The Gulf of Mexico station is located in an area rich in energy resources and likely records sound from related activities such as seismic airguns which are often a significant source of low-frequency anthropogenic sound. Seismic airgun use in the Atlantic may also increase sound levels in the Northeast U.S. station (Haver et al., 2018).

Natural biological contributions to the ambient sound levels measured at all the stations include marine mammals, fish, and invertebrates. For example, observed peaks in sound levels around 18 Hz at the Olympic Coast NMS, Channel Islands NMS, and the Northeast U.S. stations are likely indicative of fin whale (*Balaenoptera physalus*) or blue whale (*Balaenoptera musculus*) calling. Snapping shrimp are known to significantly contribute to ambient sound levels in shallow temperate and tropical waters and are likely part of the measured sound levels at the National Park of American Samoa. At all of the stations, animal chorusing (i.e., groups of animals calling at the same time over several hours) may increase sound levels within the specific frequency range of the calling species. The 70 species of marine mammals that are protected by NOAA under the MMPA have a combined vocal range of approximately 10 Hz to 200 kHz, which exceeds the upper frequency limit of the stations' hydrophones. Species acoustic presence and behavior in a given area varies due to prey availability, reproduction, weather events, or other factors (Haver et al., 2018). This variability likely affects the consistency and predictability of sound levels throughout the action area.

Natural physical contributions to the ambient sound levels measured at the stations include regional climate zones and weather conditions. Weather can influence the sound level directly via wind, rain, ice, or other physical phenomena, but also indirectly by impeding the presence of anthropogenic or biological sound sources. For example, the seasonality of sound levels observed in the Alaskan Arctic is likely related to the acoustic contrast of changing sea ice coverage. In the Alaskan Arctic the maximum monthly sound levels were recorded in January 2015 which were about 12 dB higher across most frequencies than in June 2015. Seasonally variable Arctic sea ice coverage contributes to ambient sound levels via formation, cracking, and breaking and by damping sounds at the air-sea barrier when fully formed (Haver et al., 2018).

3.5.2 Environmental Consequences

The following sections identify and evaluate potential impacts to the acoustic environment in the action area under Alternatives A, B, and C. The analysis specifically considers impacts to the airborne and underwater acoustic environments.

Activities described in Table 2.1-1 and in Section 2.2 that occur during OMAO vessel operations and could be expected to have impacts on the acoustic environment in the action area include vessel movement and active acoustic systems operations.

Impacts on the airborne and underwater acoustic environments from anchoring; waste handling and discharges; spill response; vessel repair and maintenance; operation of other sensors and data collection systems; UMS operations; UAS operations; small boat systems operations; and OTS handling, crane, davit, and winch operations are not expected to occur and are not discussed further in this section. While these activities do produce sound, the sound produced would contribute minimally to impacts on the acoustic environment compared to vessel movement/operations and active acoustic systems operations.

OMAO operations could impact the acoustic environments in the action area through: (1) the production of airborne sound (e.g., from vessel movement); and (2) the production of underwater sound (e.g., from vessel movement and active acoustic systems operations).

3.5.2.1 Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Under Alternative A, OMAO vessel operations using the existing NOAA fleet would continue across all five operational areas over the 15-year period. In addition, OMAO is constructing two oceanographic research vessels that are expected to come online by 2025 and two new charting and mapping vessels that are expected to come online in 2027 and 2028 for a total of four new ships under Alternative A. OMAO would provide a maximum annual capacity of 3,568 operational DAS for scientific projects.

3.5.2.1.1 Impacts of Airborne Sound

Vessel movement and operations require the use of propellers, generators, motors, and other machinery which produces airborne sound that would contribute to the ambient noise level around the vessel, whether the vessel is at sea or nearshore.

Airborne vessel noise could originate from engine and generator use and water hitting the hull. As discussed in Section 3.5.1.2 (**Table 3.5-2**), airborne vessel noise would be audible by people aboard the vessel. **Table 3.5-4** provides example measurements of sound levels from various locations onboard a vessel. The six ships used to develop these average noise measurements were small and large container ships with an average gross tonnage (GT) of 8,751, an average year of construction of 2007 (1998-2010), and a mean length of 139 m (456 ft) (Oldenburg et al., 2020). In comparison, NOAA vessels range from several hundred to 3,250 tons when fully loaded (OMAO, No Date-f) and are about half the length of these ships; therefore, the noise on a NOAA vessel would not be expected to exceed the levels in **Table 3.5-4**, and the relative comparison of noise levels in different locations would be similar (e.g., the engine room is louder than the deck).

Table 3.5-4. Time-Averaged Sound Pressure Level with A-frequency Weighting (dBA) by Location and Vessel Movement

Location on the Vessel	General, dBA (median [min-max])	River Passage, dBA (median [min-max])	Sea Passage, dBA (median [min-max])
Bridge	57 (45–73)	67 (57–73)	57 (49–67)
Office	62 (40–69)	64 (57–69)	62 (53–66)
Deck	77 (62–83)	77 (47–81)	78 (62–83)
Engine Room	104 (98–110)	106 (99–110)	102 (98–105)
Engine Control Room	72 (56–79)	72 (61–78)	73 (63–79)
Workshop	81 (65–87)	84 (68–87)	81 (70–86)
Crew Mess Room	63 (46–71)	66 (51–71)	64 (53–68)
Galley	68 (57–73)	69 (62–73)	66 (57–71)
Cabin	57 (36–66)	60 (51–66)	57 (47–63)
Recreational Room	62 (53–66)	57 (55–58)	63 (54–66)

Source: Oldenburg et al., 2020

Most of the noise experienced by crew members aboard the vessel would be less than 70 dBA. This sound level is consistent and although extremely unlikely, could cause psychological stress, but would not result in hearing damage or loss and is not at a high enough level to require hearing protection. In some locations on the vessel, such as the engine room, crew members are exposed to noise exceeding 80 dBA, which could result in hearing damage over time. OMAO’s Hearing Conservation Program protects employees who are required to work in such spaces with noise levels that exceed the safety threshold established by OSHA (see **Table 3.5-3** for OSHA standards). OMAO requires these spaces to be identified and provides hearing protection, hearing conservation training, and periodic hearing tests to detect changes in employee hearing. OMAO’s Marine Medicine Branch (MMB) performs a screening audiogram with each employment physical exam and notifies employees upon detection of any changes in hearing that could be attributed to noise exposure (OMAO, 2020c). OMAO policies align with the IMO Code on Noise Levels Onboard Ships which recommends requiring personnel entering spaces with nominal noise levels greater than 85 dBA to wear hearing protectors while in those spaces. Other impacts to crew health from vessel operations are discussed in Section 3.12 Human Health and Safety.

While a vessel is nearshore, people onshore would also hear noise from the vessel engine and vessel operations. As discussed in Section 3.5.1.2.1, a sound measured as 75 dBA at 15 m (50 ft) away from the source would attenuate to acceptable community noise levels (approximately 50 dBA) within less than 305 m (1,000 ft); therefore, people onshore and nearshore within several thousand feet of a NOAA vessel would likely hear a soft humming noise that would not exceed acceptable community noise levels. If an observer is near a coastal community or port, NOAA vessel noise would not be discernable in terms of sound level or frequency from other anthropogenic acoustic resources, such as vessels or vehicle traffic in the area. An observer onshore in a more remote area while the NOAA vessel was within several thousand feet of shore would hear a soft humming noise while the vessel remained in the vicinity. This would only last for a short duration, from minutes to several hours, and would not exceed sound levels that would be mildly noticeable. Vessel noise could also be audible to birds, terrestrial wildlife, and above water marine mammals such as polar bears and hauled out pinnipeds. Impacts to terrestrial and marine wildlife from airborne noise is discussed in Section 3.7 Biological Resources. Since vessel noise would not likely exceed community noise levels. It would not interfere with or prevent a person from hearing the natural biological sounds or natural physical sounds that contribute to the acoustic environment. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

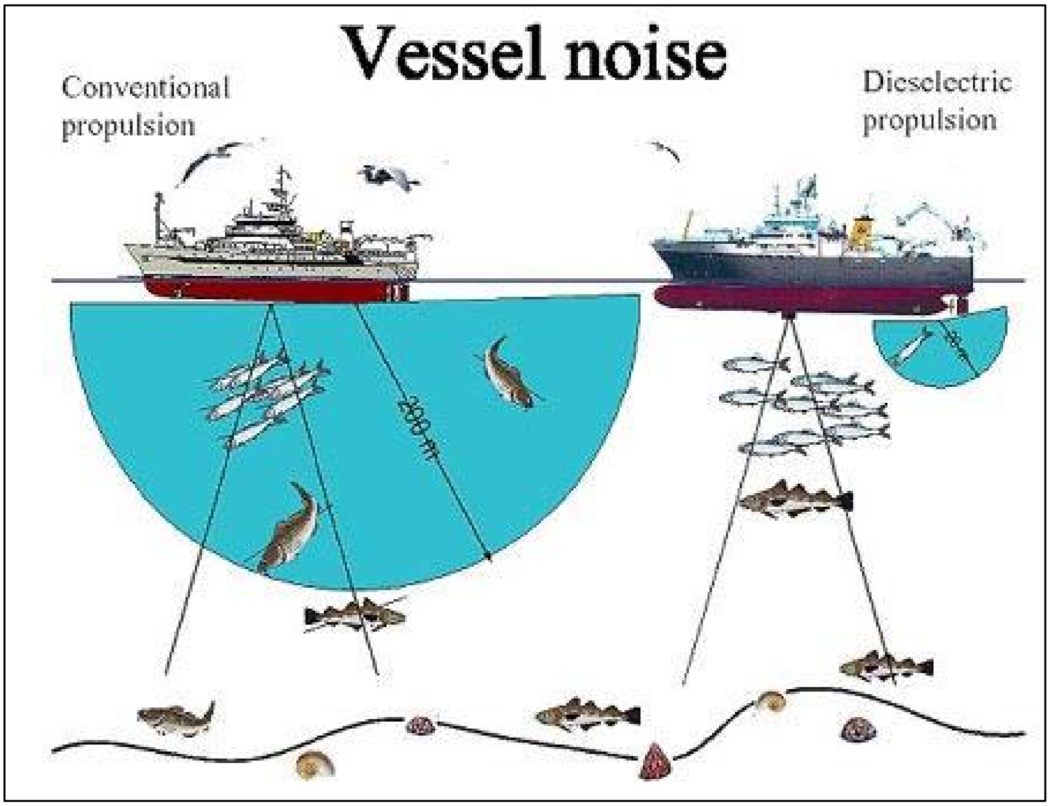
Overall, the operation of NOAA vessels under Alternative A would contribute low-frequency anthropogenic sounds to the local airborne acoustic environment that would not be discernable from sounds generated by other vessels or vehicle traffic. Crew members onboard NOAA vessels are provided adequate hearing protection in areas with noise levels that exceed the safety thresholds and hearing is monitored overtime to identify any potential concerns of noise exposure. People and wildlife onshore and nearshore would only hear a NOAA vessel if it were to pass within several thousand feet and would likely hear a soft humming noise for several minutes to several hours. Impacts would be **localized** to **regional** depending on whether the vessel is stationary or moving, **temporary** to **short-term**, and **minor** with a **high** likelihood of occurrence, and therefore insignificant.

3.5.2.1.2 Impacts of Underwater Sound

Vessel movement (i.e., propeller, generator, motor, and other machinery use) and active acoustic systems operations would contribute to the ambient underwater sound around the vessel.

Although vessel operations result in sounds ranging between low and high frequencies, most sounds that ships produce underwater are low frequency, approximately between 20 to 500 Hz (DOSITS, No Date-d). The underwater radiated noise signature (i.e., acoustic footprint) of a vessel differs based on various ship characteristics (e.g., size, hull, propellers, machinery use, and other onboard systems) and operational parameters such as speed and the load being carried; as such, vessels of the same design may have similar, but not necessarily identical noise signatures (ICES, 1995; Fischer, 2010). In general, propeller-induced cavitation (the rapid formation and collapse of bubbles) is the main source of underwater sound produced by ships (DOSITS, No Date-d).

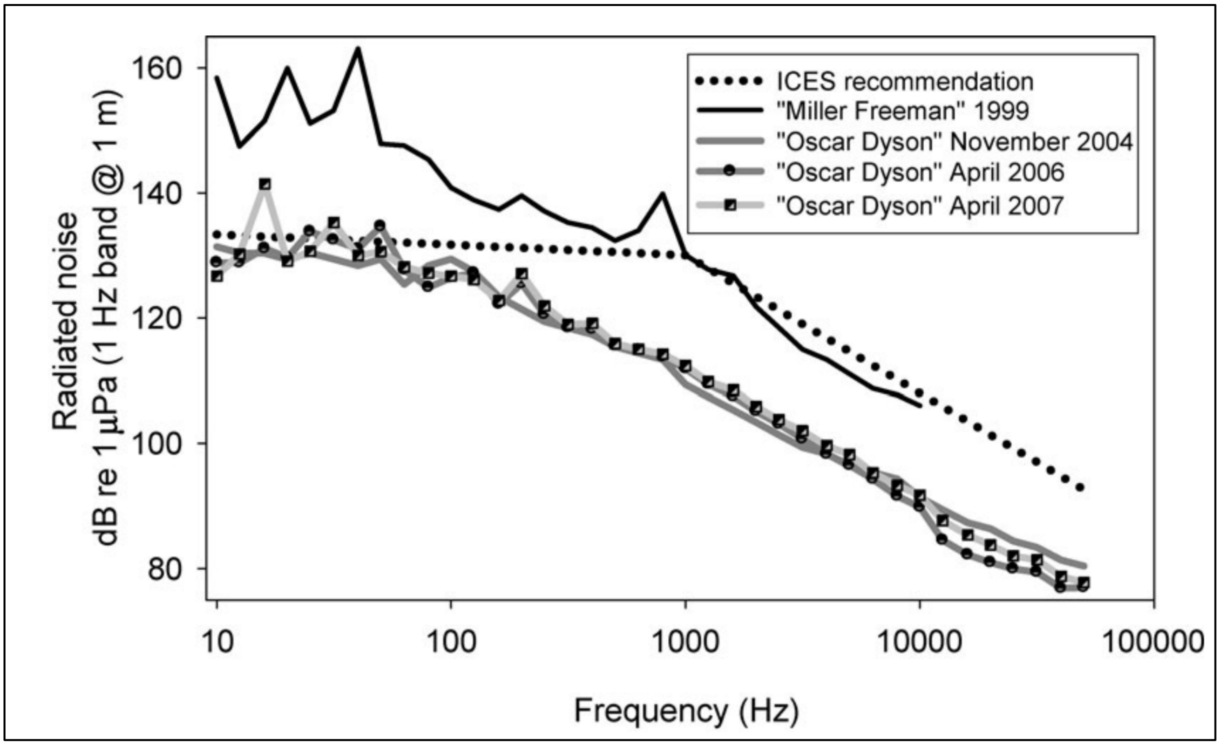
The International Council for the Exploration of the Sea (ICES) identified that noise from Research Vessels (RVs) originates mostly from the use of engines, propellers, and gearboxes; such noise was observed to cause avoidance behavior in fish 100 to 200 m (328 – 656 ft) away from the vessel (up to 400 m [1312 ft] for noisy vessels). To prevent inadvertent disturbance to the natural distribution of fish during fishery surveys, ICES developed noise specifications for fisheries research vessels to minimize disturbance to fish to 10 to 20 m (33 – 66 ft), as illustrated in **Figure 3.5-3** (ICES, 1995; Phipps, 2012). Within the NOAA fleet, NOAA Ship *Oscar Dyson* is the first in a class of ultra-quiet Fisheries Survey Vessels (FSV) designed to meet ICES noise-specifications; it is equipped with sound-dampening technology, so that fish populations can be monitored without altering their behavior (OMAO, No Date-b). *Oscar Dyson* is equipped with noise-control measures such as diesel-electric propulsion, a large fixed-pitch propeller, sound-dampening material applied to the hull and bulkheads[2], vibration isolation around equipment (e.g., around diesel generators), and acoustic insulation around the perimeter of the engine room and other noisy spaces (De Robertis et al., 2007; Fischer, 2010). **Figure 3.5-4** compares the underwater radiated-noise signature of *Oscar Dyson* (quiet design) and *Miller Freeman,* which was a NOAA vessel decommissioned in 2013 and replaced by *Oscar Dyson* (De Robertis et al., 2007; Phipps, 2012).



Source: Phipps, 2012

Figure 3.5-3. Underwater Radiated-Noise from Conventional versus Diesel-Electric Propulsion (*Oscar Dyson*)

[2] Bulkheads are the walls or barriers that separate compartments of a vessel.



Source: De Robertis et al., 2007

Figure 3.5-4. Underwater radiated-noise signature of the NOAA Research Vessels *Miller Freeman* and *Oscar Dyson* at speeds of 11 knots compared to the ICES recommendation for maxima for Research Vessel-radiated noise

Sistership FSVs have been acoustically quieted in accordance with the low radiated noise standards defined by ICES, and all FSVs are equipped with a retractable centerboard housing acoustic transducers that, when extended, allows researching to collect data away from hull-generated noise. *Henry B. Bigelow* is the second in the series of *Dyson*-class FSVs designed to meet data collection requirements and the ICES standards (OMAO, No Date-c). *Pisces* is the third *Dyson*-class FSV built for a wide range of living marine resource surveys and ecosystem research projects, and has been outfitted with a "quiet hull" to meet ICES standards. (OMAO, No Date-e). *Bell M. Shimada* is the fourth *Dyson*-class quiet FSV designed to meet the data collection requirements and the ICES standards (OMAO, No Date-d). Under Alternative A, all four of these quiet vessels would reach their End of Service Life (EOSL) between 2036 and 2048. While in operation, these vessels have acoustic signatures similar to that of *Oscar Dyson* in **Figure 3.5-4**.

NOAA vessels not designed to meet ICES standards for a quiet vessel would be expected to have underwater radiated-noise signatures more similar to that of *Miller Freeman* as shown in **Figure 3.5-4**. Most underwater sounds emitted would still be in the very low frequency range. Vessel operations would be expected to cause low frequency noise approximately ranging between 10 - 160 dB re 1 μPa. It could be measured several hundred feet away from the vessel and would last for a few hours to a few days at a time depending on if the vessel is in transit or stationary. This noise would exceed typical background noise levels (as depicted in **Figure 3.5-2**) within the vicinity of the vessel; however, it would be expected to attenuate to background levels within several hundred to several thousand feet around the vessel. Impacts to marine wildlife from underwater noise are discussed in Section 3.7 Biological Resources. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

In addition to low frequency noise from vessel operations, higher frequency underwater sound would also be produced when testing, calibrating, and troubleshooting echo sounders. Single beam echo sounders on NOAA vessels can range from 0.5 kHz up to 200 kHz or more. Multibeam echo sounders on NOAA vessels typically range from 12 kHz up to 900 kHz or more. Side-scan sonars on NOAA vessels typically range from 300 kHz to 1,600 kHz. These sources would not be used for more than several minutes to a few hours at a time for testing purposes in one location and are typically directed at a distance of about 100 m (328 ft). Similarly, testing, calibrating, and troubleshooting of ADCPs would last for no longer than several minutes to a few hours at a time in one location and would be operated at a frequency range of 75-1,200 kHz and less than 160-180 dB re 1 µPa m. Although the sounds produced by these acoustic sources use frequencies and have sound levels exceeding typical underwater background noise levels, the sources are highly directional and would not be expected to be measurable beyond several hundred to several thousand feet away from the vessel.

Overall, the operation of NOAA vessels under Alternative A would contribute low and high-frequency sounds to the underwater acoustic environment from vessel operations and testing of active acoustic systems. Low-frequency sounds would be expected to attenuate to background levels within several hundred to several thousand feet around the vessel and only be expected to occur in one location for a few hours to a few days at a time depending on if the vessel is in transit or stationary. High-frequency sounds would be expected to last for several minutes to several hours at a time in one location and would be expected to attenuate to background sound levels within several hundred to several thousand feet away from the vessel. Impacts from underwater sound production would be **localized** to **regional** depending on whether the vessel is stationary or moving, **temporary** to **short-term**, and **minor**, and therefore insignificant.

3.5.2.1.7 Conclusion

Under Alternative A, OMAO would continue to use the existing fleet to conduct operations to support NOAA's primary mission activities. OMAO would continue to operate NOAA's fleet of survey and research ships until they reach the end of their service life. Almost half the ships in the NOAA fleet would exceed their design service life by 2023; this could include NOAA Ship *Oscar Dyson*, with an estimated EOSL between 2036 - 2039. However, two new ships would come online by 2025 with two more ships projected to come online in 2027 and 2028. Since the effects of impact causing factors on the acoustic environment throughout the action area would be **adverse**, **localized** to **regional** depending on whether the vessel is stationary or moving, **temporary** to **short-term**, and **minor**, the overall impact of Alternative A on the acoustic environment, including the airborne and underwater acoustic environments, would be insignificant.

3.5.2.2 Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

OMAO operations under Alternative B would take place in the same operational areas and timeframes as under Alternative A; however, under Alternative B, OMAO would construct up to eight new ships (four as in Alternative A, plus four additional ships) to replace vessels that would reach the end of their design service life, extend the service life of aging ships through maintenance and mid-life repairs for six ships, increase fleet utilization with up to 4,138 DAS (approximately 570 more DAS annually than under Alternative A), and integrate new and greener technology as described in Section 2.4. The difference between the two alternatives is primarily a matter of scale with increased activity levels distributed unevenly among the different types of operations, the five operational areas, and within the 15-year timeframe. As such, effects under Alternative B would incrementally increase from those of Alternative A but would not differ fundamentally in type.

Impacts from OMAO operations on the airborne acoustic environment for people aboard a vessel, onshore or nearshore, and wildlife onshore or nearshore would occur under Alternative B from the same activities as those under Alternative A. Similarly, impacts from OMAO operations on the underwater acoustic environment would occur under Alternative B from the same activities as those under Alternative A. Although the number of DAS would be greater under Alternative B than under Alternative A, the additional 570 DAS (implemented in a phased approach) would be distributed across the five operational areas. 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 intensity of the impacts. Additionally, replacing seven ships with new vessels and integrating new and greener technology would likely incorporate quieter designs, thus reducing impacts to the airborne and underwater acoustic environments. In the NOAA Ocean Noise Strategy Roadmap, NOAA supports continued vessel quieting improvements and "green ship" development, in which new ships are built or existing ships are modified to include quieting in design and operational goals (NOAA, 2016). To minimize impacts from vessel noise, new designs could: (1) address hydrodynamics with unique hull and propeller design that minimizes cavitation; (2) use inherently quiet equipment and choose rotating rather than reciprocating equipment; (3) use dynamically stiff foundations for all equipment (i.e., reduce and isolate vibration); (4) place noisier equipment toward the centerline of the ship (i.e., as isolated as possible); (5) use double-hulls or place tanks (ballast and fuel tanks) outside of the engine room to further isolate engine noise; and (6) use diesel-electric hybrid systems in which diesel motors operating as generators can be isolated in the center of the ship, while low noise electric motors can be placed where needed (e.g., propeller shaft) (Phipps, 2012). These options are still being explored and developed by the industry, and OMAO has not finalized plans to pursue any specific quieting design or operational goal.

Impacts of Alternative B on the acoustic environment throughout the action area would be similar to those discussed above under Alternative A for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be lower due to the introduction of new ships and quieting technology. Sound produced by OMAO operations under Alternative B would not cause long-term changes in the airborne or underwater acoustic environments and would not substantially increase or differ in intensity as compared to Alternative A. Overall, impacts on the acoustic environment under Alternative B would be **adverse**, **localized** to **regional**, **temporary** to **short-term**, and **minor**, and therefore insignificant.

3.5.2.3 Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

OMAO operations under Alternative C would implement the same measures as under Alternative B and take place in the same operational areas and timeframe as under Alternatives A and B; however, Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B with additional measures including: maximizing crew productivity and enhancing overall fleet performance by increasing DAS by 735 beyond Alternative B levels, construction of two new ships in addition to those under Alternative B, increasing the number and use of uncrewed systems integrated into vessels, and shortening the timeframe for fleet improvement activities, implementation of greening techniques, and improvements to the small boat fleet as discussed in Section 2.5. As such, effects under Alternative C would incrementally increase from those of Alternatives A and B but would not differ fundamentally in type.

Impacts from OMAO operations on the airborne acoustic environment for people aboard a vessel, onshore or nearshore, and wildlife onshore or nearshore would occur under Alternative C from the same activities as those under Alternatives A and B. Similarly, impacts from OMAO operations on the underwater acoustic environment would occur under Alternative C from the same activities as those under Alternatives A and B. Although the number of DAS would be greater under Alternative C than under Alternatives A and B, the additional DAS would be distributed across the five operational areas. 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 intensity of the impacts. Additionally, new vessels would integrate new and greener technology that would likely incorporate quieter designs, thus reducing impacts to the airborne and underwater acoustic environments. As under Alternative B, as described in the NOAA Ocean Noise Strategy Roadmap, NOAA would continue to support vessel quieting improvements and "green ship" development, in which new ships are built or existing ships are modified to include quieting in design and operational goals (NOAA, 2016). OMAO has not finalized plans to pursue any specific quieting design or operational goal.

Impacts of Alternative C on the acoustic environment throughout the action area would be similar to those discussed above under Alternatives A and B for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be lower due to the introduction of new ships and quieting technology. Sound produced by OMAO operations under Alternative C would not cause long-term changes in the airborne or underwater acoustic environments and would not substantially increase or differ in intensity as compared to Alternative A and B. Overall, impacts on the acoustic environment under Alternative C would be **adverse**, **localized** to **regional**, **temporary** to **short-term**, and **minor**, and therefore insignificant.

3.6 HABITATS

This section describes the effects of OMAO vessel operations on definable habitat types throughout the action area. This section also discusses Essential Fish Habitat (EFH) as defined by the MSA.

3.6.1 Affected Environment

Important 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, 2021a).

Five habitat types can be found in the action area: freshwater, estuarine, shallow marine, oceanic, and terrestrial. **Figure 3.6-1** illustrates and describes the physical characteristics for each of these five habitats as defined for the purposes of this analysis. EFH, which occurs in all habitat types, is also discussed below.

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 (including anadromous and catadromous) fish species are those that spend a portion of their life cycle in both fresh water and salt water. Anadromous fish species like the salmon 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. Catadromous fish like the American eel spend most of the adult phase of their life cycle in fresh water but must return to the ocean to spawn. 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 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, usually 200 nm (370 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.

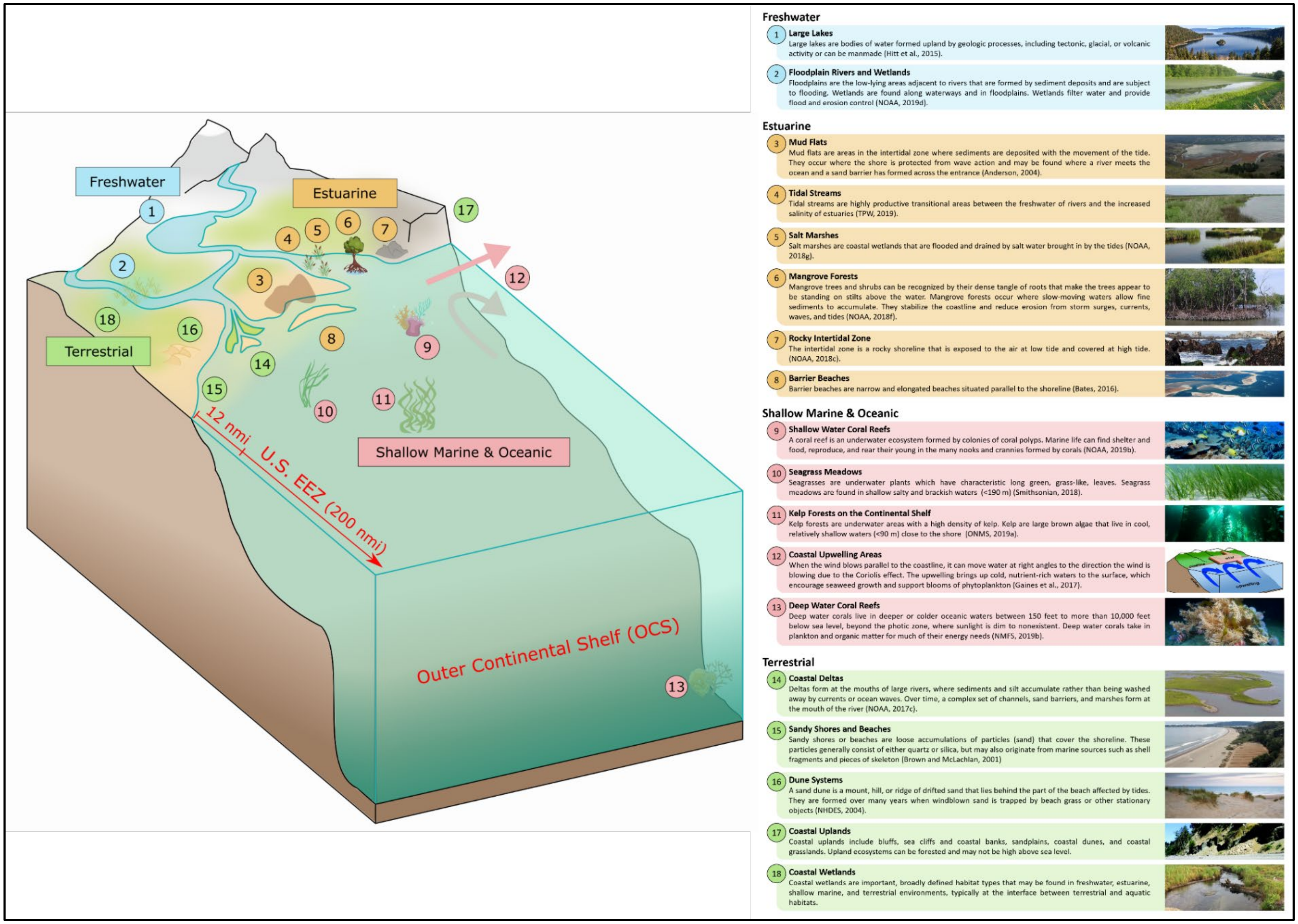
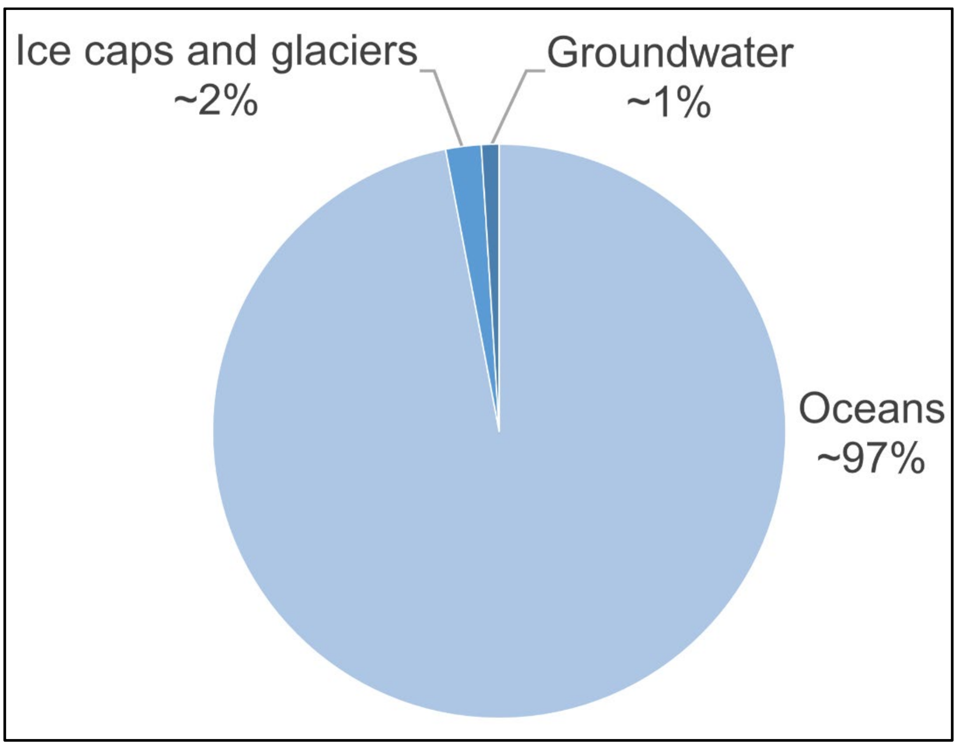


Figure 3.6-1. Habitat Types and Features Present in the Action Area

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.

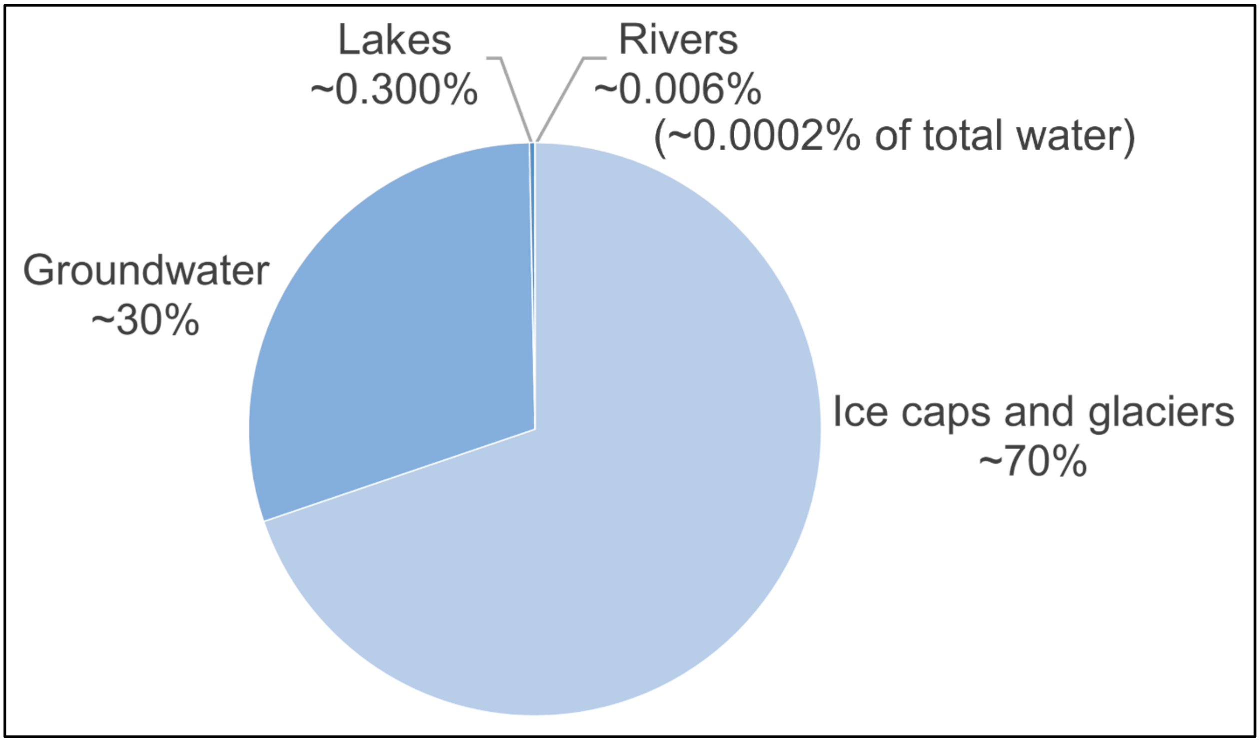
3.6.1.1 Freshwater Habitat

Freshwater habitat types consist of rivers, marshes, streams, lakes and ponds that do not have any saltwater concentration. There is a limited quantity of fresh water available globally to support freshwater habitats. Only three percent of the Earth's water is fresh water, as shown in **Figure 3.6-2**. Of this three percent, only a very small proportion 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 3.6-3**). Freshwater lakes and rivers make up approximately 0.3 percent of total fresh water on the planet and compose such a small proportion of total global water composition that they are not visible in **Figure 3.6-2**.



Source: Hitt et al., 2015

Figure 3.6-2. Global Composition of Water



Source: Hitt et al., 2015

Figure 3.6-3. Global Composition of Fresh Water

Despite their limited availability, freshwater habitats support a substantial number of described species, as shown in **Table 3.6-1**, and are extremely important ecologically (Hitt et al., 2015). 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 3.6-1. 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 types 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 phosphorus condition also declined (i.e., phosphorus 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).

3.6.1.2 Estuarine Habitat

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 aquatic macroinvertebrates, fish, and birds. Because of their restricted water circulation and exchange, these areas are particularly sensitive to human activities occurring on surrounding lands**.** For example, diking, filling, and other human activities have adversely 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 Regions (GARs) (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 3.6-4**. High concentrations of pollutants such as nitrogen and phosphates can potentially spawn algal blooms within estuaries, which reduce DO, increase turbidity, and generally degrade the habitat value of affected waters.

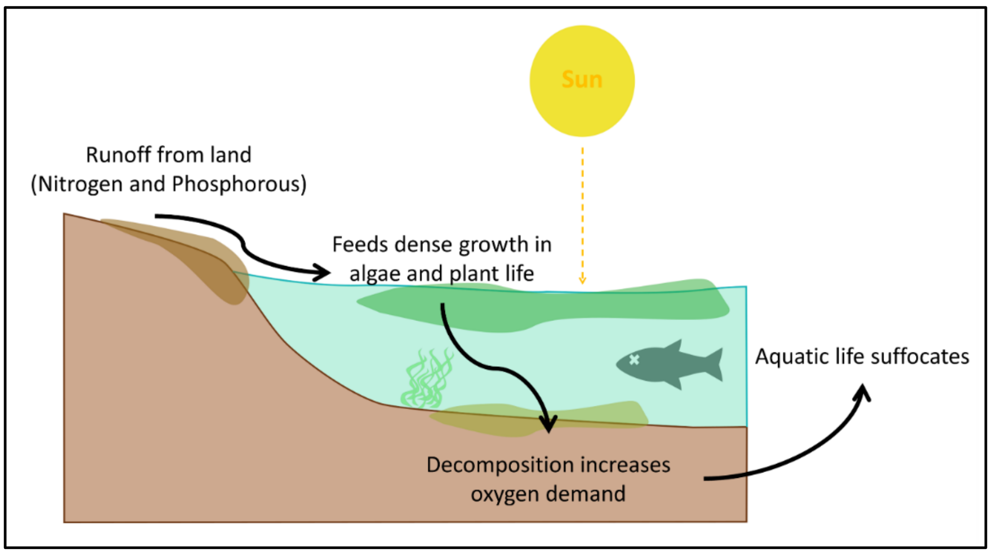
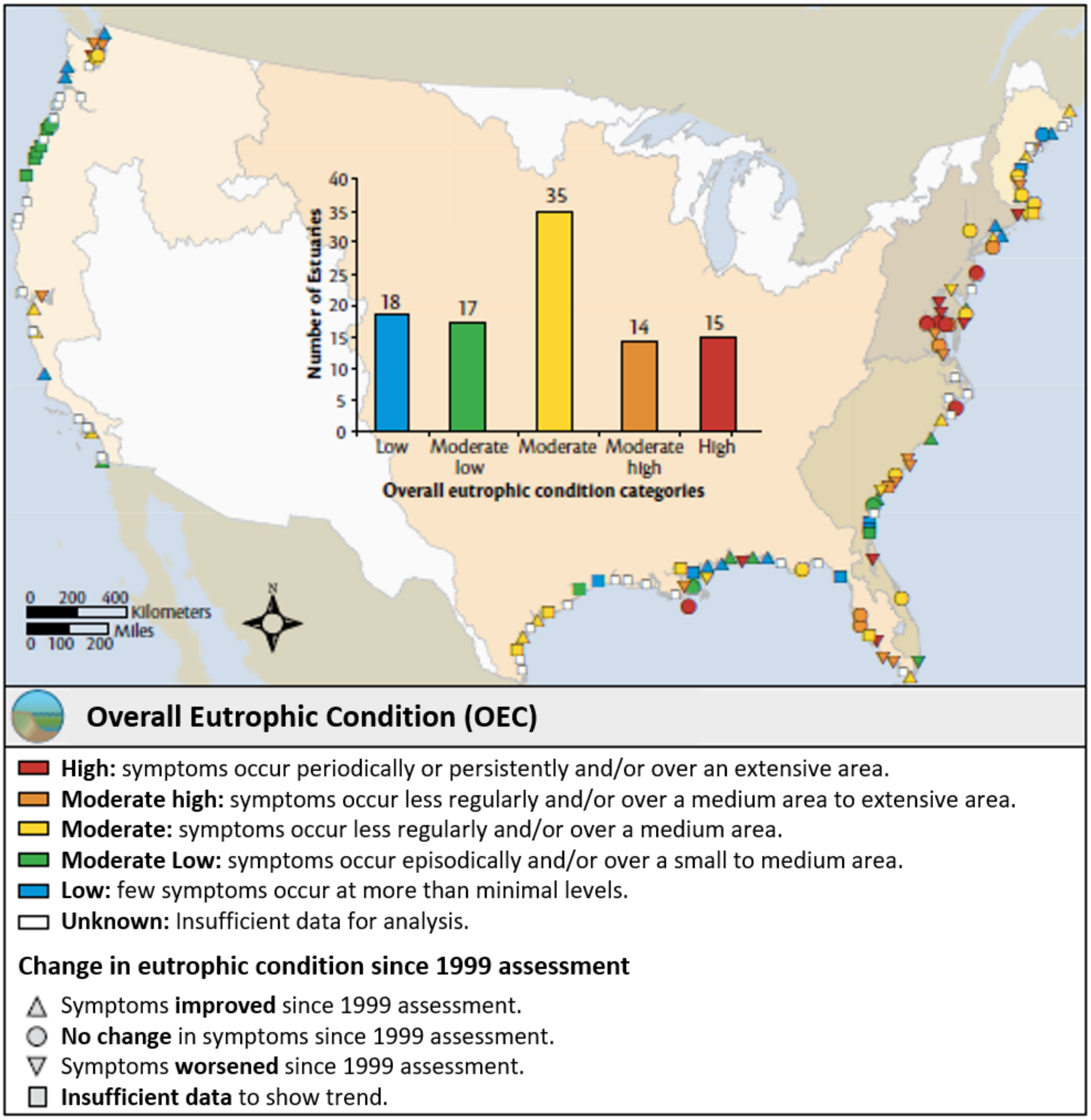


Figure 3.6-4. Eutrophication Process

The 2007 National Estuarine Eutrophication Assessment (Bricker et al., 2007) has characterized the overall eutrophication condition (OEC) 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 DO, and submerged aquatic vegetation loss. **Figure 3.6-5** depicts the eutrophication status of the major estuarine habitats in the continental U.S.



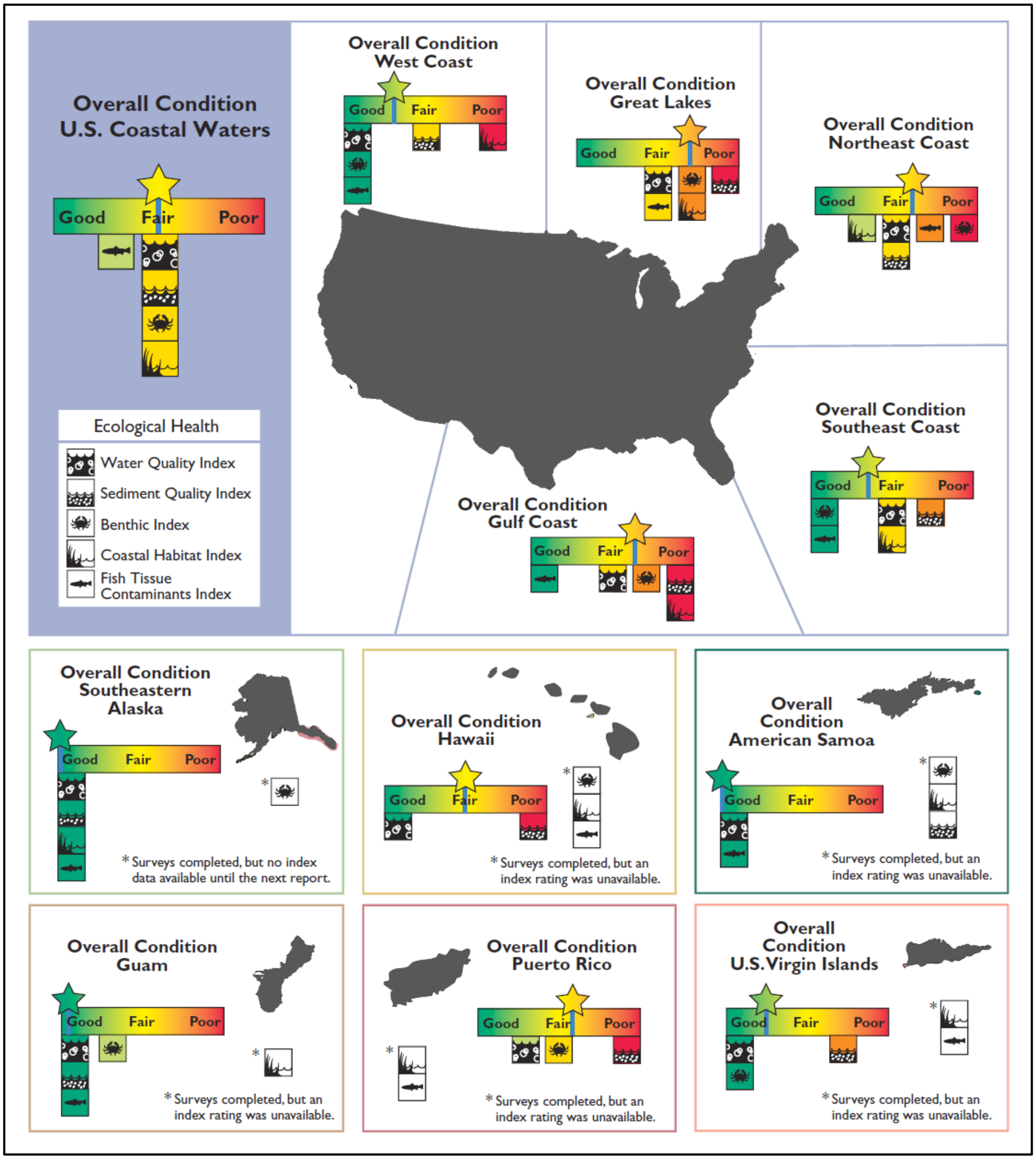
Source: Bricker et al., 2007

Note: Data for Alaska and Hawaii are not available.

Figure 3.6-5. Eutrophic Habitat Condition of Major U.S. Estuaries

3.6.1.3 Shallow Marine and Oceanic Habitat

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’ (EPA, 2012). Regional coastal water condition ratings from the NCCR IV are depicted in **Figure 3.6-6**.



Source: EPA, 2012

Figure 3.6-6. Shallow Marine Habitat Condition by Location

The West Coast Region (WCRs), Southeastern Alaska Region (AK), and Pacific Islands Regions (PIR) 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 GARs and Southeast Regions (SERs) are considered 'fair' (EPA, 2012).

3.6.1.4 Coastal Wetlands

Coastal wetlands include saltwater, 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; freshwater, brackish, or saltwater; and occur in close proximity to freshwater, 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 3.6-1.**

Coastal wetlands comprise roughly one third of all wetlands in the U.S. Within the EEZ, the AR has the highest quality coastal wetlands, whereas coastal wetlands in the WCR 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, the rate of wetland loss has decreased. Wetland loss is now at a level that is three 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 3.6-2** summarizes coastal wetland losses in the U.S.

Table 3.6-2. Coastal Wetland Losses

Coastal Wetland Type	Timeframe/ Quantity Lost (acres)	Notes
All Coastal Watershed Wetlands	2004-2009/360,000	36% 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
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
Freshwater	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

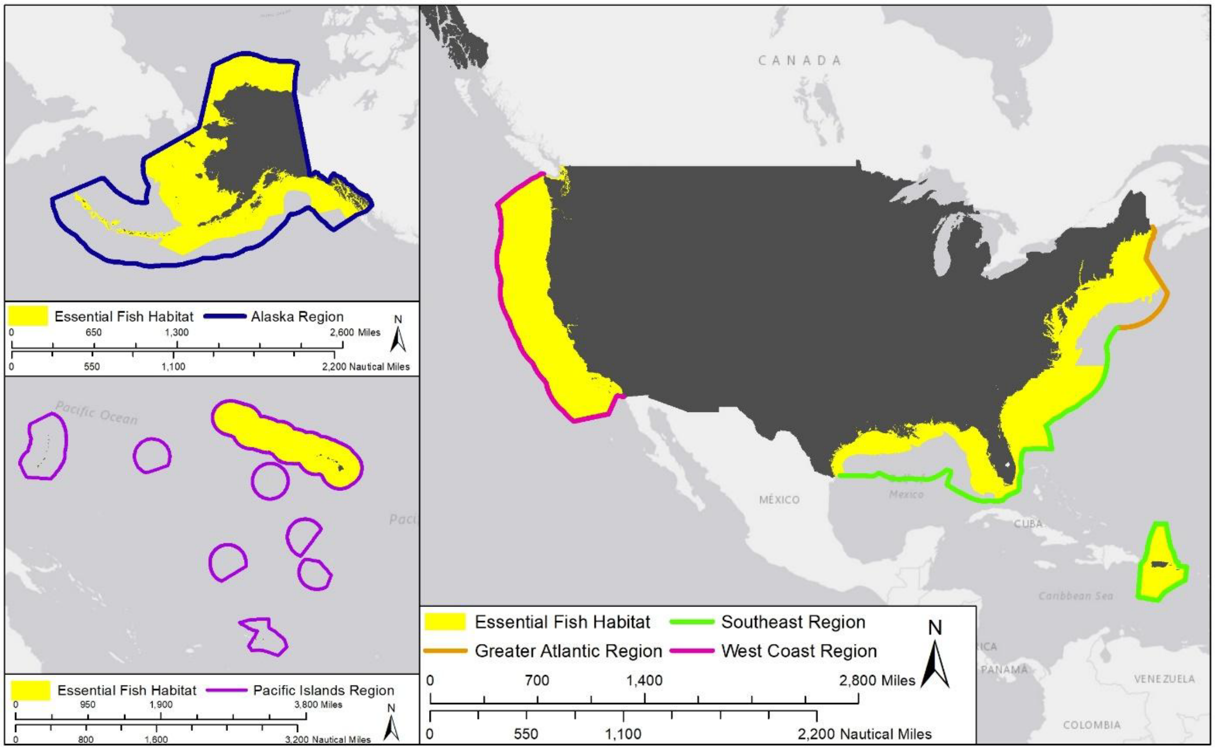
3.6.1.5 Essential Fish Habitat

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 1996 reauthorization, the National Marine Fisheries Service (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, 2014).

EFH is defined as "those waters and substrate necessary for fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C §1802 [10]). The MSA implementing regulations (50 CFR Part 600) further define the term "essential fish habitat." For the purposes of EFH, waters 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;" substrates include "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 means "any 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 (50 CFR § 600.10). Ecologically, EFH comprises waters and substrates 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 has been designated for more than 1,000 managed species to date.

Under Section 305(b)(2) of the MSA, federal agencies must consult with NMFS on all actions or proposed actions authorized, funded, or undertaken by them that may adversely affect EFH. As noted in Table 1.4-1, OMAO intends to consult with NMFS regarding potential adverse effects of the Proposed Action on EFH.

The operating areas in the Proposed Action and alternatives extend 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 habitats such as rivers, ponds, and wetlands. **Figure 3.6-7** shows the large extent of EFH as it covers most of the U.S. EEZ.



Source: NMFS, 2021a

Photo Credit: NMFS

Figure 3.6-7. EFH in the U.S. EEZ

FMPs may also identify Habitat Areas of Particular Concern (HAPCs) within EFH. HAPCs are discrete subsets of EFH and comprise specific sites or habitat types that are of particular concern based on one or more considerations: (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and (4) the rarity of the habitat type (50 C.F.R. §600.815 (a)(8)). More than 100 HAPCs have been identified across all regions. Several FMCs have designated discrete habitat areas as HAPCs, while others have broadly designated all areas of a specific habitat type as HAPCs.

EFH has been designated in the waters inside of the 320-km (170-nm) U.S. EEZ boundary in the eight FMC regions. EFH for each region is described below by text and a map. Each of the FMCs have 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, 2021a).

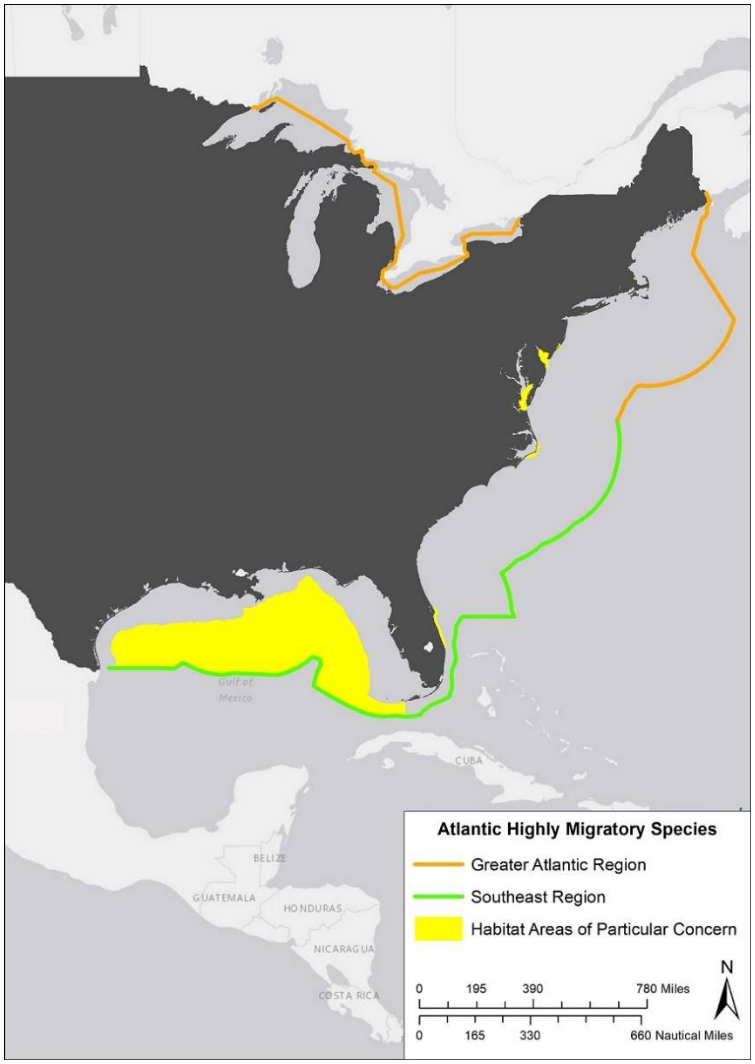
3.6.1.5.1 Regional Distribution

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) in the Atlantic such as Atlantic tunas, sharks, blue marlin, white marlin, sailfish, 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 Atlantic HMS. NMFS has identified geographic areas, rather than specific habitat types as EFH for these fisheries (see **Table 3.6-3** and **Figure 3.6-8**). Detailed descriptions of EFH and HAPC designations for Atlantic HMS are available in the Atlantic HMS FMP (NMFS, 2023a).

Table 3.6-3. EFH and HAPCs for Atlantic HMS

Fisheries	EFH	HAPC
Atlantic 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; and the Outer Banks off North Carolina; and Titusville to Jupiter off the Florida coast.

Source: NMFS, 2023a



Source: NMFS, 2021a

Figure 3.6-8. HAPCs for Atlantic HMS

3.6.1.5.1.1 Greater Atlantic Region

Two FMCs occur in the GAR: 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, 2023; MAFMC, 2023). EFH for HMS occurring in the GAR, including blue marlin, white marlin, and sailfish, are discussed above in Section 3.6.1.5.1 and shown in **Table 3.6-3**. For aquatic macroinvertebrates, EFH has been designated 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, 2021a).

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 GAR EEZ have been designated as EFH for 15 different fisheries managed by the New England and Mid-Atlantic FMCs (see **Table 3.6-4**). 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 SER); 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 3.6-4** and shown in **Figure 3.6-9** and include all canyon HAPCs and seamount 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, 2023; MAFMC, 2023).

Table 3.6-4. EFH and HAPCs for the GAR

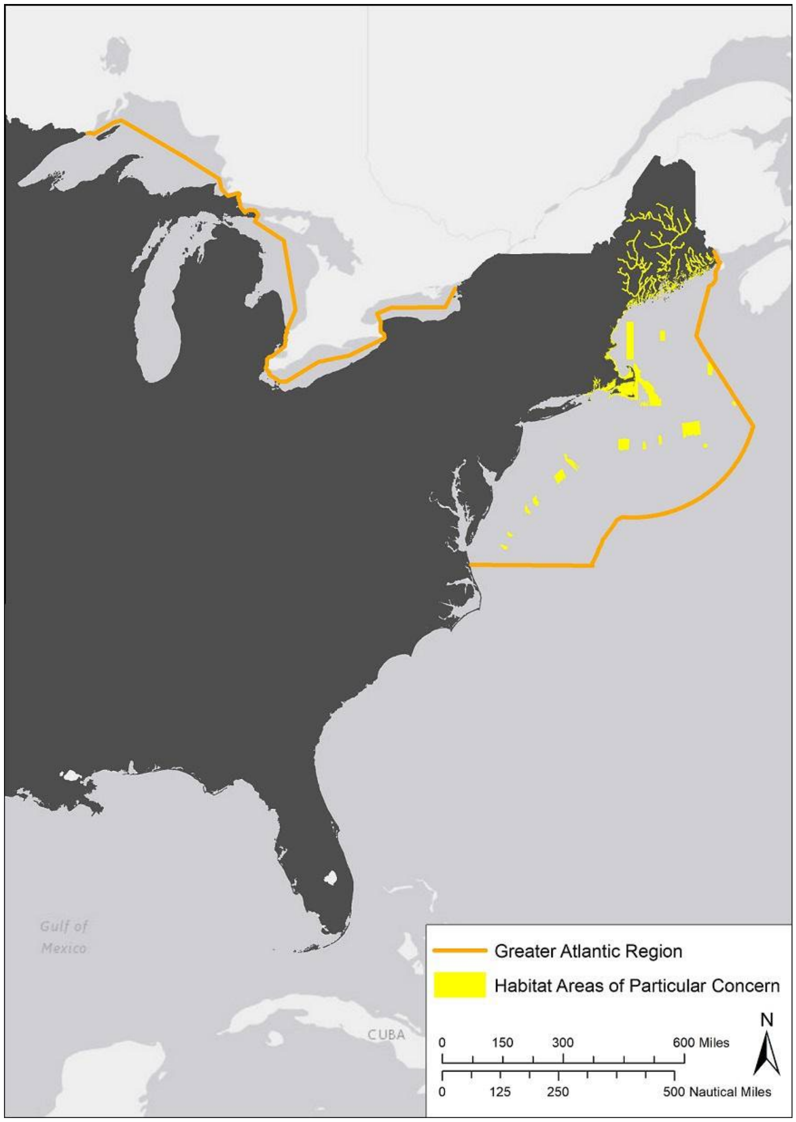
Fisheries	EFH	HAPC
New England		
Northeast Multispecies (Groundfish)	Overall: pelagic waters down to 1,250 m (4,101 ft) depth that meet certain temperature and salinity regimes, and bottoms down to 700 m (2,297 ft) depth supporting aquatic vegetation; substrates of soft mud, clay, sand, or gravel; and rough or rocky bottom locations along slopes of the outer banks in Gulf of Maine, Georges Bank,	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

Fisheries	EFH	HAPC
	southern New England, middle Atlantic south to Cape Hatteras, North Carolina; also, a range of estuaries along the coasts.	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, 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 substrates 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 substrates 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, 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.

Fisheries	EFH	HAPC
Skates	Overall: down to 750 m (2,461 ft) depth of soft substrates, including sand and mud bottoms, mud with echinoid and ophiuroid fragments, broken shells, and shell and pteropod ooze; and substrates of gravel and pebbles on offshore banks of the Gulf of Maine, Georges Bank through the Mid-Atlantic Bight to Cape Hatteras, North Carolina.	None
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 bottoms that are 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*.

Fisheries	EFH	HAPC
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 latitudes 29° north and 40° north; also, a range of estuaries along the coasts.	None
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 New England and Mid-Atlantic		
Monkfish	Overall: coastal and offshore waters to the EEZ limit that meet certain temperature and salinity ranges, and bottoms 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, 2023; MAFMC, 2023
*Note that some EFH and HAPC designations extend into the SER.

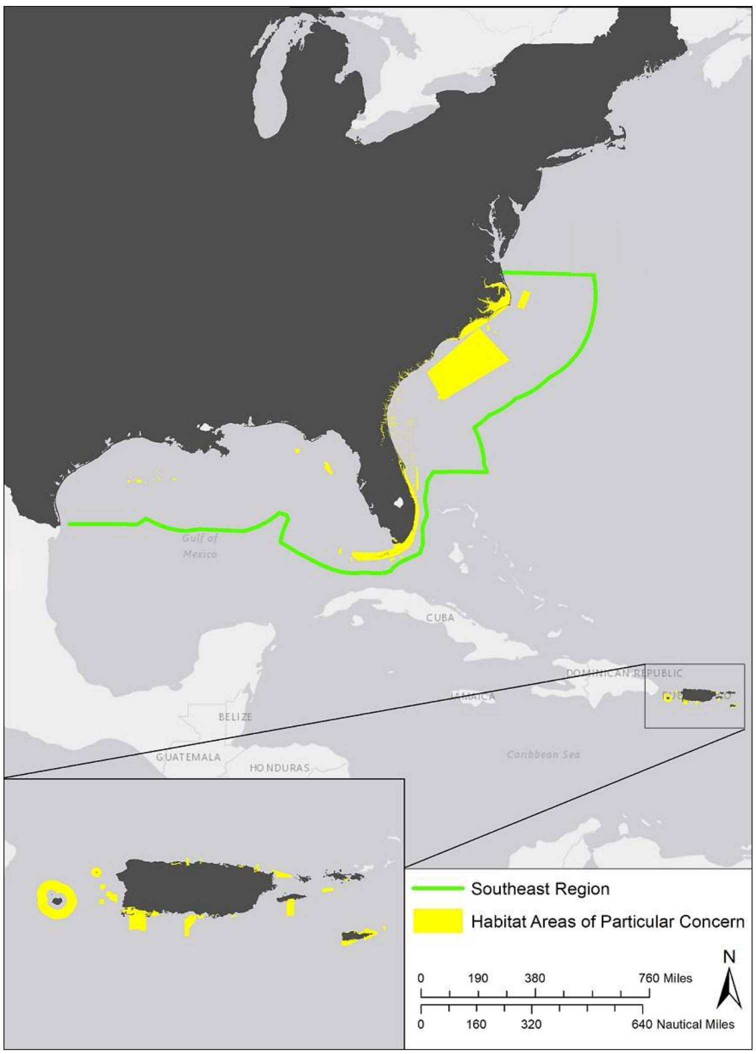


Source: NMFS, 2021a

Figure 3.6-9. HAPCs in the GAR

3.6.1.5.1.2 Southeast Region

Three FMCs occur in the SER: 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, 2023; CFMC, 2023). EFH for HMS occurring in the SER, including blue marlin, white marlin, and sailfish, are discussed above in Section 3.6.1.5.1 and shown in **Table 3.6-3**. 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 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 SER is discussed below for each FMC area: South Atlantic, Gulf of Mexico, and Caribbean. HAPCs in the SER are mapped in **Figure 3.6-10**.



Source: NMFS, 2021a

Figure 3.6-10. HAPCs in the SER

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 3.6-5**). 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/man-made 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 3.6-5**. HAPCs include: coastal inlets and Atlantic coast estuaries; pelagic and benthic sargassum; various discrete sites, bays, and sounds; MPAs and ridges; state-designated nursery habitats; various hard bottom 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 FMC's multiple FMPs (SAFMC, No Date).

Table 3.6-5. EFH and HAPCs for the SER - South Atlantic

Fisheries	EFH	HAPC
Coral, Coral Reefs, and Live/Hard Bottom	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.	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 NMS; eight deepwater Snapper Grouper 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;
Dolphin and Wahoo	Overall: Gulf Stream in the Atlantic EEZ; Charleston Gyre, Florida Current, and pelagic sargassum.	
Golden Crab	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.	
South Atlantic Shrimp	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	

Fisheries	EFH	HAPC
	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.	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; various hard bottom areas from 0-30 m depth (0-98 ft); irregular bottom comprising troughs and terraces intermingled with sand, mud, or shell hash bottoms; 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.
Snapper-Grouper	Overall: coral reefs, live/hard bottom, macroalgae, estuarine emergent vegetated wetlands (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.	
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	Overall: nearshore shelf/oceanic waters; shallow subtidal bottom;	

Fisheries	EFH	HAPC
Gulf of Mexico and South Atlantic FMCs	seagrass habitat; unconsolidated bottom; coral and live/hard bottom habitat; sponges; algal communities; mangrove habitat; and the Gulf Stream.	

Source: SAFMC, No Date

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 3.6-6**). 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 3.6-6**. These areas predominantly contain living coral reefs or hard bottom habitats 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 FMC's multiple FMPs (Gulf Council, 2023).

Table 3.6-6. EFH and HAPCs for the SER – 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 bottoms 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
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	

Fisheries	EFH	HAPC
	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]).	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, West Florida Wall, The Edges, and the Viosca Knolls (826 and 862/906).
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 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]).	
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	Overall: Gulf of Mexico waters and substrates extending from the U.S./Mexico	

Fisheries	EFH	HAPC
and Cobia) – Managed jointly by the Gulf of Mexico and South Atlantic FMCs	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]).	
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, 2023

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 3.6-7**). 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 3.6-7**, 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 FMC's multiple FMPs (CFMC, 2023).

Table 3.6-7. EFH and HAPCs for the SER – 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. 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 bottoms 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, 2023

3.6.1.5.1.3 West Coast Region

One FMC occurs in the WCR: 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-a). 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 managed by the Pacific FMC (see **Table 3.6-8**). 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; and seamounts in depths greater than 3,500 m (11,483 ft). Within these boundaries, one or more of the federally managed species are associated with water temperature regimes bounded by 13 degrees Celsius (°C) and 31°C; (55 degrees Fahrenheit [°F] and 88 °F) oxygen saturation levels greater than 60 percent; and different prey such as anchovies, squid, and herring. 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 species of salmon, groundfish, coastal pelagic, and/or HMS.

HAPCs in the WCR have been designated for two of the fisheries, defined primarily as habitat types as listed in **Table 3.6-8** and shown in **Figure 3.6-11**. For salmon, HAPCs include complex channels and floodplain habitats, thermal refugia, spawning habitat, estuaries, and marine and estuarine submerged aquatic vegetation. For groundfish, HAPCs offshore from each of the states 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.

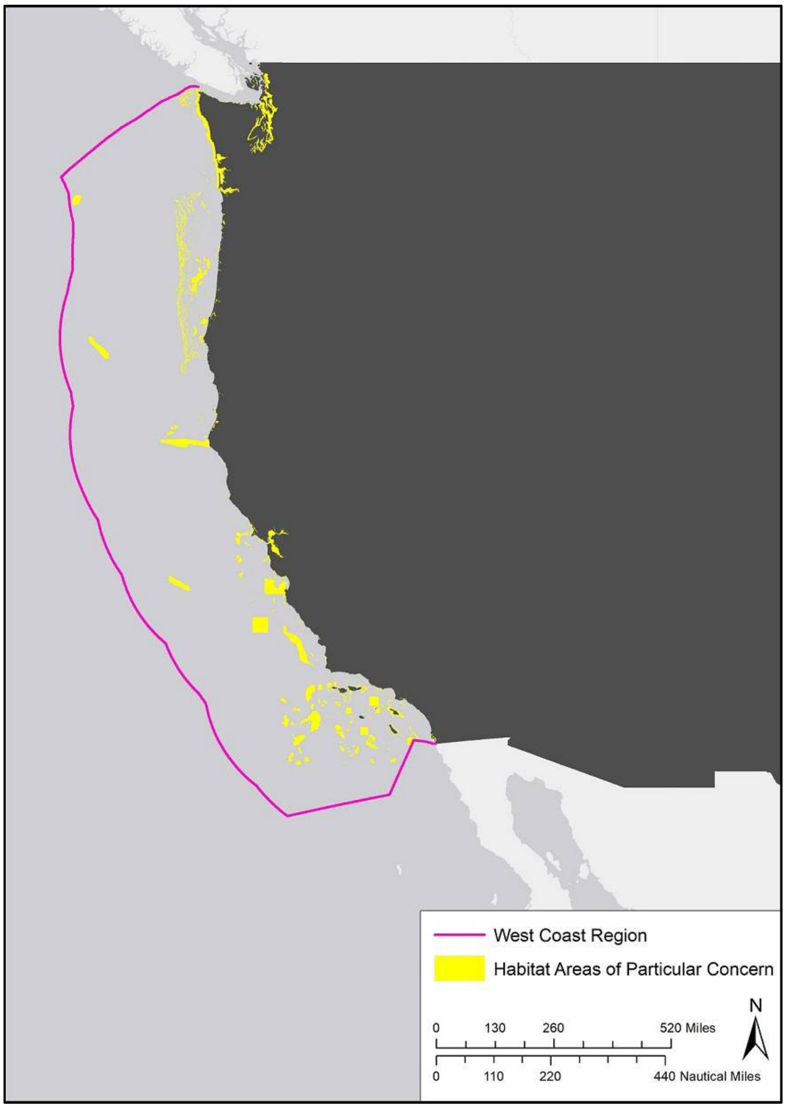
Detailed descriptions of EFH and HAPC designations in the WCR are available in the Pacific FMC's four FMPs (PFMC, No Date-a).

Table 3.6-8. EFH and HAPCs for the WCR

Fisheries	EFH	HAPC
Pacific Coast Salmon	Overall: all freshwater 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 (MHHWL) 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 Geographic Information System (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 bottoms 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.
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.

Fisheries	EFH	HAPC
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, 2021



Source: NMFS, 2021a

Figure 3.6-11. HAPCs in the WCR

3.6.1.5.1.4 Alaska Region

One FMC occurs in the AR: 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, 2023). In Alaskan waters of the Bering Sea and Aleutian Islands, EFH for aquatic macroinvertebrates has 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 habitats 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 North Pacific FMC (see **Table 3.6-9**). All marine waters above the entire continental shelf, slope, and deep basins off the coast of Alaska including the GOA, Bering Sea and Aleutian Islands (BSAI), Chukchi Sea, and Arctic Ocean from the mean high 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 groundfish, GOA groundfish, BSAI crab, salmon, scallops and/or Arctic fisheries species. The various substrate types across the continental shelf, slope, and basins above which the 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 AR have been designated for one or more of the fisheries using a site-based approach as listed in **Table 3.6-9** and shown in **Figure 3.6-12**. 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 AR are available in the North Pacific FMC's six FMPs (NPFMC, 2023).

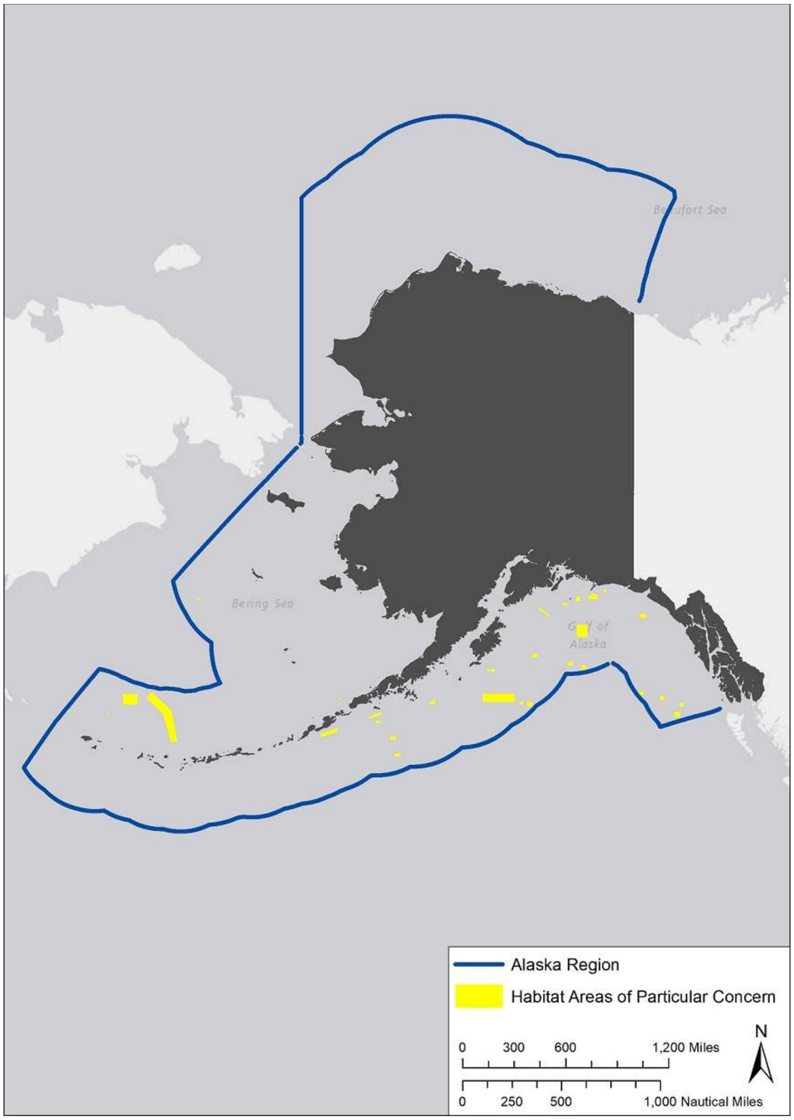
Table 3.6-9. EFH and HAPCs for the AR

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 substrates 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 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 deepwater pinnacles.	Aleutian Islands Coral Habitat Protection Areas: Great Sitkin 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

Fisheries	EFH	HAPC
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 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	Aleutian Islands Coral Habitat Protection Areas Aleutian Islands Habitat Conservation Area: the entire Aleutian Islands groundfish management subarea

Fisheries	EFH	HAPC
	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.	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 there are substrates consisting mainly of mud.	None – no HAPC has been designated for the arctic fishery in this region.

Source: NPFMC, 2023



Source: NMFS, 2021a

Figure 3.6-12. HAPCs in the AR

3.6.1.5.1.5 Pacific Islands Region

One FMC occurs in the PIR: 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 3.6-13**) 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*), mahimahi (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*), blue marlin (*Makaira nigricans*), swordfish (*Xiphias gladius*), and sharks (Selachimorpha) (WP Council, 2019). EFH for aquatic macroinvertebrates has been designated 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 3.6-10**). EFH includes the entire water column from 0 to 1,000 m (0 to 3,281 ft) depth from the shoreline out to the EEZ limit, and all bottoms from the shoreline down to 700 m (2,297 ft) depth around each of the U.S. Pacific Islands, which are designated as EFH for the eggs, larvae, juveniles and/or adults of one or more of the coral reef ecosystem, bottomfish, crustacean, precious coral, and/or pelagic fisheries species. The habitat 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 3.6-13. Coral Reef EFH in the PIR

Photo Credit: NMFS

The definitions for EFH in the PIR 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).

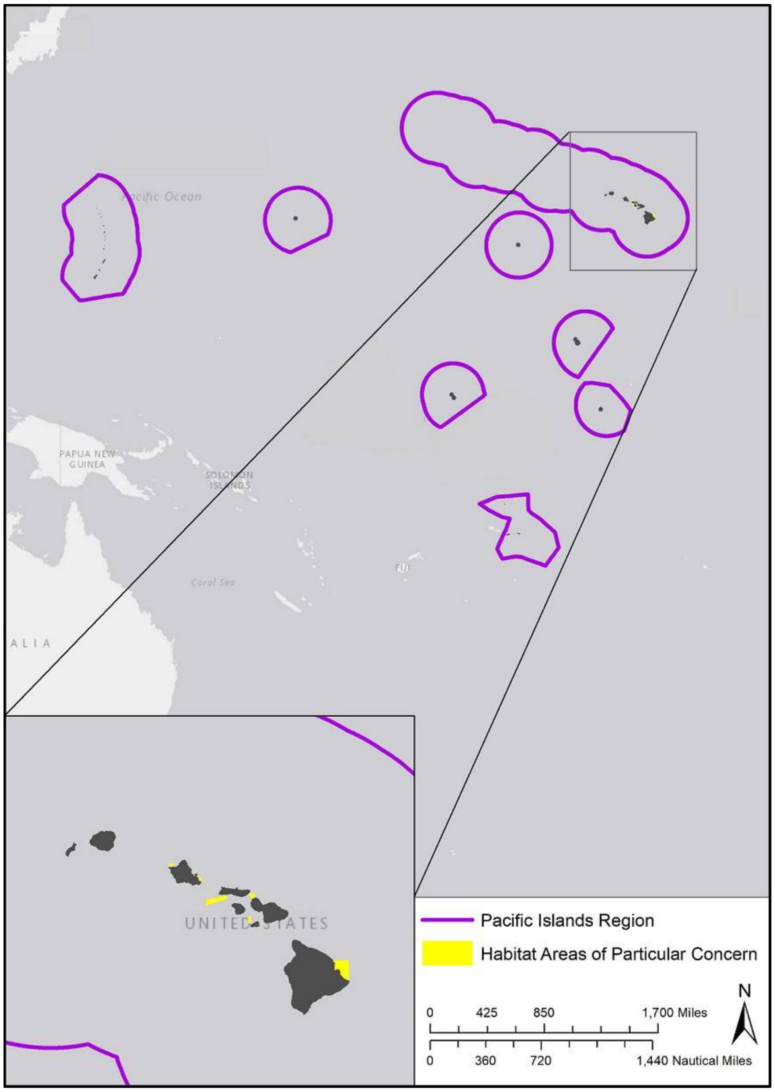
HAPCs have been designated for all fisheries primarily defined in terms of habitat types within defined depth contours as listed in **Table 3.6-10** and shown in **Figure 3.6-14**. HAPCs include the water column habitat, escarpments/slopes, banks with summits, MPAs, and research sites.

Detailed descriptions of EFH and HAPC designations in the U.S. PIR are available in the Western Pacific Regional FMC's five place-based Fishery Ecosystem Plans (FEPs) for the American Samoa Archipelago, Hawaii Archipelago, Mariana Archipelago, Pacific Remote Island Areas, and Pacific Pelagic fisheries (WP Council, 2019). 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, 2021).

Table 3.6-10. EFH and HAPCs for the PIR

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 habitats 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 habitats 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 of Oahu and one off of 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 habitats 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, Westpac bed, Brooks Bank, and 180 Fathom Bank; three black coral beds between Milolii and South Point on Hawaii, Auau Channel between Maui and Lanai, and the southern border of Kauai.	Makapuu bed, Westpac bed, Brooks Banks bed; for Black Corals, the Auau Channel.
Coral Reef Ecosystem: Pacific Remote Island Areas region	Overall: water column and all benthic substrates 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.	Water column 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.

Source: WP Council, 2019; WP Council, 2021



Source: NMFS, 2021a

Figure 3.6-14. HAPCs in the PIR

3.6.2 Environmental Consequences

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 Table 2.1-1 and in Section 2.2 that occur during OMAO vessel operations and could be expected to have impacts on habitat characteristics in the action area include vessel movement; anchoring; waste handling and discharges; active acoustic systems operations; operation of other sensors and data collection systems; Uncrewed Systems (UxSs) or Uncrewed Marine Systems (UMSs) operations; UAS operations; and small boat systems operations.

Impacts on habitat from vessel repair and maintenance; and OTS handling, crane, davit, and winch operations are not expected to occur and are not discussed further in this section.

OMAO operations could impact habitat characteristics in the action area through: (1) physical impacts to bottom substrate (e.g., from anchoring and operation of other sensors and data collection systems - specifically grab samplers and sediment corers); (2) increase in sedimentation, turbidity, and/or chemical contaminants (e.g., from vessel movement, anchoring, waste handling and discharges, UxS or UMS, operation of other sensors and data collection systems - specifically grab samplers and sediment corers, and small boat systems); (3) increased ambient sound levels (e.g., from vessel movement, active acoustic systems, UxS or UMS, UAS, and small boat systems); (4) facilitated dispersal of invasive species (e.g., from ballast water discharged during vessel movement; organisms attached to hulls, equipment, anchors, UxS or UMS, and small boats; and waste handling and discharges); and (5) impacts to the water column (e.g., from vessel movement, anchoring, UxS or UMS, operation of other sensors and data collection systems, and small boat systems).

Note that use of the term “sea floor” below also includes lake and river bottoms where OMAO vessel operations could occur.

3.6.2.1 Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Under Alternative A, OMAO vessel operations using the existing NOAA fleet would continue across all five operational areas over the 15-year period in all habitat types. In addition, OMAO is constructing two oceanographic research vessels that are expected to come online by 2025 and two new charting and mapping vessels that are expected to come online in 2027 and 2028 for a total of four new ships under Alternative A. OMAO would provide a maximum annual capacity of 3,568 operational DAS for scientific projects.

3.6.2.1.1 Physical Impacts to Bottom Substrate

Anchoring and operation of other sensors and data collection systems (specifically grab samplers and sediment corers) could physically impact bottom substrate in freshwater, estuarine, shallow marine, and oceanic habitats as well as EFH and HAPCs, potentially degrading the habitat value to dependent species.

Anchoring of vessels and testing of bottom grab samplers and sediment corers could potentially cause damage to bottom substrate in all aquatic habitat areas by reducing available structure, cover, and nutrient/food availability for dependent species. Anchors and equipment, or their attached chains/lines could drag across or create holes and divots in bottom substrates, potentially damaging or destroying underwater vegetation or sea floor structure. This alteration of underwater structure could reduce the availability of shelter and cover necessary for the survival and development of offspring 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, however, would not be a common practice. Only large vessels would typically anchor during OMAO operations, while the small boats and launches would typically return to port or to the ship each day. Most vessels would not anchor except in case of emergency, such as to avoid adverse weather conditions or in the unlikely event of an engine malfunction. Vessels would use designated anchorage areas when available; if a designated anchorage area is not available, vessels would not anchor on coral reefs, and whenever possible would avoid anchoring in hard bottom areas and endangered seagrass and abalone areas that could be easily damaged. Preferred bottom types used for anchoring would mainly consist of more resilient sticky mud or sand as those characteristics allow the flukes of the anchor to dig into the bottom and hold the chain in place. Thus, sensitive habitat areas and their dependent species would be minimally impacted, if at all. Additionally, OMAO would not drag anchor chains and would ensure that anchors are properly secured so as to minimize bottom disturbance.

Testing bottom grab samplers and sediment corers would involve the targeted removal of sediment cores in shallow marine and oceanic areas. Grab samplers and sediment corers 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. OMAO 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 [in] area and 5 centimeters [cm] [2 in deep]), and avoidance of sensitive habitat areas, the physical disturbance of bottom substrate within aquatic habitat areas associated with testing bottom grab samplers and sediment corers is expected to be very small.

When deploying equipment or autonomous systems, stiffer line materials would be used for towing and kept taut during operations to reduce the potential for entanglement in bottom features such as coral habitat. Equipment such as Autonomous Underwater Vehicles (AUVs) would be programmed and operated to avoid sea floor disturbance during testing and training. While operating in shallow water, small boats would reduce speeds and proceed with caution to avoid bottom disturbance and critical habitat. OMAO also tests dropped and towed cameras approximately 1 m (3 ft) above the sea floor, avoiding contact with bottom substrate to the extent possible. Thus, there impacts to habitat from deploying equipment or autonomous systems would not be expected.

The impacts from anchoring and testing bottom grab samplers and sediment corers under Alternative A would infrequently disrupt small areas of bottom substrate in aquatic habitat areas. Any damage to bottom habitat would not have lasting effects 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). Since disruptions to the sea floor would be expected to occur predominantly in muddy or sandy substrates, which would recover relatively quickly, physical impacts to habitats, including EFH and HAPCs, would be **adverse**, **minor**, **short term**, and **localized**, with a **high** likelihood of occurrence, and therefore **insignificant**.

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

Vessel movement, anchoring, waste handling and discharges, operation of UMS, operation of other sensors and data collection systems - specifically grab samplers and sediment corers, and operation of small boat systems could potentially increase the sedimentation, turbidity, and/or chemical contamination of all aquatic habitat areas, including EFH and HAPCs throughout the action area, degrading their value to dependent species.

Vessel movement, UMS operations, and small boat systems operations, in conjunction with activities which physically contact bottom substrate (See 3.6.2.1.1) such as anchoring and testing of grab samplers and sediment corers, would increase sedimentation and turbidity from bottom sediments loosened through displaced water from movement of vessels, UMS, and small boats or from physical contact of equipment 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 in 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 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); it could further exacerbate impacts to habitat areas from reduced nutrient and cover availability. NOAA vessels, UMS, and small boats would be routed to avoid stirring up bottom sediments whenever possible, thus 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; sediment would likely settle back to the seafloor or dissipate with prevailing currents relatively quickly.

Operation of NOAA vessels, UMS, and small boats 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 decrease the food, structure, and shelter necessary for prey species to survive and would likely create cascading impacts throughout the entire food chain that reduce the overall biodiversity of the area. 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, 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 OMAO operations, and large spills are unlikely given the size of vessels, the amount of fuel, oil, and chemicals present onboard vessels, and the waste handling and discharge protocols that are in place. In the event that a spill occurs, spill response and clean up would be promptly initiated. Hazardous wastes and incinerator ash are never discharged overboard. Depending on distance from shore, food scraps may be macerated and discharged, and greywater and treated blackwater may be discharged overboard. Deck and equipment washdown water is discharged overboard, but the nature of the cleaner and the quantity of water used for washdown help dilute pollutants in the wastewater to a very minimal concentration. Bilge water cannot be discharged to the sea without treatment because it often contains oil. Discharge of ballast water follows all required environmental compliance procedures. For these reasons, and as discussed in more detail in Section 3.4, the likelihood of chemical contamination from NOAA vessels, UMS, and small boats would be relatively small. Additionally, impacts would be minimal, especially when compared to similar disturbance and discharges from the much greater numbers of all other vessels occurring in the action area.

Overall, increased sedimentation, turbidity, and chemical contamination from OMAO operations 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. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. As such, impacts to habitats, including EFH and HAPCs, from increased sedimentation, turbidity, and/or chemical contaminants under Alternative A would be adverse, but **negligible** to **minor**, **temporary**, **regional** or **localized** depending on whether the vessel is stationary or moving, and therefore **insignificant**. 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 and their adherence to discharge regulations. If a large spill did occur, impacts would be adverse, moderate, short term to long term, and regional, but still insignificant.

3.6.2.1.3 Increased Ambient Sound

Vessel movement, active acoustic systems operations, UMS and UAS operations, and small boat systems operations would increase the ambient sound level of affected aquatic habitats through the production of underwater and airborne sound. Increasing the ambient sound level could potentially degrade the habitat value of affected areas through impacts such as behavioral disruption or injury to biological resources. Underwater and airborne sound adversely affect 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 habitats, such as predator/prey interactions, as opposed to analyzing the impact on individual species or on the ambient soundscape. See Section 3.5 for discussion of potential impacts to the acoustic environment and Section 3.7 for discussion of the potential impacts on wildlife from OMAO operations.

Vessel movement, testing of UMS and UAS, and small boat operations would generate 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.

Operation of NOAA vessels, UMS and UAS, and small boats would be infrequent in any given area, and the exposure of prey species to sounds generated by these vehicles would be limited to the immediate vicinity of the source. Exposure to such sounds would only persist for the duration of vessel transit, testing of equipment, or operation of small boats through the habitat area. As such, prey species would only be temporarily exposed to the underwater or airborne sounds generated and likely would not change their behavior or habitat occupancy in the long term. Furthermore, OMAO operations would represent a very small proportion of vessel traffic in the action area; therefore, the potential effects of sounds from NOAA vessels would be minimal as compared to the aggregate effects from sound generated by all other ship traffic in the action area. Additionally, the launching and recovering of UMS and UAS and small boats for testing, calibrating, training, maintenance, and troubleshooting that OMAO is responsible for would only be conducted intermittently for short periods of time; thus, sounds generated by these operations would be temporary and spread across locations throughout the action area. Therefore, the overall contribution to background sound in the ocean from NOAA vessels, UMS and UAS, and small boats would be very small. It would be unlikely that the exposure of prey species to these sounds would exceed levels and lengths of time that would result in more than minimal adverse effects. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Use of active underwater acoustic sources for testing, training, calibrating, and troubleshooting would involve producing repeated directional signals of short duration at relatively high frequencies which could increase the ambient sound environment of aquatic habitat areas. These instruments produce acoustic signals perceptible to several marine prey species; exposure to this sound could result in the same adverse impacts to shallow marine and oceanic habitat areas as those discussed above for sound generated by vessels, uncrewed marine systemsUxS or UMS, and small boats. However, aActive underwater acoustic sources would typically only beare operated while a ship is in motion to assist with safe navigation of the shipand for short periods of time for systems testing; 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 or attenuate through absorption into the environment. Therefore, impacts on marine prey species, if any, would be predominantly limited to temporary behavioral and stress-startle response, and would not be expected to impact the overall habitat quality of any given area.

Sound from vessel operations, UMS and UAS, and small boats, which would be generated in the mid- and low-level frequencies, is within the hearing range of most prey species, but would be infrequent, geographically widely distributed, and likely to elicit a minimal or temporary response from prey species. A majority of the sounds generated by underwater acoustic sources are well above the hearing frequencies of most prey species; thus, they are unlikely to cause behavioral disturbance and hearing impairment. Overall, OMAO operations under Alternative A that create underwater and airborne sound would have adverse, **negligible** to **minor**, **temporary**, impacts on habitat, including EFH and HAPCs. Impacts would be **regional** or **localized** depending on whether the vessel is stationary or moving. The overall impacts would, therefore, be **insignificant**.

3.6.2.1.4 Facilitated Dispersal of Invasive Species

Ballast water discharged during vessel movement; organisms attached to hulls, equipment entering the water, anchors, UMS, and small boats; and waste handling and discharges could carry aquatic species that could be invasive if transported to a new area. OMAO activities entail the use of the same physical equipment and instruments in geographically disparate operational areas, which could potentially facilitate the dispersal and establishment of invasive species. This would degrade habitat values for native marine species.

OMAO operations occur in all freshwater and marine operational areas and can potentially involve transits across large swaths of the action area using the same physical equipment and instrumentation. These longer transits 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 (Gregory, 2009). Invasive species attached to hulls, contained in washdown water, or contained in untreated ballast water could be released into surrounding waters causing infestation where none currently exists. 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 native or locally endemic species for space and nutrients (TISI, 2014).

Ballast water, or water managed aboard vessels to help maintain stability and maneuverability, could physically transport invasive species from one area to another. This could potentially occur if uptake of ballast water occurs in one area of operation, and ballast water discharge occurs in a different area of operation and the discharge is not treated through a ballast water treatment system. Invasive species could also become attached or enmeshed to objects that enter the water or remain within the residual water on a recently submerged object. OMAO activities entail the use of the same physical equipment and instruments in geographically disparate operational areas. Therefore, anchors, sensors and data collection systems, UMS, small boats, and any other type of deployment equipment, instruments, or gear that enters the water and is recovered onboard the ship could be a potential vector for invasive species. Furthermore, the unauthorized or accidental discharge of wastewaters could disperse a wide variety of foreign microorganisms and pathogens that could be invasive in the environment they are introduced into.

Native species support the natural processes of their ecosystem, such as nutrient cycling, dissolved oxygen levels, light availability, pH, and sedimentation. Invasive species do not have natural predators in their new environment, which could allow them to outcompete native species for resources such as food, light, prey, and habitat. Replacing native species with invasive species would potentially disrupt the natural processes of that ecosystem, and alter the normal water quality conditions for that affected area (Heller, 2023). Invasive species can also spread disease from one area to another. Invasive species can come from places with higher diversity and could contain pathogens or diseases not found in the native species' range. This can cause the native species to be more vulnerable and susceptible to disease and mortality (NOAA, No Date-d), which would also disrupt the natural processes of the ecosystem they support. 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 could persist until all invasive organisms are removed from or controlled in a given area through aggressive trapping, harvesting, or use of pesticides. All OMAO operations would implement mandatory invasive species prevention procedures including, but not limited to, vessel and equipment washdown, cleaning, and ballast water handling as discussed below. Proper implementation of these procedures would prevent most equipment on board NOAA vessels from serving as exchange vectors for invasive species; however, the possibility for the transmission of some invasive species would likely still exist. OMAO 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.

In order to properly manage ballast and washdown waters and prevent or minimize the dispersal of invasive species, all NOAA vessels are required to comply with all OMAO policies and procedures. This includes all procedures related to ballast water management, specifically OMAO Procedure 'Ballast Water Management', which establishes the actions for the management of ballast water to ensure compliance with USCG and IMO regulations (OMAO, 2021a). This plan requires that all ships complete and follow a Ballast Water Management Plan to ensure their ballast is managed based on their ship's capabilities, and includes treatment and/or discharge procedures, record keeping, reporting, training, and contingency plans. It is common practice on all NOAA vessels to immediately washdown deployed equipment, instruments, or gear to ensure any species attached to that object is put directly back into its area of origin; this includes thoroughly washing down the anchors and anchor chains as they are being hauled up. Additional management practices also help ships minimize and prevent invasive species dispersal, such as minimizing and managing uptake of sediments during ballasting, cleaning chain lockers to remove sediments, and ballast water uptake and discharge restrictions by location and environmental condition. Antifouling systems and management practices are also required on all NOAA vessels, such as antifouling hull paint, hull cleaning practices, and piping antifouling systems (OMAO, 2021b). Each vessel must also abide by its NPDES VGP SSI, which indicates the responsible party, management practices, and related recordkeeping for invasive species management (OMAO, 2013c). Therefore, NOAA vessels would manage ballast water and other washdown water that could contain invasive species, and all vessels would be in compliance with all regulations, policies, and procedures related to ballast water and washdown water management to prevent or minimize any adverse impacts to habitat.

Under Alternative A, vessel movement, anchoring, waste handling and discharges, other sensors and data collection systems operations, UMS operations, and small boat operations would generate washdown water or require ballasting water that could facilitate the dispersal of invasive species that would potentially affect habitats. OMAO equipment and instruments used or tested consecutively in disparate operational areas could potentially serve as transmission vectors for invasive species which could reduce the habitat value in the area of introduction by outcompeting native and endemic plants, animals, and algae. This could adversely affect habitat requirements of some species for space, cover, sites for breeding, reproduction, and rearing and development of offspring. These impacts could potentially persist until invasive species are controlled or removed from these areas via aggressive management techniques and procedures. However, OMAO crews would implement all policies, procedures, and regulations related to ballast and washdown water management, limiting the potential impact of invasive species on habitats in the action area. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. However, adverse impacts on habitats, including EFH and HAPCs, from invasive species dispersal facilitated by OMAO operations under Alternative A are unlikely and would be **minor**, **short-** to **long-term**, **localized**, and therefore **insignificant**.

3.6.2.1.5 Impacts to the Water Column

Vessel movement; anchoring; UMS operations; operation of other sensors and data collection systems; and small boat systems operations could potentially impact or disturb the water column of habitat areas through the movement of vessels and equipment.

Wakes from vessels, UMS, and small boats 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 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. These disruptions would likely reduce the availability of space, shelter, and nutrients for dependent species within oceanic and shallow marine habitat areas and in EFH. 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 systems testing 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 deepwater routes (e.g., marked channels), as practicable.

Instruments, gear, and personnel that interact with the water column, including anchors and chains, non-acoustic systems (including Conductivity, Temperature, and Depth [CTD] sensors, hydrophones, magnetometers), drop/towed cameras, bottom grab samplers, and seawater collection equipment 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. The vast majority of impacts to habitat areas would be temporary as disturbance would be limited to the immediate vicinity of instruments and gear and would only persist for the duration of the activity. Mobile species would likely only be minimally displaced from areas of operation and would not experience long-term changes in the availability of space, structure, shelter, or nutrients outside the range of natural variability.

Vessels and equipment used in activities conducted under Alternative A would disrupt the water column in areas of OMAO operations, potentially impacting habitat quality by disturbing important environmental gradients, structure, and prey availability. However, the majority of these impacts would be limited to the immediate vicinity of vessels and equipment testing and would not persist beyond the duration of operations 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. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. As such, impacts to habitats, including EFH and HAPCs, from water column disruptions under Alternative A would be adverse, but **negligible**, **temporary**, **regional** or **localized** depending on whether the vessel is stationary or moving, and therefore **insignificant**.

3.6.2.1.7 Conclusion

Under Alternative A, OMAO would continue to use the existing fleet to conduct operations to support NOAA's primary mission activities. OMAO would continue to operate its fleet of survey and research ships until they reach the end of their service life. Almost half of the ships in the NOAA fleet would exceed their design service life by 2038; however, two new ships would come online in 2025 with two more ships projected to come online in 2027 and 2028. Under Alternative A the fleet would provide a maximum annual capacity of 3,568 operational DAS for scientific projects. Since the effects of impact causing factors on habitat throughout the action area range from negligible to minor, the overall impact of Alternative A on habitats, including EFH and HAPCs, would be adverse, **minor**, **temporary** to **short-term**, **localized** to **regional** depending on whether the vessel is stationary or moving, and therefore **insignificant**.

3.6.2.2 Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

OMAO operations under Alternative B would take place in the same operational areas and timeframes as under Alternative A; however, under Alternative B, OMAO would construct up to eight new ships (four as in Alternative A, plus up to four additional ships) to replace vessels that would reach the end of their design service life, extend the service life of aging ships through maintenance and mid-life repairs for six ships, increase fleet utilization with up to 4,138 DAS (approximately 570 more DAS annually than under Alternative A), and integrate new and greener technology as described in Section 2.4. The difference between the two alternatives is primarily a matter of scale with increased activity levels distributed unevenly among the different types of operations, the five operational areas, and within the 15-year timeframe. As such, effects under Alternative B would incrementally increase from those of Alternative A but would not differ fundamentally in type.

Impacts from OMAO operations on all habitat areas through physical contact with bottom substrate, increase in sedimentation, turbidity, and/or chemical contaminants, increased ambient sound, facilitated dispersal of invasive species, and impacts to the water column would occur under Alternative B from the same activities as those under Alternative A. Although the number of DAS would be greater under Alternative B than under Alternative A, the additional 570 DAS (implemented in a phased approach) would be distributed across the five operational areas. 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 intensity of the impacts (e.g., from negligible to minor). Additionally, replacing seven ships with new vessels, potentially adding one more ship, and integrating new and greener technology would likely reduce some impacts, such as those related to energy efficiency and reduced air emissions and waste discharges into the air and aquatic environment.

Impacts of Alternative B on habitat areas throughout the action area would be similar to those discussed above under Alternative A for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be lower due to the introduction of new ships and technology. Impacts to habitat areas resulting from Alternative B would not cause long-term changes in the availability of space, shelter, cover, or nutrients necessary for dependent species and would not substantially increase or differ in intensity as compared to Alternative A. Overall, impacts on habitats, including EFH and HAPCs, under Alternative B would be adverse, **minor**, **temporary** to **short-term**, **localized** to **regional** depending on whether the vessel is stationary or moving, and therefore **insignificant**.

3.6.2.3 Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

OMAO operations under Alternative C would implement the same measures as under Alternative B and take place in the same operational areas and timeframe as under Alternatives A and B; however, Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B with additional measures including maximizing crew productivity and enhancing overall fleet performance by increasing DAS by 735 beyond Alternative B levels, construction of two new ships in addition to those under Alternative B, increasing the number and use of uncrewed systems integrated into vessels, and shortening the timeframe for fleet improvement activities, implementation of greening techniques, and improvements to the small boat fleet as discussed in Section 2.5. The difference between the three alternatives is primarily a matter of scale with increased activity levels distributed unevenly among the different types of operations, the five operational areas, and within the 15-year timeframe. As such, effects under Alternative C would incrementally increase from those of Alternatives A and B but would not differ fundamentally in type.

Impacts from OMAO operations on all habitat areas through physical contact with bottom substrate, increase in sedimentation, turbidity, and/or chemical contaminants, increased ambient sound, facilitated dispersal of invasive species, and impacts to the water column would occur under Alternative C from the same activities as those under Alternatives A and B. Along with the greater number of DAS under Alternative C as compared to Alternatives A and B, there would be greater impacts overall; however, the associated impact-causing factors would not be concentrated enough in any given area or habitat type to substantially increase the intensity of the impacts (e.g., from negligible to minor) as they would be distributed across the five operational areas and with the 15-year timeframe. The use of additional UMS and UAS would also increase such impacts as increased ambient sound levels both in air and underwater, increased sedimentation and turbidity, and impacts to the water column. However, these too would be distributed geographically and temporally, and thus would not substantially increase adverse impacts on habitat. Furthermore, there would be benefits due to the addition of two more new ships as compared to Alternative B (i.e., a total of six new ships in addition to the four included under Alternative A) and the implementation of greening measures over a shorter timeframe. These would likely reduce some impacts, for example: increased storage for treated waste/wastewater onboard would minimize the vessel's movement to or from waste discharge zones, thus reducing a variety of impacts associated with vessel movement as discussed under Alternative A; increased treatment efficiency of wastewater which would reduce waste discharges into the aquatic environment; and increased energy efficiency through the use of lithium batteries would replace some of the currently used diesel-powered generators, thereby decreasing air emissions.

Impacts of Alternative C on habitat areas throughout the action area would be similar to those discussed above under Alternatives A and B for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be lower due to the additional new ships and greening measures. Impacts to habitat areas resulting from Alternative C would not cause long-term changes in the availability of space, shelter, cover, or nutrients necessary for dependent species and would not substantially increase or differ in intensity as compared to Alternatives A and B. Overall, impacts on habitats, including EFH and HAPCs, under Alternative C would be adverse, **minor**, **temporary** to **short-term**, **localized** to **regional** depending on whether the vessel is stationary or moving, and therefore **insignificant**.

3.7 BIOLOGICAL RESOURCES

This section discusses the affected environment and environmental consequences that would result under each alternative for biological resources in the project area, including marine mammals, sea turtles, fish, aquatic macroinvertebrates, and birds. The project area for the analysis of biological resources includes all navigable U.S. waters, extending seaward to the limits of the U.S. EEZ, as described in Section 2.1.1. OMAO operations 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; however, OMAO does not anticipate that a substantial percentage of the total effort during the timeframe of this PEA would take place in freshwater.

3.7.1 Affected Environment

The following sections provide discussions of marine mammal, sea turtle, fish, aquatic macroinvertebrate, and bird species or species group (where appropriate), including regional distribution and ESA-listed species.

3.7.1.1 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 **3.7-1**, **3.7-2**, **3.7-3**, and **3.7-4**.

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." 16 U.S.C. § 1532(6). 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." 16 U.S.C. § 1532(20). 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.

3.7.1.1.1 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 miles [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 3.7-1**) and baleen plates (**Figure 3.7-2**) 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.

Photo credit: NOAA Photo Library

Figure 3.7-1. Humpback Whale with Two Blowholes

Figure 3.7-2. 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 3.7-1** 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 two with designated critical habitat; and 44 odontocetes, four of which are ESA-listed as endangered, and three with designated critical habitat.

Table 3.7-1. 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[I]	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[II], SER[III], WCR[IV], PIR[V]	--	Shallow to deep waters
Rice's whale	*Balaenoptera ricei*	Yes: throughout its range	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: throughout its range	Endangered	NMFS	WCR, AR	No	Inshore or shallow offshore continental shelf waters

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region	Critical Habitat	General Habitat
North Atlantic right whale	*Eubalaena glacialis*	Yes: throughout its range	Endangered	NMFS	GAR, SER	Yes	Coastal, shallow shelf waters, occasionally 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 phocenin*	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
Atlantic humpback dolphin	*Sousa teuszii*	No	Proposed Endangered	NMFS	Outside of U.S. jurisdiction	No	Shallow depths in warm nearshore waters, and in dynamic habitats strongly influenced by tidal patterns
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

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region	Critical Habitat	General Habitat
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 stock, and Western North Atlantic Southern Migratory Coastal stock	--	NMFS	GAR, SER, WCR, PIR	--	Harbors, bays, gulfs, estuaries, nearshore coastal waters, deeper waters over the continental shelf, and far offshore pelagic
Cuvier's beaked whale	*Ziphius cavirostris*	No	--	NMFS	All	--	Pelagic deep water

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

[I] Includes Alaskan waters and the Arctic

[II] Includes the U.S. portions of the Great Lakes, New England, and the mid-Atlantic

[III] 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)

[IV] Includes coastal California, Oregon and Washington

[V] Includes Hawai'i and territories of the U.S.

3.7.1.1.1.1 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:

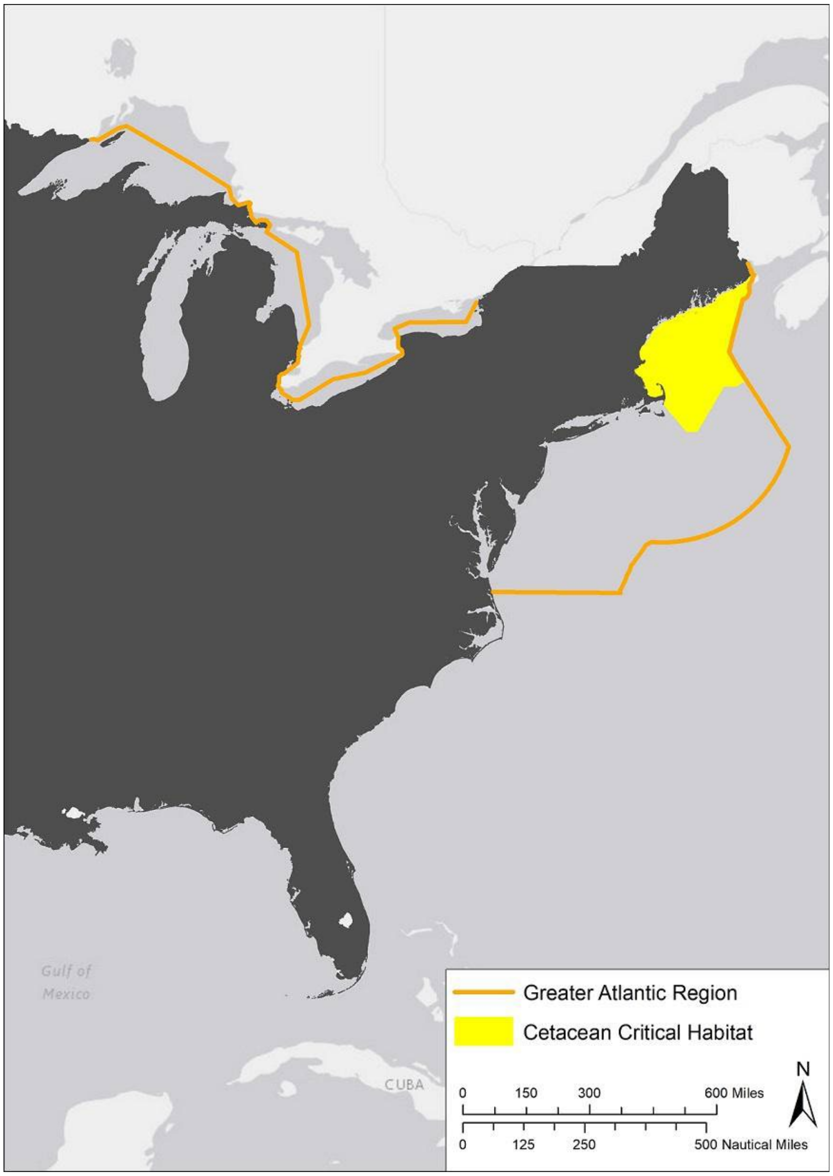
- Small and Resident Population: areas and months within which small and resident populations occupying a limited geographic extent exist.

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 OMAO 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 OMAO action area is described below.

3.7.1.1.1.2 Greater Atlantic Region

Thirty-three cetaceans (seven mysticetes and 26 odontocetes) occur in the GAR, as indicated in **Table 3.7-1**. 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 3.7-3**. One of the odontocetes is ESA-listed: the sperm whale.

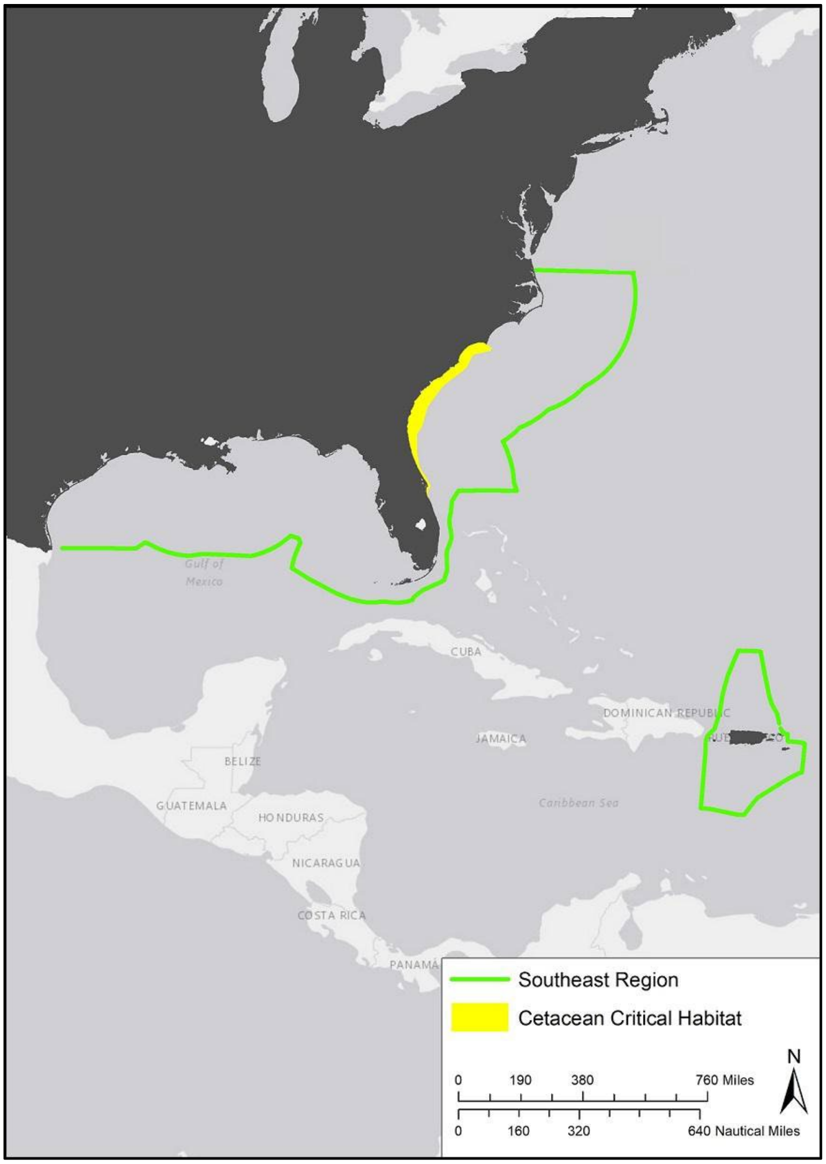


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-3. Cetacean Designated Critical Habitat in the GAR

3.7.1.1.1.3 Southeast Region

Thirty-three cetaceans (eight mysticetes and 25 odontocetes) occur in the SER, as indicated in **Table 3.7-1**. 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 3.7-4**. One of the odontocetes is ESA-listed: the sperm whale.

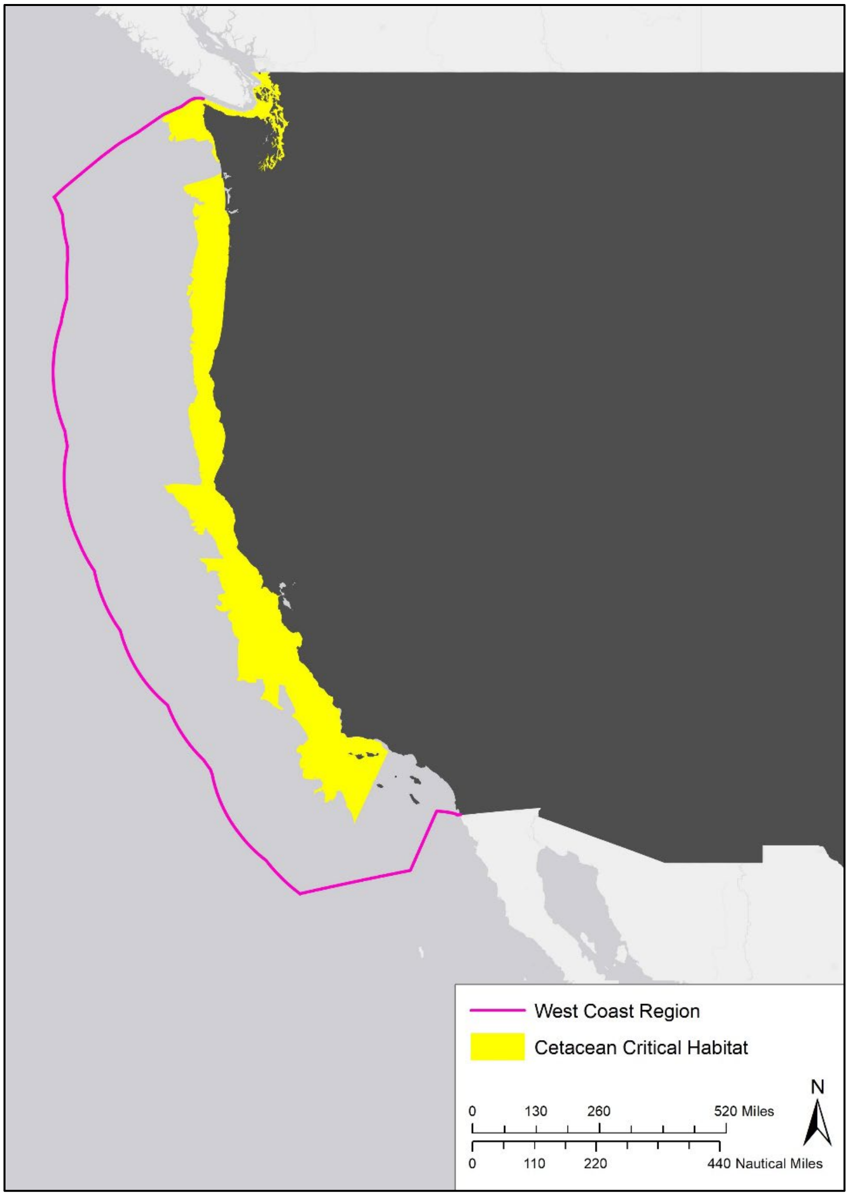


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-4. Cetacean Designated Critical Habitat in the SER

3.7.1.1.1.4 West Coast Region

Thirty-seven cetaceans (11 mysticetes and 26 odontocetes) occur in the WCR, as indicated in **Table 3.7-1**. 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 the killer whale also have designated critical habitat in the region as shown in **Figure 3.7-5**.

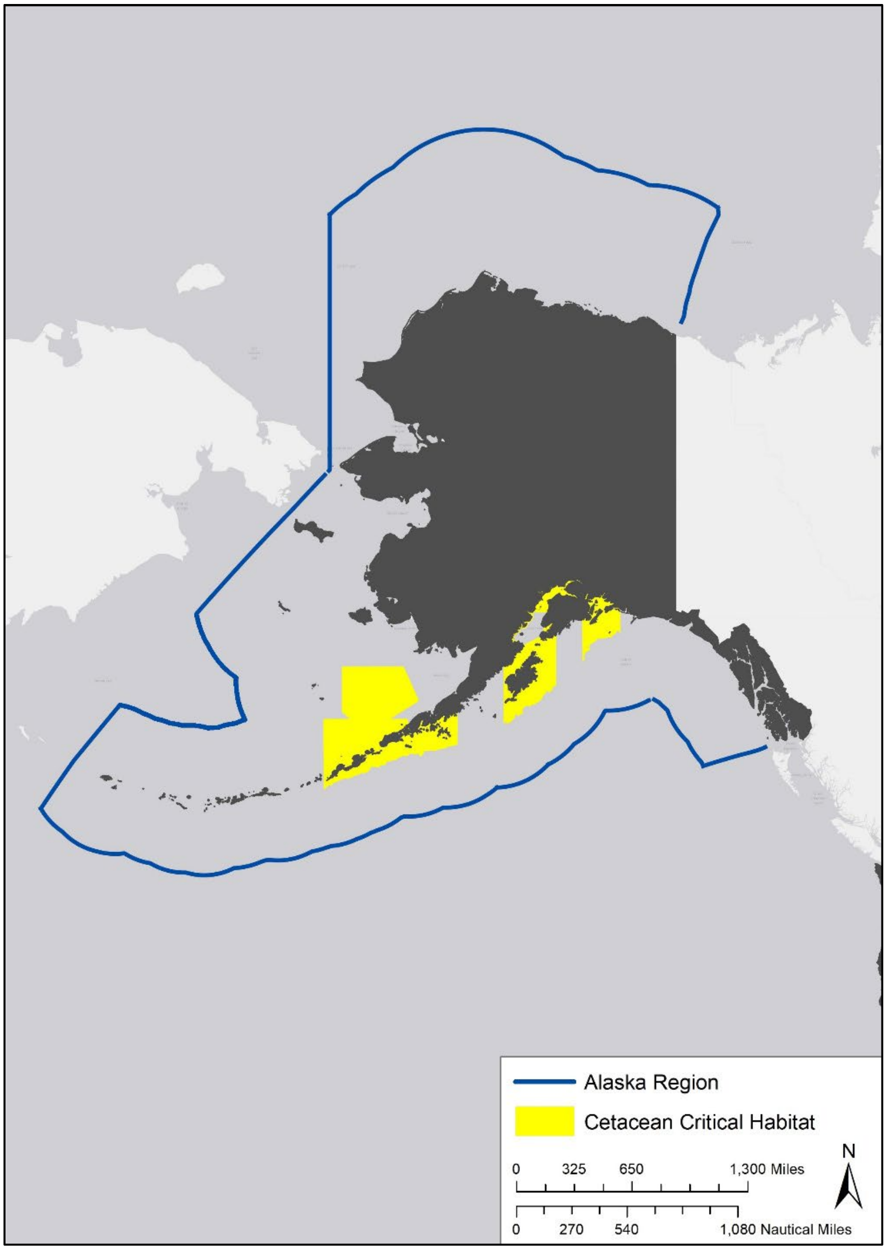


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-5. Cetacean Designated Critical Habitat in the WCR

3.7.1.1.1.5 Alaska Region

Twenty-five cetaceans (11 mysticetes and 14 odontocetes) occur in the AR, as indicated in **Table 3.7-1**. 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 the beluga whale also have designated critical habitat in the region as shown in **Figure 3.7-6**.

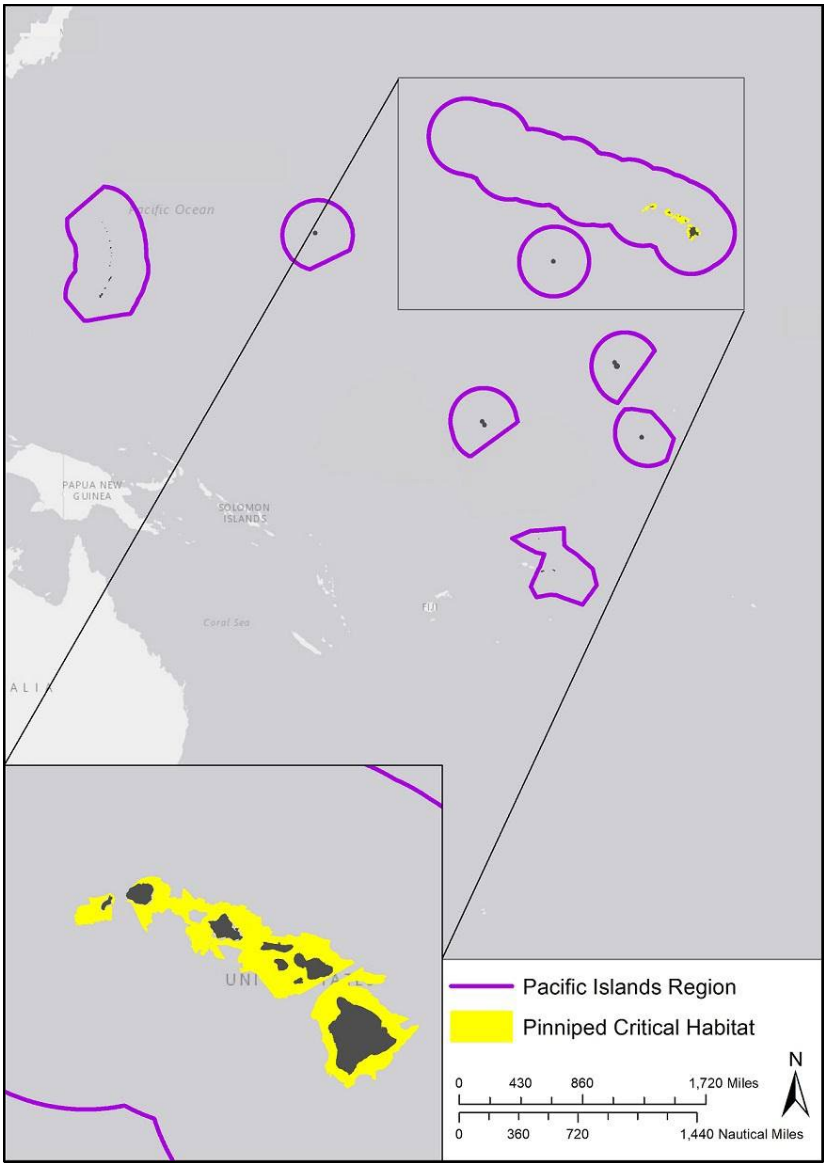


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-6. Cetacean Designated Critical Habitat in the AR

3.7.1.1.1.6 Pacific Islands Region

Twenty-seven cetaceans (seven mysticetes and 20 odontocetes) occur in the PIR, as indicated in **Table 3.7-1**. 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 and humpback whale also have critical habitat in this region as shown in **Figure 3.7-7**.



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 3.7-7. Cetacean Designated Critical Habitat in the PIR

3.7.1.1.2 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 (**Figure 3.7-8**). 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.

Figure 3.7-8. Hawaiian Monk Seal

Photo Credit: NOAA/PIFSC/HMSRP

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 3.7-2** 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.

Table 3.7-2. 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

Common Name	Scientific Name	MMPA Depleted?	ESA Status	Lead Agency	Region*	Critical Habitat	General Ecology
Hawaiian monk seal	*Neomonachus schauinslandi*	Yes: throughout its range	Endangered	NMFS	PIR	Yes	Coastal, reefs, submerged banks, deepwater coral beds, pelagic
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

3.7.1.1.2.1 Regional Distribution of Pinnipeds

Pinnipeds are widely distributed through 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.

3.7.1.1.2.2 Greater Atlantic Region

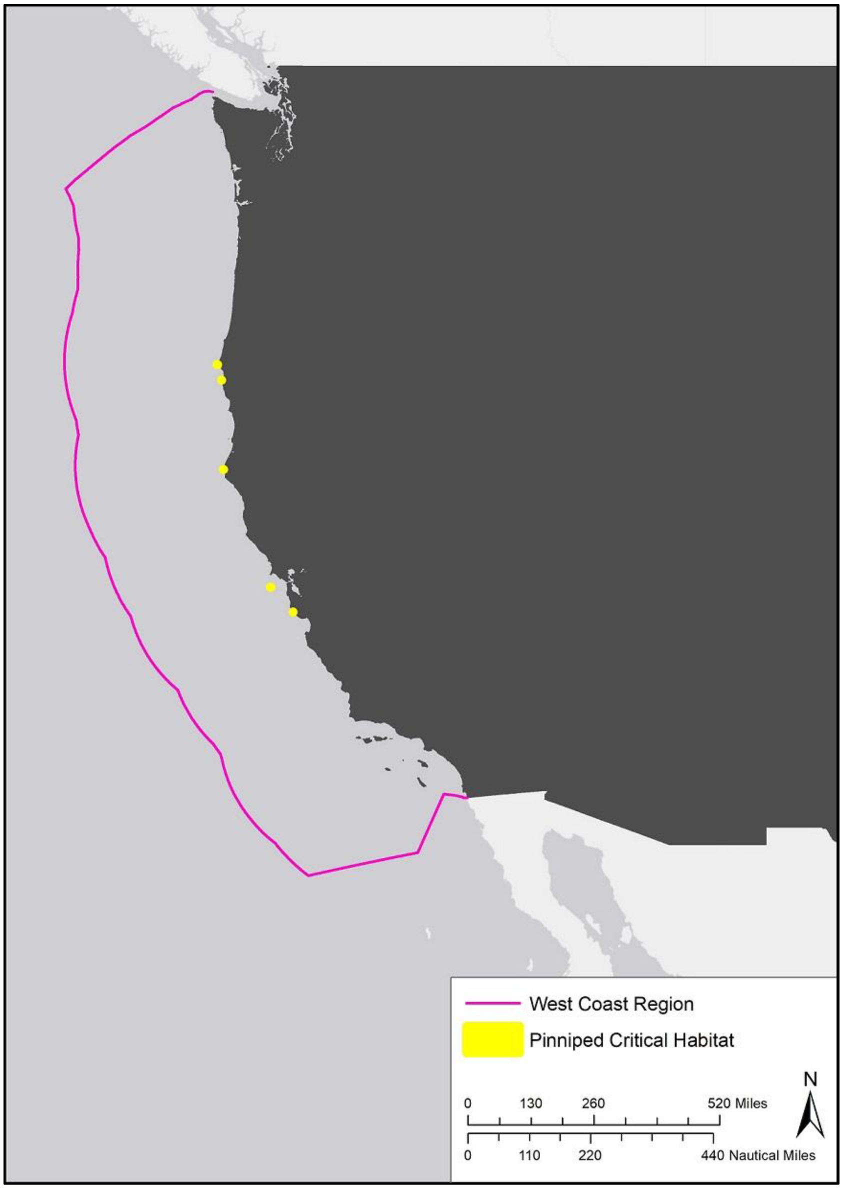
Four pinnipeds (hooded seal, gray seal, harp seal, and harbor seal) occur in the GAR, as indicated in **Table 3.7-2**. None are ESA-listed. There is no designated critical habitat in the region.

3.7.1.1.2.3 Southeast Region

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

3.7.1.1.2.4 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 WCR, as indicated in **Table 3.7-2**. The Guadalupe fur seal is ESA-listed. The Steller sea lion has designated critical habitat in the region as shown in **Figure 3.7-9**.

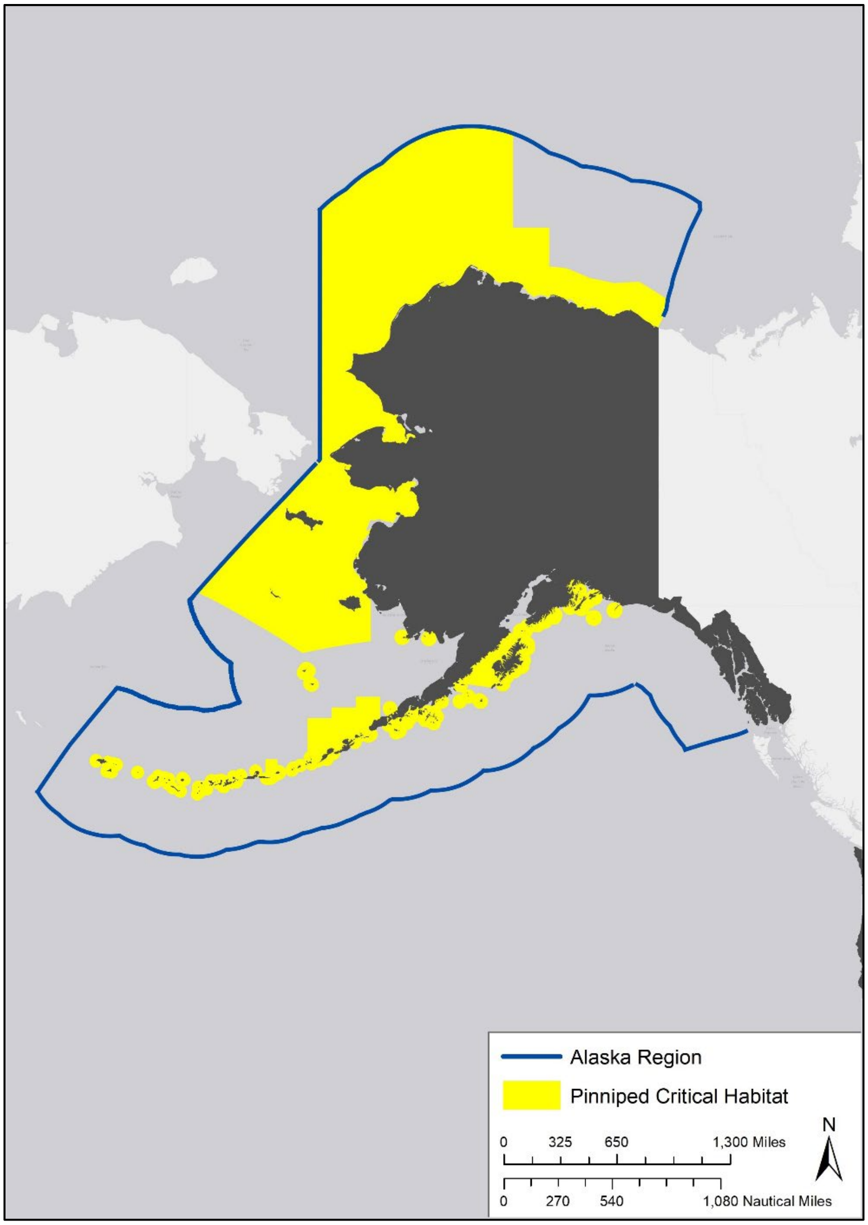


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-9. Pinniped Designated Critical Habitat in the WCR

3.7.1.1.2.5 Alaska Region

Ten pinnipeds (one odobenid, three otariids, and six phocids) occur in the AR, as indicated in **Table 3.7-2**. 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 3.7-10**.

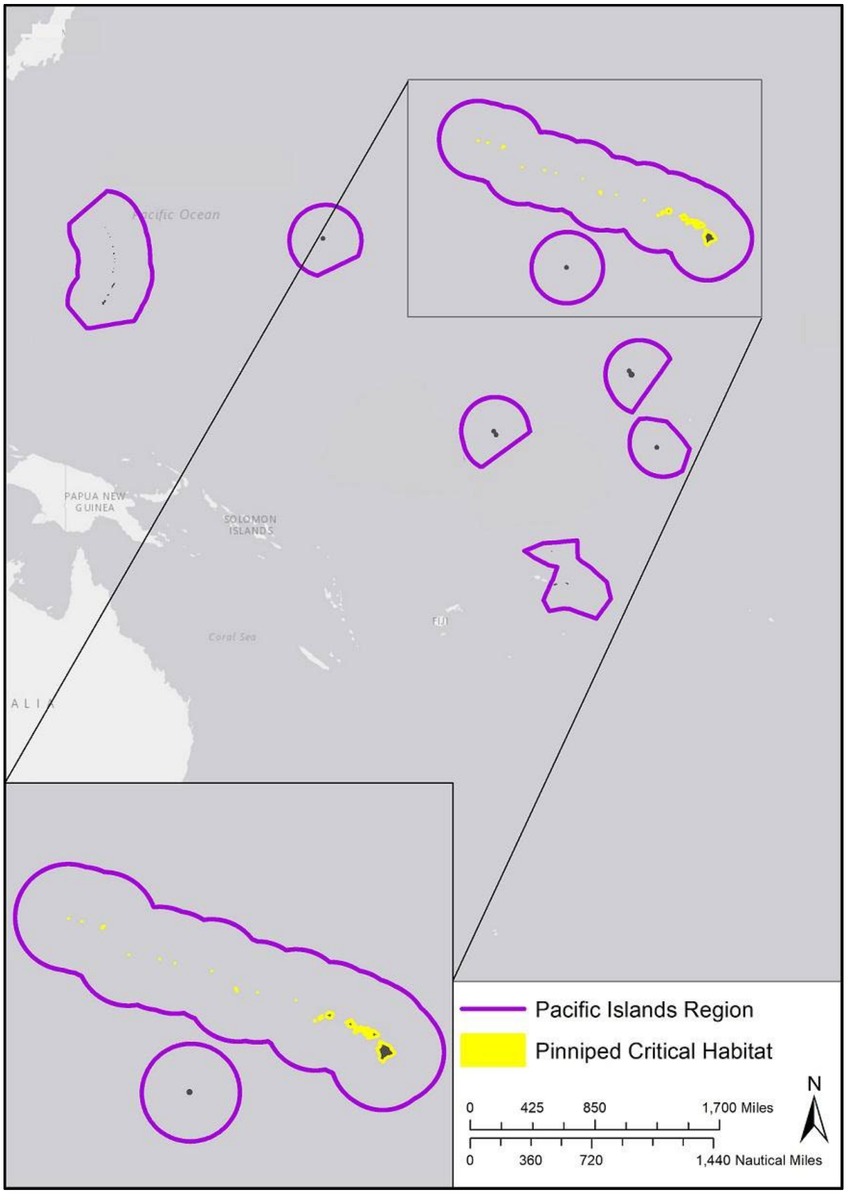


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-10. Pinniped Designated Critical Habitat in the AR

3.7.1.1.2.6 Pacific Islands Region

One pinniped (Hawaiian monk seal) occurs in the PIR, as indicated in **Table 3.7-2**. The Hawaiian monk seal is ESA-listed, and it also has designated critical habitat in the region as shown in **Figure 3.7-11**.



Sources: NMFS, No Date-z; ECOS, No Date-e

Figure 3.7-11. Pinniped Designated Critical Habitat in the PIR

3.7.1.1.3 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 3.7-12**) with two distinct subspecies (**Table 3.7-3**). The remaining three sirenian species do not occur in the action area.

Figure 3.7-12. West Indian Manatee

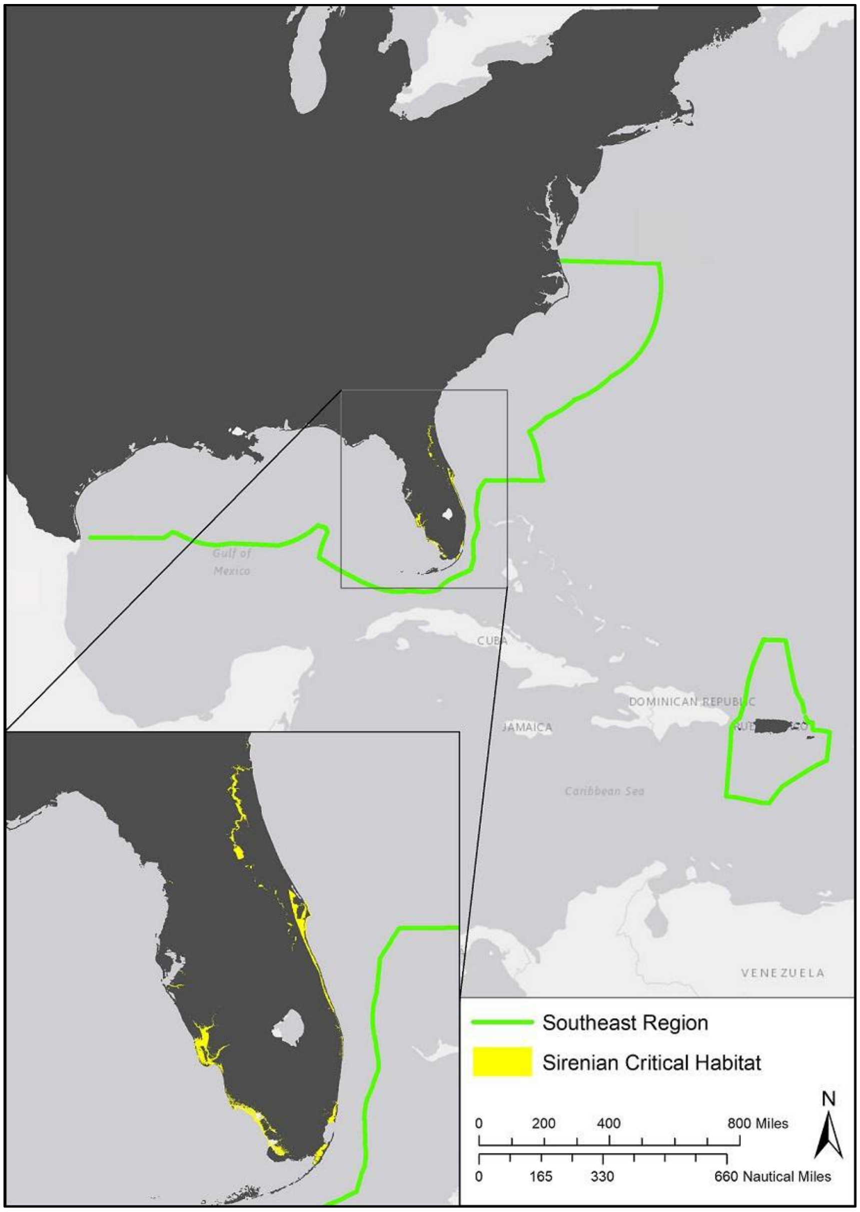
Photo Credit: David A. Straz, Jr., Manatee Critical Care Center

3.7.1.1.3.1 Regional Distribution of Sirenians

Manatees occur mainly in the SER of the action area, although they have been observed on occasion further north in the GAR.

3.7.1.1.3.2 Southeast Region

Both subspecies of the West Indian manatee occur in the SER, as indicated in **Table 3.7-3**. Both subspecies are ESA-listed, but only the Florida subspecies has designated critical habitat as shown in **Figure 3.7-13**.



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

Figure 3.5-13. Sirenian Designated Critical Habitat in the SER

Table 3.7-3. 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

3.7.1.1.4 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 (*Ursus maritimus*), 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 (**Figure 3.7-14**), in the weasel family (*Mustelidae*), and much larger than river otters, primarily live a 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.

Figure 3.7-14. Sea Otter with Sea Urchins

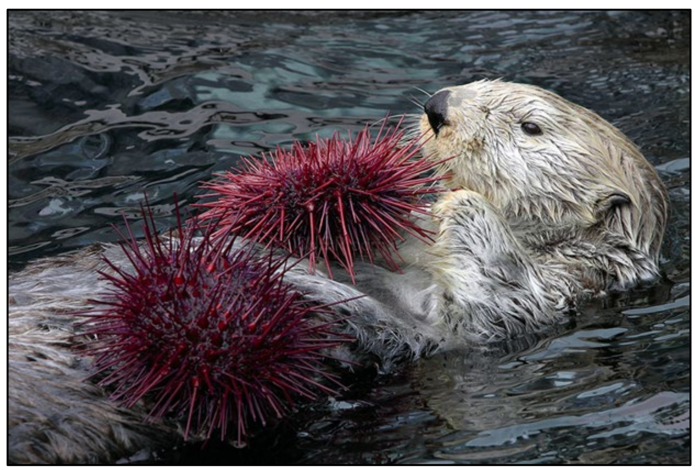


Photo Credit: Neil Fisher

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 3.7-4** lists the two species of fissipeds (four distinct species, subspecies, or DPS total) occurring throughout the action area.

Table 3.7-4. 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

3.7.1.1.4.1 Regional Distribution of Fissipeds

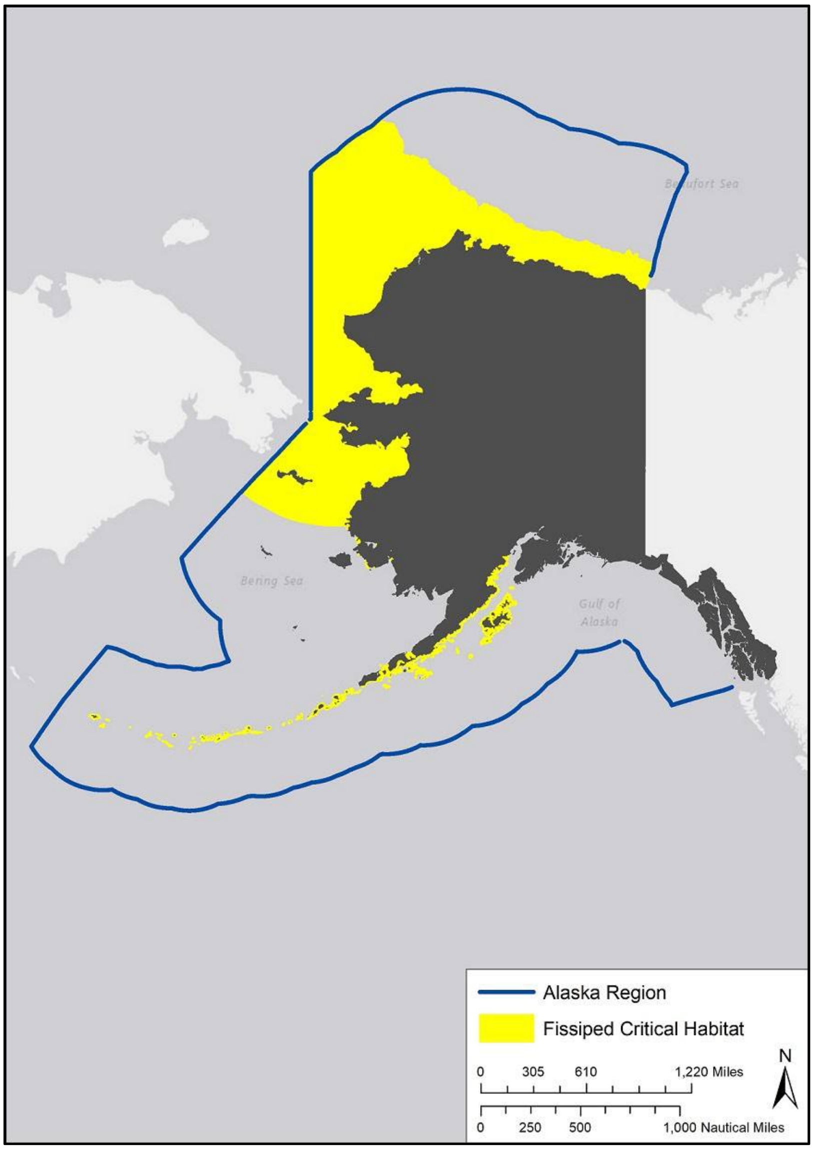
The polar bear and sea otter are distributed in two regions of the action area, described below.

3.7.1.1.4.2 West Coast Region

Two fissipeds occur in the WCR, as indicated in **Table 3.7-4**: the northern sea otter and the southern sea otter, which is ESA-listed as threatened. There is no designated critical habitat in the region.

3.7.1.1.4.3 Alaska Region

Two fissipeds (northern sea otter, including the Southwest Alaska DPS, and polar bear) occur in the AR, as indicated in **Table 3.7-4.** 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 3.7-15**.



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

Figure 3.7-15. Fissiped Designated Critical Habitat in the AR

3.7.1.2 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 3.7-5**.

The order Testudines includes all turtles and tortoises. The Cheloniidae family includes hard-shelled turtles (**Figure 3.7-16**) 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.

Figure 3.7-16. Green Sea Turtle

Photo Credit: Ali Bayless, NOAA/NMFS/PIFSC

Sea turtles are air breathing reptiles that are primarily aquatic, generally coming ashore on sandy beaches only to lay eggs in a hole the females dig in the soft sand above the high tide line. Hatching occurs after an incubation period lasting two months when hatchlings immediately enter the sea and migrate to the pelagic zone where they may shelter and feed in drift communities for one 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, 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 and feeding strategies differ by species and life-stage. Sea turtles can be herbivorous, carnivorous, and omnivorous. Sea turtles breathe by coming to the surface.

All sea turtles in U.S. waters are protected under the ESA throughout their ranges, by NMFS while in water and by the United States Fish and Wildlife Service (USFWS) while onshore. Sea turtles and their nests are also protected to varying degrees by some states and localities. Additionally, four species have critical habitat designated for their entire range or one of their constituent DPSs. **Table 3.7-5** 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 3.7-5. 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
Mexico Pacific Coast	Endangered	NMFS, USFWS	Outside of U.S. jurisdiction	No	

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

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

3.7.1.2.1 Regional Distribution

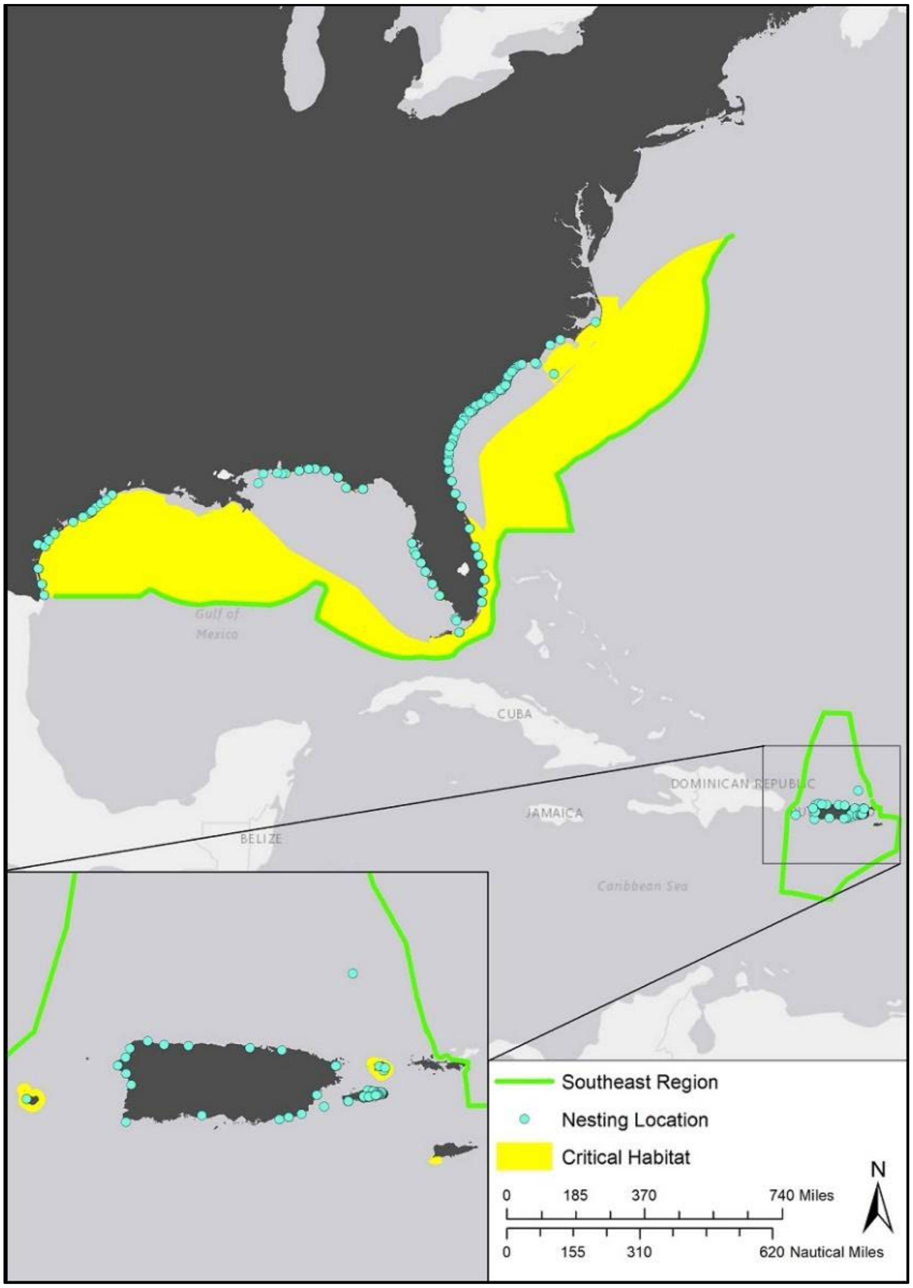
Sea turtles are found throughout the action area. Like marine mammals, sea turtles are known to make wide-ranging movements and may not be present in a specific region year-round; however, some species are considered distinct populations and do not migrate as broadly. Range varies by species and DPS, 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.

3.7.1.2.1.1 Greater Atlantic Region

Five of the six sea turtle species in the action area occur in the GAR, as indicated in **Table 3.7-5**. 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 in the GAR, although loggerhead sea turtles are known to nest there.

3.7.1.2.1.2 Southeast Region

All six of the sea turtle species in the action area occur in the SER, as indicated in **Table 3.7-5**. 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 3.7-17**). Leatherback, hawksbill, green, loggerhead, and Kemp's ridley sea turtles are known to nest in the SER (**Figure 3.7-17**).

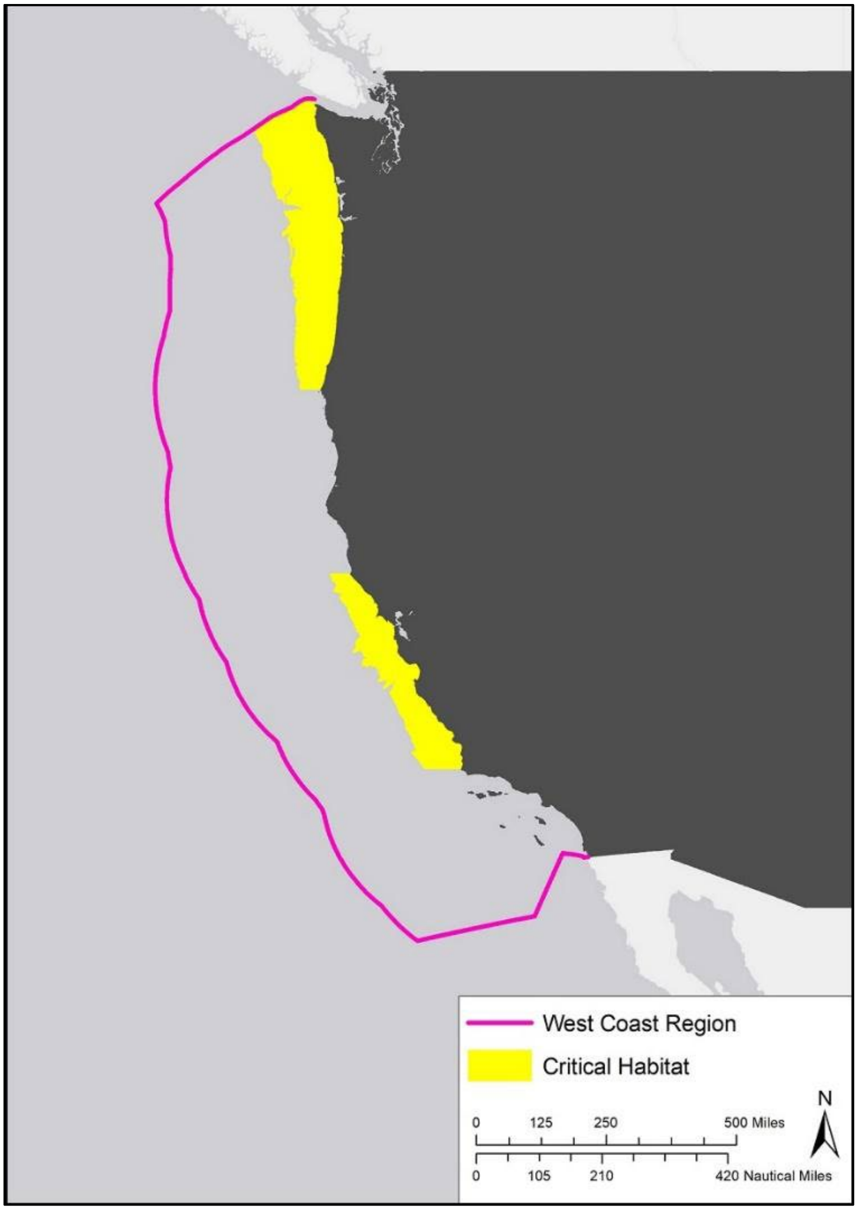


Sources: ECOS, No Date-b; NMFS, No Date-b; SWOT, No Date

Figure 3.7-17. SER Sea Turtle Designated Critical Habitat and Nesting Sites

3.7.1.2.1.3 West Coast Region

Five of the six sea turtle species in the action area occur in the WCR, as indicated in **Table 3.7-5**. 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 3.7-18**), but there are no known nest locations for any species of sea turtle.



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

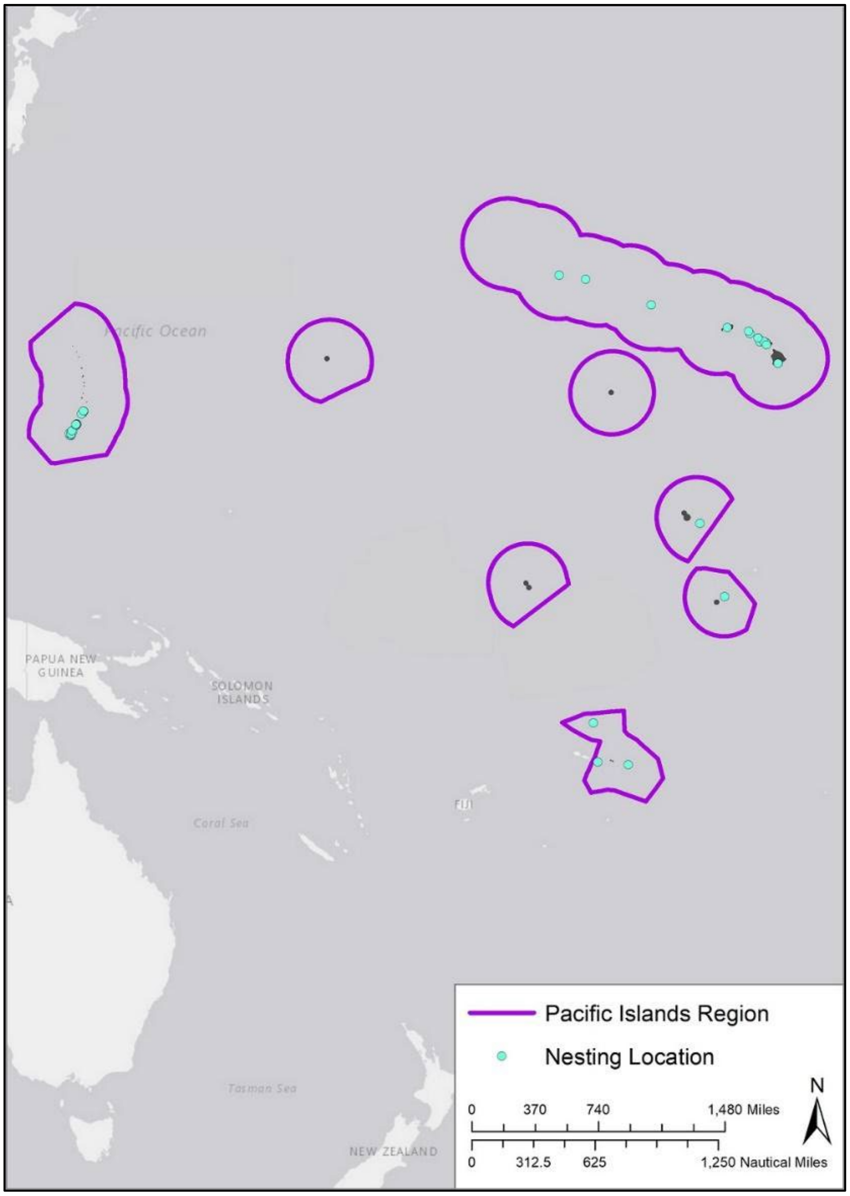
Figure 3.7-18. WCR Sea Turtle Designated Critical Habitat

3.7.1.2.1.4 Alaska Region

Four of the six species of sea turtles in the action area have ranges or have been sighted in the AR. 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 AR and is listed as endangered. Though DPS descriptions for green turtles do not extend into the AR, 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.

3.7.1.2.1.5 Pacific Islands Region

Five of the six sea turtle species in the action area occur in the PIR, as indicated in **Table 3.7-5**. 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 PIR, although green, hawksbill, leatherback, and loggerhead sea turtles are known to nest there (**Figure 3.7-19**).



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

Figure 3.7-19. PIR Sea Turtle Nesting Sites

3.7.1.3 Fish

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 3.6 for a complete discussion of EFH), or are considered the basis of important fisheries.

Globally, there are over 30,000 species of fish, existing in marine (saltwater) 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).

Nineteen ESA-listed fish species (comprising 49 distinct species, subspecies, Evolutionarily Significant Units [ESUs], or DPS total) potentially occur throughout the U.S. coastal and marine waters of the action area (**Table 3.7-6**). 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 3.7-6**). There are no federally-listed threatened or endangered fish species present within the Great Lakes.

Table 3.7-6. 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

Common Name	Scientific Name	ESA Status	Lead Agency	Region	Critical Habitat
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
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

Common Name	Scientific Name	ESA Status	Lead Agency	Region	Critical Habitat
Steelhead (Puget Sound DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes
Steelhead (Snake River Basin DPS)	*Oncorhynchus mykiss*	Threatened	NMFS	WCR	Yes
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

Common Name	Scientific Name	ESA Status	Lead Agency	Region	Critical Habitat
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
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

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

* 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).

3.7.1.3.1 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 3.7-20**), including flatfishes (Order Pleuronectiformes: soles, halibuts, and allies); sharks, skates, and rays; hagfishes; sturgeons; cods; rat-tails; and many others (Nelson, 20167). 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 3.7-21** depicts these ecological diversities among the higher groups of fish.

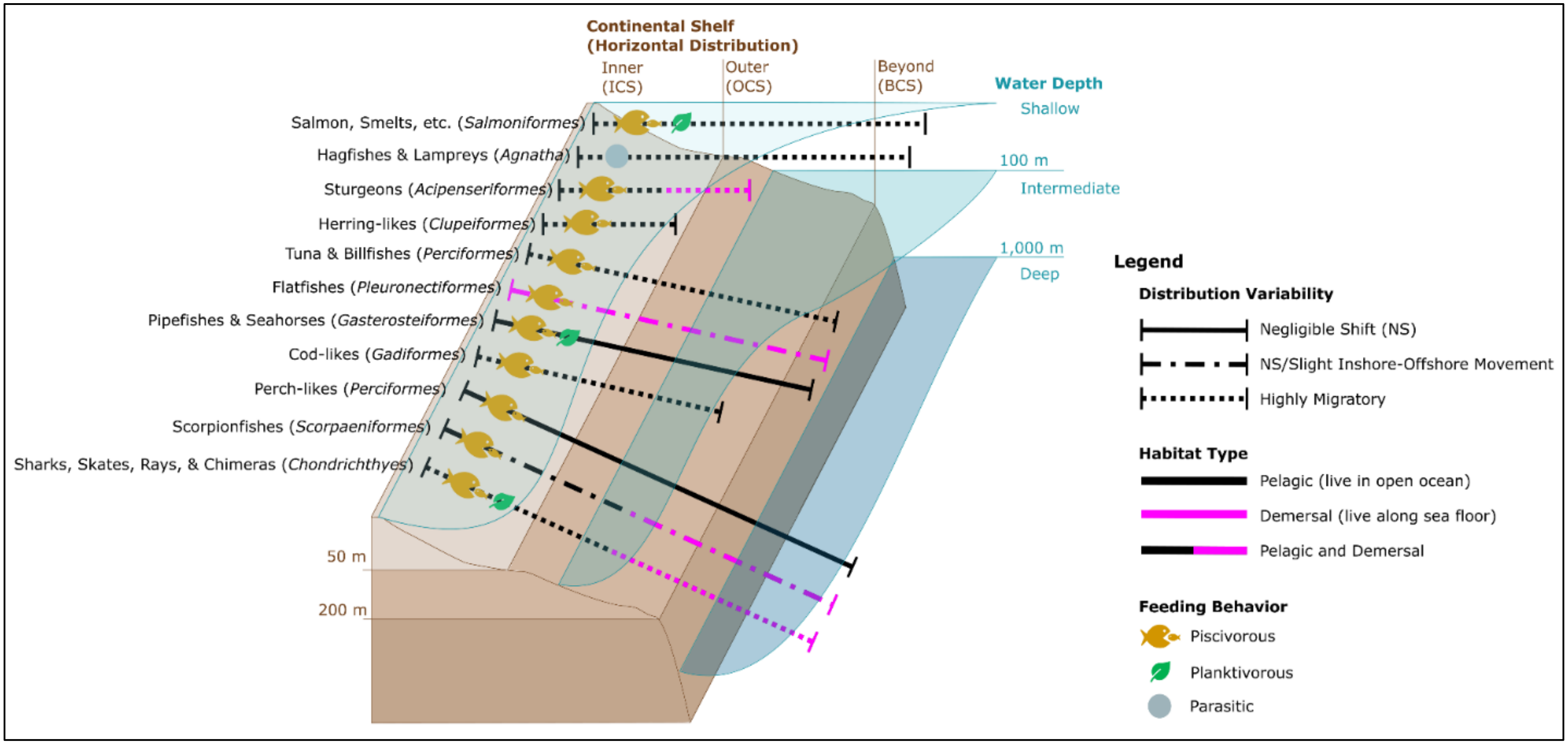
Most marine fish are piscivorous, meaning they primarily eat other fish. A few, such as anchovies, whale sharks, and basking sharks, are predominantly or exclusively planktivorous, consuming primarily small invertebrates (e.g., krill, zooplankton). Relatively few are primarily dependent on phytoplankton or macroalgae (e.g., seaweed like kelp) as food for much of their life cycle (NSF and USGS, 2011).

Figure 3.7-20. Demersal Flatfishes

Photo Credit: BreakingTheWalls

One system for classifying marine fish involves categorizing them into 11 main higher taxonomic groups (Sea Around Us, 2016). 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 3.7-6**). 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 3.7-20** 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, 2016). 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, 2016). An example is the Arctic cod which often occurs in ice holes, near the ice edge, or among broken ice.



Sources: NMFS, No Date-a; Sea Around Us, 2016; ECOS, No Date-a

Notes: a) Typical water depth: S = shallow (<100 m), I = intermediate (100-1,000 m), D = deep (>1,000 m).

b) Habitat Type: D = demersal; P = pelagic.

c) Feeding behavior: PV = piscivorous, PN = planktivorous, PS = parasitic, S = scavenger.

d) Horizontal Distribution: ICS = inner continental shelf (<50 m water depth), OCS = outer continental shelf (50-200 m), BCS = beyond continental shelf (>200 m).

e) Distribution Variability: NS = negligible shift, IO = slight inshore-offshore movement, HM = highly migratory.

Figure 3.7-20. Summary of the Status, General Ecology, and General Distribution and Movement of Marine Fish Groups Potentially Occurring within the Action Area

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, 2014). 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.

Soft bottom or sedimentary habitat is composed of medium to coarse carbonate sands distributed over an extensive continental shelf (BOEM, 2014). 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 (e.g., temperature, salinity, DO) and circulation (e.g., currents, eddies, fronts), which vary seasonally and spatially (BOEM, 2014). 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, 2014). 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 3.7-21**), 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 (*Trachichyhyidae*), 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, 2014).

Figure 3.7-21. Pelagic Atlantic Tunas

Photo Credit: Jeff Muir *©ISSF*

Important ecological considerations for fish resources of concern with respect to OMAO 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 salmons, 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 U.S. Geological Survey (USGS) Nonindigenous Aquatic Species database tracks distributions of non-native marine fish, as well as other introduced aquatic species (USGS, No Date-c). 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.

3.7.1.3.2 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 3.7-22**), 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).

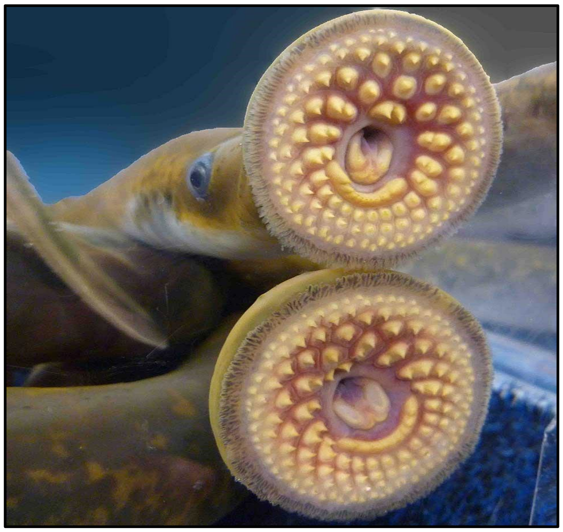


Figure 3.7-22. Sea Lamprey

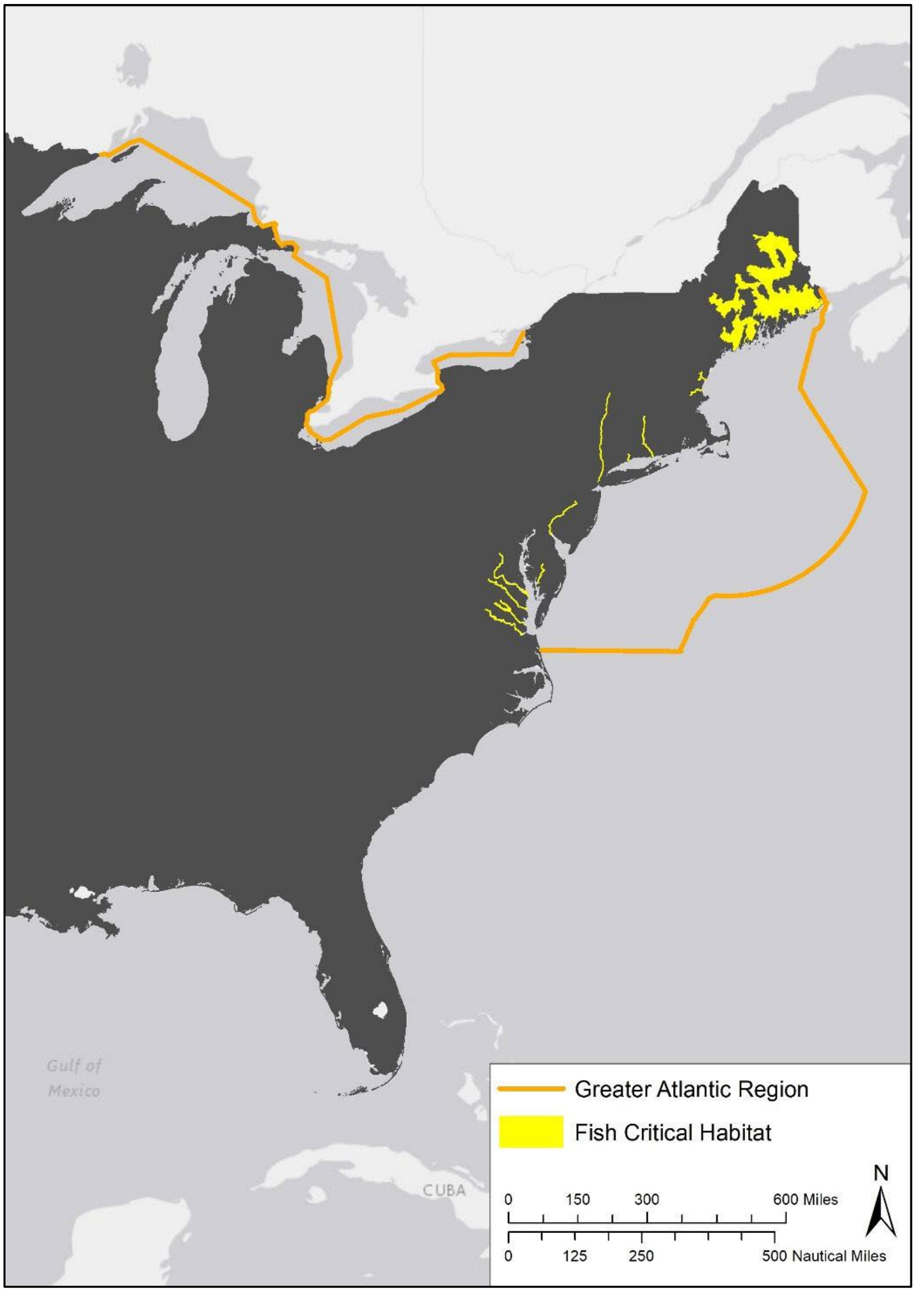
Photo Credit: Ted Lawrence/Great Lakes Fishery Commission

3.7.1.3.3 Regional Distribution

This section summarizes region-specific ESA-listed species and critical habitat. General fish assemblages are discussed in Section 3.7.1.3.1.

3.7.1.3.3.1 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 GAR, as indicated in **Table 3.7-6**. The Atlantic salmon and three DPSs of Atlantic sturgeon also have designated critical habitat in the region as shown in **Figure 3.7-23**, much of it occurring in inland rivers.

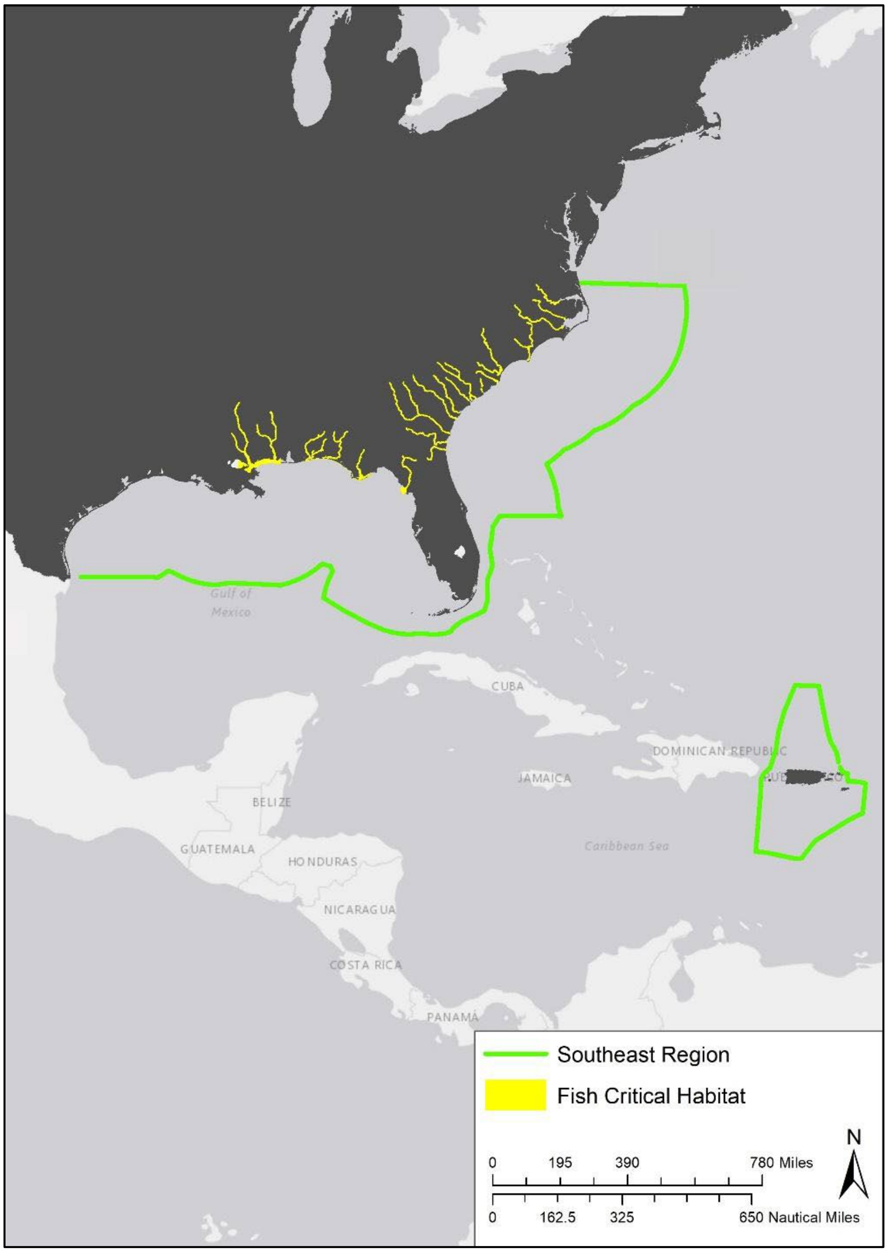


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-23. Designated Critical Habitat for Atlantic Sturgeon and Atlantic Salmon in the GAR

3.7.1.3.3.2 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 SER, as indicated in **Table 3.7-6**. 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 3.7-24**, some of it occurring in inland rivers.

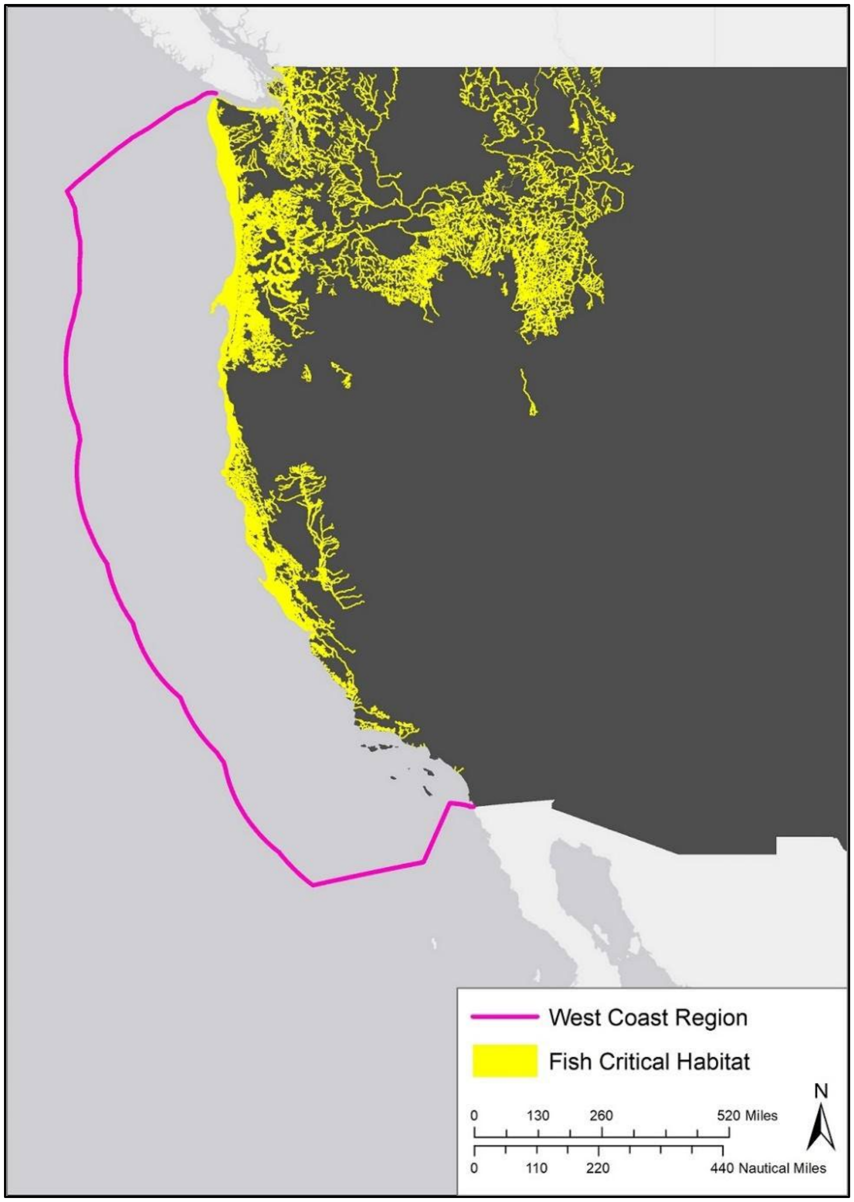


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-24. Designated Critical Habitat for Atlantic Sturgeon in the SER

3.7.1.3.3.3 West Coast Region

Thirty-six ESA-listed fish species, subspecies, ESU, or DPS occur in the WCR, as indicated in **Table 3.7-6**. All nine ESUs of Chinook salmon, two ESU 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 3.7-25**, much of it occurring in inland rivers.



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

Figure 3.7-25. Designated Critical Habitat for Ten Fish Species in the WCR

3.7.1.3.3.4 Alaska Region

Three ESA-listed fish (eulachon, bocaccio, and yellow rockfish) occur in the AR, as indicated in **Table 3.7-7**. None of these species have designated critical habitat in the region.

3.7.1.3.3.5 Pacific Islands Region

Three ESA-listed fish (giant manta, scalloped hammerhead [Eastern Pacific DPS], and scalloped hammerhead [Indo-West Pacific DPS]) occur in the PIR, as indicated in **Table 3.7-7**. None of these species have designated critical habitat in the region.

3.7.1.4 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 freshwater and saltwater (marine) habitats. They are an extremely varied assortment of organisms that span a considerable number of taxonomic phyla.

3.7.1.4.1 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 fungi kingdoms); it classifies organisms by their fundamental body plan.

Among the more prominent, better known, and studied phyla of marine macroinvertebrates are the following (MarineBio, No Date):

- Annelids – segmented worms, including polychaetes (e.g., 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;
- Cnidarias includes jellyfish, sea anemones, and corals (Figure 3.7-26);
- Echinoderms – includes sea stars, sea urchins, sea cucumbers, sand dollars, and crinoids;
- Mollusks – includes gastropods (e.g., sea snails, whelks, limpets, abalone), bivalves (e.g., clams, mussels, oysters, scallops), cephalopods (e.g., squid, octopus), and chitins;
- Poriferas– sponges; and
- Tunicates – sea squirts or sea pork.

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.

Figure 3.7-26. NOS Diver on Gray's Reef with Variety of Marine Macroinvertebrates

Photo Credit: Greg McFall, Gray's Reef NMS, NOS, NOAA

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 3.7-27**), 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 3.7-27. Jellyfish in the Order Limnomedusae

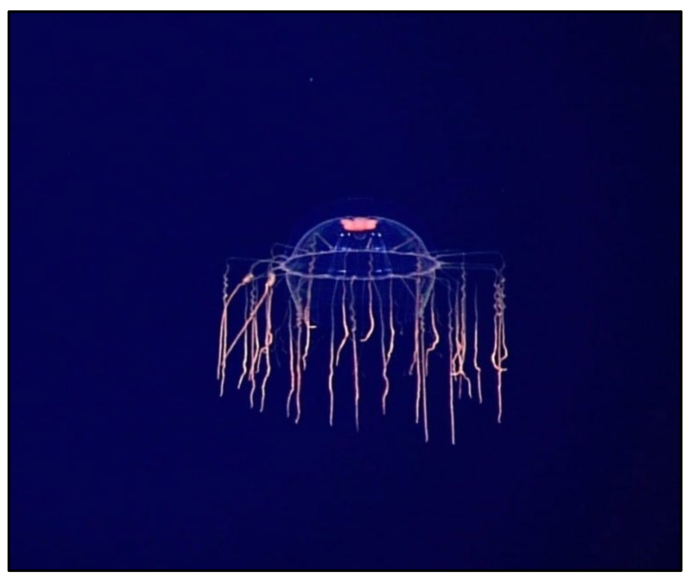


Photo Credit: NOAA Okeanos Explorer Program

The sessile, soft-bodied coral polyps attached to the sea floor secrete a hard, external skeleton of limestone (i.e., calcium carbonate or $CaCO_3$), 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-e). 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, blast fishing, and damage from anchors.

A total of 18 ESA-listed or proposed species of marine macroinvertebrates (14 coral species, two species of abalone, one conch, and one sea star) potentially occur in U.S. coastal and marine waters of the action area (**Table 3.7-7**). The corals are all within the SER and the PIR, while the abalones are found in the WCR. Three species of ESA-listed coral have designated critical habitat.

Table 3.7-7. 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
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	Proposed
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	Proposed
Lobed star coral	*Orbicella annularis*	Threatened	NMFS	SER	Proposed
Mountainous star coral	*Orbicella faveolata*	Threatened	NMFS	SER	Proposed
Boulder star coral	*Orbicella franksi*	Threatened	NMFS	SER	Proposed
Coral: no common name	*Seriatopora aculeata*	Threatened	NMFS	PIR	No
Queen conch	*Alger gigas*	Proposed Threatened	NMFS	SER	No
Sunflower sea star	*Pycnopodia helianthoides*	Proposed Threatened	NMFS	AR, WCR	No

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

3.7.1.4.2 Freshwater Macroinvertebrates

The most important freshwater aquatic macroinvertebrates are bivalve mollusks (e.g., clams and mussels), crustaceans (e.g., crayfish), and arthropods (e.g., aquatic insects and their larvae). Clams and mussels are often so inconspicuous and immobile that they can be mistaken for cobblestones; they are found in the soft substrates of rivers and streams; and feed by filtering water for microscopic plant and animal food particles (e.g., 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. Others, notably mosquitoes, whose larvae are aquatic, are disease vectors.

A total of three ESA-listed species of aquatic macroinvertebrates, all mussels, have been documented in the Great Lakes (**Table 3.7-8**).

Table 3.7-8. 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

Source: ECOS, No Date-a

Additionally, 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.

3.7.1.4.2.1 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, 2020).

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 3.7-28**). Benthic macroinvertebrates are typically found attached to rocks, vegetation, sticks, and logs, or within burrows in bottom sand and sediments (EPA, 2022c).

Figure 3.7-28. Variety of Freshwater Benthic Macroinvertebrates

Photo Credit: G. Carter via NOAA/GLERL

Non-native, invasive aquatic macroinvertebrates like the zebra mussel (*Dreissena polymorpha*) (**Figure 3.7-29**), 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, No Date-c) including the Great Lakes, Mississippi River Basin, and other watersheds, where they have threatened native freshwater mussel species (69 FR 42198, July 14, 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 3.7-29. 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 by decreasing turbidity and reduces chlorophyll in 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, 2022). 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 (USGS, No Date-c).

3.7.1.4.3 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 (e.g., segmented worms), are also present in these freshwater habitats. Brachiopods, bryozoans, Cnidaria (e.g., jellyfish and corals), echinoderms (e.g., sea stars), Porifera (e.g., 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 aquatic macroinvertebrate diversity and abundance reach their zenith, especially in warmer waters and the tropics. All five marine regions of the EEZ support abundant aquatic 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 SER and PIR. The economic value of particular commercially important aquatic macroinvertebrates varies substantially from region to region. Shrimp are particularly important in the Gulf states in the SER, while lobster support an important fishery in the GAR. Oyster harvest in Chesapeake Bay (on the boundary between the GAR and SER) 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 AR.

This section summarizes region-specific ESA-listed species and critical habitat.

3.7.1.4.3.1 Greater Atlantic Region

Three ESA-listed aquatic macroinvertebrates (Northern riffleshell, snuffbox, and rayed bean) occur in the GAR in the Great Lakes, as indicated in **Table 3.7-8**. None of these species have designated critical habitat in the region.

3.7.1.4.3.2 Southeast Region

Seven ESA-listed aquatic macroinvertebrates (staghorn coral, elkhorn coral, pillar coral, rough cactus coral, lobed star coral, mountainous star coral, and boulder star coral) occur in the SER, as indicated in **Table 3.7-7**. The queen conch, which is proposed for listing as threatened, occurs in this region as well. Staghorn coral and elkhorn coral also have designated critical habitat in the region as shown in **Figure 3.7-30**; the other five species have proposed critical habitat in the region.

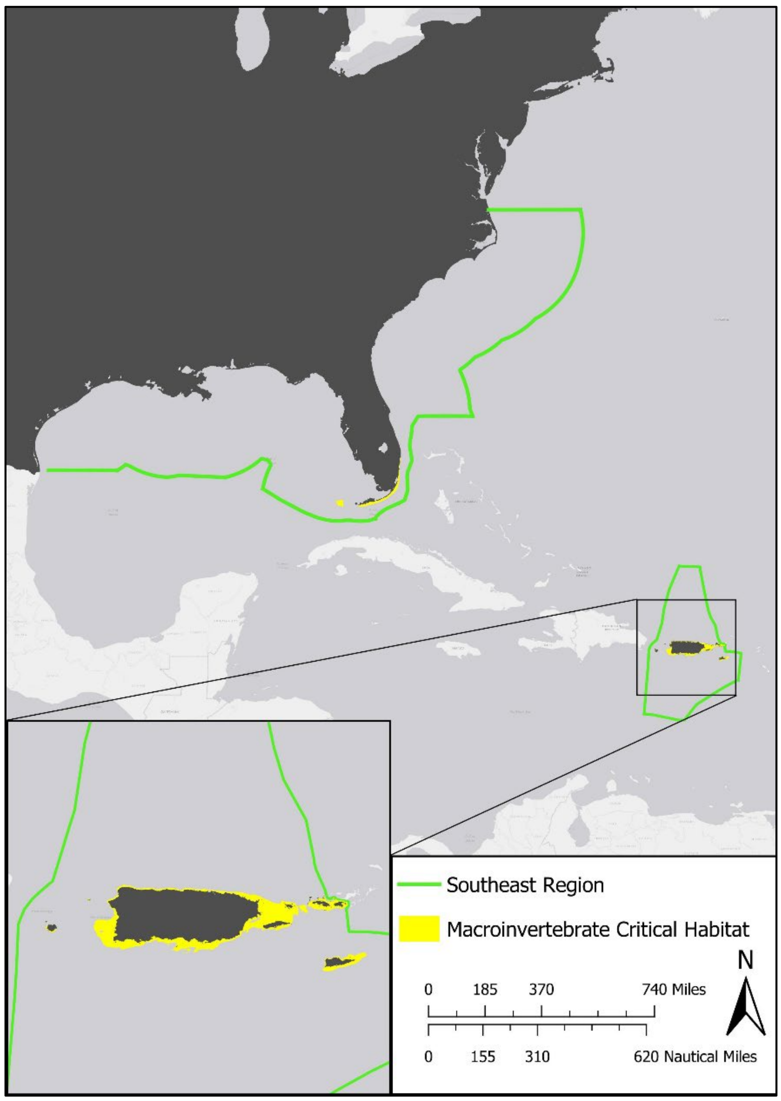


Figure 3.7-30. Designated Critical Habitat for Staghorn Coral and Elkhorn Coral in the SER

3.7.1.4.3.3 West Coast Region

Two ESA-listed aquatic macroinvertebrates (black abalone and white abalone) occur in the WCR, as indicated in **Table 3.7-7**. The sunflower sea star which is proposed for listing as threatened occurs in this region as well. Black abalone also has designated critical habitat in the region as shown in **Figure 3.7-31**.

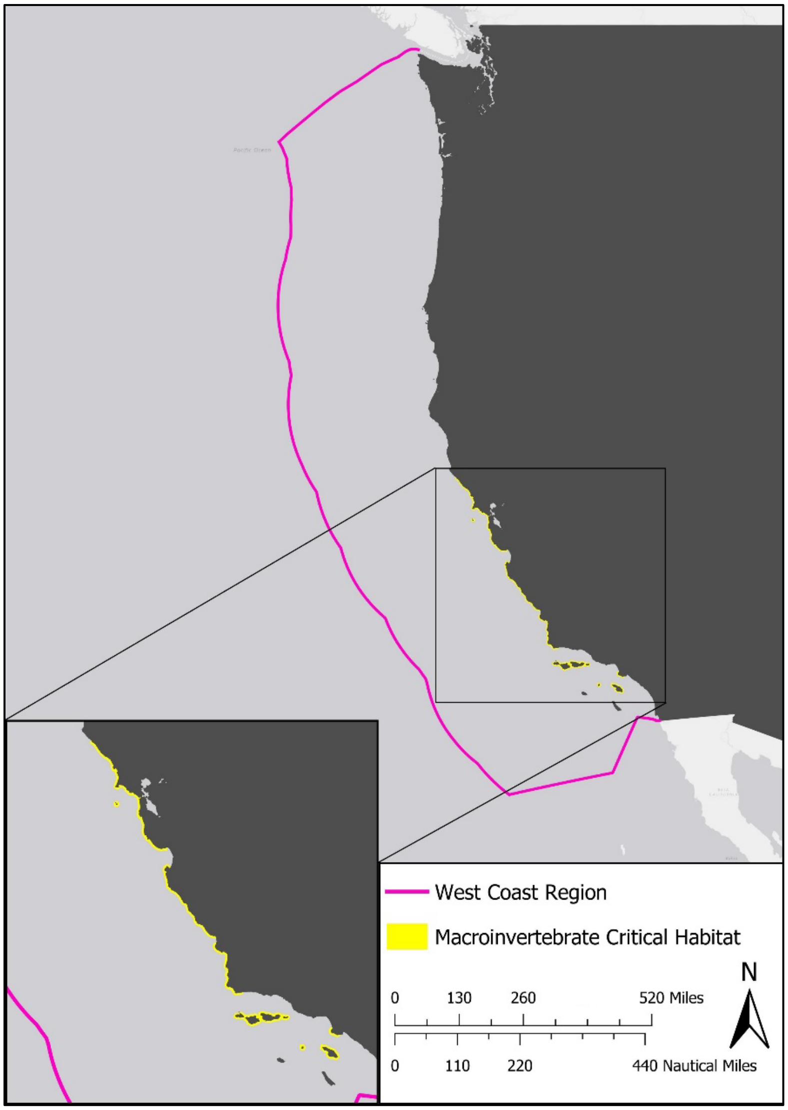


Figure 3.7-31. Designated Critical Habitat for Black Abalone in the WCR

3.7.1.4.3.4 Alaska Region

Although no ESA-listed species or designated critical habitats occur in the AR, the sunflower sea star which is proposed for listing as threatened, occurs in this region, as indicated in **Table 3.7-7**.

3.7.1.4.3.5 Pacific Islands Region

Eight ESA-listed aquatic macroinvertebrates (these species do not have common names) occur in the PIR, as indicated in **Table 3.7-7**. None of these species have designated critical habitat in the region.

3.7.1.5 Seabirds, Shorebirds, Coastal Birds, and Waterfowl

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 (**Figure 3.7-32**), 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 Migratory Bird Treaty Act (MBTA). This section presents an overview of these functional groups 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.

Figure 3.7-32. Male Short-tailed Albatross Shelters a Chick

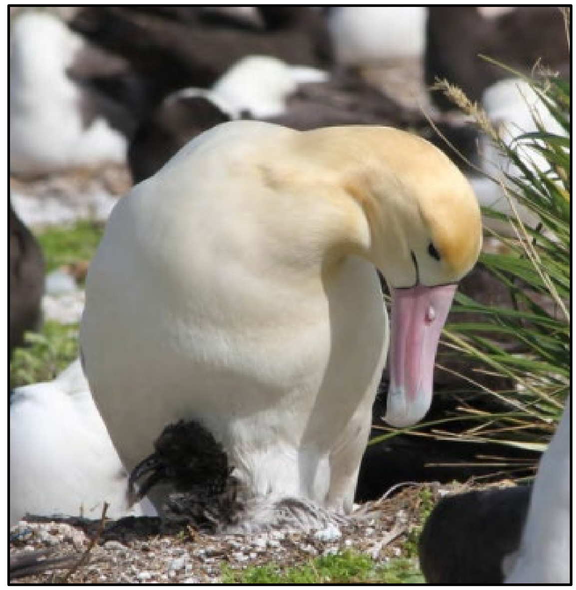


Photo credit: USFWS

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 U.S. coastal and marine waters of the action area (**Table 3.7-9**).

Table 3.7-9. 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

Common Name	Scientific Name	ESA Status	Lead Agency	Region*	Critical Habitat
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
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

Source: ECOS, No Date-a

3.7.1.5.1 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 (i.e., areas where sunlight reaches the sea floor), although specific foraging behaviors vary by species. Waterfowl (**Figure 3.7-33**) are found in freshwater and saltwater environments and spend much of their lives on the water's surface and some may dive below to feed or "dabble" from the surface. 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 3.7-10**. Birds are found in all regions of the action area, though different bird groups and species predominate in different regions and habitats.

Figure 3.7-33. Steller's Eider Male and Female

Photo credit: USFWS

Table 3.7-10. 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, harlequin, merganser, scoter	Coastal / Freshwater	Diving and dabbling (specialized surface feeding)	Invertebrates, aquatic insects, small fish, aquatic plants	Solitary, ground-nesting near bodies of water	Migratory

3.7.1.5.2 Regional Distribution

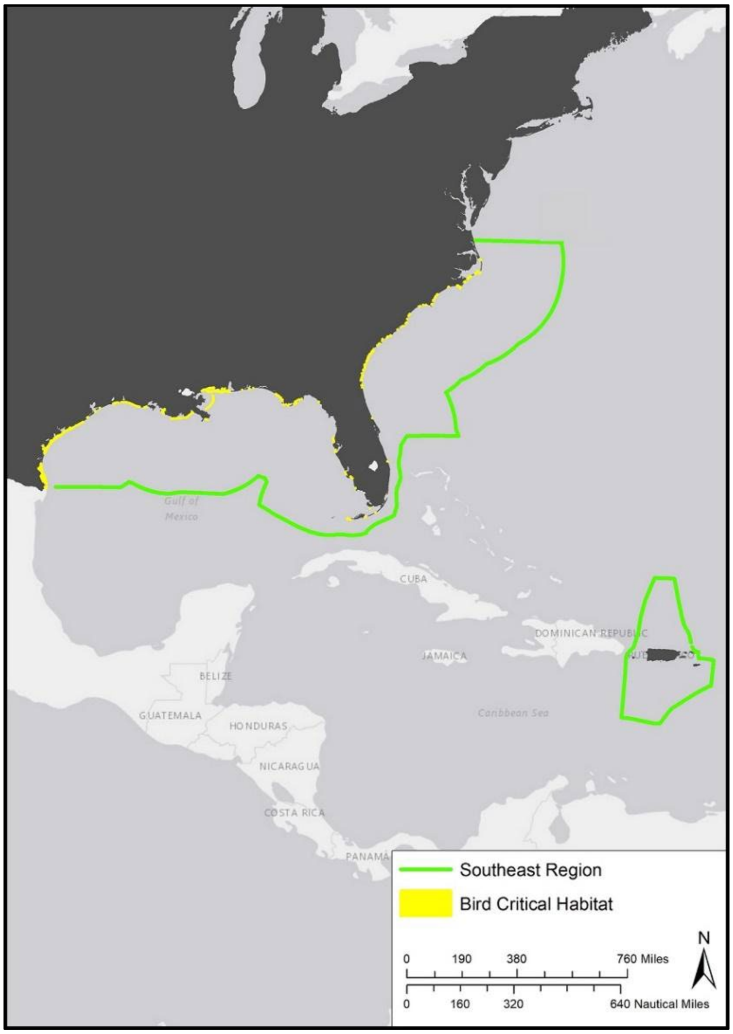
General bird assemblages are discussed in Section 3.10.1.3. This section summarizes region-specific ESA-listed species and designated critical habitat. The majority of critical habitat for birds is located within the Alaska and WCRs.

3.7.1.5.2.1 Greater Atlantic Region

Four ESA-listed bird species (roseate tern, red knot, piping plover, and whooping crane) occur in the GAR, as indicated in **Table 3.7-9**. There is no designated critical habitat for these species in this region. The bald eagle also occurs in this region.

3.7.1.5.2.2 Southeast Region

Four ESA-listed birds (red knot, whooping crane, wood stork, and piping plover) occur in the SER, as indicated in **Table 3.7-9**. Whooping cranes and piping plovers also have designated critical habitat in the region as shown in **Figure 3.7-34**. The bald eagle also occurs in this region.



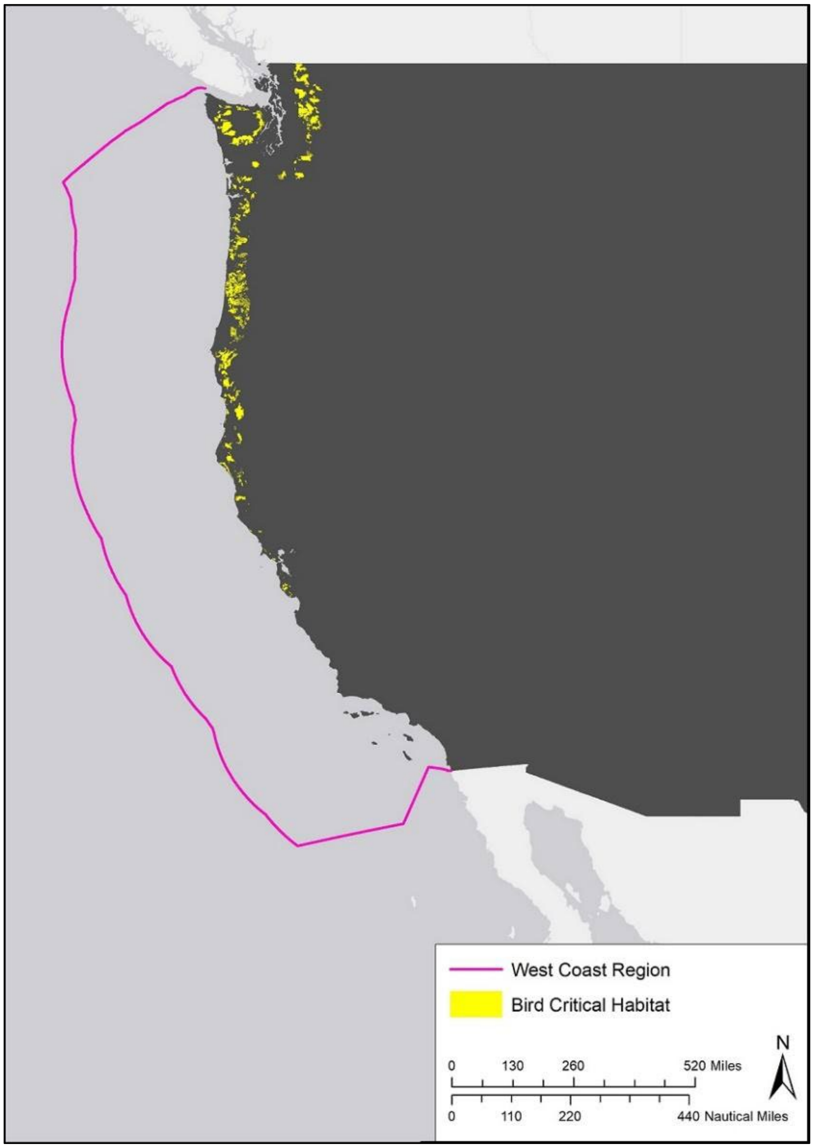
Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-34. Designated Critical Habitat in the SER

3.7.1.5.2.3 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 WCR, as indicated in **Table 3.7-9**.

Marbled murrelet and western snowy plover have designated critical habitat in the region as shown in **Figure 3.7-35.** The bald eagle also occurs in this region.

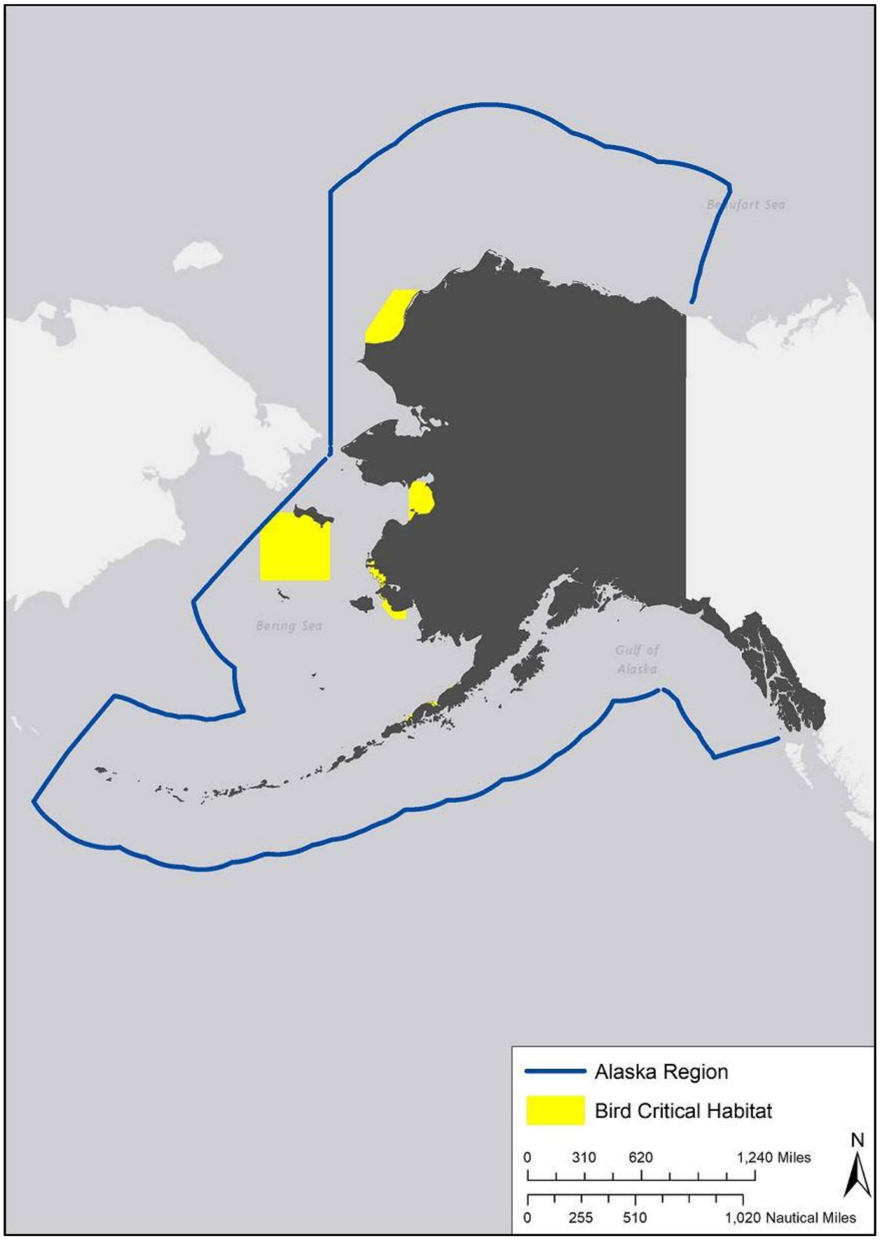


Sources: NMFS, No Date-b; ECOS, No Date-b

Figure 3.7-35. Designated Critical Habitat in the WCR

3.7.1.5.2.4 Alaska Region

Four ESA-listed birds (short-tailed albatross, Eskimo curlew, Steller's eider, and spectacled eider) occur in the AR, as indicated in **Table 3.7-9**. Steller's eider and spectacled eider have designated critical habitat in the region, as shown in **Figure 3.7-36**. The bald eagle also occurs in this region.



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

Figure 3.7-36. Designated Critical Habitat in the AR

3.7.1.5.2.5 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 PIR, as indicated in **Table 3.7-9**. None of these species have designated critical habitat in the region. The bald eagle also occurs in this region.

3.7.2 Environmental Consequences

The following sections identify and evaluate potential impacts to biological resources (marine mammals, sea turtles, fish, aquatic macroinvertebrates, and birds) occurring in the action area under Alternatives A, B, and C. 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.

Activities described in Table 2.1-1 and in Section 2.2 that occur during OMAO operations and could be expected to have impacts on biological resources in the action area include vessel movement; anchoring; waste handling and discharges; spill response; active acoustic systems operations; operation of other sensors and data collection systems; UMS operations; UAS operations; and small boat systems operations. Impacts on biological resources from vessel repair and maintenance; and OTS handling, crane, davit, and winch operations are not expected to occur (or would be due to other factors, such as vessel movement) and are not discussed further in this section.

Note that use of the term “sea floor” below also includes lake and river bottoms where OMAO operations may occur.

Impacts to the freshwater species described in Section 3.7.1 are included in the analysis below. There may be a small number of OMAO operations that occur in freshwater bodies where other select freshwater taxa may be present that are not specifically identified and analyzed in this Draft PEA. These dismissed freshwater taxa are not being addressed at this time. For prospective OMAO operations in freshwater, an ESA species list would be generated from the USFWS Information for Planning and Consultation (IPaC) report system. From this information, OMAO would determine if any ESA-listed species are present in the proposed operational area that have not already been addressed in the PEA. If any such species are identified, OMAO would consider possible impacts to ESA-listed species in the context of that specific location. If appropriate, OMAO would then initiate a Section 7 consultation with NMFS or the appropriate USFWS field office(s). Therefore, potential impacts to these freshwater species are not analyzed further in this Draft PEA.

3.7.2.1 Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Under Alternative A, OMAO operations using the existing NOAA Fleet would continue across all five operational areas over the 15-year period in all habitat types. In addition, OMAO is constructing two oceanographic research vessels that are expected to come online by 2025 and awarded contracts for two new charting and mapping vessels that are expected to come online by 2027 and 2028 for a total of four new ships under Alternative A. OMAO would provide a maximum annual capacity of 3,568 DAS for scientific projects.

3.7.2.1.1 Marine Mammals

OMAO operations may impact marine mammals in a variety of manners in the action area, including (1) increased ambient sound (e.g., from vessel movement, active acoustic systems, UMS, UAS, and small boat systems); (2) vessel presence and movement of equipment in the water (i.e., visual and physical disturbance of and risk of collisions with marine mammals); (3) accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters (i.e., from vessel operations); and (4) trash and debris (i.e., potential for entanglement and ingestion). These potential impact causing factors and their associated effects on marine mammals are discussed below.

3.7.2.1.1.1 Cetaceans

Potential impacts could occur in all of the operational areas as approximately 20 to 30 species, subspecies, or DPSs of cetaceans, including several ESA-listed species, occur in each region (see Section 3.7.1.1.1); all regions also include designated critical habitat for one or more listed cetacean species.

Increased Ambient Sound

Vessel movement, active acoustic systems operations, UMS and UAS operations, and small boat systems operations would increase the ambient sound level of affected cetaceans through the production of underwater and airborne sound. 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 (i.e., the distance between the sound source and the receiving 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).

Active underwater acoustic sources used by OMAO under Alternative A would include operation of navigational depth sounders and testing, calibration, training, and troubleshooting of single- and multi-beam echo sounders, side scan sonars, and Acoustic Doppler Current Profilers (ADCPs) as discussed in Section 2.2.7. On NOAA vessels, acoustic signals from echo sounders (which range from 1 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 (Southall et al., 2007, 2019; NMFS, 2018a, Finneran et al., 2017). Equipment that would be operated at frequencies higher than 200 kHz (e.g., some multibeam echosounders and side scan sonars) operate above the hearing range of marine mammals and thus would not have any effects. Adverse impacts of echo sounder signals could include behavioral responses, loss of hearing, stress, and physical harm. Given the directionality and small beam widths, there is low potential for Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS)[3], and cetacean communications are not expected to be masked appreciably as they would not be in the

[3] 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 (i.e., hearing loss). Threshold shifts, or incremental hearing loss, may be temporary, returning to their baseline level, or permanent. TTS is the mildest form of hearing impairment; exposure to loud sound results 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. PTS is 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.

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, but not by low-frequency mysticetes. The effects of underwater sound from ADCPs on cetaceans are similar to those from echo sounders as ADCPs have a narrow and directional beam width similar to single-beam echo sounders.

To reduce potential impacts of active acoustic sources on cetaceans, OMAO would use the lowest power appropriate to perform testing and calibration of equipment. OMAO would also continue to maintain a watch for protected species at all times and would employ animal approach restrictions and reduced vessel speeds, described in more detail below and in Appendix C. For instance, OMAO maintains distance from cetaceans, if possible, continues to monitor the cetacean until it has moved outside of the vessel's path, and proceeds with caution. Additionally, potential impacts from underwater acoustic sources are expected to be *de minimis* (i.e., referring to environmental impacts so minimal as to merit disregard). A recent study by Ruppel et al. (2022) showed that most non-seismic underwater acoustic sources, such as those used by OMAO, are unlikely to result in incidental take of marine mammals and could be considered *de minimis*. Ruppel et al. (2022) concluded that these sources may not warrant formal review under some environmental statutes.

All vessels produce underwater sound (10 Hz to 10 kHz) and are major contributors to overall background sound in the sea. Under Alternative A, vessel movement, UMS operations, and small boat systems operations would generate continuous, transitory, and relatively low frequency sound that could disturb marine mammals. 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, 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 sounds generated by vessels, UMS, and small boats. Behavioral responses of cetaceans to these underwater sounds 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 vessel movement is from the operation of propellers, including cavitation (which is the formation of bubbles as water passes over propeller blades), singing (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, and the intensity of this sound is largely related to ship size and speed (BOEM, 2014). Operating speeds would vary by the marine conditions, the capabilities of the vessel, and the survey equipment being used. NOAA vessels could move at speeds of up to 10 knots, but lower speeds would be more common.

Vessel movement would include navigating to and from ports, locations to conduct drills, equipment testing, calibration, training, troubleshooting, and other OMAO operations. NOAA vessels would be variable in size, producing variable sound levels, and could occur anywhere in navigable U.S waters including areas as shallow as 20 m (65 ft). Operations could occur any time of the year in mid-latitudes and in the spring/summer/fall months in Alaska. Impacts beyond the U.S. EEZ while vessels are transiting and conducting drills would be similar to those within the EEZ. However, NOAA vessels would represent a very small proportion of total vessel traffic in the action area, thus would not constitute a substantial portion of the existing volume of vessels already found within the EEZ.

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, 2014). Some cetaceans may be displaced a short distance, potentially from preferred or critical habitat, but they would not be anticipated to leave the vicinity of a vessel 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 portion 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). NOAA vessel sounds 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, 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; 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, OMAO operators adhere to 50 CFR § 224.105, which states: “all vessels greater than or equal to 65 ft (19.8 m) in overall length and subject to the jurisdiction of the United States, and all other vessels greater than or equal to 65 ft (19.8 m) in overall length entering or departing a port or place subject to the jurisdiction of the United States,” shall travel at a speed of 10 knots or less in designated seasonal management areas for the North Atlantic right whale. These locations and times include:

- Southeastern U.S. (south of St. Augustine, FL to north of Brunswick, GA): Calving and Nursery Grounds Nov 15 - Apr 15;
- Mid-Atlantic U.S. (from north of Brunswick, Georgia to Rhode Island): Migratory Route Nov 1 - Apr 30; and
- Northeastern U.S. (north of Rhode Island): Feeding Areas, Mandatory speed restrictions vary:
    - Cape Cod Bay - Jan 1 - May 15
    - Off Race Point - Mar 1 - Apr 30
    - Great South Channel - Apr 1 - Jul 31.

Additionally, 50 CFR § 224.103 lists special prohibitions for endangered marine mammals to which OMAO operators adhere, specifically:

- 50 CFR § 224.103(b) which states that vessels must maintain a 100-yard (91.4 m) distance from endangered humpback whales in Alaska.
- 50 CFR § 224.103(c) which states that vessels may not approach within 500 yards (460 m) of a right whale.

- 50 CFR § 224.103(e) which states that vessels may not approach, in any manner, within 200 yards (182.9 m) of any 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. Additionally, if an ESA-listed whale is sighted within 91 m (100 yards) of the forward path of a vessel, OMAO would maintain distance from the whale, if possible, continue to monitor the whale until it has moved outside of the vessel's path, and then proceed with caution. In addition to the species listed above, if any ESA-listed whale is identified while a vessel is underway, the vessel must remain at least 91 m (100 yards) from large whales and 45 m (50 yards) from dolphins and porpoises; the vessel would also attempt to remain parallel to the animal's course if feasible and avoid excessive speed or abrupt changes in direction until the cetacean has left the area. For Rice's whale, transits through the Core Distribution Area (CDA) and the 100 m to 400 m isobath in the Gulf of Mexico would be minimized, vessel speed would not exceed 10 knots, and vessels would be prohibited from entering at night; if vessels are present in the CDA/isobath at night, the vessel must be anchored, moored, or otherwise immobile.

Impacts from low-frequency underwater sound generated by UMS and small boats, as well as other equipment that may generate underwater sound, would be similar to those of surface vessels but at a much-reduced magnitude due to their smaller size and the far fewer expected instances of operation over the 15-year period across all operational areas.

UAS would generate in-air sound from their engines, airframe, and propellers, and their physical presence 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 sound from UAS (including both airborne and underwater sound) would be expected to be brief in duration; additionally, testing, calibration, training, and troubleshooting of UAS would last from a minimum of a few minutes to at most one hour in any given location. Furthermore, testing and training flights would never be conducted near or over protected species. Considering the relatively low level of activity that may occur, 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, UMS and UAS operations, and small boat systems operations 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 3.7.2.1.3 Fish and Section 3.7.2.1.4 Aquatic Macroinvertebrates for full discussions of the potential impacts on fish and aquatic macroinvertebrates from vessel sound.

The effects of underwater sound from active acoustic sources on cetaceans under Alternative A would 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. While more individual animals could experience behavioral disruptions than injury, the amount of time individuals may exceed the behavioral exposure threshold would be on average less than a few minutes per exposure incident. Similarly, the potential for masking would be minimal because the narrow beams of most active acoustic sources mean that animals would not spend much time in ensonified zones. BMPs to reduce potential impacts of sound on marine mammals would be implemented, such as avoiding the use of underwater sound sources when protected cetaceans are using feeding areas (for a full list of BMPs see Appendix C).

Considering that the proposed number of vessels associated with OMAO operations within the EEZ is very low as compared with all other shipping and vessel traffic, 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 be adverse and **minor**. BMPs would be implemented to reduce the potential impacts of sound on marine mammals; see Appendix C for a complete list. Overall, the potential impacts would likely be limited to **temporary** or **short-term** disruption of acoustic habitat and behavioral patterns. Similarly, impacts beyond the U.S. EEZ while vessels are transiting or conducting drills would be similar to those within the EEZ. In all locations, impacts 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 areas immediately surrounding OMAO operations, and impacts would be **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative A on cetaceans, including ESA-listed species, would be **insignificant**.

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. 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 the vicinity of a vessel 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 NOAA vessels 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 UMS operations and small boat systems operations 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 vehicles would quickly pass by. If displaced, cetaceans are expected to return to the area and resume normal activities once the vehicles are no longer present and the water disturbance ends. Equipment, such as echo sounders, is typically attached to a vessel or ROV, 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. Deployment of all autonomous systems, as well as other equipment, would be suspended if any protected species is sighted within 91 m (100 yards) of the vessel. Work already in progress may continue if the activity is not expected to adversely affect the animal.

Data collection equipment such as CTDs, bottom grab samplers, and drop/towed cameras, are deployed and recovered 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 lines, cables, and wires used to connect equipment to the ship can cause entanglements with cetaceans if broken free from the ship/equipment, otherwise there is too much weight under tension for entanglement. This is not expected to interfere with cetacean movements since whales, dolphins, and porpoises could swim below and avoid such equipment. Prior to using equipment, OMAO would maintain a watch 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 regarding vessel movement is the possibility of marine mammal vessel strikes. Whales are 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, 2021b; NMFS, No Date-h; 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. Vessel movement 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, 2014).

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 (>10 knots). Animal approach restrictions and decreasing vessel speeds would help reduce the potential for ship strikes of some protected species. Additionally, if an ESA-listed marine mammal is identified while a vessel is underway, the vessel must remain at least 91 m (100 yards) from large whales, and 46 m (50 yards) from dolphins and porpoises. Federal law requires vessels to remain 91.4 m (100 yards) away from humpback whales in Hawai'i (NMFS, 2022c) and Alaska waters, 182.9 m (200 yards) from killer whales in Washington State inland waters, and 460 m (500 yards) away from right whales throughout U.S. waters as discussed above. If an ESA-listed whale is identified within 91 m (100 yards) of the forward path of a vessel, 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 yards). 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 the Rice's whale CDA and the 100 - 400m 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, OMAO 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. Vessel operators on vessels operating at night would use the appropriate lighting to comply with navigation rules and best safety practices. During OMAO operations, waters surrounding the vessel would be visually monitored for any marine mammals as OMAO would ensure there is at least one individual maintaining a safe lookout. Observers 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 NOAA vessel and a marine mammal would be extremely unlikely because of several factors: 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 UMS and small boats are of low concern because of their slow speeds, small size, and built-in proximity avoidance systems (on some of them).

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 3.7.2.1.3 Fish and Section 3.7.2.1.1.2 Pinnipeds 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 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 be adverse and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups would be **temporary** or **short-term** with no life-threatening injury to individual cetaceans. Displacement of cetaceans from preferred breeding, feeding, or nursery grounds, migratory routes, or designated critical habitat would be **localized** or limited to the immediate surroundings of the vessel, and possibly at the **regional** level if a vessel is moving; however, impacts would still be considered **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. 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.

Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in the release of oil, fuel, or chemicals by a NOAA vessel from tank overflow during fueling operations, fuel transfer operations, pipe leaks due to structural failure, accidental spills of hazardous chemicals used for vessel and equipment repair and maintenance, or unintentional discharge of sewage, bilge water, or ballast water into the surrounding environment. The following is a discussion of potential effects of an accidental spill, although OMAO would follow appropriate policy and guidance to manage accidental spills so as to minimize adverse impacts.

Spills occurring at the ocean surface would be expected to disperse to a very light sheen and weather rapidly (BOEM, 2014). Volatile components of the contaminant would evaporate. Fuel such as diesel used for vessel operation is light and would float on the ocean surface; although a small proportion of heavier fuel components could potentially 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 NOAA vessel, 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, 2014). 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 NOAA vessel 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 the vessels. Death or life-threatening injury of individual cetaceans would not be expected from a small spill, nor 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 due to 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 OMAO 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 vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the crew takes appropriate action to minimize the effects of the spill. OMAO's Procedure 0701-06 'Shipboard Oil Pollution Emergency Plan & Non-Tank Vessel Response Plan (VRP/SOPEP) provides policy and guidance to all OMAO vessels regarding oil pollution emergency planning and response, consistent 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, training, drills, and exercises. This plan has been approved by the USCG, and complies with the Oil Pollution Act of 1990 and Federal Water Pollution Control Act of 1973.

Since the likelihood of occurrence of an accidental spill would be very low, impacts on cetaceans under Alternative A are expected to be adverse and **negligible** to **minor**. In the event an accidental spill does occur, the volume of oil, fuel, and/or chemicals would be fairly small given the size of the vessels and the amounts of fuel and other chemicals they typically carry. Additionally, 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. Thus, the impact on cetaceans would be **temporary** or **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving, without any impacts on population levels. Impacts on cetaceans, including ESA-listed species and designated critical habitat, would be **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

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, 2014). 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 3.7.2.1.1.2 below), less common in mysticetes, and rare among odontocetes (Laist et al., 1999). Entanglement data for mysticetes reflect a high interaction rate with active fishing gear rather than marine debris (BOEM, 2014). During proposed operations, numerous cables, lines, and other objects could be towed behind the NOAA 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.

Management, storage, and disposal of solid waste generated during OMAO's operations would be conducted in accordance with established plans, guidelines, and MARPOL regulations, thus potential impacts are expected to be avoided. In addition, no intentional vessel discharges would occur if a protected species is sighted within 91 m (100 yards) of the vessel. Impacts from discarded trash and debris on cetaceans, including ESA-listed species, under Alternative A would be adverse, **negligible**, and **localized** with a low likelihood of occurrence, and any disturbance of animals would be **temporary**. No mortality or debilitating injury would be expected, and there would be no displacement from preferred or designated critical habitat; thus, impacts would be **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. It is also not expected that trash and debris would have any impacts on designated critical habitat.

3.7.2.1.1.2 Pinnipeds

The analysis of impacts on pinnipeds considers all of the impact causing factors introduced above. Potential impacts could occur in all of the operational areas as one or more pinniped species, subspecies, or DPS occur in each region (see Section 3.7.1.1.2). Three operational areas – West Coast, Alaska, and Pacific Islands – include one or more ESA-listed species, and two operational areas, Alaska and Pacific Islands, each include designated critical habitat for one listed species.

Increased Ambient Sound

Vessel movement, active acoustic systems operations, UMS and UAS operations, and small boat systems operations would increase the ambient sound level of affected pinnipeds through the production of underwater and airborne sound. As discussed above for cetaceans, the sounds that marine mammals hear and generate vary in characteristics such as dominant frequency, bandwidth, energy, temporal pattern, and directivity.

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 both underwater and airborne 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 (NMFS, 2018a; Southall et al., 2019; Reichmuth et al., 2020). NOAA vessels and equipment operated by OMAO would generate transitory sound (10 Hz to 10kHz) into the air and underwater that would allow them to be heard by pinnipeds.

Sound frequencies produced by 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 frequencies of a downward-directed echo sounder are 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 frequencies.

To reduce potential impacts of active acoustic sources on pinnipeds, OMAO would use the lowest power appropriate to perform testing and calibration of equipment. OMAO would also continue to maintain a watch for protected species at all times and would employ animal approach restrictions and reduced vessel speeds, as well as the walrus-specific measures, described in more detail below and in Appendix C.

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. 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. OMAO would continue to maintain a watch for protected species at all times and would employ animal approach restrictions and reduced vessel speeds, as well as the walrus-specific measures, described in more detail below and in Appendix C.

Animal approach restrictions in part D of 50 CFR § 224.103 list special prohibitions for Steller sea lions to which OMAO 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 in 50 CFR § 224.103 - Listed Steller Sea Lion Rookery Sites).

Additionally, if an ESA-listed pinniped is identified while a vessel is underway, the vessel would remain at least 45 m (50 yards) from seals and sea lions.

Impacts from low-frequency underwater sound generated by or UMS and small boats, as well as other equipment that may generate underwater sound, would be similar to those of surface vessels but at a much-reduced magnitude due to their smaller size and the far fewer expected instances of operation over the 15-year period across all operational areas.

UAS would generate sound from their engines and propellers, and their physical presence can disturb pinnipeds because of both the sound and the visual disturbance, particularly to individuals resting on the sea surface or at haulout 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; additionally, testing, calibration, training, and troubleshooting of UAS would last from a minimum of a few minutes to at most one hour in any given location. Furthermore, with precautions in place, testing and training flights would not be conducted near or over protected species. Considering the relatively infrequent level of aircraft activity that may occur, potential impacts from this activity on pinnipeds are expected to be minimal. Walruses, however, are easily frightened when at haulouts 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, 2016). Stampedes are the greatest impact from aircraft and vessel disturbance and may result in cow-calf separations or injuries and mortalities. In recent years, upwards of 60,000 walruses have consistently hauled out on land near Point Lay, Alaska (USFWS, 2020). Disturbance at these types of haulouts would have a greater impact on walruses 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.

OMAO 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 C details the BMPs implemented by OMAO 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 3.7.2.1.3 Fish and Section 3.7.2.1.4 Aquatic Macroinvertebrates for full discussions of the potential impacts on fish and aquatic macroinvertebrates from vessel sound and underwater acoustic sources.

The effects of underwater sound from active acoustic sources on pinnipeds under Alternative A would be adverse and **minor**. No injury exposures in the form of hearing loss (PTS) are expected to occur. While individual animals could experience behavioral disruptions, the amount of time individuals may exceed behavioral exposure thresholds would be, on average, less than a few minutes. Similarly, the potential for masking would be minimal because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Considering that the proposed volume of vessels associated with OMAO operations within the EEZ is very low as compared with all other shipping and vessel traffic, combined with 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 be adverse and **minor**. If a walrus stampede occurs due to vessel or UAS 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. Overall, the potential impacts are likely limited to **short-term** disruption of acoustic habitat and behavioral patterns. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. At all locations, impacts 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 **localized** to **regional** depending on whether the vessel is stationary or moving. Impacts of Alternative A on pinnipeds, including ESA-listed species and designated critical habitat, would be **insignificant**.

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 haulout locations. The presence of NOAA vessels, 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 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 and able to swim much faster than NOAA vessels 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. If an ESA-listed marine mammal is identified while a vessel is underway, the vessel must remain at least 46 m (50 yards) from seals, and sea lions. Since OMAO would ensure visual observation during all vessel operations (regardless of size), along with animal approach restrictions discussed above, NOAA vessels would be unlikely to strike pinnipeds. Marine mammal strikes by UxS or UMS and small boats are of low concern because of their slow speeds, small size, and built-in proximity avoidance systems (on some of them).

Water disturbance by UMS and small boats can temporarily disturb and displace nearby pinnipeds, both those in the water and those hauled out. The impacts should be minimal and likely brief in duration as the UMS, small boat, or equipment would quickly pass by; however, impacts could increase if the frequency of disturbance becomes greater or if the vehicle gets too close to haulout 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 vessel or ROV; thus, effects on pinnipeds would occur from the presence and operation of the equipment carrier as discussed above, rather than from the presence of the equipment itself. ADCPs are often operated from buoys or fixed moorings, or are hull mounted on ROVs. As with echo sounders, any effects on pinnipeds would result 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, would be suspended if any protected species is sighted within 91 m (100 yards) of the vessel. Work already in progress may continue if the activity is not expected to adversely affect the animal. Additionally, the BMPs discussed above and in Appendix C for protecting walruses also apply for vessel presence and movement of equipment in the water.

Data collection equipment such as CTDs, bottom grab samplers, and drop/towed cameras, are deployed and recovered 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 lines, cables, and wires used to connect equipment to the ship can cause entanglements with pinnipeds if broken free from the ship/equipment, otherwise there is too much weight under tension for entanglement. However, this is not expected to interfere with pinniped movements as, prior to using equipment, OMAO would maintain a watch 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 3.7.2.1.3 Fish). This could indirectly 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 haulout, rookery, and nursing characteristics of designated critical habitat for the Steller sea lion and Hawaiian monk seal. These species could be displaced or otherwise prevented from using the habitat when vessels are present.

Since the likelihood of a vessel strike would 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 be adverse and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups would be **temporary** or **short-term** with a **medium** likelihood of occurrence and no life-threatening injury to individual pinnipeds. Displacement of pinnipeds from preferred breeding, feeding, or nursery grounds, or designated critical habitat would be **localized** or limited to the immediate surroundings of the vessel, and possibly at the **regional** level if a vessel is moving; however, impacts would still be considered **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. 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.

Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in the release of oil, fuel, or chemicals by a NOAA vessel from tank overflow during fueling operations, fuel transfer operations, pipe leaks due to structural failure, accidental spills of hazardous chemicals used for vessel and equipment repair and maintenance, or unintentional discharge of sewage, bilge water, or ballast water into the surrounding environment. The following is a discussion of potential effects of an accidental spill, although OMAO would follow appropriate policy and guidance to manage accidental spills so as to minimize adverse impacts.

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 NOAA vessel, 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 a NOAA vessel 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, 2014).

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 aquatic macroinvertebrates). 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 OMAO 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 vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the crew takes appropriate action to minimize the effects of the spill. OMAO's VRP/SOPEP procedure provides policy and guidance to all OMAO vessels regarding oil pollution emergency planning and response, consistent 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, training, 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 would be very low, impacts on pinnipeds under Alternative A are expected to be adverse and **negligible** to **minor**. 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 the vessels and the amounts of fuel and other chemicals they typically carry. Additionally, 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. Thus, the impact on pinnipeds would be **temporary** or **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving, without any impacts on population levels. Impacts on pinnipeds, including ESA-listed species and designated critical habitat, would be **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

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-a). However, the tendency of pinnipeds to generally avoid approaching vessels (in contrast with their tendency to congregate around fishing vessels) presumably reduces the risk of entanglement. During OMAO operations, cables, lines, and other objects could be towed behind the NOAA 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.

Management, storage, and disposal of solid waste generated during OMAO operations would be conducted in accordance with established plans, guidelines, and MARPOL regulations, thus potential impacts are expected to be limited. In addition, no intentional vessel discharges would occur if a protected species is sighted within 91 m (100 yards) of the vessel. Impacts from discarded trash and debris on pinnipeds, including ESA-listed species, under Alternative A would be adverse, **negligible**, and **localized**, and any disturbance of animals would be **temporary**. No mortality or debilitating injury would be expected, and there would be no displacement from preferred or designated critical habitat; thus, impacts would be **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. It is also not expected that trash and debris would have any impacts on designated critical habitat.

3.7.2.1.1.3 Sirenians

All impact causing factors for marine mammals are analyzed below for sirenians. Potential impacts could occur in one of the operational areas, the SER, as it is the only region where sirenians (two subspecies of manatees) occur; this region also includes designated critical habitat for one of the manatee subspecies. Manatees occur mainly in the SER, although they have been found on occasion to travel further north into the GAR.

Critical habitat consists of both a geographic area and Primary Constituent Elements (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 haulouts). 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.

Increased Ambient Sound

Vessel movement, active acoustic systems operations, UMS and UAS operations, and small boat systems operations would increase the ambient sound level of affected sirenians through the production of underwater and airborne sound. As discussed above for cetaceans, the sounds that marine mammals hear and generate vary in characteristics such as dominant frequency, bandwidth, energy, temporal pattern, and directivity.

Acoustic signals from echo sounders (ranging from 1 kHz to 900 kHz) are likely to be detectable by manatees (whose hearing ranges from approximately 5 kHz to 60 kHz) (Southall et al., 2019). 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 frequencies from the downward-directed echo sounder 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. The effects of underwater sound from ADCPs on manatees would be similar to those 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 frequencies.

To reduce potential impacts of active acoustic sources on sirenians, OMAO would use the lowest power appropriate to perform testing and calibration of equipment. OMAO would also continue to maintain a watch for protected species at all times and would employ animal approach restrictions and reduced vessel speeds, as well as the manatee-specific measures to prevent disturbance and harassment, described in more detail below and in Appendix C.

NOAA vessels would generate transitory sound (10 to 10,000 Hz) during operations and while transiting. 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 underwater. Especially within the freshwater habitats in 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.

Underwater vessel sound 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. 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 NOAA vessel sounds. 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 UMS, as well as other equipment that may generate underwater sound, would be similar to those of surface vessels but at a much-reduced magnitude due to their smaller size and the far fewer expected instances of operation over the 15-year period across all operational areas.

UAS would generate sound from their engines and propellers, and their physical presence can disturb sirenians 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; Erbe et al., 2018). Because of these physical variables, exposure of individual sirenians to sound from UAS (including both airborne and underwater sound) would be expected to be brief in duration; additionally, testing, calibration, training, and troubleshooting of UAS would last from a minimum of a few minutes to at most one hour in any given location. Furthermore, testing and training flights would never be conducted near or over protected species. Considering the relatively low level of activity that may occur, along with the short duration of exposure to sound and visual disturbance, potential impacts from this activity on sirenians are expected to be minimal.

Appendix C details the manatee-specific BMPs that are implemented by OMAO to prevent disturbance and harassment of manatees, including such measures as avoiding collisions with and injury to manatees, idle speed and no wake situations, approach restrictions, and reporting requirements.

The effects of underwater sound from active acoustic sources on sirenians under Alternative A would be adverse and **minor**. No PTS/injury exposure is expected to occur. Some individual animals are expected to experience behavioral disruptions, but the amount of time they may exceed the behavioral exposure thresholds would be less than a few minutes. Similarly, the potential for masking would be minimal because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Considering that the proposed volume of vessels associated with OMAO operations within the SER 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 be adverse and **minor**.

Overall, the potential impacts would likely be limited to **short-term** disruption of acoustic habitat and behavioral patterns. Impacts would not be considered outside the natural range of variability of manatees' 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 areas immediately surrounding OMAO operations, and impacts would be **localized** to **regional** depending on whether the vessel is stationary or moving. It is also not expected that changes in ambient underwater sound would have any impacts on designated critical habitat. Impacts of Alternative A on sirenians would be **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

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 NOAA vessels would not be at levels expected to cause anything more than possible localized and temporary or short-term behavioral changes.

Water disturbance by UMS and small boats can also temporarily disturb and displace nearby manatees. The impact should be minimal, and exposure of individual manatees is likely brief in duration as the UMS vehicle or equipment would quickly pass by. 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 vessel or ROV, 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 are often operated from buoys and fixed moorings, or are hull mounted on ROVs. 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, would be suspended if any protected species is sighted within 91 m (100 yards) of the vessel. Work already in progress may continue if the activity is not expected to adversely affect the animal.

Data collection equipment such as CTDs, bottom grab samplers, and drop/towed cameras, are deployed and recovered 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 lines, cables, and wires used to connect equipment to the ship can cause entanglements with manatees if broken free from the ship/equipment, otherwise there is too much weight under tension for entanglement. However, this is not expected to interfere with manatee movements as, prior to using equipment, OMAO would maintain a watch 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 would be a relatively infrequent activity, thus any potential impacts are expected to be minimal as they would rarely occur.

An important consideration for all vessel operations 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 and are all but invisible to passing vessels, is known to be at great risk of mortality or injury from vessel 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, OMAO does not operate in any critical habitat and would ensure visual observation during all vessel operations so as to avoid manatees. Marine mammal strikes by UMS and small boats are of low concern because of their slow speeds, small size, and built-in proximity avoidance systems (on some of them). Additionally, the BMPs discussed above and in Appendix C for protecting manatees also apply for vessel presence and movement of equipment in the water. Additional measures (see Appendix C) 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 installation of tide gauges 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 be very low, the overall effects on manatees from vessel presence and movement of equipment in the water under Alternative A would be **adverse** and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups would 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 be **localized** or limited to the immediate surroundings of the vessel, and possibly at the **regional** level if a vessel is moving; however, impacts would still be considered **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. Vessel presence in designated critical habitat could affect the protection capability of the habitat if animals are disturbed, displaced, or injured. 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.

Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in the release of oil, fuel, or chemicals by a NOAA vessel from tank overflow during fueling operations, fuel transfer operations, pipe leaks due to structural failure, accidental spills of hazardous chemicals used for vessel and equipment repair and maintenance, or unintentional discharge of sewage, bilge water, or ballast water into the surrounding environment. The following is a discussion of potential effects of an accidental spill, although OMAO would follow appropriate policy and guidance to manage accidental spills so as to minimize adverse impacts.

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 NOAA vessel, 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 OMAO 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 vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the crew takes appropriate action to minimize the effects of the spill. OMAO's VRP/SOPEP procedure provides policy and guidance to all OMAO vessels regarding oil pollution emergency planning and response, consistent 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, training, 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.

Impacts on sirenians under Alternative A are expected to be adverse and **negligible** to **minor**. 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 the vessels and the amounts of fuel and other chemicals they typically carry. Additionally, 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. Thus, the impact on sirenians would be **temporary** or **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving, without any impacts on population levels. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. Impacts on sirenians, which are ESA-listed species, including designated critical habitat, would be **insignificant**.

Trash and Debris

Marine debris poses two types of negative impacts on manatees and other marine mammals: entanglement and ingestion. Entanglement is a far more likely cause of mortality to marine mammals in general 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 NOAA 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.

Management, storage, and disposal of solid waste generated during OMAO operations would be conducted in accordance with established plans, guidelines, and MARPOL regulations, thus potential impacts are expected to be avoided. In addition, no intentional vessel discharges would occur if a protected species is sighted within 91 m (100 yards) of the vessel. Impacts from discarded trash and debris on manatees under Alternative A would be adverse, and **negligible**, and any disturbance of animals would be **temporary**. No mortality or debilitating injury would be expected, and there would be no displacement from preferred or designated critical habitat. For these reasons, impacts would be **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. It is also not expected that trash and debris would have any impacts on designated critical habitat.

3.7.2.1.1.4 Fissipeds

The analysis of impacts on fissipeds considers all of the impact causing factors introduced above. Potential impacts could occur in two of the operational areas: the West Coast and AR, as two to three fissiped species, subspecies, or DPS, including ESA-listed species, occur in each region. The AR also includes designated critical habitat for two of the listed species.

Increased Ambient Sound

Vessel movement, active acoustic systems operations, UMS and UAS operations, and small boat systems operations would increase the ambient sound level of affected fissipeds through the production of underwater and airborne sound. 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.

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 1 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 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 need to consume 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 (Ghoul and Reichmuth, 2014), 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.

To reduce potential impacts of active acoustic sources on fissipeds, OMAO would use the lowest power appropriate to perform testing and calibration of equipment. OMAO would also continue to maintain a watch for protected species at all times and would employ animal approach restrictions and reduced vessel speeds, as well as the polar bear- and sea otter-specific measures, described in more detail below and in Appendix C.

NOAA vessels and equipment would generate transitory sound (10 to 10,000 Hz) into the air and water while transiting and during operations, which 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 (Ghoul and Reichmuth, 2014). 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 (Nachtigall et al., 2007; Owen and Bowles, 2011); 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. 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 UMS and small boats would be similar to those of surface vessels but at a much-reduced magnitude due to their smaller size and the far fewer expected instances of operation over the 15-year period across all operational areas. Reactions to these vehicles are expected to be limited to startle or otherwise brief responses. Although it is not expected that there would be any lasting consequence to the animals, a startle response may also lead to an abandoned foraging attempt, and possibly multiple foraging attempts. As noted above, sea otters need to consume 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 adverse consequences to individuals.

UAS can disturb fissipeds because of both airborne and underwater sound and visual disturbance. It is possible that they could disturb polar bears or sea otters resting on ice, on barrier islands, or at coastal haulouts. Denning bears have been known to abandon or depart their dens early in response to repeated sound produced by extensive aircraft overflights (NMFS, 2016; BOEM, 2015a), although that would not be expected to occur from the UAS used by OMAO. 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, 2016). As testing, calibration, training, and troubleshooting of UAS would last from a minimum of a few minutes to at most one hour in any given location and training flights would never be conducted near or over protected species, impacts on polar bears would be minimal or could be avoided entirely.

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. As testing, calibration, training, and troubleshooting of UAS would last from a minimum of a few minutes to at most one hour in any given location, and training flights would never be conducted near or over protected species, it is unlikely that the aircraft used by OMAO would elicit anything other than minimal disturbance reactions.

Appendix C details the fissiped-specific BMPs that are implemented by OMAO 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 yards). If the group size is greater than 10, do not approach within 500 m (547 yards);
- 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; and
- Maintain an altitude of at least 205 m (1000 ft) when flying over northern sea otters;
- 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 haulouts, 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 above in Section 3.7.2.1.1.2 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.

The effects of underwater sound from active acoustic sources on fissipeds under Alternative A would be adverse and **minor**. No injury exposures in the form of hearing loss (PTS) are expected to occur. While individual animals could experience behavioral disruptions, the amount of time individuals may exceed behavioral exposure thresholds would be on average less than a few minutes. Similarly, the potential for masking would be minimal because the narrow beams of most active acoustic sources mean animals would not spend much time in ensonified zones. Considering that the proposed volume of vessels associated with OMAO operations within the West Coast and AR 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 be adverse and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups would 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 be **localized** to **regional** depending on whether the vessel is stationary or moving. Impacts of Alternative A on fissipeds, including ESA-listed species and designated critical habitat, would be **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Vessel Presence and Movement of Equipment in the Water

The presence of NOAA vessels has 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, 2016). Swimming can be energetically depleting for polar bears, particularly for bears engaged 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 NOAA vessels 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 a NOAA vessel 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 active operations. Also, the presence of NOAA vessels 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 UMS and small boats can temporarily disturb and displace nearby fissipeds both in the water, on land, or on ice. The impact should be minimal and likely brief in duration as these vehicles would quickly pass by; however, impacts could increase if the vehicles get too close to land or ice in locations where fissipeds are found. 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 vessel or ROV, thus effects on fissipeds would occur from the presence and operation of the carrier rather than from the presence of the equipment itself. ADCPs are often operated from buoys and fixed moorings, or are hull mounted or on UMS. 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 yards) of the vessel. Work already in progress may continue if the activity is not expected to adversely affect the animal.

Data collection equipment such as CTDs, bottom grab samplers, and drop/towed cameras, are deployed and recovered through the water column. This movement through the water could temporarily disturb and displace nearby manatees. These impacts would be temporary as pinnipeds are expected to return once water column turbulence ceases. The lines, cables, and wires used to connect equipment to the ship can cause entanglements with sea otters if broken free from the ship/equipment, otherwise there is too much weight under tension for entanglement; entanglement 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, OMAO would maintain a watch for protected species at all times.

An important consideration for all vessel operations is the possibility of marine mammal vessel strikes. Ship strikes can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds. However, 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, OMAO would ensure visual observation during all vessel operations (regardless of size) so as to avoid polar bears and sea otters. Marine mammal strikes by UMS and small boats are of low concern because of their slow speeds, small size, and built-in proximity avoidance systems (in some of them).

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. Additionally, the BMPs discussed above and in Appendix C for reducing sound impacts on fissipeds also apply for 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 3.7.2.1.3 Fish and 3.7.2.1.1.3 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 3.7.2.1.4 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.

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 be adverse and **minor**. Small disruptions of behavioral patterns or displacement of individuals or groups of fissipeds would 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 be **localized**, limited to the immediate surroundings of the vessel, and possibly at the **regional** level if a vessel is moving; however, impacts would still be considered **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. 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.

Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in the release of oil, fuel, or chemicals by a NOAA vessel from tank overflow during fueling operations, fuel transfer operations, pipe leaks due to structural failure, accidental spills of hazardous chemicals used for vessel and equipment repair and maintenance, or unintentional discharge of sewage, bilge water, or ballast water into the surrounding environment. The following is a discussion of potential effects of an accidental spill, although OMAO would follow appropriate policy and guidance to manage accidental spills so as to minimize adverse impacts.

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 NOAA vessel, sea otters and polar bears would be particularly vulnerable due to their reliance on thick fur to maintain body heat. Polar bears could be exposed to oil while swimming or coming ashore onto impacted beaches. Sea otters are especially 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, 2016). Both species can also 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 OMAO 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 vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the crew takes appropriate action to minimize the effects of the spill. OMAO's VRP/SOPEP procedure provides policy and guidance to all OMAO vessels regarding oil pollution emergency planning and response, consistent 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, training, 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.

Impacts on fissipeds under Alternative A are expected to be adverse and **negligible** to **minor**. 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 the vessels and the amounts of fuel and other chemicals they typically carry. Additionally, 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. Thus, the impact on fissipeds would be **temporary** or **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving, without any impacts on population levels. Impacts on fissipeds, including ESA-listed species and designated critical habitat, would be **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

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 sea otters or polar bears, 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 NOAA 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 NOAA vessels producing debris in which they could become entangled is low.

Management, storage, and disposal of solid waste generated during OMAO operations would be conducted in accordance with established plans, guidelines, and MARPOL regulations, thus potential impacts are expected to be avoided. In addition, no intentional vessel discharges would occur if a protected species is sighted within 91 m (100 yards) of the vessel. Impacts from discarded trash and debris on fissipeds under Alternative A would be adverse, **negligible**, and **localized**, and any disturbance of animals would be **temporary**. No mortality or debilitating injury would be expected, and there would be no displacement from preferred or designated critical habitat. For these reasons, impacts would be **insignificant**. It is also not expected that trash and debris would have any impacts on designated critical habitat. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

3.7.2.1.1.5 Conclusion

Although the effects of impact causing factors on marine mammals and their associated habitat range from negligible to moderate, moderate impacts could only occur in the very unlikely event of a vessel strike, walrus stampede, or accidental spill of oil, fuel, or chemicals. Since all the other effects of impact causing factors on marine mammals would range from negligible to minor, the overall impact of Alternative A on marine mammals, including ESA-listed species and designated critical habitat, would be

adverse, **minor**, **temporary** to **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative A would be **insignificant**.

3.7.2.1.2 Sea Turtles

OMAO operations may impact sea turtles in a variety of ways in the action area, including (1) increased ambient sound (e.g., from vessel movement, active acoustic systems, UMS, UAS, and small boat systems); (2) vessel presence and movement (e.g., visual and physical disturbance from vessels, UMS, and small boats); (3) accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters (e.g., from vessel operations); and (4) underwater activities (e.g., use of underwater equipment and anchors). These potential impact causing factors and their associated effects on sea turtles and sea turtle habitat are discussed below.

Increased Ambient Sound

Active underwater acoustic sources (i.e., echo sounders and ADCPs) could cause impacts to sea turtles from the propagation of underwater sound. The acoustic signatures generated by OMAO equipment range from 0.5 to 1,200 kHz and decrease in intensity with distance from the vessel. Acoustic sounds from these sources are typically considered a potential temporary disturbance limited to the immediate vicinity of the vessel. 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, 2014; NMFS, 2018a; 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 500 Hz (0.5 kHz). Most OMAO operations are conducted in deeper water, thus animal exposure to lower frequencies would be limited due to the distance from the source. The frequencies at which underwater sounds are produced by active acoustic sources would most likely be above the documented hearing range; therefore, the sounds would 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 likely perceptible to sea turtle aquatic macroinvertebrate prey (see Section 3.7.2.1.4) and would not affect any other characteristics of sea turtle habitat, including designated critical habitat.

Vessel sound (including UMS and small boats) represents the majority of the ambient ocean auditory environment and is becoming more prevalent with increased human marine activity. Vessel sound is a combination of tonal sounds (i.e., sounds with discrete frequencies) and broadband sounds (i.e., sounds with a combination of many frequencies) (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 from both vessels and UAS 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 a permanent reduction of hearing capabilities for 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 to 204 dB could respectively cause temporary and permanent threshold shifts in sea turtles (Navy, 2017). These estimates were derived using the best available data on sea turtle hearing thresholds and mathematical relationships of threshold shifts in similar species. However, NOAA vessels typically produce source levels of 130 to 160 dB while transiting, and only larger vessels outside the scope of OMAO operations and this Draft PEA, 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 3.5. 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 NOAA vessel sound could temporarily contribute to auditory masking for any given population of sea turtles, but it is unclear whether masking would realistically have any effect on them since the role of hearing in sea turtle ecology is unknown; there are no quantitative data demonstrating masking effects for sea turtles (BOEM, 2014).

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 the vicinity of OMAO operations. Although sound produced by NOAA vessels 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 or responses 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 and UAS 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 aquatic 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 by vessel sound (see Section 3.7.2.1.4 Aquatic Macroinvertebrates). However, displacement would likely only last for the duration of vessel activity 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.

Active underwater acoustic sound, vessel sound, and UAS sound would likely only displace sea turtles and prey within the immediate vicinity of NOAA vessels and would not cause any mortality or direct injury to sea turtles. Sea turtles and their prey are expected to return to the vicinity from which they were displaced after the completion of OMAO operations 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 NOAA vessels, UMS, and small boats would be indistinguishable from those produced by all other vessels. Any resulting impacts from increased ambient sound to sea turtles and sea turtle habitat, including designated critical habitat, under Alternative A would be adverse, **negligible**, **temporary**, **localized** to **regional** depending on whether the vessel is stationary or moving, and therefore **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Vessel Presence and Movement

OMAO vessel operations represent only a very small proportion of the total amount of vessel operations within the action area. 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 OMAO operations 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. Additionally, sargassum would be avoided, if possible, to prevent impacts on sea turtle hatching habitat.

Much like vessel sound, the visual presence of NOAA vessels could disrupt normal sea turtle behavior and displace individuals from the vicinity of a vessel. 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 NOAA vessels 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 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 only use the minimum lighting necessary to comply with navigation rules and best safety practices in order to avoid visual disturbances to nesting sea turtles and emerging hatchlings. Therefore, increased evasive behavior and additional energy expenditure as a result of vessel presence are not expected to harm individuals or populations.

NOAA vessels within the action area could potentially strike 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 (USDOC et al., 2008). The probability of sea turtle collision with any vessel is contingent upon its size and speed. Larger, relatively slow-moving vessels are less likely to strike sea turtles than smaller vessels traveling at higher speeds because turtles more easily recognize and avoid larger, slow-moving vessels. Collisions are expected to be avoided during OMAO operations and transits given the low speed and small size of most NOAA vessels (including UMS and small boats) and the constant monitoring for protected species. Additional BMPs to avoid vessel strikes include maintaining a distance of 45 m (50 yards) or greater from sea turtles; and when transiting through known sea turtle ranges posting at least one lookout for sighting of sea turtles, and a second observer in certain circumstances where visibility may be restricted. OMAO does not transit through any designated critical habitat, purposefully avoiding these areas. Behavioral observations of sea turtle vessel avoidance, however, 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 NOAA vessels 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. The difficulty in distinguishing small shapes on the water's surface at night decreases the ability of vessels to recognize and avoid sea turtles, potentially resulting in a higher risk of vessels striking sea turtles engaged in nocturnal feeding, mate searching, and movement towards nesting beaches. Poor visibility at night also prevents sea turtles from seeing vessels and avoiding them. However, as sea turtles are predominantly diurnal and do not surface often during the night, and with crewmembers posted for observation during vessel operations at night (as well as at all other times), the likelihood of nighttime collisions is expected to be very low. Extreme weather events would also reduce visibility between vessels and sea turtles but would not be expected to appreciably raise the overall probability of collision since NOAA vessels would limit, whenever possible, operations in poor weather conditions.

Wakes associated with project vessel movements could disturb the water column and adversely impact sea turtles in the vicinity of the vessel. 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 NOAA vessels 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.

The presence and movement of NOAA vessels could affect sea turtle habitat, including designated critical habitat, through the disturbance and displacement of aquatic macroinvertebrate prey. As with vessel sound discussed above, vessel presence and movement would likely displace motile (i.e., capable of self-powered motion) aquatic macroinvertebrate prey species from the vicinity of a vessel through underwater visual disturbance or turbulence from wakes. Prey are expected to return immediately following vessel activity, and any increased foraging effort, competition, or energy expenditure resulting from the displacement of aquatic macroinvertebrate prey is not expected to harm sea turtle individuals or overall sea turtle populations.

Although highly unlikely, any injury or death to sea turtles from vessel strikes would constitute a moderate or greater impact, depending on the species, given the protection status afforded to sea turtles by the ESA. Although 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 vicinity of a vessel (**localized** to **regional** depending on whether the vessel is stationary or moving), and the duration of OMAO operations would be on the order of hours, days, or weeks. Therefore, 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, NOAA vessels only represent a negligible portion of overall vessel traffic within the U.S. EEZ, and the impacts created by these vessel movements would be indistinguishable from those produced by all other vessels. Thus, the effects of vessel presence and movement under Alternative A on sea turtles and their habitat, including designated critical habitat, would be adverse, **negligible** to **minor**, **temporary**, and therefore **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in release of oil, fuel, or chemicals by a NOAA vessel from tank overflow during fueling operations, fuel transfer operations, pipe leaks due to structural failure, accidental spills of hazardous chemicals used for vessel and equipment repair and maintenance, or unintentional discharge of sewage, bilge water, or ballast water into the surrounding environment. The following is a discussion of potential effects of an accidental spill, although OMAO would follow appropriate policy and guidance to manage accidental spills so as to minimize adverse impacts.

Accidental oil, fuel, or chemical spills as a result of OMAO operations 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 distress. 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 can adhere to turtle skin or shells, prolonging and exacerbating the direct effects of tissue exposure. Larger spills would contaminate areas beyond the immediate vicinity of a vessel and increase the likelihood of sea turtle exposure to volatile chemicals, potentially resulting injury or mortality. However, the vast majority of spills or releases would be confined to the immediate area around a vessel 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 NOAA vessels produce some waste through normal operations and could accidentally lose or discard debris, a major form of marine pollution (Laist, 1997). Vessels 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 ingestion; loggerhead turtles have been found entangled in debris ranging from fishing lines to onion sacks (NMFS and USFWS, 2008). However, all vessel operations would comply with regulations that prohibit the discharge of waste unless it is processed, such that it is able to pass through a 25-mm mesh screen (33 CFR §§ 151.51–77), require the development and implementation of onboard waste management plans, mandate marine debris education for crew members, and require the use of a certified marine sanitation device to treat and discharge sewage (33 U.S.C. §§ 1905–15, 1952–53; 33 CFR § 159.7). Adherence to these regulations should prevent discharged project vessel waste from harming sea turtles. Also, no discharges would occur if any protected species are sighted within 91 m (100 yards) of the vessel. Furthermore, the vast majority of NOAA vessels are small in comparison to the vast majority of vessels and would not generate substantial amounts of food waste from galley operations.

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 aquatic macroinvertebrates and seagrasses, could become contaminated and bioaccumulate (i.e., 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 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 vicinity of a vessel 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 contaminants, trash, and debris from OMAO operations. 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 OMAO operations. In the unlikely event of an accidental spill, there would be very low likelihood for contaminants to make contact with the water because crew members are required to respond immediately using established spill response procedures. For example, on NOAA vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the crew takes appropriate action to minimize the effects of the spill. OMAO's VRP/SOPEP procedure provides policy and guidance to all OMAO vessels regarding oil pollution emergency planning and response, consistent 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, training, 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 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 almost no possibility of large spills given the size of NOAA vessels. 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 spills from NOAA vessels would be indistinguishable from those produced by all other vessels. Therefore, adverse impacts from Alternative A on sea turtles and sea turtle habitat, including designated critical habitat, from accidental leakage or spillage of oil, fuel, chemicals and waste would be adverse, **negligible** to **minor**, **short-term**, **localized** to **regional** depending on whether the vessel is stationary or moving, and **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Underwater Activities

The vast majority of underwater OMAO operations would result in a temporary disturbance to the water column, potentially impacting sea turtles. The lowering and raising of echo sounders; anchors and chains; and data collection equipment such as CTDs, bottom grab samplers, and drop/towed cameras 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 OMAO operations in an 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 or prolonged underwater activities in these areas could disrupt important, time-sensitive behaviors, which would likely have more severe or more intense adverse effects on sea turtles.

Similarly, a number of OMAO operations involve trailing the equipment listed above with lines or wire behind and beneath NOAA vessels, which poses a risk of entangling or capturing 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 (which OMAO does not use) 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 OMAO. 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, 2018a). However, the trailed equipment used during OMAO operations would only be submerged for periods of time ranging from minutes to hours, limiting the potential exposure to sea turtles and possible entanglement or capture. 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 possibly avoid trailing equipment. Furthermore, the majority of trailed equipment would stay within hundreds of meters of the towing vessel and would only potentially impact sea turtles within close range; more so, sea turtles would likely be displaced by the visual disturbance and sound of the vessel itself before they could interact with any trailed equipment. As such, entanglement with trailed OMAO equipment is not expected to be a substantial threat to sea 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 GAR are designated as critical habitat for sea 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 aquatic macroinvertebrate sea turtle prey. However, seafloor disturbance would be limited to relatively small portions of a given area and any resulting changes to water quality would be quickly dissipated by the prevailing ocean currents.

To minimize or avoid the potential adverse effects of underwater activities, BMPs would be implemented, including (also see Appendix C):

- OMAO would minimize anchor drag (i.e., provide adequate anchor scope) 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 91 m (100 yards) of the vessel. Work already in progress may continue if the activity is not expected to adversely affect the animal.

Underwater activities would likely only displace sea turtles and prey within the immediate vicinity of a NOAA vessel and would not cause any mortality or direct injury to sea turtles. Sea turtles and their prey are expected to return to the area from which they were displaced after the completion of OMAO underwater operations and are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure. To minimize or avoid the potential adverse effects of underwater activities, BMPs would be implemented, including minimizing anchor drag and suspending deployment of all autonomous systems and instruments if any sea turtles are sighted within 91 m (100 yards) of the vessel. Work already in progress would continue if the activity is not expected to adversely affect the animal(s). Therefore, the impacts of Alternative A on sea turtles and sea turtle habitat, including designated critical habitat, from underwater operations would be adverse, **negligible** to **minor**, **temporary**, **localized**, and therefore **insignificant**.

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 a vessel strike or an accidental spill of oil, fuel, or chemicals. Since all the other effects of impact causing factors on sea turtles would range from negligible to minor, the overall impact of Alternative A on sea turtles, including ESA-listed species and designated critical habitat, would be **adverse**, **minor**, **temporary** to **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative A would be **insignificant**.

3.7.2.1.3 Fish

OMAO operations that could impact fish include (1) increased ambient sound (e.g., from vessel movement, active acoustic systems, UMS, and small boat systems); (2) vessel wake and underwater turbulence (e.g., from vessel movement; UMS and small boats; survey equipment; and anchors); (3) accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters (e.g., from vessel operations); and (4) disturbance of the sea floor (e.g., from anchoring and bottom sampling). These potential impact causing factors and their associated effects on fish and fish habitat are discussed below.

Potential impacts could occur in all of the operational areas. All regions include ESA-listed species, and all regions, other than PIR, include designated critical habitat (see **Table 3.3-1**). The WCR contains the greatest number of ESA-listed species and the most designated critical habitat.

Increased Ambient Sound

Effects of human-generated sound on fish 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 OMAO operations, including echo sounders (0.5-900 kHz) and ADCPs (35-1,200 kHz), could affect pathological, physiological, and behavioral characteristics. 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, a frequency level 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 fish 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, 2018).

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 fish 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 fish (and invertebrates), and it is used to locate the direction of the source, even in those fish 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). Fish with a swim bladder involved in hearing and fish with high-frequency hearing may exhibit TTS from exposure to low- and mid-frequency sonar. Fish without a swim bladder and fish 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 OMAO operations 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 to occur 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 for those individuals within several meters of a sound source operating at high levels causing harm by the energy output of the sound, although the intensity of the impacts are unknown. The frequencies of echo sounders and ADCPs do not overlap with the frequencies at which most marine and freshwater fish, including ESA-listed fish, are known to detect or produce sound. An exception to this is that some of the herring-like fish (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 fish in the Alosine subfamily of herrings with an ability to hear frequencies above 20 kHz, exposure for most individual fish would be very brief. Therefore, active underwater acoustic sources used in OMAO operations 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 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 temporary nature of the sound sources and the brief transits of NOAA vessels in and out of an action area relative to individual fish. For alosine herrings, there is potential for disturbance responses 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.

OMAO operations 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 NOAA vessel would be in constant motion during operations. 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, 2014). 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 fish would also be expected to end (McCauley et al., 2000b).

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. Source levels and frequency characteristics are roughly related to ship size and speed. The dominant sound source of NOAA vessels 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. Impacts on fish behavior are expected to be temporary and localized to areas of NOAA vessel activity. UMS and small boats also generate engine sound, and impacts on fish would be similar to those from sounds of larger vessels, but likely at a reduced severity as these vehicles are smaller, thus producing less sound, and they would not be used as extensively as larger vessels.

NOAA vessels would represent only a negligible proportion of total vessel traffic in the action area with relatively low amounts of vessel sound produced as compared to sound from all other marine traffic in U.S. waters, and impacts from vessel sound would be limited to temporary behavioral and stress-startle responses to individual fish or schools of fish. The mobile and temporary nature of OMAO operations, as well as the small area affected during operations 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, **negligible** to **minor**, **temporary**, and **localized** impacts. Impacts on fish, including ESA-listed species, would be **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Vessel Wake and Underwater Turbulence

Water disturbance and underwater turbulence by vessel, UMS, and small boat wakes could temporarily disturb and displace nearby fish. 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. The impact from UMS and small boats would also be minimal; they would not create a large wake or much underwater turbulence because they are slow-moving and relatively small.

Vessel wakes and turbulence can generate wave and surge effects on nearby shorelines and stir up bottom sediments in shallow locations 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 fewer fish. Not only would these types of impacts occur in general fish habitat, but also in such areas as nearshore marine critical habitat for species such as bull trout and bocaccio, and estuarine critical habitat for species such as Atlantic salmon, gulf sturgeon, and green sturgeon. To assist in the reduction of adverse effects caused by wake action, NOAA vessels would operate at sufficiently lower speeds (approximately 10 knots or less); this also reduces 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 reduce 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 UMS, equipment such as CTDs, 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 used in OMAO operations, such as echo sounders, are typically attached to a vessel or ROV; thus, effects on fish due to water disturbance from this equipment would be negligible in comparison to impacts from the vessel or ROV itself. Some data collection equipment, such as CTDs, grab samplers, and drop/towed cameras, are lowered and raised through the water column and could temporarily displace fish and disrupt their behavior. This movement through the water could temporarily disturb and displace nearby fish, as well as benthic communities and prey species, 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. Lines connecting equipment to a vessel could also become entangled with, damage, or kill aquatic vegetation in fish habitat, such as seagrass.

Under Alternative A, effects on fish and fish habitat, including ESA-listed species and designated critical habitat, from vessel wake and underwater turbulence would include responses to disturbance by some individuals, limited to temporary behavioral and stress-startle responses, but without interference to factors affecting population levels, and habitat impacts would be easily recoverable with no long-term damage or alteration. Thus, impacts would be adverse and **negligible** to **minor**, **temporary** to **short-term**, **localized** to **regional** depending on whether the vessel is stationary or moving, and **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in release of oil, fuel, or chemicals by a NOAA vessel from tank overflow during fueling operations, fuel transfer operations, pipe leaks due to structural failure, accidental spills of hazardous chemicals used for vessel and equipment repair and maintenance, or unintentional discharge of sewage, bilge water, or ballast water into the surrounding environment. The following is a discussion of potential effects of an accidental spill, although OMAO would follow appropriate policy and guidance to manage accidental spills so as to minimize adverse impacts.

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, 2014).

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; Langangen et al., 2017). 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 other contaminants 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 quantity 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.

The accidental loss of a substantial amount of fuel or lubricating oil during OMAO operations 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, 2014).

Vessel bilge water discharges, engine operations, bottom paint sloughing, boat washdowns, and other vessel activities can also deliver debris, nutrients, and contaminants to waterways which may degrade water quality, contaminate sediments, and alter benthic communities in fish habitat. Vessel discharge, including greywater, 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 potentially in areas such as nearshore marine critical habitat for species such as bull trout and bocaccio, deepwater critical habitat for bocaccio and yelloweye rockfish, and estuarine critical habitat for 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 in freshwater habitats due to vessel operations in those areas.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of OMAO 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 vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the crew takes appropriate action to minimize the effects of the spill. OMAO's VRP/SOPEP procedure provides policy and guidance to all OMAO vessels regarding oil pollution emergency planning and response, consistent 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, training, 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 continue to be handled in accordance with applicable laws and crew members would continue to be appropriately trained in materials storage and usage. The likelihood of occurrence of an accidental spill from a NOAA vessel would be very **low**, although the release of other contaminants is a little more likely. Thus, impacts on fish and fish habitat under Alternative A would be adverse, **negligible**, **short-term**, **localized**, and **insignificant**. 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 NOAA vessels typically carry for onboard consumption; thus, the impact on fish and fish habitat would be adverse and **minor** as impacts on fish would be **temporary** or **short-term** without any impacts on population levels and habitat impacts would be easily recoverable with no long-term damage or alteration. Impacts on fish and fish habitat, including ESA-listed species and designated critical habitat, would be considered **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Disturbance of the Sea Floor

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 when the anchor and anchor chain come to rest on the sea floor or when it is hauled out of the water. Any displaced fish are expected to return to the area and resume normal activities once water column disturbance ceases. Adverse impacts on fish habitat can occur when vessels anchor in shallow nearshore waters and the anchor chain drags across the sea floor, damaging submerged vegetation and other benthic structures, and creating scour holes. Anchor scour has the potential to create localized turbidity and affect soft-bottomed seafloor habitat and/or rocky substrates; this 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. BMPs would be implemented to minimize adverse anchoring impacts, such as ensuring that anchors are properly secured, avoiding anchor drag, and avoiding anchoring in sensitive live bottom habitats (e.g., eelgrass, seagrass, coral reefs, abalone habitat, etc.) 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.

Increased turbidity immediately following anchoring could also temporarily reduce fish prey's ability to forage 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, temporarily reducing water clarity, and affect soft-bottomed seafloor habitat. This turbidity would likely be minimal as samplers are designed to snap shut to contain the sediment sample and prevent washout. Fish in the vicinity would likely swim away and avoid any of these turbidity impacts. OMAO would continue to follow BMPs, such as making sure that all instruments placed in contact with the sea floor create minimal bottom disturbance; OMAO would not collect bottom samples on known coral reefs, shipwrecks, obstructions, or hard bottom areas. Additionally, UMS (e.g., AUVs) would be programmed and operated so as to avoid seafloor disturbance. When deploying equipment or autonomous systems, 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 bottoms could occur in designated critical habitat if anchoring, collection of 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. BMPs would be implemented to minimize adverse impacts on fish habitat, such as: all vessels in coastal waters would operate in a manner to minimize seafloor disturbance, and transiting vessels would follow deep-water routes, as practicable, to reduce disturbance to sturgeon and sawfish habitat.

Effects on fish and fish habitat from disturbance of the sea floor under Alternative A would be adverse and **negligible** to **minor**, **temporary** to **short-term**, **localized**, and with a **high** likelihood of occurrence. Impacts to fish would 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. Habitat impacts would be easily recoverable with no long-term damage or alteration. Impacts on fish, including ESA-listed species and designated critical habitat, would be **insignificant**.

Conclusion

Since the effects of impact causing factors on fish and fish habitat would range from negligible to minor, the overall impact of Alternative A on fish, including ESA-listed species and designated critical habitat, would be **adverse**, **minor**, **temporary** to **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative A would be **insignificant.**

3.7.2.1.4 Aquatic Macroinvertebrates

OMAO operations that could impact aquatic macroinvertebrates include (1) increased ambient sound (e.g., from vessel movement, active acoustic systems, UMS, and small boat systems); (2) vessel wake and underwater turbulence (e.g., from vessel movement; UMS and small boats; survey equipment; and anchors); (3) accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters (e.g., from vessel operations); and (4) disturbance of the sea floor (e.g., from anchoring and bottom sampling). These potential impact causing factors and their associated effects on aquatic macroinvertebrates and their habitat are discussed below for each alternative.

Potential impacts could occur in all of the operational areas. Three of the regions (Southeast, West Coast, Pacific Islands) include one or more ESA-listed species, but only one region, the SER, includes designated critical habitat for aquatic macroinvertebrates (see Section 3.7.1.4). The PIR contains the greatest number of ESA-listed species (all corals), closely followed by the SER (also corals). The only designated critical habitat is for staghorn coral and elkhorn coral in the SER.

Increased Ambient Sound

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 (e.g., 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 OMAO operations should be above the detection range of aquatic macroinvertebrates.

All vessels generate low-frequency underwater sound (in the 0.01 to 10 kHz frequency range) and are major contributors to the overall background sound in the sea, which has been increasing for decades. Although aquatic macroinvertebrates can probably detect low-frequency sound from ships, scientists do not yet understand what, if anything, this sound at these levels indicates. It is likely that aquatic macroinvertebrates found in locations with high vessel traffic have already become accustomed 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 macroinvertebrate taxa. Impacts on aquatic macroinvertebrate behavior are anticipated to be temporary and localized to areas of vessel activity.

UMS and small boats also generate engine sound, and effects on aquatic macroinvertebrates would be similar to those from surface vessels but at a reduced severity as these vehicles are smaller, thus producing less sound, and would not be used as frequently as surface vessels.

Overall, given the proposed volume of vessel traffic associated with OMAO operations within the EEZ, and the active underwater acoustic sources, the mobility of the vessels, the temporary timeframe to conduct operations, and 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 operations relative to the entire EEZ, Alternative A would have adverse, **negligible**, **temporary**, and **localized** impacts on aquatic macroinvertebrates. Impacts on aquatic macroinvertebrates, both marine and freshwater (Great Lakes and major navigable rivers), including ESA-listed species, would be **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Vessel Wake and Underwater Turbulence

Water disturbance and underwater turbulence by vessels, UMS, and small boat wakes could temporarily disturb nearby aquatic macroinvertebrates and displace mobile taxa. However, these impacts would be minimal as the vessel would quickly pass by or stop moving. In any event, mobile aquatic macroinvertebrates would be expected to return to the area and resume normal activities once the vessel departs. The impacts from UMS and small boats would also be minimal; these systems would not create a large wake or much underwater turbulence due to their slow movement and small size.

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 algal blooms (which consume DO). 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 resulting in 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.

Equipment used in OMAO operations are typically attached to the vessel or ROV; thus, effects on aquatic macroinvertebrates due to water disturbance would be caused by the vessel or ROV, rather than by the equipment itself. An exception would be in the rare instances when equipment is placed directly on the sea floor which would possibly disturb nearby aquatic macroinvertebrates temporarily by moving through the water column. Some data collection equipment, such as CTDs, grab samplers, and drop/towed cameras, as well as the ship's anchor and anchor chain, are lowered and raised through the water column. This movement through the water column could temporarily cause localized turbulence and disturb nearby aquatic macroinvertebrates, such as crabs, shrimp, or lobsters (although these species are not expected to be displaced any substantial distance from the local area), as well as potentially cause damage to submerged aquatic vegetation. These impacts would be temporary, as these organisms are expected to return once water column turbulence ceases.

Effects on aquatic macroinvertebrates under Alternative A, including ESA-listed species and designated critical habitat, from vessel wake and underwater turbulence would be adverse and **negligible** to **minor**, **temporary** to **short-term**, **localized** to **regional** depending on whether the vessel is stationary or moving, and **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in the release of fuel or diesel by a NOAA vessel. Adverse impacts on aquatic macroinvertebrates could also occur from discharged wastewater/greywater that may contain nutrients and fecal coliform and accidental oil, fuel, and chemical spills. All hazardous or regulated materials would continue to be handled in accordance with applicable laws, and crew members would continue to be thoroughly trained in the appropriate use and storage of these materials.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of OMAO 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 crew takes appropriate action to minimize the effects of the spill. OMAO's VRP/SOPEP procedure provides policy and guidance to all OMAO vessels regarding oil pollution emergency planning and response, consistent 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, training, 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 species 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.

The accidental loss of a substantial amount of fuel or oil during OMAO operations could affect water quality, the water column, the sea floor, intertidal habitats, and associated biota (e.g., submerged aquatic vegetation) resulting in their mortality or substantial injury, and in alteration of the existing quality of aquatic macroinvertebrate habitats. Spill prevention and recovery plans and shipboard emergency plans outlining measures to reduce the potential for spills and isolate accidental spills, should they occur, are created for each vessel and would further reduce the potential for adverse impacts on habitat. In addition, spill response 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.

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 greywater, 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.

Although the probability of an accidental oil or chemical spill from a NOAA vessel 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.

Oil and chemicals can indirectly impact aquatic macroinvertebrates by causing changes to the ecosystem and thus affecting prey species and habitats. Many macroinvertebrates feed upon phytoplankton and zooplankton during various life stages. Even if a large quantity of plankton was affected by an accidental spill, recovery times are rapid due to high reproductive rates, rapid replacement of phytoplankton from adjacent waters, widespread distribution, and exchange with tidal currents. Moreover, NOAA vessels carry very small quantities of fuel and other chemicals 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.

All hazardous or regulated materials would continue to be handled in accordance with applicable laws and crew members would continue to be thoroughly trained in the appropriate use and storage of these materials. The likelihood of an accidental spill under Alternative A would be very low, although the release of other contaminants would be a little more likely. Thus, impacts on aquatic macroinvertebrates and their habitat under Alternative A would be adverse, **negligible**, **short-term**, **localized**, and **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ. Impacts on aquatic macroinvertebrates, including ESA-listed species and designated critical habitat, would be considered insignificant. In the event an accidental spill should occur, the volume of oil, fuel, and/or chemicals would be fairly small given the amounts of fuel and other chemicals carried by NOAA vessels for underway consumption; the impacts on aquatic macroinvertebrates would be minor or greater but still be considered insignificant.

Disturbance of the Sea Floor

Water disturbance by anchors and chains moving in the water can temporarily disturb, displace, damage, crush, injure, or kill nearby aquatic macroinvertebrates, both mobile (e.g., crustaceans) and sessile (e.g., corals, sea urchins, sea anemones, mollusks, sponges). Impacts would be minimal and localized (BOEM, 2014) and would cease with the anchoring system coming to rest. Any displaced aquatic macroinvertebrates are expected to return to the area and resume normal activities as soon as seafloor disturbance ceases.

Adverse impacts on aquatic macroinvertebrate habitat can occur when vessels anchor in nearshore waters and the anchor chain drags across the sea floor, destroying submerged vegetation and creating scour holes. 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. Increased turbidity immediately following anchoring events could temporarily reduce foraging ability of prey due to decreased visibility in the water column. 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. Suspended sediments are expected to settle quickly, and long exposures are not likely to occur. Furthermore, BMPs would be implemented throughout the fleet to minimize adverse anchoring impacts, such as avoiding anchor chain drag and avoiding anchoring in sensitive live bottom habitats (e.g., eelgrass, seagrass, coral reefs, abalone habitat, etc.) in order to minimize bottom disturbance.

Collecting bottom samples could create localized turbidity and affect soft-bottomed seafloor habitat, temporarily reducing water clarity. Such turbidity would likely be minimal as samplers are designed to snap closed to contain the sediment and prevent sample washout. Mobile aquatic macroinvertebrates in the vicinity would likely move away and avoid any of these turbidity impacts. OMAO would continue to follow BMPs to ensure all instruments placed in contact with the sea floor create minimal bottom disturbance; OMAO would not collect bottom samples on known coral reefs, shipwrecks, obstructions, or hard bottom areas. Additionally, UMS (e.g., AUVs) would be programmed and operated so as to avoid seafloor disturbance. When deploying equipment or autonomous systems, 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 aquatic macroinvertebrates from disturbance of the sea floor under Alternative A would be adverse and **negligible** to **minor**, **temporary** to **short-term**, and **localized**. Impacts would 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. Any displacement would be temporary and limited to the vicinity of the vessel. Habitat impacts would be easily recoverable with no long-term damage or alteration. Impacts on aquatic macroinvertebrates, including ESA-listed species and designated critical habitat, would be **insignificant**.

Conclusion

Since the effects of impact causing factors on aquatic macroinvertebrates and their habitat would 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**, **minor**, **temporary** to **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative A would be **insignificant**.

3.7.2.1.5 Seabirds, Shorebirds and Coastal Birds, and Waterfowl

OMAO operations may impact birds in a variety of ways in the operational area, including (1) increased ambient sound (e.g., from vessel movement, active acoustic systems, UMS, UAS, and small boats); (2) vessel presence and movement (e.g., visual and physical disturbance from vessels, UMS, UAS, and small boats); (3) accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters (e.g., from vessel operations); and (4) underwater activities (e.g., use of underwater equipment and anchors). These potential impact causing factors and their associated effects on birds and bird habitat are discussed below.

Potential impacts could occur in all of the operational areas. All regions include several ESA-listed species, and all regions, other than PIR, include designated critical habitat (see Section 3.7.1.5). The PIR contains the greatest number of ESA-listed species, and the Alaska and WCRs contain the most designated critical habitat.

Increased Ambient Sound

OMAO operations would increase ambient sound levels from active underwater acoustic sources (i.e., echo sounders and ADCPs); vessel movement; UMS; UAS; and small boat systems.

The acoustic signals emitted from equipment used by OMAO range from 0.5 to 1,200 kHz and decrease in intensity with distance from the NOAA vessel. Sounds from active acoustic sources are typically considered a potential temporary disturbance limited to the immediate vicinity of the vessel. 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. 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., murrelets) and plunge-diving birds (e.g., terns) – including ESA-listed and MBTA-protected 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).

Underwater sound from OMAO active acoustic sources could temporarily disrupt the foraging activities of diving birds in their immediate vicinity. However, diving birds have adaptations to protect their 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 underwater exposure from sound emitted by OMAO active acoustic sources resulting 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 the sound. Any increased foraging effort, competition, or energy expenditure resulting from displacement during OMAO 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.

Vessel sound (including sound from UMS and small boats) represents the majority of the ambient ocean auditory environment and is a combination of tonal sounds and broadband sounds, which 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. Because the limited data available suggest that the range of bird hearing may shift to lower frequencies in water (Dooling and Therrien, 2012), birds may be able to hear the low and mid-frequency underwater sounds emitted by NOAA vessels (Navy, 2017). These sounds 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 as mentioned above, there is no evidence of ecological use of underwater sound by birds. Furthermore, only diving birds, including the ESA-listed species described in Section 3.7.1.2.5, within several meters of operating vessels would be temporarily exposed to vessel sound. 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. 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 sound at all.

UAS are launched and recovered from vessels but would be used very infrequently by OMAO for the purposes of testing, calibration, training, and troubleshooting. UAS, including those often used in scientific marine studies, typically emit sound in the range of 60 to 150 Hz (Intaratep et al., 2016; Christiansen et al., 2016). 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 UAS. Sound generated by UAS operations would likely contribute to temporary disturbance and displacement of birds. Brisson-Curadeau et al. (2017) found that while most gulls flew away in response to an UAS, most returned to their nest within five minutes, and that the majority of the disturbance came from the aircraft's initial startup noise that can be mitigated by launching the aircraft further away from bird populations. It is possible that, similar to other disturbances, repeated, more intensive disturbances 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 Section 3.7.1.2.5, were exposed to repeated UAS-induced stress. However, UAS would not be frequently used during OMAO operations. When UAS are used, operations would be of relatively short duration, and aircraft would only remain within a given area for short periods of time (would last from a minimum of a few minutes to at most one hour) before moving to new areas. The resulting sound would likely only temporarily displace affected individuals, including ESA-listed species and their prey, and disturb existing bird habitat, including designated critical habitat, in the immediate vicinity of the UAS. Any disturbance from UAS sound would be unlikely to cause any long-term bird behavioral changes or cause mortality or direct injury. Birds and their prey are expected to return to the vicinity after the completion of OMAO UAS activities and are not likely to experience any long-term changes in habitat availability, habitat use, or energy expenditure.

Sound from active acoustic sources and vessels (including UMS and small boats) could affect bird habitat, including designated critical habitat, by displacing small fish prey species from the vicinity of the vessel during OMAO activities. Sound from both active acoustic sources and vessels could elicit pathological and behavioral effects on small fish and aquatic macroinvertebrate prey species and could displace them from the immediate vicinity during OMAO activities (see Section 3.7.2.1.3 Fish and Section 3.7.2.1.4 Aquatic Macroinvertebrates). However, given the short duration of acoustic testing, calibration, training, and troubleshooting and the attenuation of vessel sound towards the water surface, prey species are not expected to change their long-term behavior or habitat use in response to active underwater acoustic sources. Prey are expected to return to the vicinity immediately following OMAO operations, and any increased foraging effort, competition, or energy expenditure resulting from the displacement of prey populations is not expected to considerably affect diving or surface feeding birds.

Birds likely cannot hear the majority of OMAO 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. Vessel sound would displace birds, including ESA-listed species, and their prey within the immediate vicinity of NOAA vessels and would not cause any mortality or direct injury. Birds and their prey are expected to return to the vicinity after the completion of OMAO activities and are not expected to experience any long-term changes in habitat availability, habitat use, or energy expenditure. Any resulting impacts from increased ambient sound levels to birds and bird habitat, including ESA-listed species, designated critical habitat, and species protected by the MBTA, under Alternative A would be adverse, **negligible**, **temporary**, **localized** to **regional** depending on whether the vessel is stationary or moving, and **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Vessel Presence and Movement

OMAO operations, including UMS and small boats, comprise only a very small proportion of the total amount of vessel operations within the operational area. As such, the resulting impacts of vessel operations on birds would only contribute marginally to the overall impact of all vessel presence and movement within a given area. The impacts of UAS operations are also discussed here because the aircraft are launched and recovered from vessels. Vessel presence and movement as a result of OMAO operations could introduce bird–vessel interactions caused by visual disturbance, operation of UAS, vessel strikes, underwater turbulence from vessel wakes, and reduction or displacement of avian prey.

Much like vessel sound, vessel presence and movement (including UMS and small boats) as a result of OMAO activities could potentially disrupt normal bird behavior and displace individuals from the immediate vicinity of the vessel through visual disturbance and physical vessel wakes. The visual perception of NOAA vessels 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 the vicinity while vessels are present. Wakes associated with vessel movements could disturb the water column and adversely impact birds in the vicinity of the vessel. Moving vessels would displace large amounts of water, and the resulting underwater turbulence could disturb and displace nearby birds. However, this displacement would be temporary and would occur only while NOAA vessels are within close proximity. 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, movement, and wakes are not expected to harm individual birds or affect bird population numbers and demographic structure.

The presence and movement of UAS could also potentially disrupt normal bird behavior and displace individuals from the vicinity of the aircraft through visual disturbance. Although reactions differed between species, Barr et al. (2020) found that UAS operation did not increase colony-wide escape behavior compared to control periods, indicating that the birds were not substantially disturbed. Conversely, accidental crashes of UAS near nesting sites have been shown to greatly disturb bird colonies, with a 2021 crash in an ecological reserve[4] leading to the abandonment of approximately 2,000 elegant tern eggs (Wigglesworth, 2021). However, OMAO would use UAS infrequently, operations would be of relatively short duration, and aircraft would only remain within a given area for short periods of time before moving to new areas. While these relatively short, infrequent UAS flights would not be expected to disturb and displace birds in the long term, it is possible that repeated, intensive UAS flights or accidental crashes 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. Any nest site abandonment would constitute a moderate or larger impact given the protection status afforded to birds by the ESA and MBTA. However, a UAS crash, especially one near a sensitive coastal nesting area, is extremely unlikely because pilots would be certified under 14 CFR Part 107 and follow all applicable regulations. The visual disturbances from operating UAS would likely only temporarily displace affected individuals, including ESA-listed species and their prey, and disturb existing bird habitat, including designated critical habitat, in the immediate vicinity of the aircraft. Any visual disturbance and displacement would be unlikely to cause any long-term bird behavioral changes or cause direct injury or mortality. Birds and their prey are expected to return to the vicinity after the completion of OMAO UAS activities and are not likely to experience any long-term changes in habitat availability, habitat use, or energy expenditure.

Vessel presence and movement during OMAO activities 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 and MBTA-protected seabirds described in Section 3.7.1.2.5, are attracted to the lights of offshore vessels (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 vessel strikes in 2020 and 2021 of Steller's and spectacled eiders,

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[4]Operation of UAS is illegal in areas such as the Bolsa Chica Ecological Reserve, where this 2021 nest site abandonment occurred.

both of which are ESA-listed as threatened and protected by the MBTA, has occurred in the Bering Strait and in the Aleutian Islands in Alaska (USFWS, 2021b). OMAO would continue to monitor the situation very closely and adjust operations accordingly, including implementing BMPs to avoid such strikes with endangered eiders. NOAA vessels typically travel at speeds less than 10 knots during OMAO activities, allowing birds to recognize and avoid vessels. NOAA vessels operating at night would also only use the appropriate lighting to comply with navigation rules and best safety practices, limiting the exposure of birds to onboard lighting. Also, crewmembers would be posted during vessel operations at night, continually monitoring for protected species, further reducing the risk of collision with birds. It is hoped that these measures would be sufficient to curtail the increase in vessel strikes of protected birds as occurred in 2020 and 2021. 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 vessels, including UMS and small boats, 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; Schwemmer et al., 2011). The level of disturbance for the affected bird populations is based on the degree to which these populations have become acclimated 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 in comparison to 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, excessive disturbance could eventually lead to nest site abandonment and egg or nestling mortality via temperature stress, inadequate feeding of nestlings by parents, or predation. Due to the transient nature of vessel operations, the vessels would remain within a given area for a short duration before moving to new areas. As such, vessels used for OMAO activities would not repeatedly disturb birds or contribute to causing chronic stress responses.

Vessel presence and movement could affect bird habitat, including designated critical habitat, through the displacement and reduction of prey. As with increased ambient sound levels, vessel presence could elicit pathological and behavioral effects on small fish and aquatic macroinvertebrate prey species and would likely displace them from the vicinity of the vessel during OMAO activities. Prey are expected to return to the vicinity immediately following OMAO activities, 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. 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.

Although unlikely, 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 and MBTA. 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 OMAO activities would be relatively short, on the order of hours, days, or weeks, and there is only a very **low** likelihood of vessel strike occurrence. NOAA vessels operating at night would use the appropriate lighting in order to comply with safety and navigation rules and best safety practices. OMAO operations account for 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 vicinity of the vessel. 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 habitats, including ESA-listed species, designated critical habitats, and species protected by the MBTA, would be adverse, **negligible** to **minor**, **temporary**, **localized** to **regional** depending on whether the vessel is stationary or moving, and **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Accidental Leakage or Spillage of Oil, Fuel, and Chemicals

An accidental event could result in release of oil, fuel, or chemicals by a NOAA vessel from tank overflow during fueling operations, fuel transfer operations, pipe leaks due to structural failure, accidental discharge of hazardous chemicals used for vessel and equipment repair and maintenance, or unintentional discharge of sewage, bilge water, or ballast water into the surrounding environment. The following is a discussion of potential effects of an accidental discharge, although OMAO would continue to follow appropriate policies and guidance to manage accidental spills in order to minimize adverse impacts.

Accidental oil, fuel, and chemical discharges as a result of OMAO activities 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 OMAO activities, small accidental or routine discharges may occur during normal vessel operations. 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 vicinity of the vessel and increase the likelihood of bird exposure to volatile chemicals, resulting in injury or mortality.

All vessels produce some waste through normal operations. During operations, NOAA vessels could accidentally lose or discard debris, a major form of marine pollution (Laist, 1997). NOAA vessels generate waste in the form of metal, wood, glass, paper, and plastic, primarily through galley and food service operations. Birds commonly mistake improperly discharged marine waste for food items and the continued ingestion of waste over time can substantially degrade avian health (Pierce et al., 2004). However, NOAA vessels would continue to comply with all waste disposal regulations 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 CFR § 159.7). Adherence to these regulations should prevent discharged vessel waste from harming birds.

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 (e.g., baitfish and other small fish) and invertebrate (e.g., insects, krill, squid, and other aquatic macroinvertebrates) prey could become exposed and bioaccumulate (i.e., concentrate in tissue through repeated exposure and ingestion) 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 AR and along coastlines adjacent to large spills, could also be degraded as spilled substances are washed ashore, which could potentially cause birds to abandon important nesting and breeding areas. Assuming proper waste disposal regulations are followed, prey species would only continue to very rarely be exposed to oil, fuel, chemicals, and waste from OMAO activities, and prey population numbers or habitat would not substantially change.

Such accidents may be caused by equipment malfunction, human error, or natural phenomena and are not expected during the course of OMAO 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 vessels, in the event of an oil, hazardous substance, or marine pollutant spill, the crew takes appropriate action to minimize the effects of the spill. OMAO's VRP/SOPEP procedure provides policy and guidance to all OMAO vessels regarding oil pollution emergency planning and response, consistent 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, training, 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 accidental discharges is low with proper adherence to existing regulations, coastal ground-nesting ESA-listed species would be particularly susceptible to oil, fuel, and chemicals 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. Given the low likelihood of occurrence and short-term duration of most accidental discharges, adverse impacts to birds, including ESA-listed species, designated critical habitat, and species protected by the MBTA, caused by accidental leakage or spillage of oil, fuel, or chemicals under Alternative A would be adverse, **minor**, **short-term**, l**ocalized** to **regional** depending on whether the vessel is stationary or moving, and **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Underwater Activities

Many OMAO operations would cause temporary disturbance to the water column, potentially producing adverse impacts to diving birds. Lowering and raising echo sounders; anchors and chains; and data collection equipment such as CTDs, bottom grab samplers, and drop/towed cameras could temporarily displace birds and disrupt their behavior. 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 OMAO activities involve trailing equipment with lines or wire behind and beneath NOAA 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, 2014a). 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, 2014a). However, the trailed equipment used during OMAO operations is only submerged for periods of time ranging from minutes to hours, limiting the potential exposure to birds and possible entanglement. Trailed equipment is also typically more conspicuous than common entanglement hazards such as discarded monofilament fishing line, and nearby birds would likely be able to recognize and avoid trailing equipment; therefore, the likelihood of bird-equipment interactions would be low. Furthermore, trailed equipment would stay within hundreds of meters of the towing vessel and would only potentially impact birds within the immediate vicinity. Birds within the immediate vicinity of vessels would more likely be displaced by the visual disturbance and sound of the vessel itself 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 adversely affect the abundance or demographic structure of any bird populations.

Underwater activities would affect bird habitat, including designated critical habitat, predominantly through vessel presence and movement affecting the water column, and would not be expected to contribute to any long-term changes in habitat occupancy or behavior of prey species. 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 aquatic 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 vicinity of the vessel.

Underwater activities would likely only displace birds temporarily, including ESA-listed species, and bird prey within the immediate vicinity of a NOAA vessel and would not cause any direct injury or mortality. Birds and their prey are expected to return to the vicinity after the completion of OMAO 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 be adverse, **negligible** to **minor**, **temporary**, **localized**, and therefore **insignificant**.

Conclusion

Although the effects of impact causing factors on birds and their associated habitat range from negligible to moderate or greater, moderate or greater impacts could only result from the very unlikely occurrence of a vessel strike, nest site abandonment, or a large accidental discharge 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 be **adverse, minor, temporary to short-term**, and **localized to regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative A would be **insignificant**.

3.7.2.2 Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

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), and on sea turtles, fish, aquatic macroinvertebrates, and birds. OMAO operations under Alternative B would take place in the same operational areas and timeframes as under Alternative A; however, under Alternative B, OMAO would construct up to eight new ships (four as in Alternative A, plus four additional ships) to replace vessels that would reach the end of their design service life, extend the service life of existing ships through maintenance, increase fleet utilization with up to 4,138 DAS (570 more DAS annually than under Alternative A), and integrate newer technology as described in Section 2.4. The difference between the two alternatives is primarily a matter of scale with increased activity levels distributed unevenly among the different types of operations, the five operational areas, and within the 15-year timeframe. As such, effects under Alternative B would incrementally increase from those of Alternative A but would not differ fundamentally in type.

3.7.2.2.1 Marine Mammals

Vessel operations for an additional 570 DAS per year would likely contribute to proportionally greater impacts on marine mammals related to vessel and equipment sound, vessel presence and movement, accidental spills, and trash and debris across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under Alternative B as compared to Alternative A; for example, improvements to mechanical control systems on new ships could decrease the production of underwater sound and related impacts on marine mammals and their prey. However, the increased or decreased impacts would not be so great as to appreciably change the magnitude of a particular impact causing factor (e.g., from minor to moderate, or from minor to negligible).

Although the effects of impact causing factors on marine mammals and their associated habitat range from negligible to moderate, moderate impacts could only occur in the very unlikely event of a vessel strike, walrus stampede, or accidental spill of oil, fuel, or chemicals. Since all the other effects of impact causing factors on marine mammals would 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**, **minor**, **temporary** to **short-term**, **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative B would be **insignificant**.

3.7.2.2.2 Sea Turtles

Vessel operations for an additional 570 DAS per year would likely contribute to proportionally greater impacts on sea turtles related to increased ambient sound levels, vessel presence and movement, accidental spills, and underwater activities across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under Alternative B as compared to Alternative A; for example, improvements to mechanical control systems on new ships could decrease the production of underwater sound and related impacts on sea turtles and their prey. However, the increased or decreased impacts would not be so great as to appreciably change the magnitude of a particular impact causing factor (e.g., from minor to moderate, or from minor to negligible).

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 a vessel strike or an accidental spill of oil, fuel, or chemicals. Since all the other effects of impact causing factors on sea turtles would 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**, **minor**, **temporary** to **short-term**, **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative B would be **insignificant**.

3.7.2.2.3 Fish

Vessel operations for an additional 570 DAS per year would contribute to greater impacts on fish related to increased ambient sound levels, vessel wake and underwater turbulence, accidental spills, and disturbance of the sea floor across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under Alternative B as compared to Alternative A; for example, increasing treatment efficiency of the wastewater generated aboard the ships and improvements to small boats such as use of fuel sources other than gasoline could decrease potential pollutants entering the water and related impacts on fish and their habitat. However, the increased or decreased impacts would not be so great as to appreciably change the magnitude of a particular impact causing factor (e.g., from minor to moderate, or from minor to negligible).

Since the effects of impact causing factors on fish and fish habitat would range from negligible to minor, the overall impact of Alternative B on fish, including ESA-listed species and designated critical habitat, would be **adverse**, **minor**, **temporary** to **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative B would be **insignificant**.

3.7.2.2.4 Aquatic Macroinvertebrates

Vessel operations for an additional 570 DAS per year would likely contribute to proportionally greater impacts on aquatic macroinvertebrates related to increased ambient sound levels, vessel wake and underwater turbulence, accidental spills, and disturbance of the sea floor across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under Alternative B as compared to Alternative A; for example, increasing treatment efficiency of the greywater generated aboard the ships and improvements to small boats such as use of fuel sources other than gasoline could decrease potential pollutants entering the water and related impacts on aquatic macroinvertebrates and their habitat. However, the increased or decreased impacts would not be so great as to appreciably change the magnitude of a particular impact causing factor (e.g., from minor to moderate, or from minor to negligible).

Since the effects of impact causing factors on aquatic macroinvertebrates and their habitat would range from negligible to minor, the overall impact of Alternative B on aquatic macroinvertebrates, including ESA-listed species and designated critical habitat, would be **adverse**, **minor**, **temporary** to **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative B would be **insignificant**.

3.7.2.2.5 Seabirds, Shorebirds and Coastal Birds, and Waterfowl

Vessel operations for an additional 570 DAS per year would contribute to greater impacts on birds related to increased ambient sound levels, vessel presence and movement, accidental spillage of oil, fuel, and chemicals, and underwater activities across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under Alternative B as compared to Alternative A; for example, improvements to mechanical control systems on new ships could decrease the production of underwater sound and related impacts on birds and their prey. However, the increased or decreased impacts would not be so great as to appreciably change the magnitude of a particular impact causing factor (e.g., from minor to moderate).

Although the effects of impact causing factors on birds and their associated habitat range from negligible to moderate or greater, moderate or greater impacts could only result from the very unlikely occurrence of a vessel strike, nest site abandonment, or a large accidental discharge of oil, fuel, or chemicals. Since all the other effects of impact causing factors on birds would 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**, **minor**, **temporary** to **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative B would be **insignificant**.

3.7.2.3 Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

As under Alternatives A and B, impacts of Alternative C are considered for the same impact causing factors for each type of marine mammal (cetaceans, pinnipeds, sirenians, and fissipeds), and on sea turtles, fish, aquatic macroinvertebrates, and birds. OMAO operations under Alternative C would take place in the same operational areas and timeframes as under Alternative A; however, Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B with additional measures including maximizing crew productivity and enhancing overall fleet performance by increasing DAS by 735 beyond Alternative B levels, construction of two new ships in addition to those under Alternative B, increasing the number and use of UxS or UMS integrated into vessels, and shortening the timeframe for fleet improvement activities, implementation of greening techniques, and improvements to the small boat fleet as discussed in Section 2.5. The difference between the three alternatives is primarily a matter of scale with increased activity levels distributed unevenly among the different types of operations, the five operational areas, and within the 15-year timeframe. As such, effects under Alternative C would incrementally increase from those of Alternatives A and B but would not differ fundamentally in type.

3.7.2.3.1 Marine Mammals

Vessel operations for an additional 735 DAS per year would likely contribute to proportionally greater impacts on marine mammals related to vessel and equipment sound, vessel presence and movement, accidental spills, and trash and debris across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under Alternative C as compared to Alternative A; for example, improvements to mechanical control systems on new ships could decrease the production of underwater sound and related impacts on marine mammals and their prey. However, the increased or decreased impacts would not be so great as to appreciably change the magnitude of a particular impact causing factor (e.g., from minor to moderate, or from minor to negligible).

Although the effects of impact causing factors on marine mammals and their associated habitat range from negligible to moderate, moderate impacts could only occur in the very unlikely event of a vessel strike, walrus stampede, or accidental spill of oil, fuel, or chemicals. Since all the other effects of impact causing factors on marine mammals would 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**, **minor**, **temporary** to **short-term**, **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative C would be **insignificant**.

3.7.2.3.2 Sea Turtles

Vessel operations for an additional 735 DAS per year would likely contribute to proportionally greater impacts on sea turtles related to increased ambient sound levels, vessel presence and movement, accidental spills, and underwater activities across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under Alternative C as compared to Alternative A; for example, improvements to mechanical control systems on new ships could decrease the production of underwater sound and related impacts on sea turtles and their prey. However, the increased or decreased impacts would not be so great as to appreciably change the magnitude of a particular impact causing factor (e.g., from minor to moderate, or from minor to negligible).

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 a vessel strike or an accidental spill of oil, fuel, or chemicals. Since all the other effects of impact causing factors on sea turtles would range from negligible to minor, the overall impact of Alternative C on sea turtles, including ESA-listed species and designated critical habitat, would be **adverse**, **minor**, **temporary** to **short-term**, **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative C would be **insignificant**.

3.7.2.3.3 Fish

Vessel operations for an additional 735 DAS per year would contribute to greater impacts on fish related to increased ambient sound levels, vessel wake and underwater turbulence, accidental spills, and disturbance of the sea floor across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under Alternative C as compared to Alternative A; for example, increasing treatment efficiency of the wastewater generated aboard the ships and improvements to small boats such as use of fuel sources other than gasoline could decrease potential pollutants entering the water and related impacts on fish and their habitat. However, the increased or decreased impacts would not be so great as to appreciably change the magnitude of a particular impact causing factor (e.g., from minor to moderate, or from minor to negligible).

Since the effects of impact causing factors on fish and fish habitat would range from negligible to minor, the overall impact of Alternative C on fish, including ESA-listed species and designated critical habitat, would be **adverse**, **minor**, **temporary** to **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative C would be **insignificant**.

3.7.2.3.4 Aquatic Macroinvertebrates

Vessel operations for an additional 735 DAS per year would likely contribute to proportionally greater impacts on aquatic macroinvertebrates related to increased ambient sound levels, vessel wake and underwater turbulence, accidental spills, and disturbance of the sea floor across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under Alternative C as compared to Alternative A; for example, increasing treatment efficiency of the wastewater generated aboard the ships and improvements to small boats such as use of fuel sources other than gasoline could decrease potential pollutants entering the water and related impacts on aquatic macroinvertebrates and their habitat. However, the increased or decreased impacts would not be so great as to appreciably change the magnitude of a particular impact causing factor (e.g., from minor to moderate, or from minor to negligible).

Since the effects of impact causing factors on aquatic macroinvertebrates and their habitat would range from negligible to minor, the overall impact of Alternative C on aquatic macroinvertebrates, including ESA-listed species and designated critical habitat, would be **adverse**, **minor**, **temporary** to **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative C would be **insignificant**.

3.7.2.3.5 Seabirds, Shorebirds and Coastal Birds, and Waterfowl

Vessel operations for an additional 735 DAS per year would contribute to greater impacts on birds related to increased ambient sound levels, vessel presence and movement, accidental spills, and underwater activities across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under Alternative C as compared to Alternative A; for example, improvements to mechanical control systems on new ships could decrease the production of underwater sound and related impacts on birds and their prey. However, the increased or decreased impacts would not be so great as to appreciably change the magnitude of a particular impact causing factor (e.g., from minor to moderate, or from minor to negligible).

Although the effects of impact causing factors on birds and their associated habitat range from negligible to moderate, moderate impacts could only result from the very unlikely occurrence of a vessel strike, nest site abandonment, or a large accidental discharge of oil, fuel, or chemicals. Since all the other effects of impact causing factors on birds would range from negligible to minor, the overall impact of Alternative C on birds, including ESA-listed species and designated critical habitat, would be **adverse**, **minor**, **temporary** to **short-term**, and **localized** to **regional** depending on whether the vessel is stationary or moving. Thus, impacts of Alternative C would be **insignificant**.

3.8 Cultural and Historic Resources

Cultural and historic resources refer to traditional use areas, physical remains such as those found at an archaeological site, locations that are meaningful to past or modern-day cultures, and historic properties. This section discusses the cultural and historic resources potentially affected by the Proposed Action and alternatives.

The Advisory Council on Historic Preservation (ACHP) regulations define the term ‘historic property’ 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 (36 CFR § 800.16(l)(1)). The term historic property also includes any artifacts, records, and remains that are associated with the property as well as properties of traditional religious and cultural importance to Native American tribes or Native Hawaiian organizations that meet the National Register criteria found in 36 CFR § 60.4. In general, cultural resources refers to a wider range of resources than historic properties and includes resources that are not eligible for inclusion in the NRHP (CEQ, 2013).

The 1966 National Historic Preservation Act (NHPA) as amended in 2016, established a framework to preserve the nation’s historic properties. Under Section 106 of NHPA, federal agencies are required to consider the impact of their actions on historic properties and provide the ACHP with an opportunity to review the action before implementation. As part of this process, federal agencies are required to consult with State Historic Preservation Officers (SHPOs), Native American tribes and Native Hawaiian organizations with or without a Tribal Historic Preservation Officer (THPO), representatives of local government, the public, and other interested groups (36 CFR § 800.3). SHPOs reflect the interests of their State and its citizens in the preservation of their cultural heritage and 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. A THPO is the official representative of a federally-recognized tribe who has assumed the responsibilities of the SHPO. 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 Native American reservation and all dependent Native American communities.

3.8.1 Affected Environment

Cultural and historic resources exist throughout the action area; therefore, the Area of Potential Effect (APE) for cultural and historic resources is defined as the entire action area. The types of cultural and historic resources that could be present in the action area where OMAO activities would occur include:

1. Submerged cultural and historic resources;
2. Traditional Cultural Properties (TCPs) and areas where traditional fishing rights and subsistence fishing and hunting are practiced; and
3. Viewsheds of coastal communities and nearshore historic properties

These resources are discussed below.

3.8.1.1 Submerged Cultural and Historic Resources

Submerged cultural and historic resources are objects found on the seafloor, lake beds, or river beds with historic, prehistoric, or culturally significant values. Submerged cultural resources found in the U.S. include historic shipwrecks, submerged remains of historical structures, sunken military vessels and aircraft, submerged prehistoric remains, and culturally significant sites (NOS, No Date-a). Depending on their location (i.e., within inland waters, U.S. State Waters, U.S. Territorial Sea, U.S. Contiguous Zone, or U.S. EEZ), the protection of submerged cultural and historic resources is directly and indirectly managed by various federal laws, including:

- NHPA
- The Abandoned Shipwreck Act of 1987 (ASA)
- The Antiquities Act of 1906
- The Archaeological Resources Protection Act of 1979 (ARPA)
- The National Park Service Organic Act of 1916
- Coastal Zone Management Act (CZMA)
- Rivers and Harbors Act of 1899
- National Marine Sanctuaries Act (NMSA)
- Sunken Military Craft Act (SMCA) (MPA Federal Advisory Committee, No Date; NOAA, No Date-g)

Although submerged cultural and historic resources are protected under federal law, each state and U.S. territory has its own programs for managing these resources. Information about a resource's exact location, character, or ownership may not be publicly disclosed if its disclosure would result in a significant invasion of privacy, risk harm to the historic property, or impede the use of a traditional religious site by practitioners. Given the number of submerged cultural and historic resources present throughout the extensive action area, an exhaustive list is not provided here. This subsection provides an overview of the types of submerged archaeological resources present throughout each region of the action area.

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 NMSs. The NMSA prohibits injury to sanctuary resources, including cultural and historic 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.

The NOAA Office of Coast Survey's Public Wrecks and Obstructions database (also known as the Automated Wreck and Obstruction Information System [AWOIS]) contains information on over 10,000 submerged wrecks and obstructions in U.S. coastal waters. Information includes the approximate latitude and longitude of each feature and a brief historic description; however, the Office of Coast Survey stopped updating the AWOIS database in 2016 (OCS, No Date). Several databases of submerged cultural and historic resources are maintained for smaller areas, such as the Channel Islands NMS Shipwreck Database. These databases provide valuable information on the nature and location of representative submerged historic and cultural resources within a region. However, there is no single exhaustive list of coordinates of the locations of all known submerged cultural and historic resources.

3.8.1.1.1 Greater Atlantic Region

Submerged cultural and historic resources in the GAR include those found along the Northern Atlantic seaboard and the Great Lakes. In 2012, the Bureau of Ocean Energy Management (BOEM) conducted a study to identify potential locations of submerged prehistoric sites and historic shipwrecks within the Atlantic outer continental shelf region which overlaps with the GAR and the SER of the action area. The submerged cultural and historic resources identified in the study include dugout canoes, middens (sites of disposed refuse), stone tools, and lithic scatters from prehistoric settlement of the area and a wide range of wrecks of varying vessel types including: vessels from the age of exploration, military vessels, vessels of the mercantile era, steamships of the 19th and 20th centuries, modern motor vessels, modern sailing vessels, and modern work vessels (BOEM, 2012a). Rhode Island has the most shipwrecks per square mile, having more than 2,000 shipwrecks in its waters, including wrecks from colonial trading ships and military vessels from the American Revolutionary War to World War II (NPS, No Date-a). Stellwagen Bank NMS, 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 sanctuary is evidenced by the remains of several historic shipwrecks on the seafloor (ONMS, No Date).

The Great Lakes consist of Lakes Superior, Michigan, Huron, Erie, and Ontario which are bordered by Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York. Submerged cultural and historic resources in the Great Lakes include sunken 18th century warships, commercial sailing vessels, and World War II aircraft. A collection of nationally-significant Great Lake shipwrecks is protected in the recently designated Wisconsin Shipwreck Coast NMS. The sanctuary protects 36 known shipwrecks and approximately 59 suspected shipwrecks which are representative of the vessels that traversed Lake Michigan. These vessels typically carried grain and raw materials from west to east and coal, manufactured goods, and people from east to west (ONMS, 2021a). One of the most treacherous stretches of water within the Great Lakes system, known as "Shipwreck Alley," is located in Lake Huron. The Thunder Bay NMS is located adjacent to this area in northwestern Lake Huron. Nearly 200 vessels have been estimated to have sunk in and around the sanctuary (ONMS, 2014). Lake Erie acts as a highway connecting the lake's port cities in Michigan, New York, Ohio, Ontario, and Pennsylvania. More than 2,000 ships have been lost on Lake Erie (NPS, No Date-a). NOAA's Office of National Marine Sanctuaries (ONMS) has proposed the designation of Lake Ontario NMS which would protect at least one aircraft and 43 known shipwrecks including the *HMS Ontario*, which, having wrecked in 1780, is the oldest confirmed shipwreck and the only fully intact British warship found in the Great Lakes (ONMS, 2021b).

3.8.1.1.2 Southeast Region

Submerged cultural and historic resources in the SER include those found along the Southern Atlantic seaboard, the Gulf of Mexico, and the Caribbean Sea. Underwater resources off of Virginia, North Carolina, South Carolina, and Georgia include log canoes used by Native American people for transportation, trade, and fishing over 4,000 years ago as well as vessels from the American Revolution, Civil War, and World War II. There are over 5,000 reported shipwrecks in North Carolina alone. Also off the coast of North Carolina is the ironclad *USS Monitor* which sank in 1862 off Cape Hatteras and is now designated the Monitor NMS. In addition to shipwrecks, 17 miles off the coast of Georgia, an underwater prehistoric site is located in Gray's Reef NMS, in an area which was likely above sea level 15,000 years ago.

Florida separates the Atlantic Ocean from the Gulf of Mexico. Rising sea levels following the last Ice Age over the past thousands of years greatly reduced the size of Florida; as a result, many of the coastal and riverine sites of the earliest inhabitants, from about 12,000 years ago, are now submerged underwater, mostly offshore in the Gulf of Mexico (NPS, No Date-a). The prehistoric Douglas Beach Site in St. Lucie County contains a midden and sharpened wooden stakes (BOEM, 2012a). Shipwrecks in waters off the Florida coast include dugout canoes, merchant vessels, steamships, warships, and pleasure vessels. Florida has several popular dive sites where visitors can view submerged cultural and historic resources. The 1733 Spanish Galleon Trail is an 80 mile stretch off the Florida Keys that has the remains of 13 Spanish merchant vessels and warships sunk during a hurricane while sailing from Cuba to Spain. The Maritime Heritage Trail features 15 historic shipwrecks, many of which are part of Florida's larger series of underwater archeological preserves. Each site in Florida's series of underwater archeological preserves is marked by a bronze plaque and can be interpreted with a laminated site plan for self-guided underwater tours (NPS, No Date-a). Other historic shipwrecks in the Gulf of Mexico include ships from European exploration, 19th century steamships, Civil War shipwrecks, and World War II shipwrecks. Several new shipwrecks have been discovered during surveys conducted by the oil and gas industry for pipeline and well sites in the deep water areas of the Gulf of Mexico (BOEM, No Date-a).

Puerto Rico and the U.S. Virgin Islands each have different types of submerged cultural and historic resources than those found in the rest of the SER. People first settled Puerto Rico as early as 4,000 years ago and the island has been a seafaring hub for over 500 years. More than 200 shipwrecks have been identified by NPS and other agencies and groups in Puerto Rico's waters. One of the oldest of these shipwrecks is a 17th century merchant vessel off the coast of Rincon. Other notable wrecks include three sites associated with the Spanish-American War and several sites associated with the U.S. military, mostly from World War II (NPS, No Date-a).

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 managing 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, No Date-a). Parks established to protect submerged cultural and historic resources in the U.S. Virgin Islands include the St. Croix East End Marine Park, Buck Island Reef National Monument, Salt River Bay National Historical Park and Ecological Preserve, Virgin Islands Coral Reef National Monument, and Virgin Islands National Park (NPS, 2023).

3.8.1.1.3 West Coast Region

The WCR includes the states of Washington, Oregon, and California. In 2011, BOEM conducted a study to identify known and reported coastal and submerged archaeological sites, TCPs, built environment resources (i.e., human made or modified spaces), shipwrecks, and potential culturally sensitive submerged landforms on the west coast of the U.S. The study area overlaps with the WCR considered in this analysis. The BOEM study identified prehistoric resources used by the people who first lived along the west coast, such as rock shelters, pictographs, middens, and lithic scatters (concentrations of stone tools and refuse from stone tool production). Overall, 92 submerged artifacts were identified which were recovered from 33 separate locations along the west coast. Almost all of these artifacts were found off the Santa Barbara County coast and were made of stone. Other submerged cultural and historic resources include shipwrecks of early exploration vessels, vessels used for fur trade, vessels used for the California gold rush and lumber industry, and twentieth century and modern vessels. As of 2013, 5,813 vessel records off the west coast have been added to the BOEM database (BOEM, 2013).

Waters off the shore of Washington state are known to be particularly treacherous because of currents, fog, storms, and winds. Notable shipwrecks off the state of Washington include the submarine *USS Bugara*, *USS General M.C. Meigs*, and numerous 19th and 20th century wooden hulled steamships which were more prone to collisions, explosions, fire, rapids, and snags than modern vessels (NPS, No Date-a).

In Oregon, the waters where the Columbia River meets the Pacific Ocean have strong cross currents and shifting sandbars and are known as the “Graveyard of the Pacific” because about 2,000 ships have sunk, stranded, or disappeared since the first wreck in 1792. Notable shipwrecks in Oregon are the *Acme* near Brandon, the *Bella* near Florence, the *Emily Reed* near Rockaway, the *George L. Olson* near Coos Bay, and an unidentified wreck near the Umpqua River. In 2008, the Oregon Parks and Recreation Department recovered two cannons near Arch Cape that are probably from the 1846 wreck of the *USS Shark*. The largely intact hulk of the Hudson’s Bay Company supply ship *Isabella* is buried in 40 feet of water off Cape Disappointment and is listed in the NRHP (NPS, No Date-a).

California waters have submerged cultural and historic resources ranging from prehistoric artifacts to World War II naval aircraft. The remains of prehistoric seafaring trading expeditions along the Pacific Coast have 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, 2023). Known historic archaeological resources in the southern California area consist of submerged shipwrecks and submerged aircraft. Approximately 100 shipwrecks have been documented in the Channel Islands National Park in California (NPS, 2016).

3.8.1.1.4 Pacific Island Region

The PIR includes Hawaii, American Samoa, Northern Mariana Islands, and Guam. Submerged cultural and historic resources found within the PIR reflect the culture and maritime economy of the people who first settled the islands, through to the modern day, including culturally important marine and coastal natural resources.

The islands that make up the state of Hawaii were first settled by Polynesian voyagers about 1,700 years ago. Submerged cultural and historic resources in the waters of Hawaii are representative of Hawaiian maritime history including: Hawaiian settlement, early European voyagers, sailing era of whaling and trade, plantation era and steam propulsion, U.S. Navy, Pearl Harbor, and World War II, and contemporary maritime transportation. In 2017, the BOEM and NOAA’s Maritime Heritage Program developed a database of the 2,120 known, reported, and potential submerged cultural and historic resources (NOAA and BOEM, 2017). Native Hawaiians used outrigger canoes to fish and navigate along Hawaii's rocky coastline and developed a complex system of fishponds and fishing shrines. In 1778, when Europeans first recorded the islands, the maritime economy of the islands changed focus to the sandalwood trade, the export of sugar, and the export of other agricultural goods. The U.S. Navy began permanently stationing ships at Pearl Harbor and leased lands for a Navy base in the 1880s. Submerged cultural and historic resources in Hawaii include sites associated with Native Hawaiian navigation and voyaging technology and traditional fishing and aquaculture; shipwrecks of whaling ships; and warships and sunken aircraft from World War II including the *USS Arizona*, the *USS Utah*, and two Japanese submarines in or near Pearl Harbor (NOAA and BOEM, 2017; NPS, No Date-a).

American Samoa is located in between Hawaii and New Zealand and consists of five inhabited volcanic islands and two distant coral atolls. The first inhabitants of these islands likely arrived by sea from western Polynesian islands about 3,000 years ago. In 2007, ONMS created an initial maritime heritage resource inventory for American Samoa. There are 10 identified historic shipwrecks in American Samoan waters, with the earliest dating back to 1828, including whalers, military vessels, and steamboats. Other submerged resources include 43 historic sunken naval aircraft, 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) (ONMS, 2007).

The Northern Mariana Islands consists of a 300-mile-long archipelago of 14 islands along the Marianas Trench in the North Pacific Ocean. The islands were likely first settled over 3,500 years ago by ocean-going people from Southeast Asia via the Philippines. In the 16th century, the islands were conquered and governed for more than 300 years as part of the Spanish East Indies before Spain sold the islands to Germany in 1899. Six ships are reported to have been lost during the Spanish colonial period. Almost all of the native people perished under Spanish rule and new immigrants arrived from the Philippines and Carolines. Japan took over the islands in 1914. Given its location between Hawaii and the Philippines, the majority of shipwrecks are from World War II, with more than 40 sunken warships, auxiliaries, airplanes, tanks, and other military related debris (NPS, No Date-a).

Guam is the largest and southernmost island of the Mariana Islands and is surrounded by nearshore coral reefs. Guam's indigenous population, the Chamorros, came to the Mariana Islands about 4,000 years ago from Southeast Asia, having cultural and linguistic affinities to the peoples of the Philippines, Malaysia, and Indonesia. Since Spanish colonization (1700-1898) and the transition to U.S. control, Guam's waters have been filled with the remnants of past military conflicts and naval battles with wrecks of ships, planes, barges, and their cargos and contents including munitions (NPS, No Date-a; Guam SHPO, 2007). Two notable shipwrecks are the German *S.M.S. Cormoran* from World War I and Japanese *Tokai Maru* from World War II. These two shipwrecks in Apra Harbor are the only known instance in the world in which shipwrecks from two different wars are touching (Guam SHPO, 2007).

3.8.1.1.5 Alaska Region

Alaska's shoreline stretches for 33,904 miles and shares borders with the Arctic Ocean, the Beaufort Sea, the Chukchi Sea on the north, the GOA and Pacific Ocean on the south, and the Bering Sea on the west. The cold waters are prime habitat for whales and other marine mammals, which Alaska Natives have been hunting for over 2,500 years. Submerged cultural and historic resources include shipwrecks and objects which reflect Alaska's historic whaling, fishing, and shipping industries. The high volume of whaling, fishing, and shipping vessel traffic coupled with dangerous water conditions around the state resulted in many shipwrecks. 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 (McMahan, 2007). In addition to commercial vessels, a number of American and Japanese warships were sunk or lost off the coast of Alaska during World War II. The *Kad'yak,* which sank in 1860, is the oldest shipwreck discovered in the state and is the subject of native lore. When the ship sank, the mast and yard arm remained above the water, forming a cross that the native people believed to be a sign of divine retribution for the Captain's disrespect to a local canonized priest. The *Kad'yak* is only one of thousands of shipwrecks and submerged cultural and historic resources in Alaskan waters (NPS, No Date-a). Documented shipwrecks in Alaska are concentrated along the southern coast of the state where there is more vessel traffic and more recent surveys of submerged resources were likely conducted (OCS, No Date). Alaska's Office of History & Archaeology and the State Archaeologist are responsible for managing the state's submerged cultural and historic resources (NPS, No Date-a).

MMS maps indicate that known shipwrecks are scattered throughout the Western GOA, 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 (MMS, 2002a).

3.8.1.2 Traditional Cultural Places and Subsistence Hunting and Fishing Areas

In addition to physical objects and artifacts, cultural and historic resources include locations of cultural and historic significance. A TCP is a site that is eligible for inclusion in the NRHP "based on its associations with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community" (NPS, 1998). The cultural practices or beliefs that give a TCP its significance was at least observed at the time the TCP was considered for inclusion in the NRHP and usually continue to be important in maintaining the cultural identity of the community. Examples of sites that can be TCPs include a location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world; a rural community whose land use reflects the cultural traditions valued by its long-term residents; an urban neighborhood that is the traditional home of a particular cultural group and that reflects its residents' culture; a location historically and/or currently used by Native American religious practitioners to perform ceremonial activities; and a location where a community has traditionally carried out practices that are important in maintaining its historic identity. TCPs can also be a Traditional Cultural Landscape (TCL) (i.e., a natural area) that does not have evidence of human activity, but is associated with the cultural practices, beliefs, or identity of Native Americans and Alaska Natives (NPS, 1998; BOEM, 2017b; BOEM, 2017c).

Coastal and offshore TCPs may include sites on and along major navigable rivers and locations where Native Americans or Alaska Natives performed ceremonial activities, and many TCPs include subsistence hunting and fishing areas of cultural groups. "Subsistence" is 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 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 which includes hunting, fishing, and gathering rights, on lands or waters ceded by tribes (ACHP, 2018).

Between 1778 and 1871, the federal government's relations with Native American tribes were established mostly through treaties. These treaties recognized the sovereignty of Native American tribes and established rights, benefits, and conditions for the tribes that agreed to cede land in return for the recognition of property rights and federal protections. The tribes granted land and other natural resources to the U.S., while retaining all rights not expressly granted; these rights are referred to as "reserved rights." Federal treaties with Native American tribes ratified by Congress remain the law and treaties have been supplemented by federal legislation such as land claim settlement acts and EOs. Under the U.S. Constitution, treaties carry the same legal weight as federal statutes, meaning 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 always specifically defined regions. These rights have been affirmed in at least seven written opinions of the Supreme Court (Columbia River Inter-Tribal Fish Commission, No Date).

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 (1994 amendment) and the ESA, for example, Alaska Natives are allowed to harvest marine mammals as subsistence resources. The federal subsistence priority means that subsistence uses by rural residents of Alaska are given priority over non-subsistence uses (commercial or sport). Subsistence harvest practices and traditional fishing practices have been documented in many studies over the last several decades; however, the MMPA prohibits the take of marine mammals by any group other than the Alaska Natives. The role of subsistence hunting and fishing, traditional fishing rights, and TCPs in each region are described below. Relevant laws, treaties, and organizations are noted throughout the next sections.

3.8.1.2.1 Greater Atlantic Region

There are 17 federally-recognized tribes within the states along the North Atlantic seaboard, including four tribes in Maine, two in Massachusetts, one in Rhode Island, two in Connecticut, and eight in New York. These tribes may be responsible for managing bodies of water that are adjacent to tribal lands and have protected traditional fishing rights. For example, under Maine law, sustenance fishing is a "designated use" for tribal waters identified by the Maine Department of Environmental Protection (MDEP) and the four tribes in Maine: the Penobscot Indian Nation, Passamaquoddy Tribe, Houlton Band of the Maliseets, and the Aroostook Band of Mic Macs (NRCM, 2019).

In the GAR, Nantucket Sound, Massachusetts was determined to be eligible for the NRHP in 2010 as a TCP for its association with Native American exploration and settlement of Cape Cod and for the important cultural, historical, and scientific information likely available in the area. Nantucket Sound is considered to be integral to the Wampanoag tribes' folklife, traditions, religion, and narratives and is associated with the central events of the Wampanoags' stories of Maushop and Squant/Squannit. The designation of the Nantucket Sound TCP is considered to have established a precedent because it does not have a precisely defined boundary. Although the exact boundary is not precisely defined, the Sound is eligible as an integral, contributing feature of a larger district (NPS, 2010a).

To the west, there are 31 federally-recognized tribes located in the states surrounding the Great Lakes, including: one tribe in Indiana/Michigan, 11 in Michigan, eight in Minnesota, and 11 in Wisconsin. Several of these tribes signed four treaties with the U.S. government in 1836, 1837, 1842, and 1854 in which the tribes ceded land in northern Michigan, Wisconsin, and Minnesota, but retained the rights to hunt, fish, and gather in the ceded territories.

The Chippewa Ottawa Resource Authority (CORA) represents five tribes in the 1836 treaty; the treaty covers portions of Lakes Superior, Michigan, and Huron. Under the CORA, the Charter the Great Lakes Resource Committee was established to serve as an inter-tribal management body for the 1836 Treaty fishery (GLFHT, No Date). The Great Lakes Indian Fish & Wildlife Commission (GLIFWC) represents 11 Ojibwe tribes who reserved rights under the later three treaties of 1837, 1842, and 1854, which cover land around Lake Superior (GLIFWC, No Date). These two tribal organizations manage traditional fishing rights and resources in the Great Lakes.

3.8.1.2.2 Southeast Region

There are 23 federally-recognized tribes across the continental SER: 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. There are no federally-recognized tribes in Puerto Rico or the U.S. Virgin Islands. Although the history of each island has a unique impact on the development of the island's fishing economy, fishing and access to historic fishing grounds are universally important to the culture and livelihood of many individuals on all of the U.S. Caribbean islands. Many of the island's residents and businesses are tied directly and indirectly to commercial, recreational, or subsistence fishing. Puerto Rico's and the U.S. Virgin Islands' fisheries are woven into the cultural fabric of local communities and make an important contribution to ensuring the attainment of food and nutrition security. A significant portion of fishermen in these areas engage in subsistence fishing, meaning they retain a portion of their landings for their own or their family's consumption. 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, 2014b).

3.8.1.2.3 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, 2023b). Tribes along the west coast have historically relied on the ocean's resources and are integral in its management. The Northwest Indian Fisheries Commission (NWIFC) is a natural resources management support service organization that represents 20 treaty tribes in western Washington (NWIFC, No Date).

An example of an offshore TCP in the WCR is Chelhtenem (also known as Lily Point), located in Puget Sound, Washington (**Figure 3.8-1**). It was added to the NRHP in 1994 for its cultural importance as a fishing site. Chelhtenem 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 ensuring a return the following year" (Whatcom Land Trust, No Date). In the late 19th century, non-Native American fish traps displaced traditional reef nets. Alaska Packers purchased a cannery at Lily Point in 1884. The cannery was abolished in 1917, leaving pilings and debris still visible today (Whatcom Land Trust, No Date).

Source: Whatcom Land Trust, 2007

Figure 3.8-1. Chelhtenem (Lily Point) TCP, Washington

The Olympic Coast NMS on the coast of Washington is entirely encircled by the traditional harvest areas of the Hoh, Makah, and Quileute tribes, and the Quinault Indian Nation. As sovereign nations, these tribes have treaty fishing rights and co-manage fishery resources and fishing activities within the sanctuary with the State of Washington. The Hoh, Makah, and Quileute tribes, the Quinault Indian Nation, the state of Washington, and NOAA's ONMS created the Olympic Coast Intergovernmental Policy Council (IPC) in 2007 to facilitate government-to-government collaboration in managing the sanctuary's resources (NOAA, No Date-f). The exception to the marine mammal takes prohibition under the MMPA 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 (ENP) gray whales. In September 2021, NOAA published a recommendation in support of a waiver of the MMPA's moratorium of the take of marine mammals to allow the Makah Tribe to engage in a limited hunt for ENP gray whales; the public comment period for the recommended decision was scheduled to close in October 2021. The proposed decision is described further in Section 3.10, Environmental Justice (NMFS, 2022a).

Cannonball Island, off Cape Alava in Washington, is a TCP of importance to the Makah people. It was historically used, and is still used today, as a navigation marker for Makah fisherman, who oriented themselves at sea by triangulation from the island and other landmarks. The island was also used as a lookout point for seal and whale hunters and for war parties, a burial site, and a kennel for dogs raised for their fur (NPS, 1998).

3.8.1.2.4 Pacific Islands Region

Fish resources from traditional subsistence fishing have always been an important component of the economies, cultural integrity, and social cohesion of Pacific Island communities (WP Council, 2009). There are many subsistence fishermen within the Native Hawaiian community. For example, the Hawaiian island of Molokaʻi has a population of approximately 7,500, over 60 percent of whom are of Native Hawaiian descent. The residents of Molokaʻi still largely rely on subsistence lifestyles, particularly hunting and fishing, which are commonly practiced on all parts of the island. Despite numerous cultural properties throughout the Hawaiian Islands, there are no TCPs in Hawaii on the NRHP (BOEM, 2017a).

Subsistence fishing in the Northern Mariana Islands largely occurs in Saipan Lagoon, around which nearly all of the island's population lives. In Guam, residents continue the traditional practice of sharing the catch of *atulai* (*Selar crumenophthalmus*) from a surround net. In this practice, equal portions of the catch are given to the owner of the net, the village where the fish were caught, and the group that participated in the harvest. Subsistence fishing in the Northern Mariana Islands and Guam is important in meeting the subsistence needs of the Chamorro and Carolinian people and is important to preserving their history, cultural identity, and traditional knowledge of marine resources and maritime traditions. Similarly, 80-90 percent of American Samoa residents are Native, many of whom rely on subsistence fishing (WP Council, 2009).

3.8.1.2.5 Alaska Region

In Alaska, subsistence hunting, fishing, and gathering is key to maintaining and preserving Alaska Native culture, economy, and nutrition; for this reason, some Alaska Natives refer to subsistence as "Our Way of Life" (BIA, No Date). Ninety-five percent of rural households use subsistence-caught fish; subsistence fishing and hunting represents about 0.9 percent of the fish and game harvested annually in Alaska (ADFG, 2018). The AR 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). Natural resources can be harvested for subsistence throughout the year in a regular cycle of seasonal efforts timed for availability, access, and condition of the resources; however, changes in the seasonal abundance of resources, physical and regulatory restrictions, and visual and social disturbances may affect the timing of harvest activities over the course of an annual cycle. Subsistence harvests can include many species of fish, marine mammals, land mammals, invertebrates (e.g., shellfish), and waterfowl (MMS, 2010). The rights for Alaska Native groups to hunt and fish specific protected species as subsistence resources are protected under the MMPA and ESA. Marine mammals that are subject to subsistence hunting include species of seals, sea lions, walruses, and whales. Although food is one of the most important subsistence uses of natural resources, there are also many other protected uses such as clothing, fuel, transportation, construction, home goods, sharing, customary trade, ceremony, and arts and crafts (BLM, No Date).

On October 1, 1999, the Secretaries of the Interior and Agriculture published regulations (36 CFR Part 242 and 50 CFR Part 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 (FSB, 2021).

The Title VIII of the Alaska National Interests Conservation Act of 1980 (ANILCA) mandates that rural residents of Alaska receive priority subsistence use of fish and wildlife resources on federal lands, including water adjacent to and/or within these lands. This applies not only to Native Americans, Eskimos, and Aleuts, but to non-Native rural residents as well. The Federal Subsistence Board (FSB) is responsible for implementing ANILCA Title VIII and it consists of Regional Directors from five agencies: the BIA, Bureau of Land Management (BLM), USFWS, NPS, and the U.S. Forest Service (USFS) as well as three members of the public to represent rural Alaskan communities (BIA, No Date). Section 3.10, 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.

3.8.1.3 Viewsheds of Coastal Communities and Nearshore Historic Properties

Other cultural and historic resources located along the coastline include fishing communities, whaling villages, and Native American settlements. As defined by the MSA Provisions, 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 (e.g., boatyards, ice suppliers, tackle shops) (50 CFR § 600.345). In Alaska, the interests of 11 whaling villages in the northern half of the state are represented by the Alaska Eskimo Whaling Commission (AEWC). One such community is the whaling village of Point Hope, Alaska (also known by its Inupiaq name, Tikigaq). It is one of the oldest continuously inhabited settlements in North America and its whaling traditions extend back thousands of years. 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, 2021).

Historic properties located near the shoreline that are listed or eligible for listing on the NRHP include structures such as boat houses, lighthouses, archaeological sites, and cultural remains which represent the prehistory and history of coastal communities. 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 the association of historic properties. Setting refers to the physical environment and character of a historic property. Setting can include natural or human-made elements, such as topographic features, vegetation, paths, or fences, as well as the relationship between the historic property and surrounding features or open space. Feeling refers to a property’s expression of the aesthetic or historic character of a particular time period. Association refers to the connection between the historic property and an important historic event or person. For association to remain intact, this connection should be conveyed to an observer (Sullivan et. Al, 2018).

In 2012, BOEM created a Geographic Information System (GIS) database of 9,600 known cultural resources and historic properties that could be visually affected by the introduction of off-shore energy facilities along the entire east coast of the U.S. Each resource was assessed using existing data of 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. The cultural resources/historic properties included national historic landmarks; NRHP-listed, eligible, and non-eligible sites; TCPs, and SHPO-listed and non-eligible sites; and more (BOEM, 2012b).

Many coastal resources listed on the NRHP derive all or part of their significance from their historic maritime setting and may include purposefully designed views or vistas. These resources include TLCs, 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. The viewshed of a TLC is particularly important, as 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 (Sullivan et. Al, 2018). For example, many Native Americans of the eastern seaboard consider themselves to be “The People of the Dawn,” “People of the First Light,” or “Dawnland People” and as such, many ceremonies call for places of quiet contemplation and unhindered views to the rising sun (BOEM, 2012b).

3.8.2 Environmental Consequences

The following sections identify and evaluate potential impacts to cultural and historic resources in the action area under Alternatives A, B, and C. The analysis specifically considers impacts to the following types of cultural and historic resources characteristics:

1. Submerged Cultural and Historic Resources
2. TCPs and Subsistence Hunting and Fishing Areas
3. Viewsheds of Nearshore Historic Properties

Activities described in **Table 2.1-1** and in Section 2.2 that occur during OMAO vessel operations and could have impacts on cultural and historic resources in the action area include vessel movement; anchoring; operation of other sensors and data collection systems (only operation of grab samplers and sediment corers); and active acoustic systems operations.

Impacts on cultural and historic resources from waste handling and discharges; spill response; vessel repair and maintenance; operation of other sensors and data collection systems (except the operation of grab samplers and sediment corers); UMS operations; UAS operations; small boat systems operations; and OTS handling, crane, davit, and winch operations are not expected to have impacts because these activities do not include any physical interactions or contact with the sea floor (note that the term "sea floor" includes lake and river bottoms), wrecks, or archaeological resources; therefore, these activities are not discussed further in this section.

OMAO operations could impact cultural and historic resources in the action area through: (1) physical impacts to submerged cultural and historic resources (e.g., from anchoring and operation of grab samplers and sediment corers) and (2) visual and noise impacts to historic properties from the presence of NOAA vessels (e.g., from vessel movement); and (3) visual and noise impacts to TCPs and subsistence hunting and fishing areas from the presence of NOAA vessels and operation of active acoustic sources (e.g., from vessel movement).

3.8.2.1 Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Under Alternative A, OMAO vessel operations using the existing NOAA fleet would continue across all five operational areas over the 15-year period. In addition, OMAO is constructing two oceanographic research vessels that are expected to come online by 2025 and two new charting and mapping vessels that are expected to come online in 2027 and 2028 for a total of four new ships under Alternative A. OMAO would provide a maximum annual capacity of 3,568 operational DAS for scientific projects.

3.8.2.1.1 Physical Impacts to Submerged Cultural and Historic Resources

Anchoring and operation of grab samplers and sediment corers could physically impact submerged cultural and historic resources.

3.8.2.1.1.1 Anchoring

Anchoring has the potential to impact submerged isolated artifacts (e.g., fragments of tools, arrow points, and soapstone bowls) from prehistoric or historic voyages, resources submerged as a result of sea level rise (e.g., sites in Florida), or undocumented downed aircraft or shipwrecks. Potential damage due to physical impacts could be permanent; however, the likelihood of an anchor landing on a cultural and historic resource is low (i.e., non-zero but very small likelihood of occurrence).

NOAA vessels abide by all OMAO procedures and practices related to anchoring to minimize or prevent potential impacts to submerged cultural or historic resources. NOAA vessels may anchor within U.S. navigable waters to perform OMAO vessel operations. Small boats and launches would typically return to port or to the ship each day and do not anchor. For vessel movement spanning multiple days or while under project instructions from another NOAA Line Office (LO) or an organization, a vessel may anchor to avoid adverse weather or in the unlikely event of an equipment malfunction. While the choice of anchoring location is at the discretion of the ship's CO or Master, they select the anchor location based on depth, protection from seas and wind, and bottom type when anchoring close to locations where vessel operations are to be conducted. 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. Vessels would use designated anchorage areas when available.

OMAO does not anchor on known shipwreck sites or other known locations of cultural and historic resources, and whenever possible would avoid anchoring in hard bottom areas. The only exceptions would be in case of an immediate emergency, without the possibility of scoping a different location first. Since OMAO operates the NOAA fleet in support of charting and hydrographic surveys, when working in an un-surveyed area or in an area that has not been surveyed in many years, the CO or Master would try to anchor in bays where data has already been collected, ensuring the ship has the best information on a location to safely drop anchor. Additionally, records of historic/legacy anchoring locations (i.e., anchoring locations that OMAO has used in the past) are maintained on each vessel to avoid causing excess disturbance and to ensure the safety of the vessel. Furthermore, if fishery vessel operators need to anchor in a new location, they contact hydrographic survey vessel operators to request the best available survey data for the area. These practices minimize the potential adverse physical impacts to submerged cultural and historic resources from anchoring. The likelihood of adverse impacts would be low, given the low probability of submerged cultural or historic resources being present in any one area compared to the large size of the action area and continued adherence to OMAO anchoring protocols.

3.8.2.1.1.2 Testing Bottom Grab Samplers and Sediment Corers

Testing bottom grab samplers and sediment corers could potentially disrupt submerged cultural and historic resources, however the likelihood of actually making contact with historic shipwrecks, submerged remains of historical structures, sunken military vessels and aircraft, submerged prehistoric remains, and culturally significant sites is low. NOAA ships adhere to all OMAO procedures and practices related to testing of bottom equipment to minimize and prevent potential impacts to submerged cultural or historic resources. Testing bottom grab samplers and sediment corers would involve collecting the top layer of sediment (approximately the first 5 cm (2 in) of sediment). OMAO would test this equipment in previously surveyed areas when available, which would help to ensure bottom samples are not collected near any documented or potential cultural and historic sites. Typically, testing is done in areas of familiarity to ensure the safety of the crew and equipment. Collecting the top few inches of sediment is unlikely to disturb any objects that may be present, as there is likely a thick layer of sediment over long-buried objects. OMAO would not test bottom grab samplers or sediment corers on shipwrecks, obstructions, or hard bottom areas. These practices continue to minimize the potential for adverse impacts to submerged cultural and historic 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 submitted to the appropriate SHPO and THPOs, along with photographs of the sample and, if practicable, the recovered object itself.

3.8.2.1.1.3 Conclusion for Physical Impacts to Submerged Cultural and Historic Resources

Anchoring and operation of grab samplers and sediment corers under Alternative A could physically impact submerged cultural and historic resources. These impacts would not occur beyond the U.S. EEZ because these activities would not be conducted outside of the U.S. EEZ. All NOAA vessels abide by all OMAO procedures and practices related to anchoring and testing bottom grab samplers and sediment corers to minimize and prevent potential impacts to submerged cultural and historic resources. As a result of these OMAO protocols, the likelihood of adverse impacts from anchoring or testing of bottom equipment would be low. Therefore, physical impacts on submerged cultural and historic resources would be **adverse**, **permanent, negligible**, and **localized**. In the event of inadvertent resource discovery during activities that involve contact with the sea floor, impacts could be **beneficial**. 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. Beneficial impacts would be **permanent, negligible**, and **localized**. As such, impacts would be **insignificant**.

3.8.2.1.2 Visual and Noise Impacts to Historic Properties from the Presence of NOAA Vessels

Vessel movement or the presence of a vessel nearby or visible or audible from a nearshore historic property could disturb the purposefully designed view or vista (e.g., a historically significant view toward the open sea).

Visual impacts to historic properties are considered with respect to the integrity of setting, feeling, and/or the association of historic properties, as described in Section 3.8.1.3. NOAA vessels would likely not remain in one area for more than a few days and most likely not for more than a few hours; therefore, the overall integrity of a historic property's setting, feeling, association, or other historic characteristics would not be impacted. Additionally, most of the nearshore historic properties listed in the affected environment were established after the beginning of the 19th century when steel ships using coal and steam became more prevalent than wooden ships. The visual and noise impacts from NOAA vessels would not substantially differ from these early steel ships that were around when the property was established and thus would not affect the integrity of setting, feeling, and/or association of historic properties along the coastline constructed after the early 1800s (especially at a distance). Therefore, vessel movement would not adversely impact historic properties along the coastline constructed after the early 1800s. The historic properties established before this time are generally covered as TCPs or TCLs which are addressed in the following section.

Visual and noise impacts from vessel movement under Alternative A would have no impact on the integrity of setting, feeling, and/or association of historic properties along the coastline constructed after the early 1800s. As such, impacts would be **insignificant**.

3.8.2.1.3 Visual and Noise Impacts to TCPs and Subsistence Hunting and Fishing Areas from the Presence of NOAA Vessels and Operation of Active Acoustic Sources

Vessel movement and testing/calibrating active acoustic systems within or near a TCP, TCL, or subsistence hunting and fishing area could disturb the activities for which the TCP, TCL, or subsistence hunting and fishing area was established to protect.

The presence of a NOAA vessel would be an additional element in the view, vista, or view corridor of TCPs, TCLs, or subsistence hunting and fishing areas and the visual presence and vessel noise could potentially disrupt subsistence hunting and fishing activities. The view of a vessel at sea for several hours to several days would likely have minimal impacts to people within a TCP or TCL onshore. Impacts to subsistence hunting and fishing are discussed in this Draft PEA from a cultural and historic resources perspective and an environmental justice perspective. This section addresses subsistence hunting and fishing areas as they are considered to be TCPs and addresses impacts to the subsistence hunting and fishing experience with the understanding of the cultural importance placed on the way of life and ability to participate in subsistence hunting and fishing. Impacts to environmental justice populations that rely on subsistence hunting/fishing and impacts to the fish and marine mammals that are subject to subsistence hunting and fishing in the context of subsistence hunting and fishing are discussed in Section 3.10. The environmental justice section considers impacts on subsistence hunting and fishing populations, potentially as a result of active acoustic systems operations, vessel movement, human activity, accidental leakage or spillage, trash and debris, and air emissions. The predominant impact discussed is inadvertently causing behavioral disruptions in individual animals that may affect the success of hunting or fishing activities and were evaluated to likely be adverse and minor.

Vessel movement, testing, and calibrating active acoustic systems could adversely impact the subsistence hunting and fishing experience, causing a disturbance to the marine mammals and fish hunted in subsistence areas. The practice of and harvest from subsistence hunting and fishing are crucial to the traditions and customs of subsistence communities; any decrease in harvest or catches or increase in hunting difficulty could 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 these communities (BOEM, 2018a). The magnitude of these impacts would depend on the degree of overlap between the hunting season and OMAO activities. OMAO activities and peak subsistence hunting and fishing seasons are bound to overlap due to safety and weather considerations in places like Alaska, therefore it would not be practicable for OMAO to avoid activities during all subsistence hunting seasons, but impacts are minimized through coordination with the appropriate groups. OMAO activities within TCPs and subsistence hunting and fishing areas would require communication with appropriate SHPOs, THPOs, and tribal officials.

Where relevant, the THPO assumes oversight of the Section 106 process from the state, providing the tribe with review authority over federal undertakings (NPS, 2012). 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 treaty 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.

E.O. 13175, Memorandum on Uniform Standards for Tribal Consultation (Nov. 30, 2022), and the NOAA Tribal Consultation Handbook provide required procedures for consultation with federally-recognized Tribes in recognition of the sovereignty of federally-recognized Tribes and the federal government's trust responsibility to those tribes. 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 NOAA 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 NOAA activities to affect ecotourism and to contribute to commercial vessel traffic. Concerns about the potential for NOAA work to damage or alter historically or culturally significant sites have not been routinely identified in either location by Tribal representatives.

OMAO and the LO responsible for project activities would continue to attempt to coordinate vessel operations occurring 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 OMAO activities on subsistence hunting and fishing practices of Alaska Natives and indigenous tribes are discussed in further detail in Section 3.10.2 (Environmental Justice). 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 3.10.2.

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 community may also be required (NPS, No Date-b). With the legal protection afforded to listed TCPs by the Section 106 review process, the impacts from vessel movement and presence on TCPs under Alternative A are expected to be **adverse**, **temporary** (lasting only during the time that vessel operations are being conducted), **negligible** to **minor**, and **insignificant**.

OMAO and other LOs would continue to facilitate tribal involvement related to planned projects throughout the action area. For example, regional NOS Office of 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.

Visual and noise impacts from vessel movement under Alternative A could affect the view to or from a TCP or TCL; however, vessels would not remain in view for more than a few days and the presence of a transient vessel would not impact the integrity of the area. For TCPs or TCLs that span across the U.S. EEZ, impacts beyond the U.S. EEZ would be similar to those within the EEZ. Although vessel movement and active acoustic system operations under Alternative A could interfere with traditional subsistence hunting and fishing practices during peak seasons or times, ongoing communication between OMAO, other LOs, THPOs, and tribal officials in addition to the attempted avoidance of these areas during peak times to the extent practicable would minimize impact. Impacts from vessel movement and active acoustic sources under Alternative A on TCPs, TCLs, and subsistence hunting and fishing areas, would continue to be **adverse**, **temporary** to **short-term**, **negligible** to **minor**, and **insignificant**.

3.8.2.1.4 Conclusion

Under Alternative A, OMAO would continue to use the existing fleet to conduct operations in support of NOAA's primary mission activities. OMAO would continue to operate NOAAs fleet of survey and research ships until they reach the end of service life. Almost half the ships in the NOAA fleet would exceed their design service life by 2038; however, two new ships would come online by 2025 with two more ships projected to come online in 2027 and 2028. Under Alternative A the fleet would provide a maximum annual capacity of 3,568 operational DAS for scientific projects. Since the effects of impact causing factors on cultural and historic resources throughout the action area range from adverse to beneficial and negligible to minor, the overall impact of Alternative A on cultural resources, would be **adverse**, **minor**, **temporary** to **permanent**, **localized**, and therefore **insignificant**.

3.8.2.2 Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

OMAO operations under Alternative B would take place in the same operational areas and timeframes as under Alternative A; however, under Alternative B, OMAO would construct up to eight new ships (four as in Alternative A, plus four additional ships) to replace vessels that would reach the end of their design service life, extend the service life of aging ships through maintenance and mid-life repairs for six ships, increase fleet utilization with up to 4,138 DAS (approximately 570 more DAS annually than under Alternative A), and integrate new and greener technology as described in Section 2.4. The difference between the two alternatives is primarily a matter of scale with increased activity levels distributed unevenly among the different types of operations, the five operational areas, and within the 15-year timeframe. As such, effects under Alternative B would incrementally increase from those of Alternative A but would not differ fundamentally in type.

Impacts from OMAO operations on cultural and historic resources through physical impacts to submerged cultural and historic resources and presence of NOAA vessels would occur under Alternative B from the same activities as those under Alternative A. Although the number of DAS would be greater under Alternative B than under Alternative A, the additional 570 DAS (implemented in a phased approach) would be distributed across the five operational areas annually. 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 intensity of the impacts.

Impacts of Alternative B on cultural and historic resources throughout the action area would be similar to those discussed above under Alternative A for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be lower due to the increased charting and mapping supported by increased vessel use (i.e., increasing the proportion of the sea floor that is surveyed/charted would further reduce the chance of accidental impacts to unknown/unidentified submerged resources). Impacts to cultural and historic resources resulting from Alternative B would not substantially increase or differ in intensity as compared to Alternative A. Overall, impacts on cultural and historic resources under Alternative B would be **adverse**, **minor**, **temporary** to **permanent**, **localized**, and therefore **insignificant**.

3.8.2.3 Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

OMAO operations under Alternative C would implement the same measures as under Alternative B and take place in the same operational areas and timeframe as under Alternatives A and B; however, Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B with additional measures including: maximizing crew productivity and enhancing overall fleet performance by increasing DAS by 735 beyond Alternative B levels, construction of two additional new ships in addition to those under Alternative B, increasing the number and use of uncrewed systems integrated into vessels, and shortening the timeframe for fleet improvement activities, implementation of greening techniques, and improvements to the small boat fleet as discussed in Section 2.5. As such, effects under Alternative C would incrementally increase from those of Alternatives A and B but would not differ fundamentally in type.

Impacts from OMAO operations on cultural and historic resources through physical impacts to submerged cultural and historic resources and presence of NOAA vessels would occur under Alternative C from the same activities as those under Alternative A and B. Along with the greater number of DAS under Alternative C as compared to Alternatives A and B, there would be greater impacts overall; however, the associated impact-causing factors would not be concentrated enough in any given area to substantially increase the intensity of the impacts.

Impacts of Alternative C on cultural and historic resources throughout the action area would be similar to those discussed above under Alternatives A and B for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be lower due to the increased charting and surveying supported by increased vessel use (i.e., increasing the proportion of the sea floor that is surveyed/charted would further reduce the chance of accidental impacts to unknown/unidentified submerged resources). Impacts to cultural and historic resources resulting from Alternative C would not substantially increase or differ in intensity as compared to Alternatives A and B. Overall, impacts on cultural and historic resources under Alternative C would be **adverse**, **minor**, **temporary** to **permanent**, **localized**, and therefore **insignificant**.

3.9 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 enables NOAA's LOs to rapidly and efficiently collect data to ensure safe navigation for coastal-dependent industries, assist local communities to plan for coastal resiliency in response to climate change, and provide accurate assessment of commercial fishery stock quotas to fishing industries and communities. 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 any direct or indirect socioeconomic impacts.

There are over 128 million people living in U.S coastal counties (OCM, 2023). Although some OMAO operations 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 Preferred Alternative would not require hiring at a scale which would substantially alter any local economies or stimulate migrations of populations. Furthermore, all of OMAO's operations would occur offshore, so sound and visual intrusions from these 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 Draft PEA, 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 3.10, Environmental Justice.

The COVID-19 pandemic caused many changes in the ocean economy. Widespread reductions in consumer behaviors and demand drastically disrupted the maritime shipping, tourism, and commercial fishing sectors. For example, revenue from commercial fisheries landings, which averaged $5.8 billion annually from 2015 to 2019, declined 19 percent in March 2020 compared to the 5-year monthly average and continued to decline throughout the spring (NMFS, 2021c). 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 and 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 (OCM) 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.

3.9.1 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.

In 2018, the ocean economy's 162,000 business establishments employed about 3.4 million people, paid $140 billion in wages, and produced $346 billion in goods and services. As described in the 2021 NOAA Report on the U.S. Ocean and Great Lakes Economy, this accounted for 2.3 percent of the nation's employment and 1.7 percent of its gross domestic product (GDP) in 2018. Employment in the ocean economy rose 3.1 percent (adding 102,000 jobs) from 2017 to 2018 – faster than the national average employment growth of 1.6 percent during the same period. To put this in perspective, the ocean economy employed a larger share of the U.S. workforce in 2018 than crop production, telecommunications, and building construction combined (OCM, 2021).

National data by industry sector for the ocean economy in 2018 are shown below in Table **3.9-1**. The tourism and recreation sector was the largest in terms of establishments, employment, wages, and contribution to GDP.

Table 3.9-1. U.S. Ocean and Great Lakes National Economy by Sector (2018)

Industry Sector	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
Tourism and Recreation	133,200	2,462,851	65,559,975	143,170,229
Marine Transportation	10,559	535,742	37,132,070	66,112,347
Offshore Mineral Extraction	4,554	117,557	17,844,435	96,422,659
Living Resources	8,747	88,321	4,273,947	11,193,207
Marine Construction	3,125	50,818	4,027,566	7,312,773
Ship and Boat Building	1,828	162,598	11,437,952	21,695,897
Total	**162,013**	**3,417,887**	**140,275,945**	**345,907,112**

Source: OCM, 2018a

National data by region for the ocean economy in 2018 are shown in **Table 3.9-2**. The Mid-Atlantic Region had the most establishments (44,612), employees (849,210), and wages (about $33.4 billion) compared to the other regions; but the Gulf of Mexico produced the most in goods and services (about $119 billion).

Table 3.9-2. U.S. Ocean and Great Lakes National Economy by Region (2018)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
Mid-Atlantic	44,612	849,210	33,428,083	67,091,112
Gulf of Mexico	24,567	591,752	32,083,246	119,013,092
West	34,903	767,831	32,820,690	67,202,418
Southeast	19,805	438,295	13,706,518	30,341,931
Northeast	15,582	271,426	10,664,698	21,141,361
Great Lakes	15,459	330,517	9,942,372	21,311,785
North Pacific	2,495	44,929	2,662,324	9,532,050
Pacific	4,589	123,926	4,968,013	10,273,363
Total	**162,012**	**3,417,886**	**140,275,944**	**345,907,112**

Source: OCM, 2018b

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 2018 dataset are presented below in Sections 3.9.1.1 through 3.9.1.6 for each of the six sectors making up the ocean economy, highlighting the importance of contributions from ocean and Great Lakes-dependent activities to the nation's economy. As stated above, OMAO operations enable NOAA's LOs to acquire charting data that provide essential safe navigation, crucial to the ocean economy. This data serves a variety of users including commercial and recreational mariners, emergency and coastal managers and responders, researchers, educators, and others. Furthermore, this data provides information essential for coastal resiliency planning for coastal communities, particularly on the East Coast.

3.9.1.1 Tourism and Recreation

In 2018, 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 41.4 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, 2021).

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 wages for employees in this sector. From 2017 to 2018, tourism and recreation gained 55,000 jobs, accounting for most of the employment growth in the ocean economy. The majority of the jobs are in hotels and restaurants, in areas close to the shore where most of the tourist attractions are located. Combined, these two industries account for 93.8 percent of employment and 92.4 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, 2021).

California and Florida are the two largest contributors to the sector, accounting for more than one-third of the sector’s total employment and GDP in 2018 (OCM, 2021). A summary of the tourism and recreation sector by region is shown in Table **3.9-3** below.

Table 3.9-3. Tourism and Recreation Sector by Region (2018)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
Mid-Atlantic	39,597	628,927	18,616,806	41,596,827
West	29,128	553,426	15,750,053	33,484,409
Gulf of Mexico	16,841	353,298	7,898,580	16,247,353
Southeast	15,990	346,923	8,377,175	18,596,189
Great Lakes	12,862	249,249	5,448,387	11,860,845
Northeast	12,823	196,961	5,020,515	11,053,436
Pacific	4,259	110,871	3,867,319	9,178,615
North Pacific	1,699	23,192	581,140	1,152,556
Total	**133,199**	**2,462,847**	**65,559,975**	**143,170,230**

Source: OCM, 2018b

3.9.1.2 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 15.7 percent of the employment and 19.1 percent of the GDP of the U.S. Ocean and Great Lakes economy. About 21.1 percent of employment and 25.3 percent of GDP attributable to the sector are supported by California. The rest is distributed across the nation, concentrated around major ports (OCM, 2021). A summary of the marine and coastal transportation sector by region is shown in **Table 3.9-4** below.

Table 3.9-4. Marine and Coastal Transportation by Region (2018)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
West	2,543	145,013	11,795,086	20,642,427
Mid-Atlantic	2,326	153,373	10,203,616	17,384,245
Gulf of Mexico	2,097	90,213	6,113,358	11,646,662
Great Lakes	1,265	65,083	3,569,295	6,280,403
Southeast	1,429	47,061	2,623,662	4,967,949
Northeast	563	28,991	2,331,437	4,226,018
North Pacific	236	2,026	156,661	350,139
Pacific	100	3,978	338,954	614,504
Total	**10,559**	**535,738**	**37,132,069**	**66,112,347**

Source: OCM, 2018b

Warehousing is the largest component of this sector in terms of employment, accounting for 55.1 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 $1.7 trillion of cargo imported or exported through U.S. ports in 2018 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, 2021). Many 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). Ships accounted for 23.6 percent of imports and 21 percent of exports as measured by weight, and 8.7 percent of imports and 9.3 percent of exports as measured by value in 2018. 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, 2021).

3.9.1.3 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 3.4 percent of the total employment in the ocean economy in 2018, but contributed 27.9 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 $152,000 – almost three times the national average (OCM, 2021).

Oil and gas production is the largest component of this sector and is principally located in the Gulf of Mexico, as shown below in **Table 3.9-5**. The Gulf of Mexico, both onshore and offshore, is one of the most important regions for energy resources and infrastructure. Federal offshore oil production in the Gulf of Mexico accounts for 15 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 (EIA, 2022a). Crude oil production in federal waters exceeded 1.6 million barrels/day and dry gas production was 714 billion cubic feet in 2020 (EIA, 2023a; EIA, 2023b). U.S. natural gas production on federal lands has declined each year from 2009 to 2017, much of which can be attributed to offshore production falling by over 55 percent (CRS, 2018). Over 47 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). Annual domestic crude oil prices increased about 22 percent in 2018 compared to the previous year. From 2017 to 2018, this sector saw an increase of 0.7 percent in employment but a decrease of 5.7 percent in GDP. This decline was primarily concentrated in the Gulf of Mexico region where much of this industry is located (OCM, 2021).

Table 3.9-5. Offshore Mineral Extraction by Region (2018)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
Gulf of Mexico	2,997	96,124	15,444,694	85,988,910
West	488	7,529	702,839	2,200,658
Mid-Atlantic	289	1,527	107,041	292,009
Great Lakes	273	965	75,471	544,000
North Pacific	176	9,569	1,395,741	7,017,857
Southeast	146	487	23,995	55,428
Northeast	91	465	34,016	146,000
Pacific	9	101	9,973	39,396
Total	**4,469**	**116,767**	**17,793,770**	**96,284,258**

Source: OCM, 2018b

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, 2021).

3.9.1.4 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 2.6 percent of the employment and 3.2 percent of GDP of the ocean economy in 2018 (OCM, 2021). Seafood markets are the largest producer in the living resources sector and accounted for 41.5 percent of its GDP in 2018. 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 47.1 percent of the sector in 2018 (OCM, 2021). In 2017, the seafood industry supported 1.2 million full-and part-time jobs and generated $170.3 billion in sales, $44.6 billion in income, and $69.2 billion in value-added impacts nationwide. The seafood retail sector generated the largest employment impacts across sectors (549,922 jobs) and the largest income impacts ($13.3 billion) (NMFS, 2021d).

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. 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, 2021). 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 3.9-6**).

Table 3.9-6. Living Resources Economy by Region (2018)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
West	1,900	21,523	1,246,947	2,993,812
Gulf of Mexico	1,654	17,648	651,091	1,992,047
Mid-Atlantic	1,668	14,026	619,880	1,923,379
Northeast	1,695	12,278	718,795	1,756,678
Southeast	867	7,294	290,713	853,851
Great Lakes	492	4,459	200,598	567,733
North Pacific	319	9,490	476,638	931,865
Pacific	152	1,599	69,286	173,842
Total	**8,747**	**88,317**	**4,273,948**	**11,193,207**

Source: OCM, 2018b

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.

3.9.1.5 Marine Construction and Planning

The marine construction sector accounts for heavy construction activities associated with dredging of navigation channels, beach renourishment, and pier building[5]. Marine construction accounted for 1.5 percent of the employment and 2.1 percent of the GDP in the ocean economy in 2018. 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 $79,000, 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, 2021).

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 1m (2-3 ft) annually along the Atlantic coast and over 2m (6 ft) annually in areas bordering the Gulf of Mexico. Pacific coastlines tend to erode less than 0.3m (1 ft) each year, but this lower rate is primarily a result of averaging episodic cliff erosion events, which can erode over 31m (100 ft) of coastline at one time, over many years. 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

[5] 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, 2021).

(Heinz Center, 2000). 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 2018 accounted for about 62.2 percent of the employment and about 58.4 percent of GDP contribution from this sector. Marine construction economics by region are shown below in **Table 3.9-7**.

Table 3.9-7. Marine Construction Economy by Region (2018)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
West	495	10,741	1,103,775	2,057,040
Gulf of Mexico	721	19,177	1,307,897	2,208,411
Mid-Atlantic	595	8,977	769,091	1,422,411
Northeast	158	1,621	138,238	232,686
Southeast	663	6,466	377,082	783,020
Great Lakes	319	2,180	179,533	329,146
North Pacific	40	284	30,407	47,367
Pacific	42	831	80,176	154,652
Total	**3,033**	**50,277**	**3,986,199**	**7,234,733**

Source: OCM, 2018b

3.9.1.6 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 6.3 percent of GDP in the ocean economy in 2018. 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 80.8 percent of the sector's employment and 80.3 percent of GDP (OCM, 2021).

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 2018, Virginia contributed most to employment in this sector, accounting for 29.1 percent of the national total. Washington State was the largest contributor to GDP, accounting for 25.5 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 11.4 percent of the employment and 21.6 percent of the GDP in the nation's ship and boat building sector (OCM, 2021). The number of establishments, employment, wages, and contribution to GDP are shown by region in the below **Table 3.9-8**.

Table 3.9-8. Ship and Boat Building by Region (2018)

Region	Establishments	Employment	Wages ($000)	Contribution to GDP ($000)
West	324	29,093	2,188,795	5,745,533
Gulf of Mexico	563	34,558	2,166,417	4,258,576
Mid-Atlantic	154	40,837	3,024,819	4,278,056
Northeast	128	13,367	950,039	905,164
Southeast	236	3,594	179,136	333,930
Great Lakes	67	4,352	218,886	1,018,946
North Pacific	25	365	21,736	32,266
Pacific	27	6,543	602,305	112,354
Total	**1,524**	**132,709**	**9,352,133**	**16,684,825**

Source: OCM, 2018b

3.9.2 Environmental Consequences

This section discusses potential impacts of Alternatives A, B, and C on socioeconomic resources in the action area.

OMAO's vessel operations (described in **Table 2.1-1**) and the activities that would occur under all alternatives (see Section 2.2) would not directly impact socioeconomic resources since they would not result in the hiring of personnel. Instead, these operations would help fulfill the organization's primary missions described in Section 1.2.1 and 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.

Section 3.2.2 describes the significance criteria for the resources analyzed in this Draft PEA and provides a structured framework for assessing impacts from the alternatives. The subsequent sections describe potential socioeconomic impacts from Alternatives A, B, and C in terms of context, duration, likelihood, and intensity; and whether impacts are significant or insignificant overall.

3.9.2.1 Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Under Alternative A, OMAO vessel operations using the existing NOAA fleet would continue across all five operational areas over the 15-year period. In addition, OMAO is constructing two oceanographic research vessels that are expected to come online by 2025 and two new charting and mapping vessels that are expected to come online in 2027 and 2028 for a total of four new ships under Alternative A. OMAO would provide a maximum annual capacity of 3,568 operational DAS for scientific projects.

3.9.2.1.1 Economic Benefits of Data Acquired by the NOAA Fleet

As described in Chapters 1 and 2 of this Draft PEA, OMAO oversees the operation, management, and maintenance of NOAA's fleet of vessels to support the organization's at-sea missions and long-term goals. Data collected using the NOAA fleet are used by both public and private consumers and are vital to the economy and health of the nation. For example, the National Ocean Service (NOS) relies on hydrographic surveys to develop nautical charts, which facilitate safe and efficient marine navigation. The value of forecast improvements can be quantified in avoided evacuations, which result in saved lives and realized economic value; for example, over $600 million and $391 million were saved in evacuation costs for Hurricanes Laura and Delta, respectively, as a result of accurate track forecasts. Accurate track forecasts also saved billions of dollars in saved oil fields (15 percent of all U.S. oil production is from the Gulf of Mexico [GoM]), oil refineries (47 percent of all oil refineries in the U.S. is along states in GoM, and hospital evacuations. Accurate maps of coastal areas help inform tsunami inundation models and storm surge predictions, which are crucial for urban planning and emergency management. Physical, chemical, and biological observations from NOAA's fleet allow NOAA to manage and protect key species and resources and serve as the basis for fisheries stock assessments, which help fishery managers to set appropriate catch limits (OMAO, 2018). Therefore, the distribution and availability of data collected as an indirect result of OMAO's vessel operations could benefit ocean economy stakeholders by increasing the efficiency and risk management of ocean-related operations.

Estimating the value of environmental goods and services is challenging because the price individuals are willing to pay for such products is not revealed in economic markets and much of their presumed value accrues directly to individual users or consumers whose interests and behaviors cannot be easily determined. While economists can employ methods to estimate the value of these products, such as through surveys to ascertain society's willingness to pay for the benefits received, these methods are often expensive and time consuming (OMAO, 2018). 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 impacts across the entire action area.

To illustrate the indirect benefits that the data collected using the NOAA fleet would have on nearly all sectors of the ocean economy, this section describes findings from OMAO's 2018 report titled "NOAA Fleet Societal Benefit Study" that identifies and monetizes the benefits associated with a subset of key NOAA products and services that are dependent on the NOAA fleet. According to NOAA's Office of Technology Planning and Integration for Observation (TPIO), data collected by the NOAA fleet support the development of 638 NOAA products and services across the 26 NOAA mission service areas. To establish the socioeconomic benefits associated with the fleet's data collection activities, the research team analyzed 12 of the 638 NOAA products and services that the NOAA fleet directly supports. The research team developed a qualitative "value chain" model for each of the 12 products. A value chain model describes how the data from the fleet helps in the development of the product, the end users of the product, the decisions made by the users based on the information provided by it, and the resulting value to society. The value chains were developed using data from TPIO's NOAA Observing System Integrated Analysis (NOSIA-II) Value Tree (a hierarchical model), along with information obtained by conducting extensive interviews with subject matter experts from NOAA's LOs (OMAO, 2018). The initial subset of 12 products and services for which value chains were developed are highly dependent on the NOAA fleet and/or have a relatively large societal benefit. **Table 3.9-9** summarizes the value chain for each of the 12 products, including a brief description of the product, key users, and the associated societal benefits as presented in the 2018 report.

Table 3.9-9. Summary of Value Chains for 12 NOAA Products and Services

Value Chain/NOAA Product	Description	Users/Uses	Benefits
Coral Reefs: Coral Reef Status and Trends Report Cards	National and jurisdictional-level reports that provide standardized indicators on coral reef health.	Decision makers will use reports to manage coral reefs under NOAA jurisdiction.	Will protect coral reefs and associated ecosystem services, including use and non-use benefits (e.g., tourism).
Sea Level Rise: Sea Level Rise Viewer	Web-based map viewing tool that provides visual information on sea level rise inundation, flood frequency, and socioeconomics.	Planners use information to identify potential community vulnerabilities and assess adaptation options.	Avoids impacts/costs of sea level rise, including: ▪ Property damage ▪ Loss of critical infrastructure ▪ Impacts to vulnerable populations
Bathymetry/Hydro-graphic Surveys: Nautical Charts	Electronic and paper navigational charts/maps of U.S. coastal and marine waters as well as the Great Lakes.	Commercial and recreational vessels use charts for navigation and port entry; informs scientific efforts and marine infrastructure location decisions.	Provides safe and efficient marine transportation and commerce; avoids losses from accidents and unnecessary slowdowns.
Seasonal Forecasts: El Nino Southern Oscillation (ENSO) Outlook	Seasonal forecast that describes expected El Nino and La Nina conditions, and temperature and precipitation predictions.	High-level decision-makers, emergency planners, economic sectors (e.g., agriculture, energy, retail) use Outlook to allocate resources and optimize revenues in face of ENSO conditions.	▪ Avoids costs of ENSO-related events ▪ Provides cost savings from more effective response/preparation ▪ Increases revenues for agriculture, energy, retail, and other sectors
Ecosystem Management: National Marine Sanctuaries Conditions Report	Reports on ecosystem health, trends, and other indicators for individual National Marine Sanctuaries.	Decision-makers will use reports to manage all Sanctuary resources under NOAA jurisdiction.	▪ Protects special status species, coral reefs, marine habitats ▪ Helps maintain ecosystem services, including use and non-use benefits (e.g., tourism)

Value Chain/NOAA Product	Description	Users/Uses	Benefits
Fisheries Management: Fisheries Stock Assessments	Assessment of changes in abundance of fishery stocks and expected future trends.	Fisheries managers use assessments to set catch limits and manage species; informs sustainable seafood consumption/fishing.	▪ More accurate catch limits allow commercial fishermen to catch more than would otherwise be permitted ▪ Provides sustainable management and harvest of fish species
Tsunamis: Tsunamis Inundation Forecast Model	Series of models that calculate the height and extent of tsunami flooding in U.S. coastal regions.	NOAA uses real-time tsunami forecasting. Communities use models to create tsunami inundation maps, evacuation/response plans, and risk assessments and mitigation plans.	▪ Avoids unnecessary evacuation costs ▪ Decreases tsunami impacts, including lives lost, property damage, and other losses
Harmful Algal Blooms (HAB): HAB Forecasts and Mitigation Capability (Gulf of Maine)	Harmful Algal Bloom Operational Forecast Systems assess and predict extent of HABs.	State/local managers use forecasts to make more informed decisions about beach closures, shell fishing restrictions, and other HAB-affected activities.	Minimize impacts of HABs, including: ▪ Lost landings ▪ Lost tourism/recreation opportunities ▪ Adverse public health outcomes
Hypoxia: Hypoxia Watch (Gulf of Mexico)	Near real-time, web-based contour maps and data on Gulf region dissolved oxygen for the peak annual hypoxic period. Maps and data provide a 15-year baseline of the Gulf Hypoxic Zone.	Maps and data help form the scientific basis upon which policymakers and managers make management decisions to reduce Hypoxic Zone and associated impacts. Commercial and recreational fishermen can use Hypoxic Watch to better plan where to fish and avoid hypoxic areas.	Helps to sustain commercially- and recreationally-important fish species in the Hypoxic Zone. This supports the commercial fishing industry, recreational fishing, and tourism.

Value Chain/NOAA Product	Description	Users/Uses	Benefits
Ocean Noise: Ocean Noise Mapping	Web-based mapping tools that show density, distribution, and migratory patterns, as well as impacts of anthropogenic ocean noise for select species.	Public agencies and industry planners use maps to better understand the effect of anthropogenic noise for proposed ocean-related activities, and to meet environmental regulations.	Protects species by allowing natural defense and mating sound clues to operate normally by permitting normal migratory patterns.
Hurricanes: Hurricane Outlook	Seasonal forecast of expected hurricane activity.	Communities, businesses, and other stakeholders use Outlook to improve hurricane preparedness. High-level decision makers use Outlook to allocate resources to hurricane preparedness.	Reduces property damage, mortality and morbidity, societal costs associated with evacuation, and lost business activity.
Emergency Response	▪ Deliver emergency supplies, conduct hydrographic surveys to re-open ports, and assess hazardous materials after hurricanes and major storms ▪ Locate and map debris fields for aviation disasters ▪ Conduct scientific surveys in response to major oil spills ▪ Survey waterways in response to national security threats ▪ Perform research, rescue, and evacuation services	U.S. emergency response network calls on NOAA ships because they have unique technologies and are staffed with scientists and engineers with necessary expertise. They are also available across a wide geographic range, resulting in a timely response.	Saves lives, allows for rapid reopening of ports after hurricanes and continuation of commercial activities at ports, and informs natural resource damage assessments. Provides cost-effective and timely response capabilities, resulting in cost-savings for U.S. taxpayers.

Source: OMAO, 2018

Next, the research team coordinated with OMAO and NOAA's Observing Systems Council to select five products for further evaluation. They developed monetary estimates of the benefits derived from these five products and estimated the portion of this benefit that is attributable to the NOAA fleet, shown in **Table 3.9-10** below. The products were selected for further evaluation and monetization based on the following criteria:

- Highest/largest benefits to society;
- Degree of dependency on data from NOAA fleet;
- Availability of data to appropriately quantify/monetize the societal benefits of the product; and
- Availability of the products' output data that could be validated as being crucial for a specific use and showed improvement with additional measures.

To estimate the benefits associated with each product, the team relied on estimates from existing studies and literature, and applied these estimates (or range of estimates) to the relevant product.

Table 3.9-10. Societal Benefits of Select NOAA Products and Associated Value of NOAA Fleet (millions of dollars)

Value Chain/Product	Annual Anticipated Benefit of Product	Annual Anticipated Benefits Attributed to NOAA Fleet	
		Value	Percent
Coral Reefs: Coral Status and Trend Report	$590 - $1,190	$90 - $710	15.0% - 60.0%
Sea Level Rise: Sea level Rise Viewer	$1,480	$30 - $560	2.0% - 37.5%
Bathymetry/Hydrographic Surveys: Nautical Chart Products	$58 - $120	$17 - $48	30.0% - 40.0%
Seasonal Forecasts: El Nino Southern Oscillation Outlook	$560 - $1,300	$26 - $270	4.6% - 20.0%
Ecosystem Management: National Marine Sanctuary Reports	$2,420 - $5,180	$610 - $1,800	25.0% - 35.0%

Source: OMAO, 2018

3.9.2.1.2 Conclusion

OMAO's vessel operations enable the collection of a wide variety of atmospheric, fisheries, hydrographic, and oceanographic data that is used by NOAA LOs, other U.S. government agencies, communities, and businesses around the nation. This data helps keep U.S. ports open to maritime commerce, understand changes to the planet, monitor the health of fish stocks, and make economic and policy decisions (OMAO, 2018). As such, OMAO's vessel operations under Alternative A would continue to 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., facilitation of safe and efficient marine navigation, protection of key species and resources for tourism, sustainable management and harvest of fish species for commercial and recreational fisheries, provision of emergency response services to minimize interruptions to maritime trade and commerce). Indirect economic benefits would range in the magnitude of hundreds of millions of dollars for each product, as shown in **Table 3.9-10** above, although it is important to note these estimates are broadscale and contingent on assumptions of data use and availability.

However, as the NOAA ships reach the end of their service life and are retired from the fleet, OMAO would be unable to continue utilizing the fleet at its current levels. Consequently, the quality and quantity of products and services supported by the reduced fleet may decline, resulting in fewer benefits to society across economic sectors compared to current levels. Overall, Alternative A would have an **indirect, beneficial** impact on the ocean economy. The impact would be **long-term** since the vessels would need to periodically collect data to ensure availability of the latest data products to the end users. The impact would be **regional** and vary in intensity from **moderate** (current levels) to **minor** (at the end of the 15-year timeframe of this Draft PEA).

3.9.2.2 Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

OMAO operations under Alternative B would take place in the same operational areas and timeframes as under Alternative A; however, under Alternative B, OMAO would acquire up to eight new ships (four as in Alternative A, plus up to four additional ships) to replace vessels that would reach the end of their design service life, extend the service life of existing ships through maintenance and mid-life repairs for six ships, increase fleet utilization up to 4,138 DAS (approximately 570 more DAS annually than under Alternative A), and integrate new and greener technology as described in Section 2.4.

The types and mechanisms of impacts for Alternative B would be similar to the impacts discussed for Alternative A, with minor variations as described below. As with Alternative A, ocean data collected under Alternative B would be used 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 populations or economic sectors experiencing maximum benefits may not necessarily occur in operational areas with the greatest data collection effort. Under Alternative B, the size of NOAA's fleet would be maintained at the current level by the addition of newer, more technologically-advanced ships with greater data collection capabilities, though the exact number of operational ships may vary year to year. Furthermore, the service life of existing NOAA ships would be extended by providing greater levels of maintenance and upgrades to select ships. These measures would result in OMAO increasing the utilization of the NOAA fleet more effectively compared to current levels. Therefore, the difference between the two alternatives is primarily a matter of scale with an increased activity level of the NOAA fleet distributed unevenly among the different types of operations, the five operational areas, and within the 15-year timeframe, leading to a corresponding, incremental increase in effects under Alternative B as compared to Alternative A. Consequently, the quality and quantity of products and services supported by the fleet under Alternative B would increase, resulting in greater benefits to society across economic sectors compared to Alternative A. Overall, Alternative B would have an **indirect, beneficial** impact on the ocean economy. The impact would be **regional**, **long-term**, and would be **moderate** in intensity.

3.9.2.3 Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

OMAO operations under Alternative C would implement the same measures as under Alternative B and take place in the same operational areas and timeframe as under Alternatives A and B; however, Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B with additional measures including acquiring two additional new ships, increasing the number and use of uncrewed systems integrated into the ships to increase the DAS by 735 beyond Alternative B levels, shortening the timeframe of fleet improvement activities, extending service life of aging NOAA ships, expediting improvements to the OMAO small boat fleet, and purchasing/developing technology to enable efficient scheduling of assets as discussed in Section 2.5. The difference between the three alternatives is primarily a matter of scale with increased activity levels of the NOAA fleet distributed unevenly among the different types of operations, the five operational areas, and within the 15-year timeframe. As such, effects under Alternative C would incrementally increase from those of Alternatives A and B but would not differ fundamentally in type compared to Alternative B.

The types and mechanisms of impacts for Alternative C would be similar to the impacts 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 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 operational areas, the resulting impacts would not necessarily be geographically correlated with the collection of data. Under Alternative C, the size of NOAA's fleet would increase beyond the level anticipated under Alternatives A and B due to the addition of newer, more technologically-advanced vessels to the fleet with greater data collection capabilities, including ships, uncrewed systems, and small boats. Furthermore, the service life of existing NOAA ships would be extended by providing greater levels of maintenance and upgrades to select ships. These measures would result in OMAO increasing the utilization of the NOAA fleet meaningfully compared to the levels expected under Alternatives A and B. The quality and quantity of products and services supported by the fleet under Alternative C would increase, resulting in greater benefits to society across economic sectors compared to Alternatives A and B. Overall, Alternative C would have an **indirect, beneficial** impact on the ocean economy. The impact would be **regional**, **long-term**, and would be **moderate** in intensity.

3.10 ENVIRONMENTAL JUSTICE

Executive Order (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. EO 14096 "Revitalizing Our Nation's Commitment to Environmental Justice for All" supplements the foundational efforts of EO 12898 by seeking to integrate the consideration of unserved and overburdened communities into the federal decision-making process.

The EPA defines environmental justice as "the just treatment and meaningful involvement of all people regardless of income, race, color, national origin, Tribal affiliation or disability, in agency decision-making and other Federal activities that affect human health and the environment so that people:

(i) are fully protected from disproportionate and adverse human health and environmental effects (including risks) and hazards, including those related to climate change, the cumulative impacts of environmental and other burdens, and the legacy of racism or other structural or systemic barriers; and

(ii) have equitable access to a healthy, sustainable, and resilient environment in which to live, play, work, learn, grow, worship, and engage in cultural and subsistence practices."

The goal of "just treatment" is not to shift risks among populations, but to identify potential disproportionate and adverse impacts on minority and low-income communities and other communities with environmental justice concerns, 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.

The federal decision-making process also involves solicitation of input from federally-recognized Indian tribes, as well as the indigenous peoples of Alaska, on matters having substantial direct effects on them. EO 13175 "Consultation and Coordination with Indian Tribal Governments" requires federal agencies to uphold the unique "government-to-government" sovereign relationship between the U.S. government and federally-recognized tribes and Alaskan Natives. Central to this relationship is the "trust responsibility" of the U.S. government, which is the federal government's obligation to carry out mandates of federal law with fiduciary consideration for the rights and interests of American Indian and Alaska Native tribes and villages. The U.S. protects the political rights of these communities by working with them on a government-to-government basis to address issues concerning Indian tribal trust resources, treaty rights, and the unique relationship between the federal government and Indian tribal governments (NOAA, 2020b).

3.10.1 Affected Environment

The majority of the impacts identified in this Draft PEA are to the aquatic environment, and as such, the environmental justice analysis considers potential disproportionate impacts on communities with EJ concerns that utilize resources from the ocean. The analysis focuses on those 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 OMAO activities that occur onshore are outside the scope of this PEA and 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.

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, 2021). 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.

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 3.7, Biological Resources.

3.10.1.1 Subsistence Hunting

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 and the Administrative Law Judge's recommended decision to the NOAA Fisheries is described below in Section 3.10.1.1.2, Gray Whales (NMFS, 2022a).

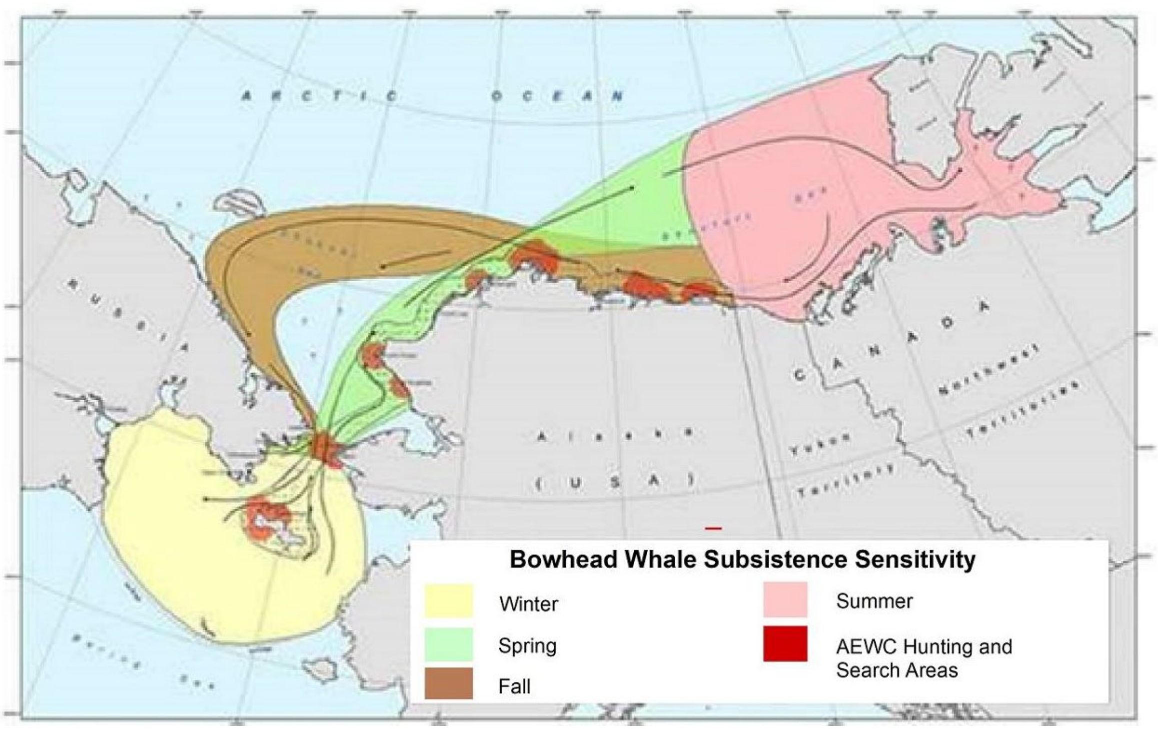
3.10.1.1.1 Bowhead Whale (*Baleana mysticetus*)

The bowhead whale is one of the most culturally important resources harvested by Alaska Natives. The Iñupiat 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 Taqulik, 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 Iñupiat 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 Iñupiat and Siberian Yupik people, who inhabit 11 bowhead whaling villages along the western and northern coasts of Alaska, regulate their bowhead whale subsistence activities via the AEWC (IWC, 2023). The AEWC communities hunt bowheads for the nutritious food that they provide and use their baleen and large bones to make handicrafts (NOAA, 2018b).

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, 2023c). 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 Environmental Impact Statement (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 3.10-1 shows the AEWC spring and fall hunting areas 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). 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 incorporated modern technologies such as darting and shoulder guns for improved efficiency and humane hunting (NOAA, 2018b).



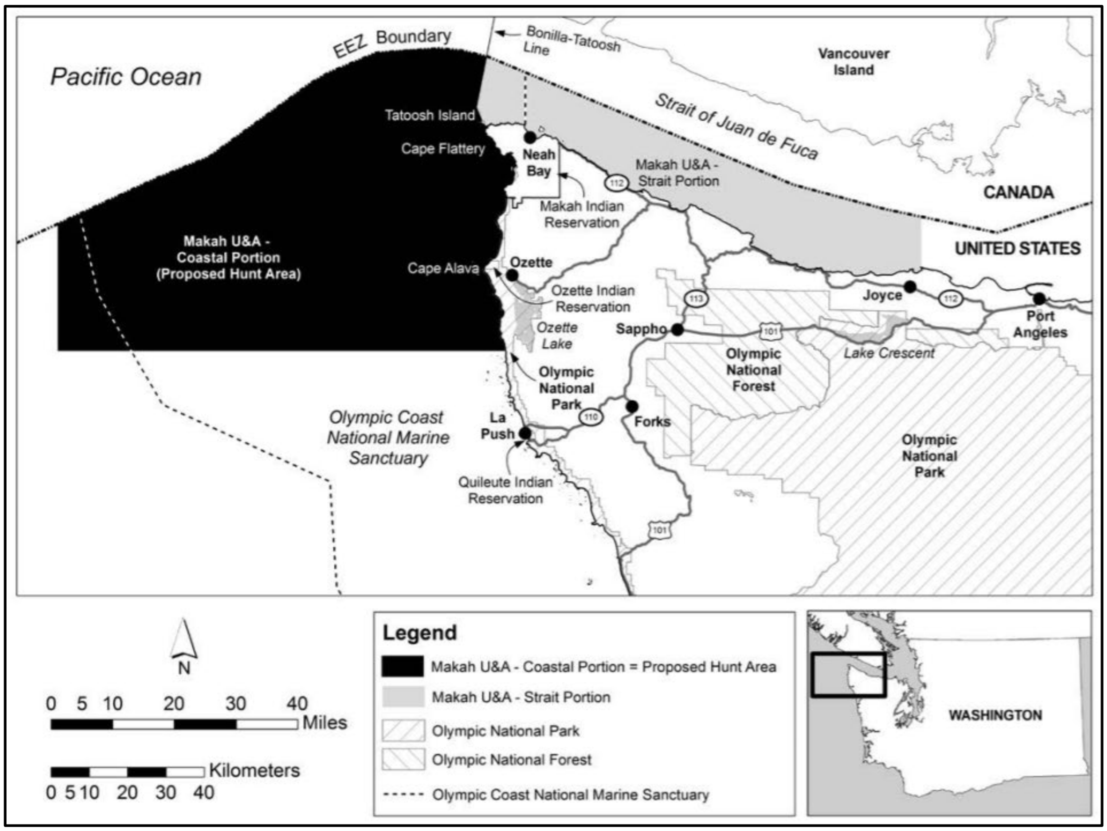
Source: NSB, No Date-a

Figure 3.10-1. Bowhead Whale Hunting Areas

3.10.1.1.2 Gray Whale (*Eschrichtius robustus*)

As stated in Section 3.10.1.1, 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 this Tribe to NMFS.

Since the 1990s, the Makah Tribe has sought to exercise their right to whale, as established under the Treaty of Neah Bay. In 2002, a federal court determined that this Tribe must first apply for a waiver of the MMPA take moratorium, which the Makah 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. On September 23, 2021, the administrative law judge sent his recommended decision to NOAA Fisheries which, if implemented by NOAA, would enable this Tribe to conduct ceremonial and subsistence hunting of eastern North Pacific gray whales in Pacific Ocean waters near their reservation on the northwestern tip of Washington's Olympic Peninsula, as shown in **Figure 3.10-2** below (NMFS, 2015b; NMFS, 2023d). The judge's recommended action, as well as public comments on the supplement to the 2015 Draft EIS[6], published in July 2022, will inform NOAA Fisheries' final decision on the Makah Tribe waiver request. 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 PEA, this section would be developed further.



Source: NMFS, 2015b

Figure 3.10-2. Proposed Gray Whale Hunting Area

[6] In 2008, NOAA Fisheries released a Draft EIS on the Makah Tribe's request to continue treaty right subsistence hunting of eastern North Pacific gray whales. The Draft EIS considered various alternatives to the Tribe's proposed action. In 2015, NOAA Fisheries released a new Draft EIS to consider a new set of alternatives from the ones assessed in the 2008 Draft EIS, which was eventually terminated in 2012 (NMFS, 2022b).

3.10.1.1.3 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[7]. Hunting is done in the spring as whales travel northward through leads (narrow, linear cracks) 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).

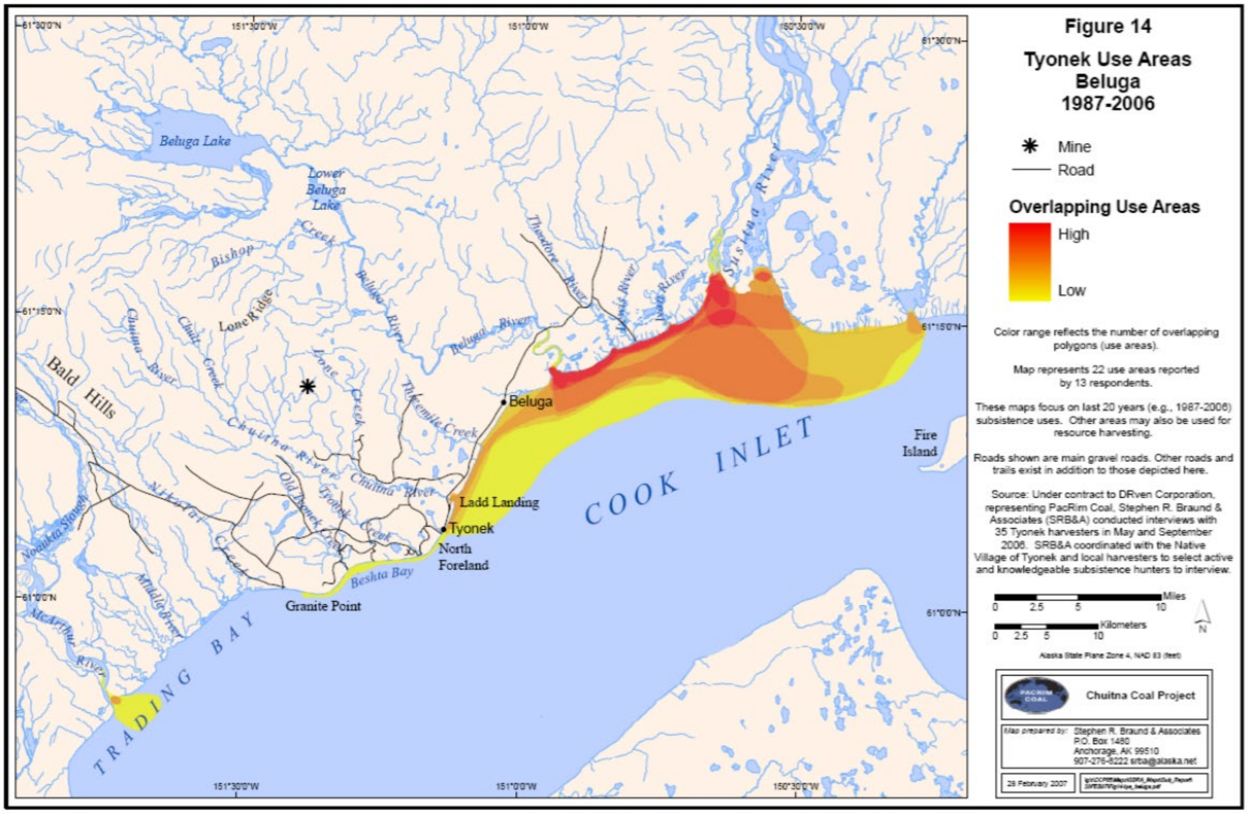
In 2008, NMFS issued final regulations to establish long-term limits on the maximum number of Cook Inlet beluga whales that may be taken by Alaska Natives for subsistence and handicraft purposes. The final rule established a harvest level for a 5-year period based on the average abundance of beluga whales in the previous 5-year period and the growth rate during the previous 10-year period. A harvest is not allowed if the previous 5-year average abundance is less than 350 beluga whales (NMFS, 2021e). 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 (NMFS, 2021e).

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 3.10-3** below. Native hunting camps are

[7] 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

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).



Source: NOAA, 2008a

Figure 3.10-3. Beluga Hunting Areas (Cook Inlet stock)

3.10.1.1.4 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, 2019).

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). 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[8] 124.5 centimeter (cm) (49 inch) 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

[8] A sub-adult fur seal is a fur seal between 2-5 years old and less than 124.5 cm (49 inch) long (NMFS, 2017).

and arrow, or stunning followed immediately by exsanguination. Additionally, annual harvest of young, male fur seals[9] on St. George Island occurs between September 16 and November 30, with a harvest limit of 150. 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(d)).

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 up to 20 female seals incidental to the hunt. 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[10] male fur seals could be harvested using alternative hunting methods (NMFS, 2019).

3.10.1.1.5 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 GOA. 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 GOA (NOAA, 2008b). Steller sea lions are reportedly taken during the spring (March – April) and the 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 in the Bering Sea, on the Aleutian Islands, and in the GOA. 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).

3.10.1.1.6 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

[9] Young, male fur seals refer to pups, or a fur seal less than a year old and dependent on its mother for food (NMFS, 2017).

[10] 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 1 year old (NMFS, 2017).

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).

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; ADF&G, 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).

3.10.1.1.7 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 Global Positioning Systems (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).

3.10.1.1.8 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, 2018). 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-d).

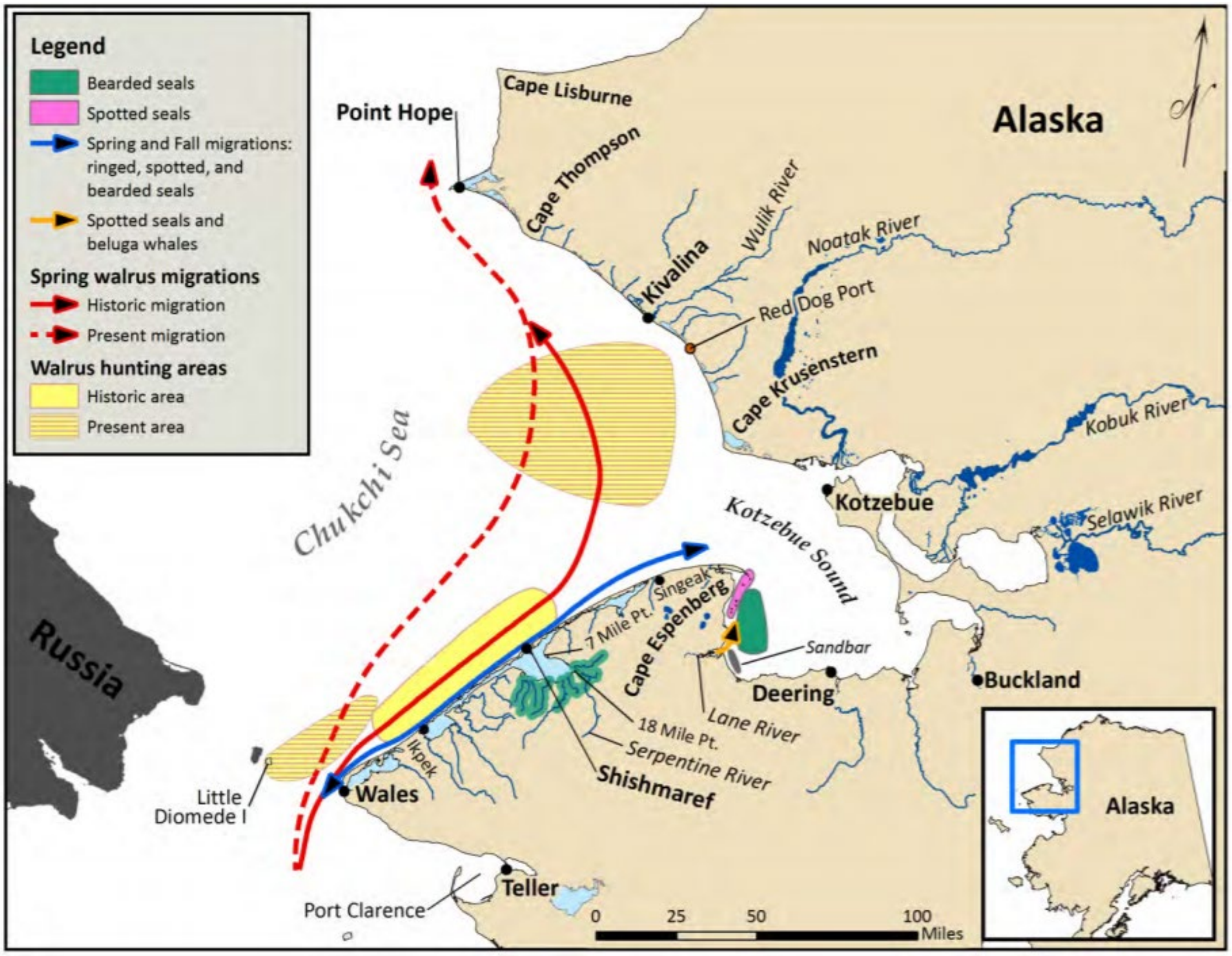
Walrus hunting was an opportunity for the elders to pass on their traditional values across generations. Young men had to earn the respect of the senior hunters and the right to lead hunts themselves by demonstrating their knowledge of the rules. Hunting was a highly organized activity since it was essential 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, 2010).

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[11] 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-a). 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 the summer, hunters may only travel 8-16 km (5-10 mi) out and in the 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-a)[12]. 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 3.10-4** shows the historical and present-day walrus hunting areas in Northwestern Alaska in the Chukchi Sea.

[11] The co-management agreement between USFWS and EWC covers the Pacific walrus hunting practices of the St. Lawrence Island Yupik, Central Yupik, and Iñupiat 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.

[12] 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 3.10-4. 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, 2014a). The annual harvest in Alaska is monitored by the USFWS.

3.10.1.1.9 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)[13] (USFWS, No Date-b). 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-c). Usually, hunters fly or boat to the hunting areas and use modern weapons such as rifles to hunt the otters (Vox, 2013; 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, 2014b). The mean reported annual subsistence harvest of sea otters between 2017 – 2021 from the Southwest stock was 176 animals/year. Annual sea otter harvest increased between 2015 and 2018 to a high of 379 sea otters, reflecting escalated hunting effort to increase the availability of sea otter hides to be sold (USFWS, 2023a). For the Southcentral stock, total annual subsistence harvest removals averaged 388 sea otters/year over this same 5-year period (USFWS, 2023b). Total annual subsistence harvest removals averaged 851 sea otters/year from 2017 – 2021 for the Southeast stock (USFWS, 2023c).

3.10.1.1.10 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 bears 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-e).

The polar bear is designated as threatened under ESA. Two stocks of polar bears occur in Alaska: the Southern Beaufort Sea stock and the Chukchi/Bering Seas stock (CBS). 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 Canadian Natives) signed an agreement to coordinate management of the Southern Beaufort Sea stock. The Inuvialuit- Iñupiat 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).

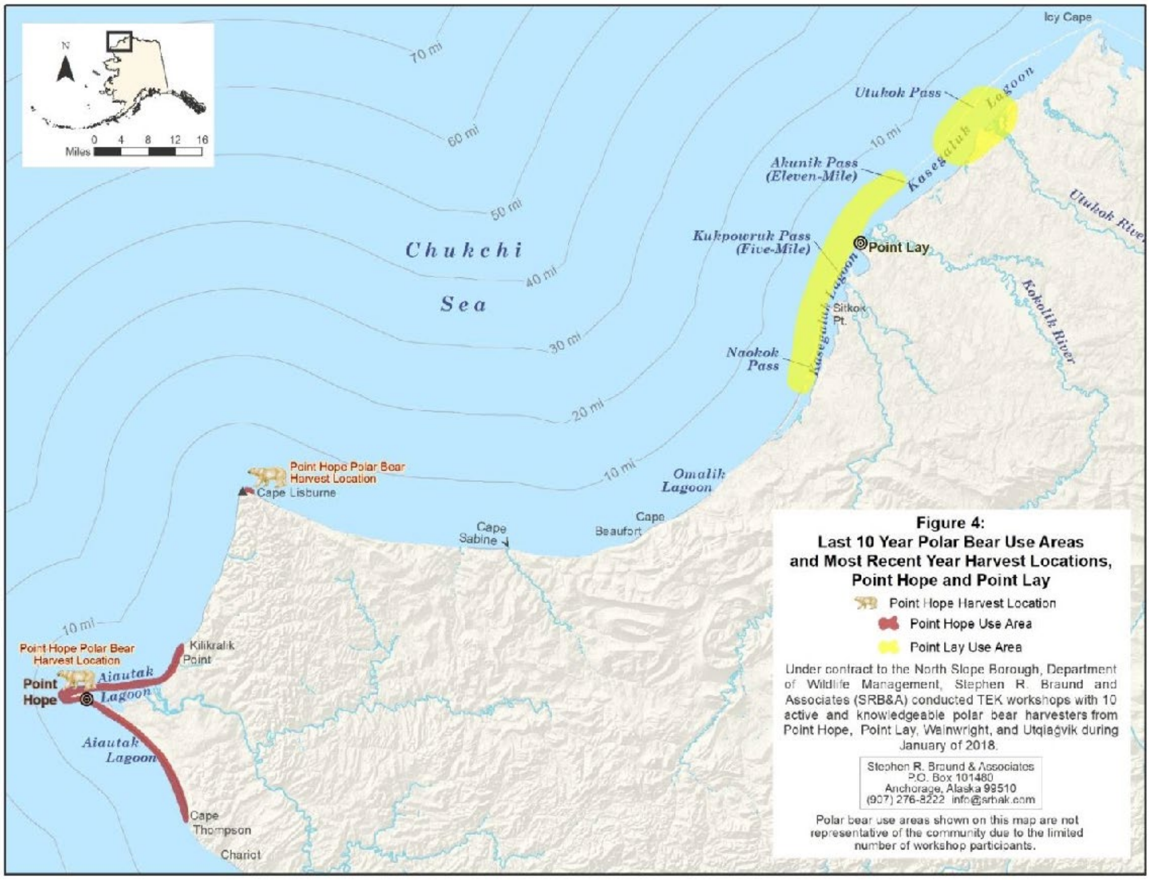
Figure 3.10-5 shows the Alaska Native communities that hunt the CBS stock of polar bears for subsistence use. The exact timing of polar bear hunting varies by village and depends on the community's social calendar and the timing of other subsistence activities. However, they are primarily hunted between November and April; hunters prefer to catch them in late fall and early winter because the bears are healthier at that time (Voorhees et al., 2014). In general, hunting areas are confined to locations 5-8 km

[13] 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-b).

(3-5 mi) offshore along the ice leads and areas with barrier islands, as shown in **Figure 3.10-6** for Point Lay and Point Hope hunting communities (Braund et al., 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 3.10-5. Alaska Native Communities Engaged in Polar Bear Subsistence Hunting



Source: NBS, 2018

Figure 3.10-6. Polar Bear Hunting Areas for the CBS Stock in Point Hope and Point Lay Communities

Table 3.10-1 summarizes the subsistence hunting information related to each of the species of marine mammals described in this section.

Table 3.10-1. 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 Savoonga may harvest whales during the winter (December and January) as well.	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 was 100 (67 + 33).
Beluga Whale	Beaufort Sea, Bristol Bay, eastern Bering Sea, and eastern Chukchi Sea stocks: Alaska Native across six 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,	Spring, summer, and autumn are open water periods.	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 Michael, Stebbins, Unalakleet. Yukon Delta: Alakanuk, Emmonak, Hooper Bay, Kotlik, Mountain Village, Nunam Iqua, Pilot Station, Pitka's Point, 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

Species	Communities Engaged in Subsistence Hunting	Hunting Season	Hunting Areas	Harvest limits
				harvest up to 150 male young annually. Up to 3 mortalities of female fur seals are authorized each year for subsistence reasons.
Steller Sea Lion	Aleut hunters in the Aieutian 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.
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	No harvest limits.

Species	Communities Engaged in Subsistence Hunting	Hunting Season	Hunting Areas	Harvest limits
			and Saint Lawrence Islands.	
Northern Sea otter	Tlingit and Haida people inhabiting southeastern Alaska.	Year-round; peak hunting season commonly occurs during fall.	The 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, Shishmaref, 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, 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,	Year-round, although the prime hunting season is in the spring (mid-April to early June). September 10 – October 20 for subsistence hunting at Round Island.	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 private lands may have hunting or access restrictions Round Island waters and beaches within 5 km (3 mi) of Round Island.	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 for subsistence purposes. Round Island set a harvest limit of 20 walruses (including struck and lost animals).

Species	Communities Engaged in Subsistence Hunting	Hunting Season	Hunting Areas	Harvest limits
	Clark's Point, Ekuk, Ekwok, and New Stuyahok.			

3.10.1.2 Subsistence Fishing

For numerous communities with EJ concerns 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-c). As mentioned in Section 3.10, the U.S. government has a trust responsibility toward American Indian tribes and Alaska Natives to protect the rights of these communities to exercise sovereign power over their members and territories. This extends to activities such as subsistence, cultural, and recreational fishing undertaken by tribal and Native Alaskan communities in their respective territories.

This section provides a description of some of the important fish species used for subsistence purposes by Alaska Natives, indigenous tribes, and other communities with EJ concerns; the cultural importance of these species; the common fishing practices and methods; and the established fishing seasons and areas, as applicable.

3.10.1.2.1 Pacific Salmon (*Oncorhynchus*)

Salmon[14] 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 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 former governor of Alaska, Bill Walker, 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). 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, 2021).

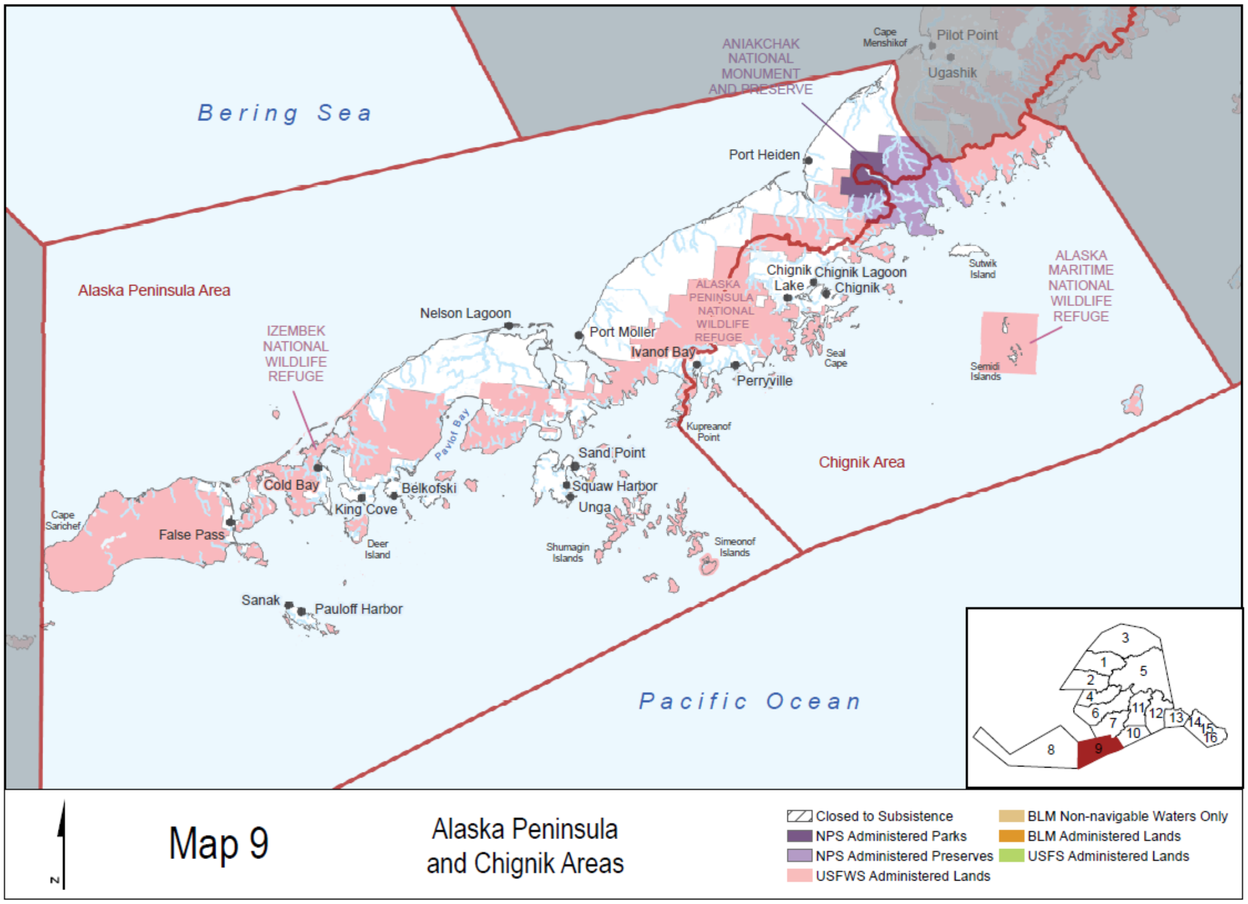
[14] The section provides a combined narrative for all five species of Pacific salmon hunted for subsistence, namely Chinook (king), Chum (dog), Coho (silver), Pink (humpback), and Sockeye (red).

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; NPS; BLM; BIA; and USFS. 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[15] 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 3.10-7**). 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, Pacific Fishery Management Council (PFMC) is the central fishery management authority (PFMC, No Date-b). 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-c). 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).

[15] 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 3.10-7. Subsistence Fishing in Alaska Peninsula and Chignik Areas

3.10.1.2.2 Pacific Halibut (*Hippoglossus stenolepis)*

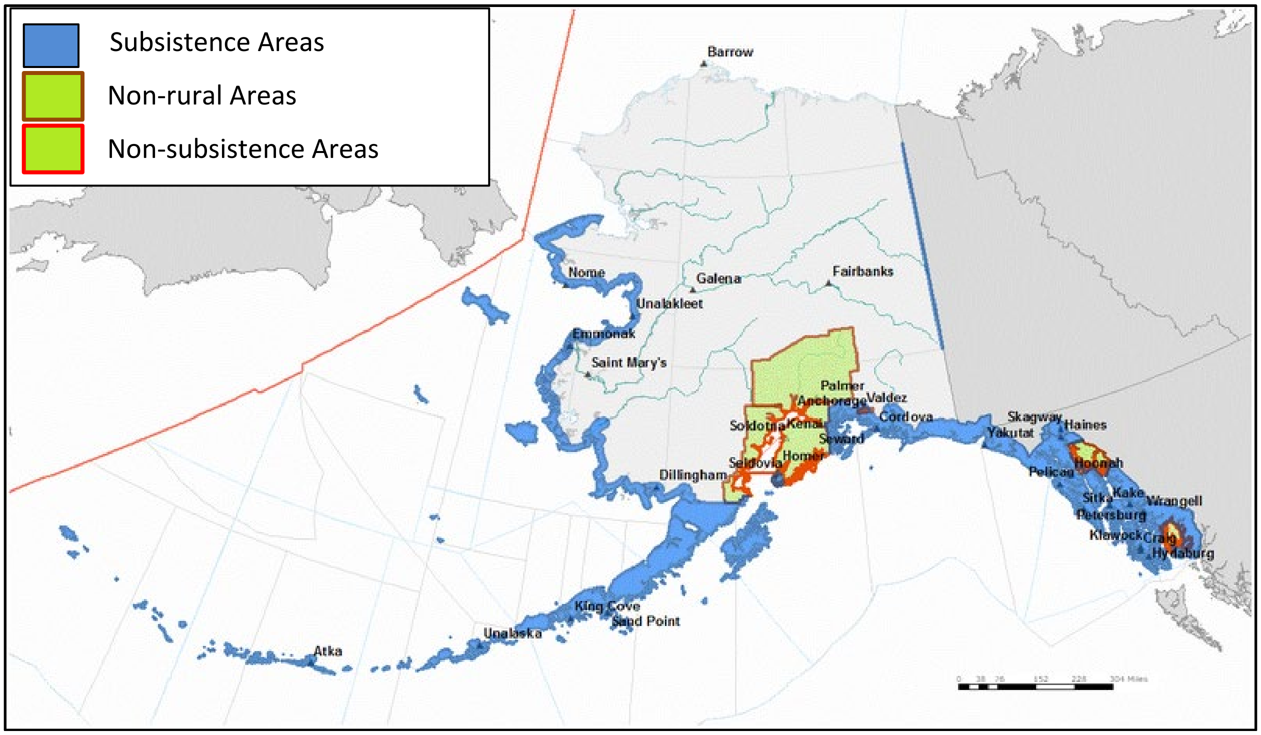
Halibut are mythologically important to many tribes in the Pacific Northwest. It is used as a clan crest in some Northwest Coast tribes and can sometimes be found carved on totem poles and potlatch dishes. The creation myths of some Kwakiutl tribes hold that their first ancestors were transformed from a halibut into a man. The halibut is a symbol of prosperity for the Haida people. Some Native Alaskan fishermen make special offerings of the first halibut they catch each season (NLA, No Date).

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, 2017).

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, 2015c). These regulations are intended to enhance the conservation of Pacific halibut and further the goals and objectives of the PFMC and the Northern Pacific Fishery Management Council (NPMFC). 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). 13 western Washington tribes[16] 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). The IPHC apportions annual catch limits for the Pacific halibut fishery among regulatory areas: Area 2A (Oregon, Washington, and California); Area 2B (British Columbia); Area 2C (Southeast Alaska); Area 3A (Central Gulf of Alaska); Area 3B (Western GOA); and Area 4 (which is further divided into 5 areas, 4A through 4E, in the Bering Sea and Aleutian Islands of Western Alaska). Subsistence and sport halibut fishery regulations for Alaska are codified at 50 CFR Part 300. Catch sharing plans are implemented annually across the regulatory areas to allocate the halibut catch limits and seasons in each area (88 FR 14066, February 8, 2023).

Before fishing under the subsistence halibut regulations in Alaska, 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-d). **Figure 3.10-8** shows a map of subsistence halibut fishing areas around Alaska.

[16] 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).



Source: NMFS, No Date-e

Figure 3.10-8. Halibut Subsistence Fishing Areas

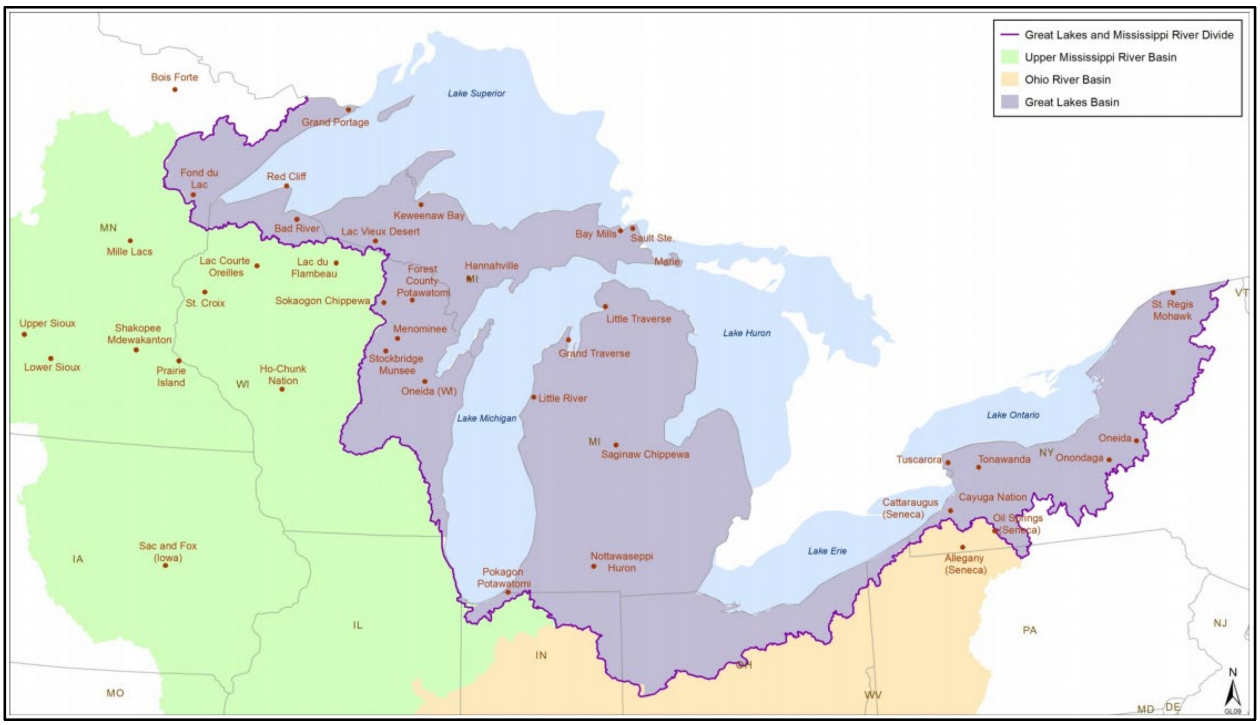
Table 3.10-2 summarizes the subsistence fishing information related to salmon and halibut described in Sections 3.10.1.2.1 and 3.10.1.2.2.

Table 3.10-2. 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.

3.10.1.2.3 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 rights to hunt, fish, and gather under several treaties signed with the federal government (referred to as "treaty tribes")[17] and continue subsistence harvesting in the Great Lakes and Upper Mississippi River Basins (see **Figure 3.10-9**). 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 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 3.10-9. Federally Recognized Tribes in and Around the Great Lakes Basin

[17] 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).

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 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 3.10-3** provides an overview of the species of fish harvested and the fishing methodologies employed by the tribes regulated by CORA and GLIFWC.

Table 3.10-3. 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		

Regulatory Authority	Member Tribes	Fish Species Harvested	Harvest Limits
	Fond du Lac Band of Lake Superior Chippewa Indians		

Source: USACE, 2012b

*Table 3.10-3 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 bluegill 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, 2002b).

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, 2012c). 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, 2002b). 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, 2012c).

Hawaiian fishing communities are also dependent on or engaged in recreational, subsistence, and traditional fishing practices. Fish species such as blue marlin, mahimahi, goatfishes, trevallies 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 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).

3.10.2 Environmental Consequences

This section discusses potential impacts of the activities associated with Alternatives A, B, and C on Alaska Natives, indigenous tribes in Hawaii, Pacific Islands, and the continental U.S., and other communities with

EJ concerns who hunt marine mammals and/or fish primarily for their subsistence, as well as for cultural, economic, ceremonial, and recreational purposes.

The operational activities described in Table 2.1-1 and in Section 2.2 could be expected to have impacts on marine mammals and fish hunted for subsistence or other purposes described in the affected environment section in the action area. These activities include vessel movement; anchoring; waste handling and discharges; active acoustic systems operations; operation of other sensors and data collection systems; UMS operations; UAS operations; and small boat systems operations. Potential impacts on marine mammals and fish are discussed in Section 3.7 (Biological Resources) and are referenced throughout this section as they relate to the ability of communities with EJ concerns to hunt or fish for subsistence or other purposes.

OMAO operations may also indirectly benefit communities with EJ concerns with the availability of new ocean data such as updated nautical charts, fisheries stock assessments, and accurate weather forecasts. Economic benefits are discussed in Section 3.9 (Socioeconomic Resources). The associated potential benefits to communities with EJ concerns are discussed below.

As such, communities with EJ concerns would not be impacted by vessel transits and operations beyond the U.S. EEZ since hunting/fishing areas designated for subsistence and other socio-cultural purposes do not extend beyond the U.S. EEZ. Impacts from vessel repair and maintenance; and OTS handling, crane, davit, and winch operations would not occur and are not discussed further in this section.

Section 3.2.2 describes the significance criteria for the resources analyzed in this Draft PEA and provides a structured framework for assessing impacts from the alternatives. The subsequent sections describe potential impacts to communities with EJ concerns from Alternatives A, B, and C in terms of context, duration, likelihood, and intensity; and whether impacts are significant or insignificant overall.

3.10.2.1 Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Under Alternative A, OMAO vessel operations using the existing NOAA fleet would continue across all five operational areas over the 15-year period. Additionally, OMAO is constructing two oceanographic research vessels that are expected to come on-line by 2025 and two new charting and mapping vessels that are expected to come online in 2027 and 2028 for a total of four new ships under Alternative A. OMAO would provide a maximum annual capacity of 3,568 operational DAS for scientific projects.

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 communities with EJ concerns that engage in subsistence fishing in these regions. Since subsistence hunting and fishing in the Greater Atlantic and Southeast regions are not well documented, the scope of potential impacts from projects in these regions is limited.

Impacts of Alternative A are discussed by impact causing factors for marine mammals and fish species harvested for subsistence by communities with EJ concerns, which include (1) increased ambient sound levels (e.g., from vessel movement, active acoustic systems, UMS, UAS, and small boat systems); (2) vessel strike and movement of equipment in the water (i.e., visual and physical disturbance of and risk of collisions with marine mammals); (3) accidental leakage or spillage of oil, fuel, and chemicals into surrounding waters (i.e., from vessel operations); (4) entanglement with equipment and marine trash/debris and potential for ingestion; and (5) availability of updated ocean data. These potential impact causing factors and their associated effects on communities with EJ concerns are discussed below.

3.10.2.1.1 Increased Ambient Sound Levels

Section 3.7.2.1 details the adverse impacts of noise from vessel movement, active acoustic systems operations, ROVs and uncrewed marine and aircraft systems operations, and small boat systems operations on cetaceans (i.e., bowhead, gray, beluga whales), pinnipeds (i.e., seals and walruses), fissipeds (i.e., sea otters and polar bears), and fish. Cetaceans, pinnipeds, fissipeds, and fish species important to the subsistence of Alaska Natives would primarily be subject to behavioral disruption exposures. 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, avoidance behaviors, disruptions in breeding, nursing, and migration, as well as displacement from preferred or critical habitat.

Increased ambient sound levels could cause behavioral disturbance in at least some animals, adversely affecting subsistence activities. Species' movements could 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 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 communities with EJ concerns. Hunting/fishing crews could be required to travel greater distances from shore to newer hunting areas, which could lead to increased expenditure on gas, additional travel time, and potential increased risk to crews from adverse weather, depending on 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, 2016). However, displaced species are expected to return to their preferred habitats and resume normal activities once the vessel leaves the area. Vessel sound is already so prevalent (and is commonly considered a usual source of ambient underwater sound) that any additional sound from the NOAA fleet is not expected to cause anything more than possible localized and temporary or short-term behavioral changes (see Section 3.5, Acoustic Environment). Impacts from low-frequency underwater sound generated by vessel operations such as performance and acceptance testing, calibrating, training, and troubleshooting of active acoustic systems, ROVs, UMS, and small boats, as well as other equipment that may generate underwater sound, would be similar to those of surface vessels but with less intensity due to their smaller size and the far fewer expected instances of operation over the 15-year period across all operational areas.

Since cetaceans, certain pinnipeds, and fish species are less responsive to UAS in comparison to vessels in water, the sound emitted by UAS 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 primarily impact those pinnipeds and fissipeds that spend a greater amount of time resting on the sea surface or at haulout locations. Walruses, for example, are extremely sensitive to visual and sound disturbances when at haulouts and a flight response by one animal can trigger mass exodus to water, potentially causing stampedes and injuries. Similarly, aircraft presence and sound could disturb polar bears and sea otters resting on ice or haulouts and cause them to temporarily abandon their habitats. In such situations, subsistence hunters may face additional challenges in capturing and harvesting pinnipeds and fissipeds, as described above. However, potential adverse impacts from UAS would be minimal considering the relatively low level of aircraft activity that would occur along with the short duration of exposure to sound and visual disturbance and would most likely not elicit anything other than minimal disturbance reactions in pinnipeds and fissipeds. OMAO would operate UAS at distances from animals to avoid outside interference and associated impacts to the extent possible.

The intensity of the impacts would depend on the degree of overlap between the hunting season and the activities, with greater adverse impacts on communities with EJ concerns that rely on species with restricted hunting seasons. OMAO operations and whaling seasons are bound to overlap due to safety and weather considerations, therefore it would not be practicable for OMAO to avoid vessel operations during all subsistence hunting seasons. Increased hunting time coupled with restrictions on hunting seasons could potentially decrease harvest numbers, though this would be minimized since OMAO sends project notifications to tribes months before they are scheduled to transit tribal hunting/fishing areas and provide frequent location updates to the tribes to minimize overlap. Vessel operations occurring in the spring/summer months in Alaska could impact 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. 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 whales 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 whales 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, 2023). However, these communities do not rely solely 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 harvested by the residents of northern and western Alaskan villages (BOEM, 2018a).

Most communities with EJ concerns across all five geographic regions rely on the harvest of fish for subsistence purposes. Similarly, many communities with EJ concerns, 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 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 3.10.1, 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).

OMAO's operations do not commonly take place in areas designated as fishing or hunting grounds that require consultation. OMAO communicates its plans, as needed through designated NOAA representatives to Alaska Native, Pacific Northwest, and other indigenous tribal communities through outreach letters and/or at established meetings. OMAO 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 OMAO plans for vessel operations that overlap areas designated as fishing or hunting grounds. OMAO would attend meetings to provide a platform for Alaska Native, Pacific Northwest, and other indigenous tribal communities to voice any of their thoughts or concerns, particularly those pertaining to treaty or subsistence hunting and fishing activities. OMAO would work closely with tribal or subsistence communities to ensure concerns related to vessel operations in areas designated as fishing or hunting grounds for ceremonial or subsistence species, especially during crucial fishing or hunting seasons, are addressed as appropriate. OMAO would attempt to coordinate vessel operations occurring 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. Through this communication strategy, OMAO 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. Considering that the proposed number of vessels associated with OMAO operations within the EEZ is very low as compared with all other shipping and vessel traffic, and the assumption that individuals or groups of subsistence species may be familiar with various and common vessel-related sounds, particularly within frequented shipping lanes, as described in Section 3.5, Acoustic Environment and Section 3.7, Biological Resources, the effects of vessel sound on communities with EJ concerns under Alternative A would be **adverse** and **minor**. Displacement of subsistence species from preferred hunting or fishing habitat would likely be **temporary** or **short-term** and would be limited to the areas immediately surrounding OMAO operations, causing impacts to be **regional** in extent. As the NOAA ships reach the end of their service life and are retired from the fleet, OMAO would not utilize the fleet at its current levels and the impacts to communities with EJ concerns are expected to reduce in intensity over the 15-year timeframe. 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 be **insignificant**.

3.10.2.1.2 Vessel Strikes and Movement of Equipment

As described above, increased ambient sound levels from vessel movement (as well as active acoustic system operations, ROVs and uncrewed marine and aircraft systems operations, and small boat systems operations) would primarily cause behavioral disturbance in at least some animals that would adversely affect subsistence activities. In addition, the potential of marine mammal vessel strikes could result in mortality and reduce the available harvest numbers. Movement of equipment could cause turbulence to the water column and disturb the seafloor.

Data collection equipment such as CTDs, bottom grab samplers, and drop/towed cameras, are lowered and raised through the water column. Likewise for anchoring operations, where one or two anchors are lowered from the ship into the ocean through the water column. This movement of equipment through the water could temporarily disturb and displace nearby marine mammals and fish species. Additionally, deploying bottom grab samplers has the potential to create localized turbidity and affect soft-bottom seafloor habitat of certain fish species, causing them to swim away from their habitat. In the event that the species stray too far away from their usual hunting/fishing grounds, there would be adverse impacts to the subsistence communities from increased travel time, and additional expenditure on gas (as discussed above under Increased Ambient Sound Levels). However, these impacts would be temporary as disturbed individuals are expected to return once water column turbulence and seafloor disturbances cease.

Mortality of subsistence species as a result of a 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 extremely unlikely because of several factors: relatively low vessel speeds and visual observation during all vessel operations would avoid vessel strikes with all marine mammal species. Impacts to harvest numbers of subsistence species are therefore not anticipated. The intensity and likelihood of impacts from vessel strikes would vary based on factors such as vessel speed, size, location, frequency, and pattern of travel, as well as the timing of the activities. Since most vessel operations in the Alaska Region would occur in spring/summer/fall seasons, impacts would be greater on the communities engaged in subsistence hunting/fishing activities during this period. 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.

Since the likelihood of a vessel strike and impacts from water turbulence and seafloor disturbance would be very low, overall effects on communities with EJ concerns under Alternative A would be **adverse** and **minor**. The presence of vessels and equipment is expected to cause only **temporary** or **short-term** disturbances and would be limited to the areas immediately surrounding OMAO operations, causing impacts to be **regional** in extent. As the NOAA ships reach the end of their service life and are retired from the fleet, the impacts to communities with EJ concerns would be expected to reduce in intensity over the 15-year timeframe. Since vessel operations would be dispersed across five geographic regions over a period of 15 years, adverse effects would continue to be **insignificant**.

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

An accidental event could result in the release of oil, fuel, or chemicals by a NOAA vessel from tank overflow during fueling operations, fuel transfer operations, pipe leaks due to structural failure, accidental spills of hazardous chemicals used for vessel and equipment repair and maintenance, or unintentional discharge of sewage, bilge water, or ballast water into the surrounding environment. In the case of an accidental event, 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. Impacts would be greater if accidental leakages/spills or discharges occurred within or adjacent to hunting areas, or if they adversely impacted prey species. 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, the effects of an accidental event would be **adverse** and **minor** due to the low likelihood of occurrence, as a result of the OMAO policies and procedures NOAA ships must abide by to prevent accidental spills (see Section 3.4, Water Quality). OMAO would follow appropriate policy and guidance to manage accidental spills, minimizing adverse impacts on subsistence hunting and fishing. Impacts would be **temporary** or **short-term** and **regional** in extent. If impacts to public health occur, they could be **long-**

term or **permanent**. 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**.

3.10.2.1.4 Entanglement with Equipment and Marine Trash/Debris and Ingestion

Both entanglement and ingestion could potentially reduce the available harvest numbers of marine mammals. While an entangled animal is easier to capture during subsistence hunting, it is more likely that the entanglement will cause mortality. 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-a). However, the tendency of pinnipeds to generally avoid approaching vessels (in contrast with their tendency to congregate around fishing vessels) presumably reduces the risk of entanglement. During OMAO operations, cables, lines, and other objects could be towed behind the NOAA 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 pinnipeds could get entangled, the likelihood of this occurring would be low. 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 NOAA vessels producing debris in which they could become entangled is low, as a result of the OMAO policies and procedures NOAA ships must abide by to prevent ships from producing debris (see Section 3.4, Water Quality).

Adverse impacts could result from the ingestion of trash or debris by individuals. 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). 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.

Since the likelihood of subsistence species entangling with equipment and ingesting marine trash and debris would be very low, overall effects on communities with EJ concerns under Alternative A would be **adverse** and **minor**. Management, storage, and disposal of solid waste generated during OMAO's operations would be conducted in accordance with established plans, guidelines, and MARPOL regulations. 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 entanglement with or ingestion of equipment parts and marine trash and debris. If impacts to public health occur, they could be **long-term** or **permanent** and **regional** in extent. Overall, impacts to subsistence hunting/fishing activities resulting from entanglement with and ingestion of equipment parts and marine trash and debris would be minimal, and adverse effects are expected to be **insignificant**.

3.10.2.1.5 Availability of Ocean Data Acquired by the NOAA Fleet

OMAO's operations enable the collection of a wide variety of atmospheric, fisheries, hydrographic, and oceanographic data that is used by communities with EJ concerns for the harvest of cetaceans, pinnipeds, fissipeds, and fish species. For example, hydrographic surveys conducted by NOAA's LOs 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-h). 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 or rising sea level events that affect local communities, and identification of the location of historic wrecks (NOAA, 2018c). As such, OMAO's operations would have indirect, **minor**, **beneficial** impacts to communities with EJ concerns from the availability of ocean surveying and mapping data.

3.10.2.1.6 Conclusion

The overall impact of Alternative A on subsistence hunting and fishing, the local economy, and the culture of communities with EJ concerns would be **adverse** and **minor**. The duration of impacts may range from **temporary** to **permanent**, and would be **regional** in extent. The ocean-related data and products indirectly generated by Alternative A would yield **beneficial** effects for communities with EJ concerns. As such, overall impacts of Alternative A on environmental justice would be **insignificant**.

3.10.2.2 Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

As under Alternative A, impacts of Alternative B are considered for the same impact causing factors for communities with EJ concerns. OMAO operations under Alternative B would take place in the same operational areas and timeframes as under Alternative A; however, under Alternative B, OMAO would acquire up to eight new ships (four as in Alternative A, plus up to four additional ships) to replace vessels that would reach the end of their design service life, extend the service life of existing ships through maintenance and mid-life repairs for six ships, increase fleet utilization with up to 4,138 DAS (approximately 570 more DAS annually than under Alternative A), and integrate newer technology as described in Section 2.4. 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 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 communities with EJ concerns that engage in subsistence fishing activities.

As discussed in Sections 3.7.2.2, vessel operations for an additional 570 DAS per year would contribute to greater impacts on marine mammals and fish species related to vessel and equipment sound, vessel presence and movement, accidental spills, and trash and debris across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under

Alternative B as compared to Alternative A; for example, improvements to mechanical control systems on new ships could decrease the production of underwater sound and related impacts on marine mammals and their prey. However, the increased or decreased impacts would not be so great as to appreciably change the intensity of a particular impact causing factor (e.g., from minor to moderate, or from minor to negligible). Consequently, for these four 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 four impact causing factors under Alternative B would be the same or slightly, but not appreciably, greater than those discussed under Alternative A. Thus, the corresponding impacts of Alternative B on communities with EJ concerns 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 four impact causing factors.

The overall impact of Alternative B on communities with EJ concerns would be **adverse**, **minor**, **temporary** to **permanent**, and **regional**. The ocean surveying and mapping data generated by Alternative B would yield slightly greater **beneficial** effects for communities with EJ concerns than would occur under Alternative A. Thus, impacts of Alternative B would be **insignificant**.

3.10.2.3 Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

As under Alternatives A and B, impacts of Alternative C are considered for the same impact causing factors for communities with EJ concerns. OMAO operations under Alternative C would take place in the same operational areas and timeframes as under Alternative A; however, Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B, with additional measures including, acquisition of two additional new ships, increasing the number and use of uncrewed systems integrated into vessels to increase the DAS by 735 beyond Alternative B levels, shortening the timeframe of fleet improvement activities, extending the service life of aging NOAA ships, greening the existing fleet over a shortened timeframe, expediting improvements to the OMAO small boat fleet, and purchasing/developing technology to enable efficient scheduling of assets as discussed in Section 2.5.

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 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 communities with EJ concerns that engage in subsistence fishing activities.

As discussed in Sections 3.7.2.3, vessel operations for an additional 735 DAS per year would contribute to greater impacts on marine mammals and fish species related to vessel and equipment sound, vessel presence and movement, accidental spills, and trash and debris across all five operational areas. Integration of new technology could provide beneficial effects and potentially reduce some impacts under

Alternative C as compared to Alternative A; for example, improvements to mechanical control systems on new ships could decrease the production of underwater sound and related impacts on marine mammals and their prey. However, the increased or decreased impacts would not be so great as to appreciably change the intensity of a particular impact causing factor (e.g., from minor to moderate, or from minor to negligible). Consequently, for these four factors, the impacts of Alternative C on Alaska Natives primarily engaged in subsistence hunting of marine mammals (most of which fish for subsistence as well), would be the same, or slightly greater as compared to Alternatives A and B. For fish species, the effects of all four impact causing factors under Alternative C 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 communities with EJ concerns 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 Alternatives A and B for all four impact causing factors.

The overall impact of Alternative C on communities with EJ concerns would be **adverse**, **minor**, **temporary** to **permanent**, and **regional**. The ocean surveying and mapping data generated by Alternative C would yield slightly greater **beneficial** effects for communities with EJ concerns than would occur under Alternatives A and B. Thus, impacts of Alternative C would be **insignificant**.

3.11 Hazardous, Universal, and Special Waste

This section describes the affected environment for hazardous, universal, and special waste and assesses OMAO vessel operations as they pertain to the generation, storage, handling, transfer, and disposal of these wastes. Other types of non-hazardous solid waste are discussed in Section 3.4 Water Quality. The area of analysis for hazardous, universal, and special waste is onboard the NOAA fleet.

3.11.1 Affected Environment

Hazardous waste has properties that make it dangerous or capable of having a harmful effect on human health or the environment. Hazardous waste is generated from many sources, from industrial manufacturing process wastes to batteries from electronic devices, and may come in many forms, including solids, liquids, gases, and sludges. The EPA has developed regulations for hazardous waste management to protect human health and the environment. These regulations aim to foster environmentally sound recycling and conservation practices, facilitate understanding of the rules leading to better compliance, and provide flexibility in how certain hazardous wastes are managed (EPA, 2022d).

Routine OMAO vessel operations, including vessel movements, waste handling and discharges, and vessel repair and maintenance could generate waste that may pose a risk to human health and the environment if not managed properly. Some of these wastes could be considered potentially hazardous, such as paint-related materials, corrosive and caustic substances, compressed gas canisters, flares, and smoke signals, while other wastes could be considered universal or special waste depending on their composition. OMAO properly stows all potentially hazardous waste onboard its vessels, identifies hazardous, special, and universal waste once the waste is transferred to a NOAA shoreside support facility, and properly transfers or disposes of all hazardous, universal, or special waste onshore.

This section explains the regulatory framework for hazardous, universal, and special waste as it applies to OMAO vessel operations, the types of potentially hazardous, universal, and special waste generated onboard NOAA ships, and a description of OMAO's Hazardous, Universal, and Special Waste Management Plan, along with other policies, documents, and procedures that demonstrate OMAO's compliance with federal regulations. Solid waste is also discussed in other sections of this Draft PEA as it relates to other aspects of the environment such as water quality and air quality.

3.11.1.1 Regulatory Framework

This section discusses the hazardous, universal, and special waste regulatory framework as it applies to NOAA ships. Pollution streams generated from NOAA ships fall into one of the six Annexes of the MARPOL 73/78 protocol and are subject to applicable U.S. regulations, which are discussed in Sections 3.3 and 3.4 of this Draft PEA. Hazardous, universal, and special waste are federally regulated under the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). These laws manage the generation, storage and handling, and disposal of these wastes, in addition to the required response in the event of a release above the regulatory threshold.

3.11.1.1.1 Resource Conservation and Recovery Act

In 1976, Congress passed RCRA, which allowed EPA to establish a framework for the proper management of hazardous waste (EPA, 2022d). RCRA regulations require the generator of waste to identify if that waste is hazardous using the criteria provided in 40 CFR Part 261, Subparts C and D. RCRA regulations (40 CFR Part 273) also specify that a number of hazardous wastes may be treated as universal waste, including batteries, lamps, mercury-containing thermometers, and aerosol cans (EPA, 2008). Special waste pose less of a risk to human health and the environment compared to hazardous waste, and therefore, are not defined as hazardous waste under RCRA. Categories of special waste could include crude oil and natural gas waste, fossil fuel combustion waste, or mining and mineral processing waste (EPA, 2022e). Once waste has been identified as hazardous, the generator must comply with federal regulations regarding its labeling, storage, handling, and management. Hazardous waste generators are regulated based on the amount of hazardous waste produced each month and divided into three categories: large quantity generators (LQGs), small quantity generators (SQGs), and very small quantity generators (VSQGs) (Cornell Law School, No Date-c). Once hazardous waste is ready to be treated, stored, or disposed, it can be transferred to a hazardous waste transporter that delivers the waste to its final destination. Transporters must comply with the EPA’s Hazardous Waste Manifest System, which is designed to track hazardous waste from the time it leaves the generator facility where it is produced, until it reaches the off-site waste management facility that will store, treat, or dispose of the hazardous waste (EPA, 2023h).

3.11.1.1.2 Comprehensive Environmental Response, Compensation, and Liability Act

In the event of a hazardous waste release that is above the regulatory threshold, CERCLA requires that any person in charge of a vessel, an offshore facility, or an onshore facility shall, as soon as they gain knowledge of any release, immediately notify the National Response Center (NRC). The NRC conveys the notification expeditiously to all appropriate government agencies. The only exception is if the hazardous substance is issued via a federally permitted release (EPA, 2008). A transporter must clean up a hazardous waste discharge so that the discharge no longer presents a hazard to human health or the environment (EPA, 2023h).

3.11.1.2 OMAO Hazardous, Universal, and Special Waste Environmental Compliance

OMAO maintains policies, procedures, instructions, and other relevant information that pertain to the Hazardous, Universal, and Special Waste Management Plan within the DMS, as discussed in Sections 3.3 and 3.4.

42 U.S. Code § 6939d provides specific regulatory guidance regarding hazardous waste generated aboard public vessels, such as NOAA ships. It stipulates that any hazardous waste generated on a public vessel shall not be subjected to the storage, manifest, inspection, or recordkeeping requirements until such waste is transferred to a shore facility (Cornell Law School, No Date-b). As such, OMAO manages any potentially hazardous waste onboard according to OMAO Procedure 'Hazardous, Universal, and Special Waste Management' in order to prevent or minimize any impacts to human health or the environment. This procedure establishes the template SSI for the onboard storage of wastes, transfer and storage of wastes at shoreside facilities, and disposal of wastes. This procedure applies to all ships in the NOAA fleet and any NOAA shoreside support facility receiving hazardous, universal, or special wastes for disposal (OMAO, 2021c). Supplemental policies and procedures are introduced below and discussed as they apply.

3.11.1.2.1 Identifying Hazardous, Universal, and Special Waste

In order to comply with federal regulations, OMAO identifies hazardous waste, universal waste, and special waste when the waste is transferred to a NOAA shoreside support facility. Prior to this transfer, NOAA ships are exempt from the storage, manifest, inspection, or recordkeeping requirements of hazardous waste. NOAA ships continue to properly store and manage potentially hazardous, universal, and special waste via OMAO procedures and policies to prevent or minimize impacts to human health or the environment.

Once hazardous waste is transferred from NOAA ships to NOAA shoreside support facilities, the facility classifies the hazardous waste and assumes responsibility for waste handling and management. All NOAA shoreside support facilities maintain VSQG status with regard to hazardous waste generation. This means that no site may generate more than 100 kg (220 lb. or approximately 22 gallons) of hazardous waste per calendar month or store more than 1,000 kg (2,200 pounds or approximately 220 gallons) at any time (OMAO, 2021c). NOAA ships must maintain communications with NOAA shoreside support facilities to ensure that the facility does not exceed 22 gallons of hazardous waste each month. Universal waste must be disposed of within one year of its transfer to a support facility. Most special wastes have no storage or time limitations and must only be disposed of as needed to maintain a safe and clean storage area. Solvent-contaminated wipes must be disposed of at least every 180 days (OMAO, 2021c).

OMAO identifies hazardous wastes via 40 CFR Part 261 by the four hazardous characteristics (ignitability, corrosivity, reactivity, or toxicity) and by the EPA's specific hazardous waste lists (F, K, U, and P). NOAA ships may generate F wastes (toluene, chlorinated solvents, and methyl ethyl ketone) and U wastes (various flammable solvents). Other examples of hazardous waste streams generated aboard NOAA ships include paint related materials, corrosive and caustic wastes, compressed gas canisters, and pyrotechnics. OMAO identifies universal wastes as wastes generated in a wide variety of settings (not solely industrial), generated by a vast community, and present in significant volumes in nonhazardous management systems. Examples of universal waste streams generated aboard NOAA ships include aerosol cans, spent batteries (including lithium batteries), spent lamps and bulbs, and mercury-containing thermometers and thermostats. OMAO identifies special wastes as wastes that do not fall under the definition of hazardous or universal but are regulated and must be handled accordingly. Examples of special wastes generated aboard NOAA ships include oily rags and absorbents, solvent-contaminated rags, fuel and oil filters, waste or used oil, nonflammable adhesives, grease, and lube, antifreeze, cooking oil, off-specification fuels (e.g., contaminated gasoline), bilge water, oily water, unidentified waste material, and empty containers (OMAO, 2021c). While some of these wastes fall under the EPA's special waste category of fossil fuel combustion waste, most of these wastes differ in comparison to the EPA's categories of special waste under RCRA.

3.11.1.2.2 Storage and Handling of Hazardous, Universal, and Special Waste

Each NOAA ship must develop a Shipboard Storage and Transfer SSI. This document outlines the onboard storage instructions and transfer to shore instructions of every waste stream of every type of waste generated aboard a NOAA ship. It details how to handle, store, and label the waste, where to store the waste, and what other considerations that should be noted based on that specific waste product. Each ship's SSI will be unique to their own capabilities and operations (OMAO, 2021d). OMAO Procedure 'Lithium Battery Safety Procedures' discusses the safety and handling procedures with regard to lithium batteries. Personnel who use or handle lithium batteries must be familiar with their properties, safety precautions and emergency response, handling and charging procedures, proper storage, transportation, and disposal requirements (OMAO, 2020d).

A Hazard Communication Plan is required for each NOAA ship via OMAO Procedure 'Marine Operations Hazard Communication', and may entail Site Specific Instructions as necessary. The OSHA Hazard Communication Standard (29 CFR §§ 1910.1200) states that employees have a fundamental right to know the hazards and identities of the chemicals they are exposed to while working, as well as the measures they can take to protect themselves. This plan provides the requirements for labeling, training, maintaining the Safety Data Sheet (SDS), and maintaining a chemical inventory, as well as making this information available to all personnel (OMAO, 2015).

3.11.1.2.3 Transfer and Disposal of Hazardous, Universal, and Special Waste

NOAA ships must follow their Shipboard Storage and Transfer SSI when the ship disposes its hazardous, universal, and special waste through a NOAA shoreside support facility. The ship's HAZWASTE person is in charge of the proper storage, handling, and transfer of these wastes to the support facility using a Waste Classification Form for each waste type (OMAO, 2021d). If a NOAA ship must dispose of its hazardous, universal, or special waste directly to a vendor when a visit to a NOAA shoreside support facility is not possible, the ship's HAZWASTE person must develop a Disposal SSI. This document outlines the handling and disposal of every waste stream of every type of hazardous, universal, or special waste generated aboard a NOAA ship when it is directly coordinating and transferring the waste to a hazardous waste transporter or disposal facility. It details how to handle, store, and label generated waste streams in preparation for disposal, and how to make the proper arrangements with a licensed waste transporter or disposal facility. It also details what records must be kept for each waste stream, and where those files must be located in OMAO's Hazardous Waste and Materials Binder. Recycling options are also listed as applicable (OMAO, 2021e). However, it is more common for NOAA ships to transfer these wastes to a NOAA shoreside support facility.

3.11.1.2.4 Visiting Scientists' Hazardous Materials Responsibilities

Visiting scientists and scientific parties from other NOAA LOs or other organizations may bring chemicals and other hazardous materials onboard in conjunction with their Project Instructions and mission requirements. OMAO Document 'Visiting Scientists' Chemicals and Related Hazardous Materials (Mission Hazmat)' outlines the procedure to address the requirements and responsibilities associated with visiting scientists' chemicals and other hazardous materials – referred to hereafter as 'mission hazmat'. Mission hazmat includes but is not limited to flammable substances (e.g., ethanol, acetone, hydrogen gas, gasoline, etc.), toxic substances (e.g., formaldehyde, mercuric chloride, etc.), acids and bases, cryogenic fluids, compressed gases, and lithium batteries. It is the responsibility of the Chief Scientist (CS) to ensure the scientific party's mission hazmat is handled safely and in accordance with OMAO's procedures. The CS and the scientific party must provide an initial inventory of mission hazmat, properly store and label mission hazmat, properly handle and use mission hazmat within laboratory areas, retain waste for shoreside disposal, and transfer or dispose of all mission hazmat in accordance with applicable regulations and procedures (OMAO, 2017c).

3.11.1.2.5 Management of Asbestos

OMAO Procedure 'Management of Asbestos' establishes a program to minimize exposure of employees to the hazards of asbestos. While asbestos is designated as a hazardous substance under CERCLA (40 CFR § 302.4), it is not listed as a hazardous waste under RCRA and is not subject to RCRA regulations. CERCLA designates asbestos as a hazardous substance when the material contains more than one percent asbestos and the material is friable, meaning it can easily crumble. An Asbestos Management Plan (AMP) and SSI are only required for NOAA Ships *Rainier*, *Fairweather*, and *Oregon II* because they have asbestos containing materials (ACM) on board. These ships were the only ones delivered in the late 1960's before asbestos regulations were passed in the U.S. in the 1970's. The plan includes but is not limited to proper labeling and tracking of ACM, routine awareness training, and restrictions governing contact with known ACM in order to remain below the OSHA Permissible Exposure Limit (PEL) (OMAO, 2020e). The EPA also regulates the airborne exposure of asbestos through the Asbestos National Emissions Standards for Hazardous Air Pollutants (NESHAP) (EPA, 2023g).

3.11.2 Environmental Consequences

The following sections identify and evaluate potential impacts from hazardous, universal, and special waste occurring in the action area under Alternatives A, B, and C.

Activities described in **Table 2.1-1** and in Section 2.2 that occur during OMAO vessel operations and could impact hazardous, universal, and special waste in the action area include vessel movement; waste handling and discharges; vessel repair and maintenance; UMS operations; small boat operations; and OTS handling, crane, davit, and winch operations. These activities could include the generation, storage and handling, and transfer and disposal of hazardous, universal, and special waste.

Impacts on hazardous, universal, and special waste from anchoring; active acoustic systems operations; other sensors and data collection systems operations; and UAS are not expected to occur and are not discussed further.

OMAO operations could impact potentially hazardous, universal, and special waste in the action area through: (1) generation of hazardous, universal, or special waste (e.g., from vessel movement, waste handling and discharges, vessel repair and maintenance, UMS operations, small boat operations, and OTS handling, crane, davit, and winch operations); (2) storage and handling of hazardous, universal, or special waste (e.g., from vessel movement, waste handling and discharges, vessel repair and maintenance, UMS operations, small boat operations, and OTS handling, crane, davit, and winch operations); and (3) transfer and disposal of hazardous, universal, and special waste (e.g., from vessel movement, waste handling and discharges, vessel repair and maintenance, UMS operations, small boat operations, and OTS handling, crane, davit, and winch operations).

3.11.2.1 Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Under Alternative A, OMAO vessel operations using the current NOAA ships would continue across all five operational areas over the 15-year timeframe for this Draft PEA. In addition, OMAO is constructing two oceanographic research vessels that are expected to come online by 2025 and two new charting and mapping vessels that are expected to come online in 2027 and 2028 for a total of four new ships under Alternative A. OMAO would provide a maximum annual capacity of 3,568 operational DAS for scientific projects.

3.11.2.1.1 Generation of Hazardous, Universal, and Special Waste

Vessel movement, waste handling and discharges, vessel repair and maintenance, UMS operations, small boat operations, and OTS handling, crane, davit, and winch operations could generate potentially hazardous, universal, and special wastes onboard NOAA vessels in the action area. The generation of hazardous, universal, and special waste during OMAO activities would present a potential impact by creating waste in an area where it did not previously exist. Since NOAA ships are public vessels, they are exempt from the storage, manifest, inspection, or recordkeeping requirements of hazardous waste. NOAA shoreside support facilities identify hazardous waste once it has been transferred, and assumes all responsibilities regarding storage, manifesting, and inspection requirements. All NOAA shoreside support facilities are generally required to maintain the status of VSQG – the smallest hazardous waste generator category – in order to prevent or minimize adverse impacts from generated hazardous waste (on rare occasions, a support facility may lapse into SQG and will contact EPA to make the proper arrangements). This means that NOAA ships must minimize the amount of potentially hazardous waste transferred to a NOAA shoreside support facility so that no facility exceeds 100 kg (220 pounds or approximately 22 gallons) of hazardous waste per calendar month or store more than 1,000 kg (2,200 pounds or approximately 220 gallons) on site at any time. NOAA ships are responsible for maintaining effective communication with NOAA shoreside support facilities regarding the amount of potentially hazardous, universal, and special waste stored onboard to help maintain the support facility's VSQG status. All support facilities must fully document that the hazardous waste they handle is properly identified and managed. This includes completion of the Hazardous Waste Accumulation Log. It is also NOAA policy to employ source reduction and other pollution prevention approaches to protect the environment. Ships are encouraged to minimize their potentially hazardous, universal, and special waste by substituting with less hazardous products, purchasing materials only in quantities that will be completely used, and using existing stores before buying more (OMAO, 2021c). Therefore, while NOAA ships would generate potentially hazardous, universal, and special waste, the total amount is minimized to the maximum extent. OMAO also abides by record-keeping requirements, hazardous waste management procedures, and marine operations hazard communication procedures in order to prevent or minimize any adverse impacts. The generation of some potentially hazardous, universal, and special wastes are also discussed in Section 3.4 (Water Quality).

Under Alternative A, vessel movement, vessel repair and maintenance, UMS operations, small boat systems operations, and OTS handling, crane, davit, and winch operations would generate a variety of potentially hazardous, universal, and special wastes based on the activity and operation of the ship. Since all NOAA ships are exempt from the storage, manifesting, and inspection requirements of hazardous waste, and minimize potentially hazardous, universal, and special waste transferred to NOAA shoreside support facilities, including substituting and minimizing these wastes where possible, impacts from the generation of potentially hazardous, universal, and special waste would be adverse, **negligible** to **minor**, **temporary**, and **localized**, and therefore **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting or conducting routine vessel repair and maintenance would be similar to those within the EEZ.

3.11.2.1.2 Storage and Handling of Hazardous, Universal, and Special Waste

As discussed in Section 3.11.2.1.1, OMAO activities including vessel movement, waste handling and discharges, vessel repair and maintenance, UMS operations, small boat operations, and OTS handling, crane, davits, and winch operations could generate potentially hazardous, universal, and special waste that must be stored and handled properly. If not stored or handled properly, substances could have adverse impacts not only to the marine environment but to human health and safety (see Section 3.12.2, Human Health and Safety).

Since NOAA ships are public vessels, they are exempt from the storage, manifest, inspection, or recordkeeping requirements of hazardous waste. However, all NOAA ships are required to adhere to all OMAO policies and procedures in order to prevent or minimize adverse impacts from storing and handling potentially hazardous, universal, or special waste. The OMAO Procedure 'Hazardous, Universal, and Special Waste Management' establishes the requirements for the management of these wastes. Ships must develop and follow a Shipboard Storage and Transfer SSI that outlines the onboard storage instructions for how to handle and store potentially hazardous, universal, and special wastes generated onboard. The instructions list every hazardous, universal, and special waste generated onboard and how to properly label and store each substance. For example, corrosive and caustic hazardous waste must be labeled as such, stored within a secondary container to prevent leakage, and stored on a low shelf away from flammable substances (OMAO, 2021d). OMAO would store appropriate materials onboard to contain and clean potential spills, and operators would perform daily pre-work equipment inspections for cleanliness and leaks. Toxic and hazardous substances are also addressed through each vessel's NPDES VGP SSI, which indicates the responsible party, management practices for substances, and related recordkeeping (OMAO, 2013c). Furthermore, per OSHA and OMAOs Hazard Communication Plan, all hazardous materials and chemicals must be inventoried annually, and the SDS Library must be housed on the ship (OMAO, 2015). Therefore, while NOAA ships would store and handle potentially hazardous, universal, and special waste, such activities would follow the proper procedures to prevent or minimize any adverse impacts. The storage and handling of some hazardous, universal, and special waste are also discussed in Section 3.4 (Water Quality).

OMAO implements other procedures, systems, and infrastructure to help maintain and manage the potentially hazardous, universal, and special waste onboard NOAA ships. Medical waste has its own separate system and is stored until the ship comes into port. NOAA ships utilize paint lockers that house all the paints and related materials needed onboard. Paint lockers can be completely closed off in the event of a spill or fire, and carbon dioxide can be pumped into storage areas to dispel potential fires. AFFF fire suppression systems and fire extinguishers are located onboard and contain water and/or chemicals to help control fires. Spill response lockers are located throughout the ships and contain dewatering pumps, rags, diapers, containment bins, and other supplies to contain and clean spills. Each NOAA ship must also abide by the SOPEP & non-tank VRP. These plans establish the procedure for responding to an accidental discharge or spill of oil, hazardous substances, or marine pollutants (OMAO, 2017b). Therefore, NOAA ships maintain a number of additional systems and plans, especially the SOPEP/VRP, which would prevent or minimize any adverse impacts from potentially hazardous, universal, and special waste.

Under Alternative A, vessel movement, waste handling and discharges, vessel repair and maintenance, UMS operations, small boat operations, and OTS handling, crane, davit, and winch operations could impact the storage and handling of potentially hazardous, universal, and special waste. Since all NOAA ships are required to abide by all policies and procedures related to potentially hazardous, universal, and special waste storage and handling, including the Hazard Communication Plan and the SOPEP/VRP, and maintain systems and infrastructure in place to contain accidental discharges and spills should they occur, the impacts from the storage and handling of potentially hazardous, universal, or special waste would be adverse, **negligible** to **minor**, **temporary**, and **localized**, and therefore **insignificant**. In the rare event that an accidental discharge or spill occurs, the impact could extend past the immediate vicinity of the NOAA ship, particularly if the ship is moving. In this case, the impacts would be adverse, **minor** to **moderate**, **temporary**, **local** or **regional**, with a **low** likelihood of occurrence, and therefore **insignificant**. Impacts beyond the U.S. EEZ while vessels are transiting or conducting routine vessel repair and maintenance would be similar to those within the EEZ.

3.11.2.1.3 Transfer and Disposal of Hazardous, Universal, and Special Waste

Once hazardous, universal, and special waste is ready to be treated and disposed, NOAA ships either transfer their waste to a NOAA shoreside support facility or directly to a hazardous waste transporter. All NOAA ships are required to adhere to all OMAO policies and procedures regarding hazardous, universal, and special waste transfer or disposal, particularly the Shipboard Storage and Transfer SSI or the Disposal SSI. Each type of waste must be handled, stored, and labeled according to the type of hazard in preparation for its transfer; thus, any adverse impacts would be identical to those described in Section 3.11.2.1.2.

Both the transfer and disposal of hazardous, universal, and special waste would occur while NOAA ships are in port or at a NOAA shoreside support facility; OMAO activities that occur in port or at shoreside facilities are not covered under this Draft PEA. Therefore, the impacts are not discussed further in this section.

3.11.2.1.4 Conclusion

Under Alternative A, OMAO would continue to use the current fleet to conduct operations in support of NOAA's primary mission activities. OMAO would continue to operate NOAA's fleet of survey and research ships until they reach the end of service life. Almost half the ships in the NOAA fleet would exceed their design service life by 2038; however, two new ships would come on-line in 2025 with two more ships projected to come online by 2027 and 2028. Under Alternative A the fleet would provide a maximum annual capacity of 3,568 operational DAS for scientific projects. Since the effects of impact causing factors from hazardous, universal, and special waste range from negligible to moderate, the overall impact of Alternative A on hazardous, universal, and special waste would be adverse, **negligible** to **moderate**, **temporary**, **regional** or **localized** depending on whether the ship is stationary or moving, and therefore **insignificant**.

3.11.2.2 Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

OMAO operations under Alternative B would take place in the same operational areas and timeframes as under Alternative A; however, under Alternative B, OMAO would construct up to eight new ships (four as in Alternative A, plus four additional ships) to replace ships that would reach the end of their design service life, extend the service life of aging ships through maintenance and mid-life repairs for six ships, increase fleet utilization with up to 4,138 DAS (approximately 570 more DAS annually than under Alternative A), and integrate new and greener technology as described in Section 2.4. As such, effects under Alternative B would incrementally increase from those of Alternative A but would not differ fundamentally in type.

Impacts from OMAO operations involving generation and storage and handling of potentially hazardous, universal, and special waste would occur under Alternative B from the same activities as under Alternative A. Although the number of DAS would be greater under Alternative B than under Alternative A, the additional 570 DAS (implemented in a phased approach) would be distributed across the five operational areas. While the increase in 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 intensity of the impacts. Additionally, replacing aging ships with new ships and integrating new and greener technology may reduce hazardous, universal, and special waste generated during some activities, and potentially generate more during others. Toxic zinc-coated corrosion prevention and cathodic protection systems would be replaced with aluminum-coated systems and would reduce the amount of waste generated during vessel repair and maintenance. Diesel-powered generators would be replaced with lithium batteries to power the ship's hotel mode and certain propulsion systems. While this would reduce the amount of oily waste generated during vessel movement, waste handling and discharges, and vessel repair and maintenance, it would also generate lithium battery waste in the process. Six NOAA ships including *Ronald H. Brown, Oscar Dyson*, *Henry B. Bigelow*, *Pisces*, *Bell M. Shimada*, and *Reuben Lasker*, would undergo midlife repairs that would replace or upgrade ship infrastructure to improve their functionality, reliability, and efficiency, and would likely reduce the amount of waste generated as a result of these upgrades. Overall, the difference in impacts between Alternative B and Alternative A would be minimal.

Impacts of Alternative B on hazardous, universal, and special waste throughout the action area would be similar to those discussed above under Alternative A for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be slightly lower due to the introduction of new ships and technology. OMAO would continue to adhere to all policies and procedures to minimize or prevent adverse impacts from hazardous, universal, and special waste generation and storage. Overall, impacts from hazardous, universal, and special waste under Alternative B would be adverse, **negligible** to **moderate**, **temporary**, **regional** or **localized** depending on whether the ship is stationary or moving, and therefore **insignificant**.

3.11.2.3 Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

OMAO operations under Alternative C would implement the same measures as under Alternative B and take place in the same operational areas and timeframe as under Alternatives A and B; however, Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B with additional measures including maximizing crew productivity and enhancing overall fleet performance by increasing DAS by 735 additional days, construction of two new ships in addition to those under Alternative B, increasing the number and use of uncrewed systems integrated into vessels, and shortening the timeframe for fleet improvement activities, implementation of greening techniques, and improvements to the small boat fleet as discussed in Section 2.5. As such, effects under Alternative C would incrementally increase from those of Alternatives A and B but would not differ fundamentally in type.

Impacts from OMAO operations involving generation and storage and handling of potentially hazardous, universal, and special waste would occur under Alternative C from the same activities as under Alternatives A and B. Along with the greater number of DAS under Alternative C as compared to Alternatives A and B, there would be greater impacts overall; however, the associated impact-causing factors would not be concentrated enough in any given area to substantially increase the intensity of the impacts as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Furthermore, while there would be benefits from the acceleration of proposed measures under Alternative B that would occur more quickly with increased funding under Alternative C, it may not result in a noticeable difference in impacts among alternatives. New ships would enter the fleet sooner than anticipated under Alternative C, in addition to two new ships to replace aging ships as compared to Alternative B (i.e., a total of ten new ships). New greening and improvement techniques for the current fleet and new ships, along with mid-life repairs and other maintenance to aging ships, would occur over a shortened timeframe including additional measures for the new fleet such as use of environmentally friendly lubricants and oils in systems to minimize impacts from potential discharge into the marine environment during vessel movement or repair and maintenance. However, hazardous, universal, and special waste would still be generated from new ships and greening techniques, such as expanded use of lithium batteries and associated waste discussed in 3.11.2.2. Therefore, there would be minimal differences in impacts from Alternative C compared to Alternatives A and B.

Impacts of Alternative C on hazardous, universal, and special waste throughout the action area would be similar to those discussed above under Alternatives A and B for each impact causing factor. Although some impacts could be slightly, but not appreciably, larger due to more DAS, others could be similar or slightly lower due to the additional new ships and greening measures. OMAO would continue to adhere to all policies and procedures to minimize or prevent adverse impacts from hazardous, universal, and special waste generation and storage. Overall, impacts on hazardous, universal, and special waste under Alternative C would be adverse, **negligible** to **moderate**, **temporary**, **regional** or **localized** depending on whether the ship is stationary or moving, and therefore **insignificant**.

3.12 Human Health and Safety

This section discusses the affected environment and environmental consequences that would result under each alternative for human health and safety on NOAA vessels during OMAO operations.

3.12.1 Affected Environment

Human health and safety aboard NOAA vessels primarily involve occupational hazards. The area of analysis for this resource are NOAA vessels during OMAO operations. This section introduces the regulatory framework and then discusses potential workplace injuries.

3.12.1.1 Regulatory Framework

The requirements for human health and safety are derived from federal OSHA regulations and policies developed by NOAA. The regulations and policies work together to provide requirements for crew safety and education training, personal protective equipment (PPE), equipment inspection and testing, spill response, and general vessel operations.

NOAA Administrative Order (NAO) 209-1A establishes NOAA safety policy and defines procedures for implementing occupational safety and health activities throughout NOAA. The NAO also establishes the NOAA Occupational Safety and Health Management System (OSHMS), which provides regulatory and statutory compliance by assigning responsibilities and prescribing procedures for implementing safety and health guidelines throughout NOAA. The general safety policies and procedures outlined in NAO 209-1A are derived from:

- Title 5, USC, Sections 7901, Health Service Programs and 7902 Safety Programs;

- 29 CFR Part 1910, Occupational Safety and Health Standards;
- 29 CFR Part 1960, Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters; and
- EO 12196, Occupational Safety and Health Programs for Federal Employees.

NOAA policies take the requirements found in the orders, policies, and regulations discussed above and apply them to NOAA-specific operations and activities. OMAO shipboard policies include the following categories: Engineering, Environmental, Operations, and Small Boats. Engineering policies include topics such as oil transfer procedures, generic fueling plans, and standards for lifting appliances. Environmental policies include shipboard waste water management and MSD effluent testing. Operations policies include lithium battery safety and crane and winch operations. Small boat policies include small boat operations and standards and procedures for small boats. Each policy has different components as necessary (i.e., subsections for applicable training or regulations), but always includes purpose, scope, and responsibilities, at a minimum. For example, a general policy on lifting appliances standards, includes a list of required standards and regulations for different types of weight handling equipment. The policy on winch operations, a specific type of weight handling equipment, identifies the need to complete hands-on training during day and night operations and a winch operator training test. For most policies, the vessel's CO or Master is responsible for developing the unique SSIs specific to each vessel's capabilities and operations.

3.12.1.2 Potential Workplace Injuries

As defined by BLS, the most comparable industry to OMAO operations is water transportation. It includes the same hazards that could occur aboard NOAA vessels, such as slippery surfaces, storms, chemicals, and machinery (NIOSH, 2020). Since safety data exists for this industry, it is used here to describe the current environment of human health and safety aboard vessels. In 2018, the BLS reported that the total recordable injuries and illnesses incident rate (see note under Table 3.12-1) for water transportation was 2.6, which resulted in a rate of 1.9 cases requiring days away from work. The total recordable injuries and illnesses rate for water transportation was lower than the average rate of 3.1 for all industries. However, the rate of cases with days away from work was higher for water transportation than the average for all industries (**Table 3.12-1**). This suggests a higher level of severity for injuries, even though injuries were less common, on average, in water transportation than all industries. For comparison, the injury and illness incident rates for the construction and publishing industries are 3.0 and 0.6, respectively, and the rates of cases with days away from work are 1.8 and 0.3, respectively (BLS, 2018). OMAO's current incident rates of workplace injuries would be expected to be similar to that of the water transportation industry. Each NOAA fleet vessel has a workplace injury tracker that specifies the number of days without an injury.

Table 3.12-1. Incident Rate* Comparison of 2018 Workplace Injuries and Illnesses Across Several Industries

Industry	Total Recordable Injuries and Illnesses	Cases with Days Away from Work
Publishing (except internet)	0.6	0.3
Water transportation	2.6	1.9
Construction	3.0	1.8
All industries including private, state, and local government	3.1	1.7

* The incidence rates represent the number of injuries and illnesses per 100 full-time workers and were calculated as: (N/EH) x 200,000, where N = number of injuries and illnesses; EH = total hours worked by all employees during the calendar year; and 200,000 = base hours for 100 equivalent full-time workers (working 40 hours per week, 50 weeks per year).

Source: BLS, 2018.

3.12.2 Environmental Consequences

This section identifies and evaluates potential impacts to human health and safety under Alternatives A, B, and C. The OMAO activities described in Table 2.1-1 and in Section 2.2 which could be expected to have impacts on human health and safety include vessel movement; waste handling and discharges; spill response; vessel repair and maintenance; and OTS handling, crane, davit and winch operations.

Impacts on human health and safety from anchoring; active acoustic systems operations; other sensors and data collection systems operations; UMS operations; and small boat operations[18] would originate from the hazards introduced by using machinery and moving heavy equipment. Thus, impacts are analyzed and discussed generally for OTS handling, crane, davit and winch operations. Impacts on human health and safety from UAS operations are not expected to occur and are not discussed further in this section.

OMAO operations could impact human health and safety through: (1) vessel movement (e.g., from slips, trips, and falls); (2) chemical and biological hazards (e.g., from spill response, vessel repair and maintenance, and waste handling and discharges); and (3) OTS handling, crane, davit, and winch operations (e.g., from deploying and retrieving anchors, active acoustic systems, other sensors and data collection systems, UMS, and small boats). The analysis below is organized into these areas of concern.

3.12.2.1 Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Impacts to human health and safety that could occur under Alternative A are discussed below for each human health and safety area of concern. For each OMAO activity, impacts to human health and safety would be considered localized because they would only occur in the immediate vicinity of the vessel. Under Alternative A, OMAO would provide a maximum annual capacity of 3,568 operational DAS for scientific projects. OMAO would continue to use the current NOAA fleet until vessels reached their end of service life. In addition, OMAO is constructing two oceanographic research vessels that are expected to

[18] This PEA only considers the impacts from small boats that are physically connected to the larger ship via davits or similar equipment. See Section 2.12 for more information.

come online by 2025 and two new charting and mapping vessels that are expected to come online in 2027 and 2028 for a total of four new ships under Alternative A.

3.12.2.1.1 Vessel Movement

During vessel movement, vessels roll, pitch, and yaw with the sea's conditions. In the event of storms at sea, visibility can be reduced and high winds can quickly lead to rising seas. These conditions can cause unstable, dynamic footing and shifting loads which could be dangerous for crew members, leading to slips, trips, falls, and damage to personnel or equipment. Types of injuries could include but are not limited to: sprains, scrapes, lacerations, and fractures. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Vessel rolling is exacerbated by a phenomenon known as free surface effect, where liquid shifting within a partially filled tank (e.g., fuel, ballast, and fresh water tanks) changes the vessel's center of gravity, which lowers the ship's stability and makes rolling more likely. Free surface effect is reduced by keeping as many tanks as possible filled and with modern designs that implement baffles to slow the movement of liquid within a tank. Select ships (T-AGOS, FSV, RB, new builds) have baffles in some ballast tanks, depending on the location and purpose of the tank (ballast vs. anti-roll, etc.). While baffles may reduce the free surface effect within that tank, they cannot replace the need for ballasting with water. Fuel tanks are also pressed up and cross-tank valves are closed and secured. Non-slip textures are installed on decks, crew members wear non-slip footwear to prevent slipping, uneven surfaces are marked as hazards to prevent tripping, and railings are installed where practical to prevent falling. Vessels hold daily safety meetings to share safety topics, and safety standdowns to brief crew members on safety measures before new operations are implemented. All crew members are required to complete first-aid training with Cardiopulmonary Resuscitation (CPR) every two years, and all vessels are required to have two U.S. Coast Guard certified Medical Persons In-Charge (MPICs) that oversee reported injuries. NOAA vessels have nearly constant internet access and a number of radar and satellite dishes that allow for regular weather updates which can notify personnel of future storms. Optimum ship track routing is provided by the U.S. Naval base in San Diego, California, which uses long-range predictions of wind, waves, and currents to provide the safest ship route. Storms at sea are sometimes unavoidable. Operations can be halted for safety purposes when certain limitations are met: winds exceeding 25-30 knots and swells exceeding 6-8 feet. Additionally, vessel speeds are typically lower than 10 knots, which would reduce sudden, jarring movements that can lead to slips, trips, and falls.

The impacts from vessel movement under Alternative A could result in injuries and affect human health and safety. However, because of the mitigation measures discussed above, the likelihood of injuries occurring to onboard personnel from vessel movement would be low. Overall impacts on human health and safety from vessel movement would be **adverse**, **minor**, **short-term**, and **insignificant**.

3.12.2.1.2 Chemical and Biological Hazards

Chemical and biological hazards exist aboard NOAA vessels from a variety of routine activities, including vessel repair and maintenance, spill response, and waste handling and discharges. While these activities could potentially expose personnel to a range of harmful chemical and biological substances, the likelihood would be low and exposure and acute health effects could be avoided or reduced with mitigation measures such as receiving spill response and general safety training and wearing PPE. **Table 3.12-2** presents a list of shipboard activities, primary pollutants, possible exposure routes, potential acute health effects, and the mitigation measures that are used by OMAO to minimize impacts to human health and safety from chemical and biological hazards. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Table 3.12-2. Activities, primary pollutants, possible exposure routes, potential acute health effects, and mitigation measures

Activity	Primary Pollutants	Possible Exposure Routes	Potential Acute Health Effects	Mitigation Measures
Vessel repair and maintenance	Solvents; Benzene, Toluene, Ethylbenzene, and Xylene (BTEX)[1]; noise	Ingestion; inhalation; hearing	Headaches; eye irritation; nausea; vomiting fatigue; hearing loss	Training and response plans; storage of chemicals in secure, designated areas; spill kits; PPE; use minimally-toxic, biodegradable, phosphate-free cleaners; toxic material contingency plan
Spill response; fuel transfer	BTEX[1]	Ingestion; inhalation	Nose and throat irritation; headaches; vomiting; confusion; difficulty breathing	Training and drills; fuel transfer plans, roles and responsibilities; daily/weekly/monthly inspections; spill kits; PPE; toxic material contingency plan
Incinerator operation	Particulate matter; Sulfur Oxides; Nitrogen Oxides	Inhalation	Difficulty breathing; reduced lung function; eye and throat irritation	Training; operations restricted as far from human settlements as possible; typically conducted at night; incineration of certain types of garbage, such as plastics and heavy metals, is avoided when possible.
Black and greywater management	Coliform; E. coli	Ingestion	Vomiting; dehydration; cramps; diarrhea; shock	Training; MSD; PPE.
Universal waste management	Lithium-metal oxides; solvents	Skin contact; ingestion; inhalation	Nausea; vomiting; fatigue; eye, lung, and skin irritation	Training; disposal following universal waste procedures; specially designated receptacles; insulating battery terminals.

[1]BTEX are common components of petroleum products, including but not limited to fuels and lubricants.

Sources: (EPA, 2012); (EPA, 2022f); (Gaffield et al., 2003); (NJDOH, 2008)

The impacts from chemical and biological hazards under Alternative A could result in injuries and affect human health and safety. However, due to the mitigation measures, the likelihood of injuries as a result of coming into contract with these hazards would be low. Overall, impacts on human health and safety would be **adverse**, **negligible** to **minor**, **temporary** to **short-term**, and **insignificant**.

3.12.2.1.3 OTS handling, Crane, Davit, and Winch Operations

OTS handling, cranes, davits, and winch operations (herein referred to as weight handling equipment) may be used to deploy and retrieve anchors, scientific equipment, cargo, small boats, and UMS. While these systems are designed to minimize hazards and injuries to personnel handling heavy weight, human health and safety can be affected if an accident or equipment failure occurs.

An accident or equipment failure could result in injuries such as sprains, scrapes, lacerations, and fractures from powerful machinery and heavy weight coming into contact with personnel. While very unlikely, there is also a chance of more severe injuries occurring, such as crushed limbs, paralysis, or death depending on the type of equipment being used, the load it is bearing, and what part of the body is injured. Another risk with weight handling equipment, or any time a line, wire, or cable is under tension, is snapback. This is where high tension causes a line (such as those made of synthetic material like nylon or another polymer), wire, or cable to stretch and part before breaking and slicing through the air. Any personnel in the immediate vicinity could be severely injured. Impacts beyond the U.S. EEZ while vessels are transiting would be similar to those within the EEZ.

Injuries from OTS handling, cranes, davits, and winch operations could occur accidentally from operator error or equipment failure. The likelihood of injury from operating weight handling equipment, however, would be very low due to the rigorous standards in place for both operators and equipment. The American Bureau of Shipping (ABS) is the primary source of guidance for testing, inspecting, assessing, and certifying safe operating criteria for the NOAA fleet. OMAO tests and maintains weight handling equipment per 46 CFR § 189.35, and NOAA Manual 209-10: OSHMS, which details NOAA-specific protocols. All operators are trained in the proper use of the equipment, periodic inspections are conducted by qualified inspectors at least every twelve months and prior to the use of equipment that has been idle for six months or more, and all appliances are visibly marked with the maximum load capacity and the date of the last inspection. Test records and requirements for equipment are maintained in a register according to 46 CFR § 91.25-25(a)(3), to include but not limited to the following: chains, rings, hooks, shackles, hoists, cranes, and winches. Results of periodic tests, inspections, major repairs, and preventative maintenance associated with weight handling gear are logged in the SAMMS. Primary life-saving equipment, such as rescue boats and their launching appliances, are maintained and repaired per 46 CFR §§ 199.160 & 190 and Chapter III, Part B, Section I, Regulation 20 of the International Convention of the Safety of Life at Sea (SOLAS).

Although very unlikely, a permanent injury or death resulting from OTS handling, cranes, davits, and winch operations could constitute a moderate or greater impact. The severity of injuries from weight handling equipment would be reduced by adhering to the rigorous standards set forth by OSHA, ABS, and NOAA. Overall, impacts from OTS handling, cranes, davits, and winch operations on human health and safety under Alternative A would be **adverse**, **minor**, **short-term**, and **insignificant**.

3.12.2.1.4 Conclusion

While the effects of OMAO operations on human health and safety would range from negligible to moderate or greater, moderate or greater impacts would only be expected to result from the very unlikely occurrence of a permanent injury or death during an onboard emergency or from OTS handling, crane, davit, and winch operations. Since all other impacts range from negligible to minor and temporary to short term, the overall impact of Alternative A on human health and safety would be **adverse**, **minor**, **short term**, and **localized**. Thus, the impacts of Alternative A would be **insignificant**.

3.12.2.2 Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

OMAO operations under Alternative B would take place in the same operational areas and timeframes as under Alternative A; however, under Alternative B, OMAO would construct up to eight new ships (four as in Alternative A, plus four additional ships) to replace vessels that would reach the end of their design service life, extend the service life of aging ships through maintenance and mid-life repairs for six ships, increase fleet utilization with up to 4,138 DAS (approximately 570 more DAS annually than under Alternative A), and integrate newer technology as described in Section 2.4. Impacts from OMAO operations from vessel movement; chemical and biological hazards; and OTS handling, crane, davit, and winch operations would occur under Alternative B from the same activities as under Alternative A. There is a direct correlation between DAS and human health and safety: a greater number of DAS under Alternative B presents more risks from the hazards described under Alternative A. Alternative B would result in 570 more DAS than Alternative A, which would most likely increase the overall impacts to human health and safety because there would likely be an increase in the annual number of reported injuries. While these additional operations could result in greater impacts overall, the context, duration, likelihood, and intensity of impacts would not change enough to noticeably increase the impacts (e.g., from medium to high) because the types of activities and safety measures would remain the same. Additionally, replacing seven aging vessels and integrating newer technology would likely reduce some impacts. For example: newer, standardized equipment would minimize the risk of operator error and equipment failure, thus reducing the impacts associated with weight handling equipment.

Impacts of Alternative B on human health and safety would be similar to those discussed under Alternative A. Although some impacts could be slightly, but not appreciably, larger due to more DAS, and thus result in a potential increase in the annual number of reported injuries, others could be lower due to the introduction of new ships and safer, more standardized technology. While the effects of OMAO activities on human health and safety would range from negligible to moderate or greater, moderate or greater impacts would only be expected to result from the very unlikely occurrence of a permanent injury or death from OTS handling, crane, davit, and winch operations. Since all other impacts range from negligible to minor and temporary to short term, the overall impact of Alternative B on human health and safety would be **adverse**, **minor**, **short term**, and **localized**. Thus, the impacts of Alternative B would be **insignificant**.

3.12.2.3 Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

OMAO operations under Alternative C would implement the same measures as under Alternative B and take place in the same operational areas and timeframe as under Alternatives A and B; however, Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B with additional measures including maximizing crew productivity and enhancing overall fleet performance by increasing DAS by 735 beyond Alternative B levels, construction of two new ships in addition to those under Alternative B, increasing the number and use of uncrewed systems integrated into vessels, and shortening the timeframe for fleet improvement activities, implementation of greening techniques, and improvements to the small boat fleet as discussed in Section 2.5.

Impacts from OMAO operations would occur under Alternative C from the same activities as under Alternatives A and B. Along with the greater number of DAS under Alternative C as compared to Alternatives A and B, there would likely be greater impacts overall. As discussed above in Alternative B, a greater number of DAS could result in an increase in the annual number of reported injuries, so the annual number of reported injuries and illnesses would likely be even higher under Alternative C as compared to Alternatives A and B. While these additional operations could result in greater impacts overall, the context, duration, likelihood, and intensity of impacts would not change enough to noticeably increase the impacts (e.g., from medium to high) because the types of activities and safety measures would remain the same. Additionally, replacing two more vessels compared to Alternative B (i.e., a total of ten new ships) and integrating newer technology would likely reduce some impacts, as newer, standardized equipment would minimize the risk of operator error and equipment failure and reduce the impacts associated with weight handling equipment.

Impacts of Alternative C on human health and safety would be similar to those discussed under Alternatives A and B. Although some impacts could be slightly, but not appreciably, larger due to more DAS, and thus result in a potential increase in the annual number of reported injuries, others could be lower due to the introduction of new vessels and safer, more standardized technology. While the effects of OMAO activities on human health and safety would range from negligible to moderate or greater, moderate or greater impacts would only be expected to result from the very unlikely occurrence of a permanent injury or death from OTS handling, crane, davit, and winch operations. Since all other impacts range from negligible to minor and temporary to short term, the overall impact of Alternative C on human health and safety would be **adverse**, **minor**, **short term**, and **localized**. Thus, the impacts of Alternative C would be **insignificant**.

3.13 CLIMATE CHANGE

This climate resource section describes the effects of OMAO vessel operations on climate throughout the geographic regions where OMAO operations are projected to occur during the fifteen-year period covered by the PEA and, to the extent possible, the effects on global climate. The section also considers the effects that global climate change may have on these same OMAO operations.

On February 19, 2021, President Biden's EO 13990, "Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis" reinstated the Obama administration's Climate Change EO 13653, "Preparing the United States for the Impacts of Climate Change") and the White HouseCEQ's 2016 Final Guidance for Federal Departments and Agencies on Consideration of GHG Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews. The CEQ guidance directs federal agencies to quantify the direct and indirect GHG emissions of a proposed action and weigh climate change impacts in considering alternatives and in evaluating mitigation measures. When quantification tools, methodologies, and/or data inputs are not reasonably available to quantify GHG emissions, this CEQ guidance also recommended that lead agencies include a qualitative analysis of climate change impacts.

In the February 19, 2021 Notice, CEQ indicated that it will develop future revisions and updates to the Obama administration's 2016 GHG Guidance. CEQ also noted that, in the interim, federal agencies "should consider all available tools and resources in assessing GHG emissions and climate change effects of their proposed actions, including, as appropriate and relevant, the 2016 GHG Guidance." Thus, the February 2021 Notice's language gives agencies flexibility in using the 2016 GHG Guidance (Schneider et al., 2021).

On January 9, 2023, CEQ published a notice of interim guidance and request for comments in the *Federal Register* on consideration of greenhouse gas emissions and climate change in NEPA documents (88 FR 1196, January 9, 2023). The notice states:

> 'This guidance does not establish any particular quantity of GHG emissions as "significantly" affecting the quality of the human environment. However, quantifying a proposed action's reasonably foreseeable GHG emissions whenever possible, and placing those emissions in appropriate context are important components of analyzing a proposed action's reasonably foreseeable climate change effects.'

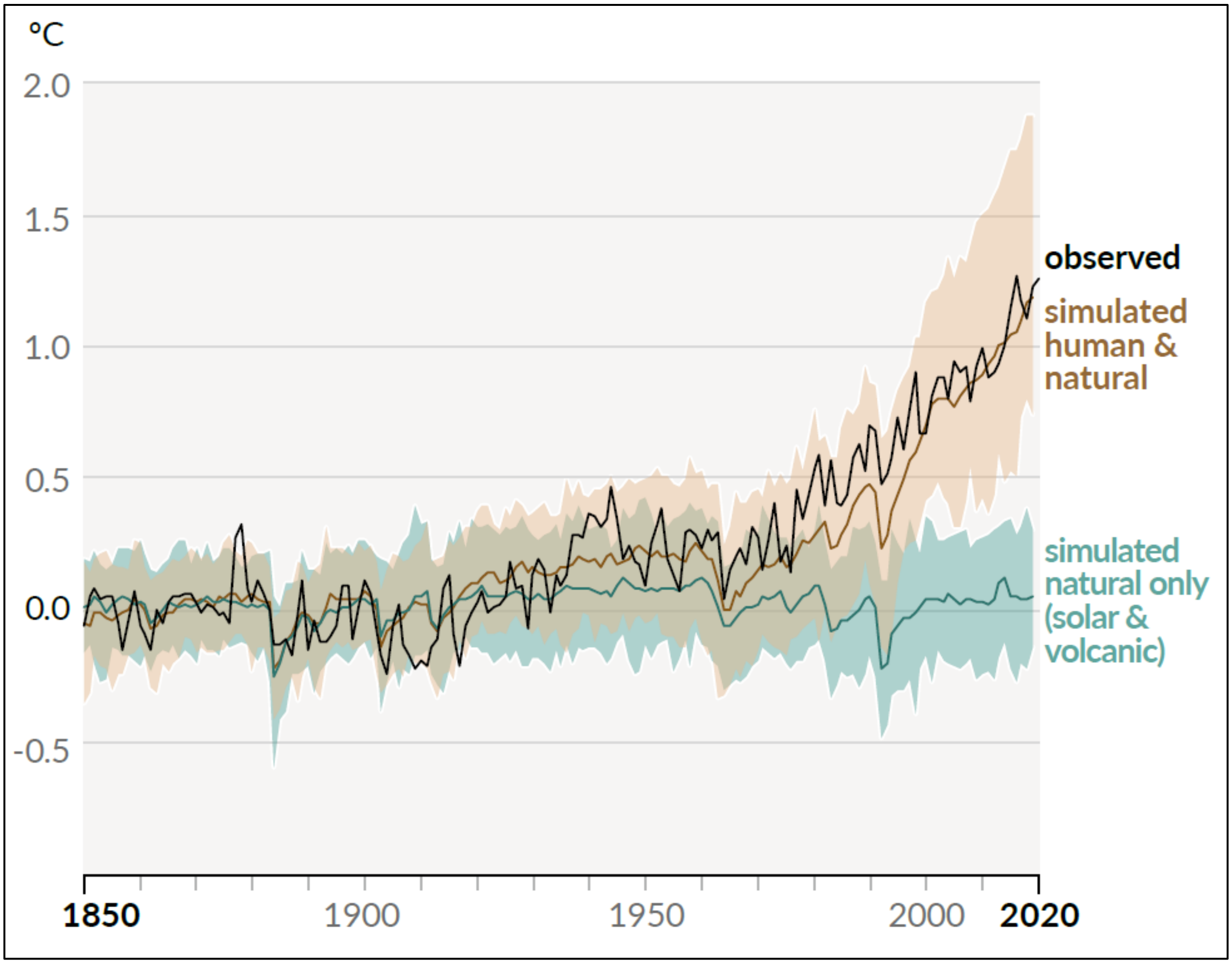
3.13.1 Affected Environment

This section draws primarily on the Sixth Assessment of the Intergovernmental Panel on Climate Change (IPCC), released in 2021, to describe the present state of the global climate and global climate change trends (IPCC, 2021). These anticipated changes in climate will affect all areas of the U.S. EEZ, although unequally.

3.13.1.1 Warming

The IPCC reports that increasing GHG emissions associated with expanding human activity have warmed the climate at a rate that is "unprecedented in at least the last 2,000 years" (IPCC, 2021).

Figure 3.13-1 depicts changes in global surface temperature over the past 170 years (black line) relative to 1850–1900 and averaged annually, compared to climate model simulations of the temperature response to both human and natural drivers in brown, and to only natural drivers – solar and volcanic activity – in green.



Source: IPPC, 2021

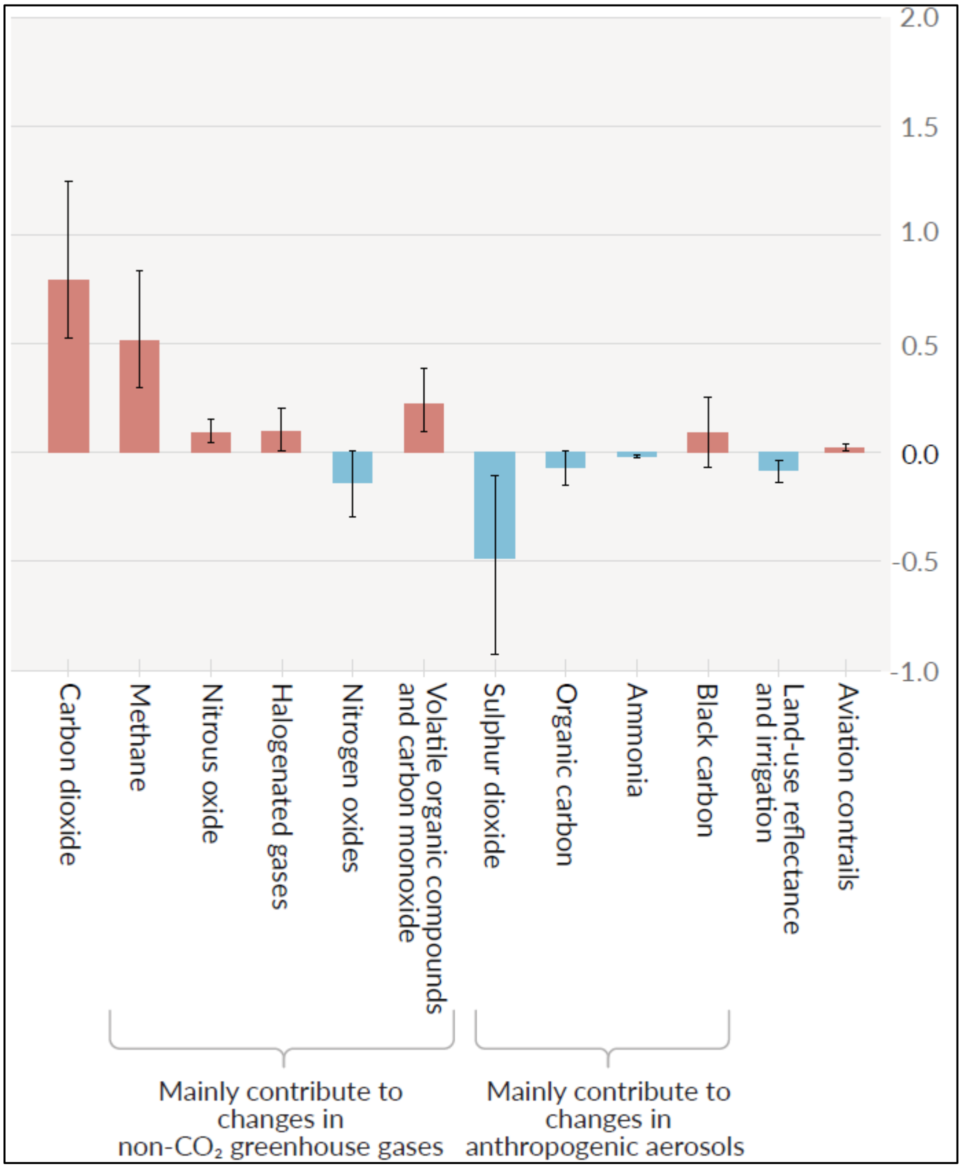
Figure 3.13-1. Global Surface Temperature Change (1850-2020) as Observed (black) and Simulated Using Human and Natural (brown) and Natural Only Factors (green)

According to the IPCC, the "likely" range of total anthropocentric global surface air temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C (1.4°F to 2.3°F), with a "best estimate" of this increase at 1.07°C (1.93°F). In addition, the following are "likely":

- Well-mixed GHGs (those dispersed evenly throughout the atmosphere) contributed to surface (tropospheric) air temperature warming of 1.0°C to 2.0°C
- Other human drivers (principally aerosols) contributed a cooling of 0.0°C to 0.8°C
- Natural drivers changed global surface temperature by –0.1°C to 0.1°C, and
- Internal variability changed surface temperatures by –0.2°C to 0.2°C.

The IPCC considers it "very likely" that well-mixed GHGs were the main factor driving tropospheric warming since 1979, and "extremely likely" that human-caused stratospheric ozone depletion was the main cause of a cooling in the lower stratosphere between 1979 and the mid-1990s (IPCC, 2021).

In summary, rising emissions from increasing human activities drive observed warming, with GHG warming partly masked or offset by aerosol cooling (**Figure 3.13-2**). The y-axis in **Figure 3.13-2** is temperature change in degrees Celsius. The bars represent degrees change (upward in red/orange or downward in blue) from the 1850-1900 baseline and the brackets represent the statistical range for each driver. OMAO activities contribute primarily to the left-most bar, carbon dioxide.



Source: IPCC, 2021

*Temperature change in degrees Celsius

Figure 3.13-2. Contributions to 2010-2019 Warming Relative to 1850-1900, Assessed from Radiative Forcing Studies*

Atmospheric carbon dioxide (CO_2) concentrations are now more elevated than at any time in at least the past two million years, while concentrations of two other key GHGs – methane (CH_4) and nitrous oxide (N_2O) – are higher than at any time in at least 800,000 years. Since 1750, increases in concentrations of CO_2 (47 percent) and CH_4 (156 percent) far surpass, and increases in N_2O (23 percent) are comparable to, the natural multi-millennial changes between glacial and interglacial periods over at least the past 800,000 years (IPCC, 2021).

The rapid increase in climate-forcing GHGs is paralleled by a rapid increase in temperatures. The global mean surface air temperature has increased faster since 1970 than in any other comparable 50-year period over at least the last 2,000 years. Global average air temperatures during the most recent decade (2011–2020) are higher than those of the most recent multi-century warm period, around 6,500 years ago. Previously, the next most recent warm period was about 125,000 years ago (IPCC, 2021).

Sustained higher air temperatures globally are causing the widespread melting of sea ice and glaciers. During 2011–2020, the annual average area of Arctic Ocean sea ice reached its lowest level since at least 1850. Late summer Arctic Ocean sea ice area was less than any time in at least the last millennium. The global scale of receding and retreating glaciers since the 1950s, with almost all of the world's glaciers shrinking simultaneously, is unprecedented in at least the last 2,000 years (IPCC, 2021).

Sea level is rising not only because of melting glaciers but because of thermal expansion of warmer ocean water. Rising sea level exacerbates storm surges as shown in **Figure 3.13-3**. (Above 4°C or 39°F, water expands in volume with rising temperature.) Global mean sea level has risen faster over the past century than in any preceding century for at least the last 3,000 years. Furthermore, the ocean appears to have warmed faster over the past century than at any point since the end of the Ice Age about 11,000 years ago (IPCC, 2021).

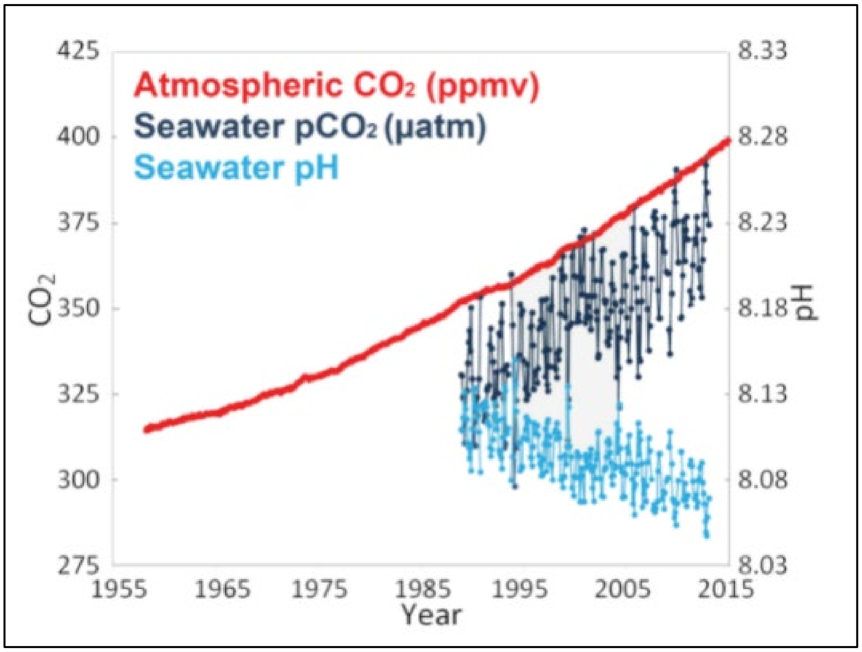
Source: NOAA

Figure 3.13-3. Storm Surge on Louisiana Highway Shows Effects of Rising Sea Level

3.13.1.2 Ocean Acidification

The mean pH of the world's oceans is falling, which means they are becoming acidified (**Figure 3.13-4**). Ocean acidification is happening because the ocean is absorbing more CO_2 from the atmosphere (where CO_2 concentration is increasing), resulting in lower pH and higher acidity in the upper layers of the sea. This is causing a fundamental shift in the chemistry of the entire ocean (NOAA, 2021b). When CO_2 is absorbed by seawater (H_2O), a series of chemical reactions occur, resulting in the increased concentration of hydrogen ions (H^+) in the ocean. Acidity is measured as a function of the concentration of hydrogen ions (pH), so the increased concentration of H^+ causes the seawater to be more acidic and less alkaline or basic. A portion of the excess hydrogen ions react with carbonate (CO_3^{2-}) to form greater of bicarbonate (HCO_3^-), causing CO_3^{2-} to become less abundant (Hardt and Safina, 2008; NOAA, 2020b). CO_3^{2-} are a critical component of $CaCO_3$, which many marine macroinvertebrates use to manufacture shells and exoskeletons. When the concentration of CO_3^{2-} 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, 2020b; USGCRP, 2018).

The IPCC states that it is "virtually certain" that CO_2 emissions from human activity are the main driver of the ongoing global acidification of the surface open ocean (IPCC, 2021).



Source: NOAA

Figure 3.13-4. Time Series of Carbon Dioxide and Ocean pH at Mauna Loa, Hawaii

3.13.1.3 Deoxygenation

Increased CO_2 levels in the atmosphere are also causing a decline in ocean concentrations of DO. 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. Deoxygenation can also occur from "oxygen demanding" pollutants entering the water, mostly from nitrogen and phosphorus nutrients associated with agricultural/fertilizer runoff (USGCRP, 2018).

The three processes (warming, acidification, and deoxygenation) interact with one another and with other agents of environmental stress in the ocean environment, resulting in a wide array of cumulative impacts (USGCRP, 2018). Impact-causing factors associated with climate change include changes to water characteristics (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, 2019a).

3.13.1.4 Extreme Weather

Anthropogenic climate change is already impacting a number of weather and climate extremes across every region, ocean, and continent on the planet. Observed changes in extremes include increased heatwaves, droughts, wildfires, storms and heavy precipitation, floods, and tropical cyclones. Evidence that human influence is driving these extremes has strengthened since the IPCC's Fifth Climate Assessment in 2014 (IPCC, 2021).

Heatwaves have become more frequent and more intense across most land regions since the 1950s, while cold waves have become less frequent and less severe, and there is "high confidence" that human-induced global warming is the main factor behind these changes. Some of the recent heatwaves over the past decade would have been "extremely unlikely" without human influence on the climate. In addition, the frequency of marine heatwaves has approximately doubled since the 1980s and human influence has "very likely" contributed to most of these heatwaves since at least 2006 (IPCC, 2021).

Both the frequency and the intensity of heavy precipitation events have increased since the 1950s over most land areas for which observational data are adequate for trend analysis. Anthropogenic climate change is probably the main cause of these meteorological extremes. Human-induced climate change, from increased evapotranspiration, has also contributed to increases in droughts affecting both natural ecosystems and agricultural areas in some regions (IPCC, 2021).

The global proportion of major (Category 3–5) tropical cyclone (hurricane) occurrence has likely increased over the last four decades. At the same time, the latitude where tropical cyclones in the western North Pacific achieve peak intensity have shifted northward. Evidence indicates that human-induced climate change increases heavy precipitation associated with tropical cyclones. Since the 1950s, human influence has likely increased the probability of compound extreme climate events. This includes increases in the frequency of simultaneous heatwaves and droughts (**Figure 3.13-5**); fire weather in some regions; and compound flooding at some sites (IPCC, 2021).

Source: NOAA

Figure 3.13-5. Abandoned Cotton Field in Drought-Stricken Texas, 2014

The IPCC concludes that overall human influence has unequivocally warmed the atmosphere, ocean and land. Concomitant, rapid, and widespread changes to the atmosphere, ocean, cryosphere (frozen parts of the planet) and biosphere have followed. Each of the last four decades has been successively warmer than any previous decade since1850 (IPCC, 2021).

3.13.1.5 Summary of the Current State of Climate

NOAA summarizes the current state of the Earth's changing climate and its implications for the U.S. in particular:

- Global temperatures have risen about 1.8°F (1°C) from 1901 to 2020.
- Sea level rise has accelerated from 1.7 mm/year throughout most of the twentieth century to 3.2 mm/year since 1993.
- Glaciers are shrinking: average thickness of 30 well-studied glaciers has decreased more than 60 feet since 1980.
- The area covered by sea ice in the Arctic at the end of summer has shrunk by about 40 percent since 1979.
- The amount of CO2 in the atmosphere has risen by 25 percent since 1958, and by about 40 percent since the Industrial Revolution.

- Snowpack is an important source of freshwater in the western U.S. As temperatures warm, there is less snow overall and snow begins to melt earlier, so that snowpack may not be a reliable source of water during warm and dry seasons.
- Flooding is an increasing issue, as both stronger and more frequent, abnormally heavy precipitation events increase across most of the U.S.
- Drought is becoming more common, particularly in the western U.S..
- Increased temperatures, drought and water stress, diseases, and weather extremes are adversely affecting farms and ranches.
- Climate change is already impacting human health, endangering lives from heat, hurricanes, droughts, wildfires, flooding, waterborne diseases, injuries, and spreading geographic ranges of disease vectors such as mosquitoes and ticks.
- The most vulnerable groups in society, including children, the elderly, those with preexisting health conditions, outdoor workers, people of color, and low-income residents, are at an even higher risk because of compounding factors from climate change.
- Ecosystems and organisms are all impacted, though not equally. The Arctic is especially vulnerable, as it is warming at least twice the rate of the global average and melting land ice sheets and glaciers are helping cause global sea level rise.
- The ocean absorbs about 30 percent of the CO_2 that is released into the atmosphere. Ocean acidification is adversely affecting marine life.
- Coral reef ecosystems, home to thousands of species, are vulnerable to many effects of climate change (Figure 3.13-6): coral bleaching is occurring from warming waters, stronger and more destructive hurricanes, and reefs being smothered by sediments due sea level rise (NOAA, 2021a).

Source: NOAA

Figure 3.13-6. Dead Coral Reef

3.13.1.6 Future Climate Scenarios

The IPPC's Sixth Assessment Report (AR6) released in 2021 developed a set of five emissions scenarios to investigate the response of the global climate system to a range of potential GHG emissions, land use trends, and possible air pollution futures (e.g., aerosols such as SO_2). Emissions vary between the five scenarios – depending on socioeconomic assumptions, levels of climate change mitigation and air pollution controls (for aerosols and non-methane ozone precursors). These scenarios or projections also account for natural background influences such as solar and volcanic activity. The AR6 scenarios cover the near-term (2021–2040), mid-term (2041–2060) and long-term (2081–2100), relative to 1850–1900 (IPCC, 2021) (IPCC, 2021). This PEA considers the near-term scenarios, which most closely correspond to the time frame of this proposed action.

Figure 3.13-7 shows emissions trajectories for the five scenarios from 2015 to 2100 for CO_2 from all sectors in gigatons per year ($GtCO_2$/yr.). As a result of the climate forcing from CO_2 and other human-emitted GHGs, the IPCC expects global surface temperature to continue increasing until at least 2050 under each of the emissions scenarios. Global warming of 1.5°C and 2°C (above the 1850-1900 baseline) will be exceeded during the 21st century unless deep reductions in CO_2 and other GHG emissions take place in the coming decades.

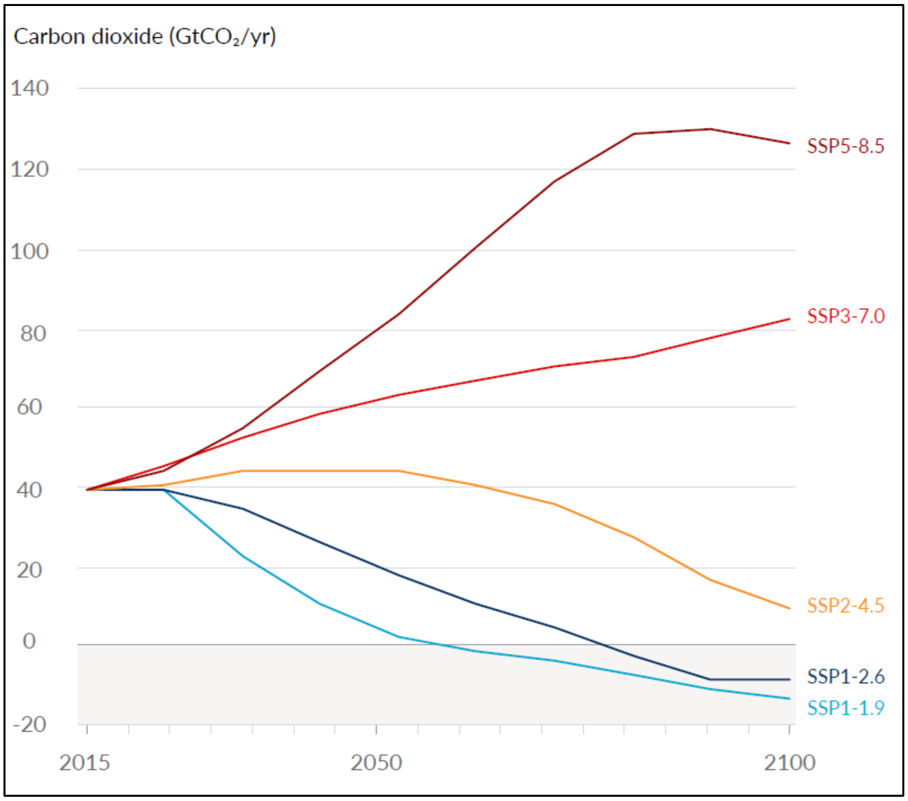
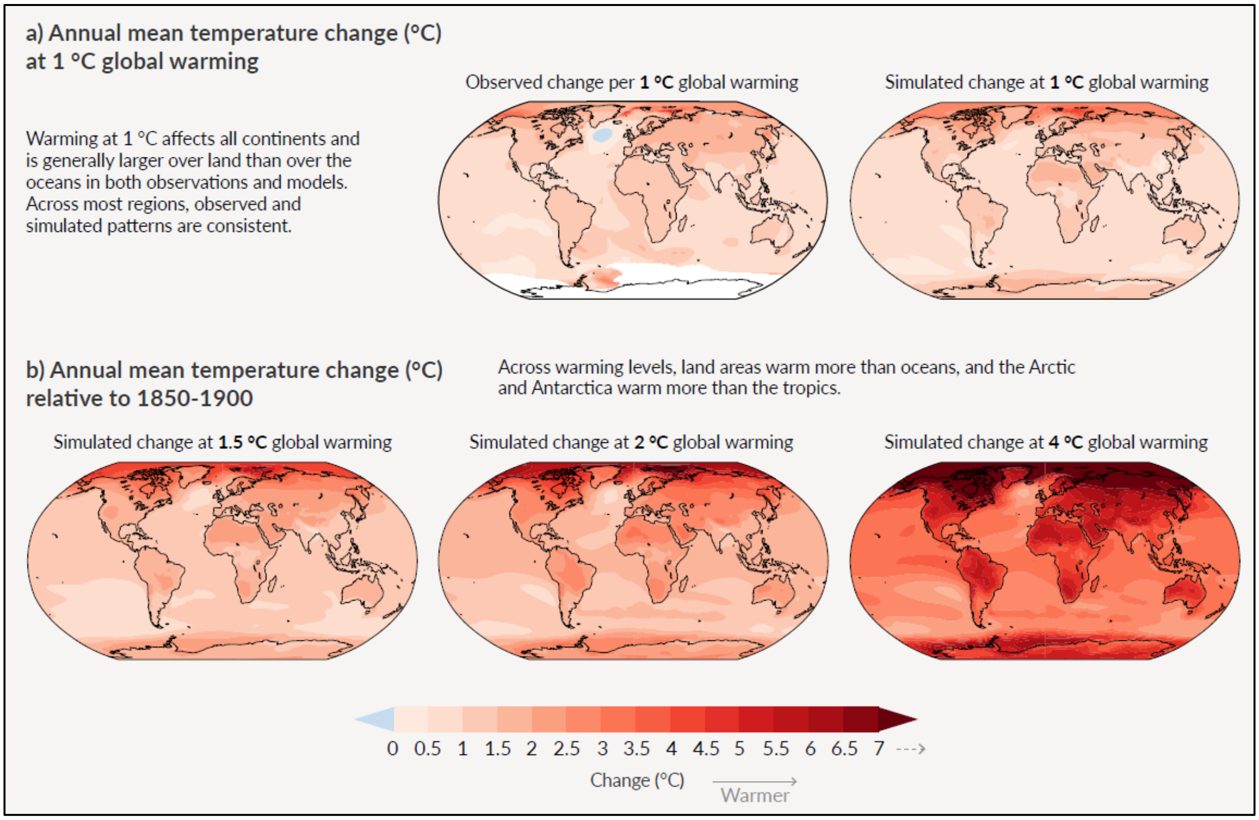


Figure 3.13-7. Future Emissions of CO2 Under the AR6's Five Emissions Scenarios

The anticipated rise in global surface temperature under AR6 modeling, from 2021 to 2040 (near-term) is 1.5 degrees Celsius above the 1850-1900 baseline in four of the scenarios; and 1.6 degrees in one of the scenarios.

Many of the future changes in the climate system predicted by models intensify in direct proportion to increasing global warming. These include increases in the frequency and intensity of heatwaves, marine heatwaves (warmer water surface temperatures such as those associated with the ENSO), heavy precipitation events, agricultural and ecological droughts in some regions, the proportion of stronger tropical cyclones, reductions in Arctic Ocean sea ice, snow cover and permafrost (IPCC, 2021).

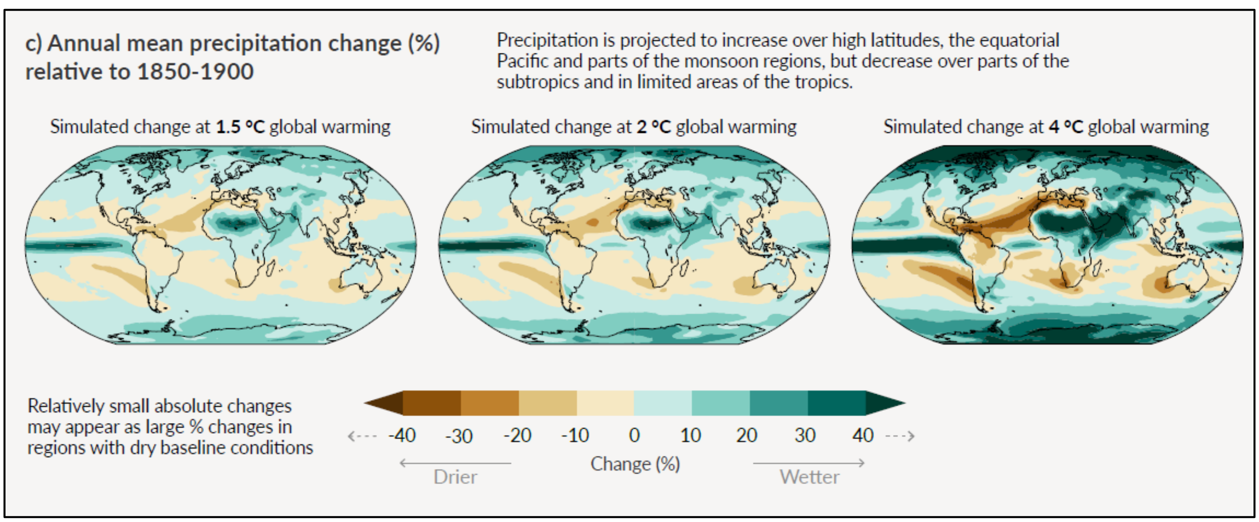
The IPCC considers it to be "virtually certain" that the land surface will continue to warm faster than the ocean surface (likely 1.4 to 1.7 times faster). It is also virtually certain that the Arctic will continue to warm faster than the average global surface temperature, probably above two times the rate of global warming (**Figure 3.13-8**). With every added increment of temperature, extremes increase in frequency. For instance, every increment of 0.5°C causes clearly noticeable increases in the intensity and frequency of hot extremes – including heatwaves and heavy precipitation – as well as agricultural and ecological droughts in some regions. Continued global warming will intensify the global water cycle (increasing the volume of water circulated and transported through that cycle), including its variability, global monsoon precipitation, and the severity of wet and dry events (IPCC, 2021).



Source: IPCC, 2021

Figure 3.13-8. Observed and Simulated Mean Surface Air Temperature Change

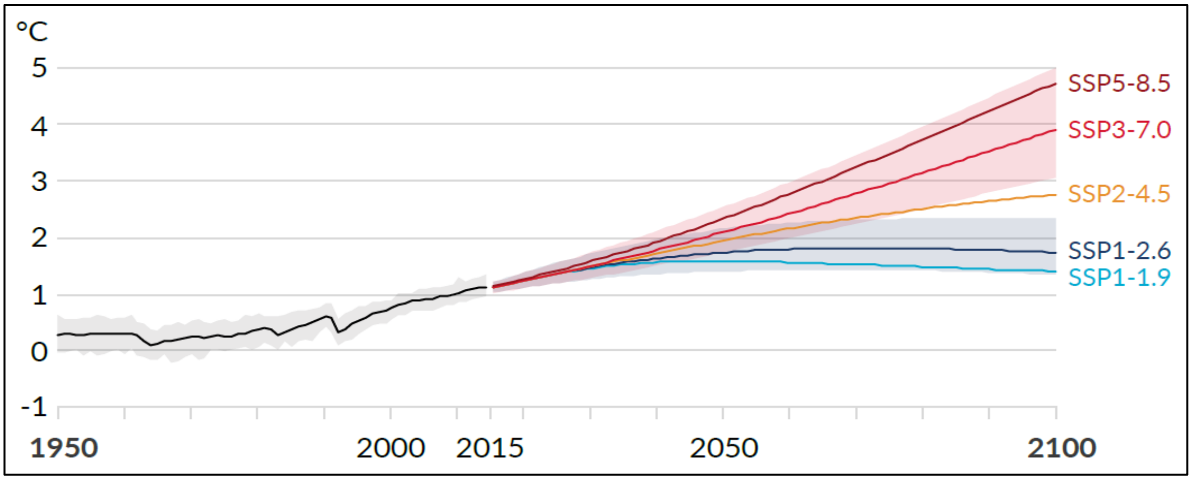
Figure 3.13-9 shows projected changes in global precipitation patterns associated with different temperature increments.



Source: IPCC, 2021

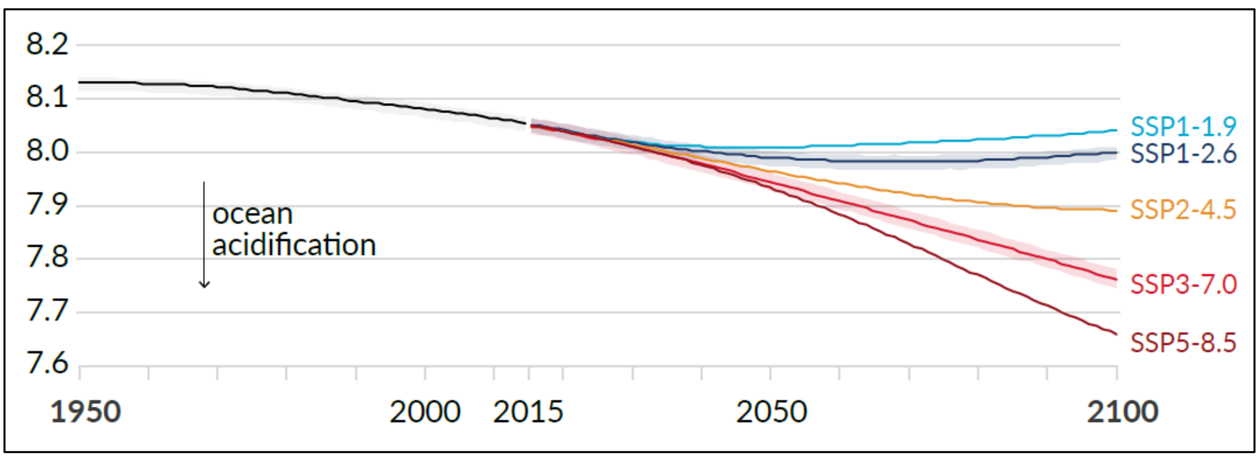
Figure 3.13-9. Change in Annual Mean Precipitation Relative to 1850-1900

In summary, increasing human activities and related GHG emissions are affecting, and in the future will have even greater effects, on all major aspects of the global climate system. Some of these components will respond across decades and others across centuries (IPCC, 2021). **Figure 3.13-10** shows future surface temperature projections for the five modeling scenarios; **Figure 3.13-11** shows global ocean surface pH.



Source: IPCC, 2021

Figure 3.13-10. Projected Global Surface Air Temperature Changes Relative to 1850-1900



Source: IPCC, 2021

Figure 3.13-11. Global Ocean Surface pH

3.13.1.7 GHG Emissions from OMAO Activities

Over the past two decades, GHG emissions from all ships and boats in the U.S. have ranged from 40 to 47 million metric tons of CO_2 equivalent (CO_2e) (Statistica.com, 2023). There was a slight decline in maritime GHG emissions over this time period, and the 2019 maritime emissions of 40 million metric tons comprised 0.6 percent of total U.S. GHG emissions of 6,558 million metric tons of CO_2e (EPA, 2023i). GHG emissions from OMAO vessel operations, both within and while transiting outside the EEZ, represent a very small fraction of all U.S. shipping and boating emissions, and thus an even smaller fraction of total U.S. GHG emissions. Transit miles attributable to OMAO vessel operations likely represent less than 0.01 percent of total vessel use within the EEZ, which means that GHG emissions from burning fossil fuels (diesel fuel, etc.) to propel vessels these distances would comprise approximately one-ten-thousandth (1/10,000) of annual U.S. emissions of 40 to 47 million metric tons of CO_2e from all boating and shipping, or about 4,000-4,700 metric tons CO_2e annually. This comes to 0.006 percent of annual U.S. GHG emissions measured in CO_2e.

GHG emissions and concomitant climate change, including rising marine surface water temperatures and ocean acidification, are beginning to have widespread, long-term effects on marine ecosystems and their components, ranging from tropical coral reefs to shellfish, commercial fisheries, and marine mammals.

The contribution of NOAA vessels to this global problem could be reduced through implementing greater energy and fuel efficiency measures and increased use of renewable energy sources where applicable.

3.13.2 Environmental Consequences

This section discusses: 1) the qualitative effects of OMAO vessel operations on climate, and 2) potential effects global climate change may have on these same OMAO operations over the coming 15 years.

The activities describing OMAO operations in Table 2.1-1 and in Section 2.2 that are expected to contribute to the increase of CO_2 in the atmosphere and its resultant effects on climate include vessel movement; UMS operations; UAS operations; and small boat systems operations. Of these, vessel movement contributes by far the greatest amount of fuel consumption and related carbon dioxide emissions.

Anchoring; waste handling and discharges; vessel repair and maintenance; active acoustic systems operations; other sensors and data collection systems operations; and OTS handling, crane, davit, and winch operations are not expected to impact the climate and are not discussed further in this section.

NOAA vessels require fossil fuel combustion for ship’s propulsion, electricity, and operation. OMAO activities emit CO_2 to the atmosphere and thus contribute, incrementally, to changes in the climate. Effects of global climate change, including continuing sea level rise, ocean acidification and deoxygenation, reductions in Arctic Ocean sea ice, and an increase in the frequency of extreme weather events such as hurricanes could change the type and frequency of OMAO operations over the next 15 years.

3.13.2.1 Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet

Under Alternative A, OMAO operations using the existing NOAA fleet would continue across all five operational areas over the 15-year period. In addition, OMAO is constructing two oceanographic research vessels that are expected to come online by 2025 and two new charting and mapping vessels that are expected to come online by 2027 and 2028 for a total of four new ships under Alternative A. OMAO would provide a maximum annual capacity of 3,568 operational DAS for scientific projects.

3.13.2.1.1 Effect of OMAO Operations on Climate Change

The most important GHGs in descending order are CO_2, CH_4, N_2O, halogenated gases, and ground-level O_3. In terms of those GHGs emitted to the atmosphere by human activities in general and OMAO activities in particular, CO_2 has the greatest influence on the climate (Buis, 2022; IPCC, 2021). The main anthropogenic source of CO_2 emissions globally is the combustion of non-renewable fossil fuels – oil, natural gas, and coal – to provide energy for a variety of purposes in modern, industrialized societies. Fuel is required to provide propulsion for ocean-going vessels such as those belonging to NOAA, the operations of which are the focus of this EA. The largest vessel in the fleet, NOAA Ship *Ronald H. Brown*, displaces 3,250 tons when fully loaded, has two 3,000 horsepower propulsion motors and can reach speeds up to 15 knots (17 mph). The liquid fuels used for propulsion are all originally derived from oil.

GHG emissions from all ships and boats in the U.S. account for less than one percent (0.6 percent) of total U.S. GHG emissions (EPA, 2023i) and an even smaller share of global emissions measured in tons of CO_2 equivalent (0.08 percent) (World Bank, 2022). As noted above, OMAO GHG emissions from burning diesel fuel, and other fossil fuels are estimated to comprise approximately one-ten-thousandth (1/10,000) of annual U.S. emissions of 40-47 million metric tons of CO_2e from all boating and shipping, or about 4,000-4,700 metric tons CO_2e annually. This comes to 0.006 percent of annual U.S. GHG emissions measured in CO_2e. EPA is in the process of updating the social cost of GHG emissions and estimates that carbon emissions are now $190 per metric ton (tonne) (RFF, 2023). At this price, the annual social cost for OMAO activities would be in the range of $760,000 to $893,000.

Other forms of air pollution (e.g., caused by the "criteria pollutants" regulated under the Clean Air Act, namely ground-level ozone, carbon monoxide, lead, nitrogen dioxide, particulate matter, and sulfur dioxide) can have localized or regional effects on air quality, ecosystem integrity, visibility, and public health, depending on the location and proximity to the source(s) of air pollutants. In contrast, CO_2 emissions and the resulting buildup of CO_2 in the atmosphere is a global phenomenon, one with consequences that can vary substantially from one region or ecosystem to another around the globe. In other words, the specific location of CO_2 emission sources is irrelevant. Over time, CO_2 emissions are continuously mixed, dispersed, and circulated throughout the atmosphere.

As stated above, the combustion of fossil fuels to provide propulsion and electricity to the vessel during OMAO operations would emit CO_2 to the atmosphere and thus contribute incrementally to changes in the climate due to higher CO_2 levels. The resulting effects include warming air and water temperatures, changing precipitation patterns, sea level rise, ocean acidification and deoxygenation, reductions in Arctic Ocean sea ice, and an increase in the frequency of extreme weather (e.g., more floods, droughts, and destructive hurricanes). Indirect effects of climate change from anthropogenic CO_2 and overall GHG emissions would likely occur on natural ecosystems, flora and fauna distribution, biodiversity, soils, agriculture, hydrology, human settlements, and migration to different locations.

As mentioned above, OMAO's largest contribution to climate change from CO_2 emissions is vessel movement. Converting fossil fuels into energy and releasing emissions is necessary to propel NOAA's fleet thousands of miles annually. However, OMAO's emissions represent only approximately 0.006% of all U.S. and global CO_2 and overall GHG emissions. Release of CO_2 into the atmosphere from OMAO operations contributes directly and adversely, albeit negligibly, to the incremental, long-term buildup of atmospheric CO_2 causing global climate change. Overall, the effects of climate change from OMAO operations under Alternative A would be adverse, **permanent**, **negligible**, **regional** to **global**, and with a **high** likelihood of occurrence. The overall impacts would, therefore, be **insignificant**.

3.13.2.1.2 Effect of Climate Change on OMAO Operations

The potential effects anthropogenic climate change may have on OMAO operations over the coming 15 years are likely to be minimal in comparison with those projected by the IPCC and other climatologists through the year 2100. Continuing sea level rise, ocean acidification and deoxygenation, reductions in

Arctic Ocean sea ice, and an increase in the frequency of extreme weather events such as hurricanes will all lead to incremental changes in the marine environment over the next 15 years, changes which are likely to have corresponding effects on OMAO operations.

For example, if sea level continues to rise at the rate of 3.2 mm/year since 1993, it will have risen 4.8 cm (nearly two inches) after 15 years; this value could be considered a minimum. An additional two inches of sea level rise would have slight, but consequential impacts on OMAO operations., especially within ports and harbors. These impacts could include changes to docking actions, unusable infrastructure, wear on facilities, greater exposure to storm surge during severe weather events, and others. Projected reductions in sea ice could increase OMAO operations in the Arctic. A high priority could be set to have a greater NOAA presence to conduct surveys in the region. There would be a greater risk of oil spills or other accidents with environmental implications in this formerly pristine and harsh environment. Worsening ocean acidification and deoxygenation will further stress marine environments and living resources, possibly leading to new OMAO-supported NOAA projects or missions in different regions. Finally, an increase in hurricanes or other extreme weather events could increase OMAO's participation in emergency response.

As noted in the introductory section above, ongoing global climate change would lead to certain changes in the marine environment and would potentially have an adverse effect on OMAO operations over the coming 15 years. However, in view of the observed rate of climate change and the predicted (perhaps accelerated) future rate, changes in sea level, storm severity and frequency, acidity and deoxygenation, and melting of Arctic Ocean Sea ice in summer months would all be relatively small from those experienced at present. Thus, the presumptive direct and indirect adverse effects of climate change (over and above current climate conditions) on OMAO operations in the near future would likely range from **negligible** to **minor**, both **regional** and global, and **long-term** to permanent. The overall impacts would, therefore, be **insignificant**.

3.13.2.1 Conclusion

Under Alternative A, OMAO would continue to use the existing fleet to conduct operations to support NOAA's primary mission activities. OMAO would continue to operate the survey and research ships until they reach the end of their service life. Almost half the ships in the NOAA fleet would exceed their design service life by 2038; however, two new ships would come online by 2025 with two more ships projected to come online by 2027 and 2028.

Since the effects of impact-causing factors on climate change in the action area are **negligible**, the overall impact of Alternative A on climate would be adverse, **highly** likely**, negligible, long-term** to **permanent,** and **regional** to **global,** and therefore **insignificant**. The vulnerability of OMAO operations under Alternative A to climate change would be adverse and would range from **negligible** to **minor, long-term** to **permanent,** of **high** likelihood**,** and **regional** to **global,** and therefore **insignificant** as well.

3.13.2.2 Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities

OMAO operations under Alternative B would take place in the same operational areas and timeframes as under Alternative A; however, under Alternative B, OMAO would construct up to eight new ships, (four as in Alternative A, plus four additional ships), to replace vessels that would reach the end of their design service life, extend the service life of aging ships through maintenance and mid-life repairs for six ships, increase fleet utilization with up to 4,138 DAS (approximately 570 more DAS annually than under Alternative A), and integrate new and greener technology as described in Section 2.4. The difference between the two alternatives is primarily a matter of scale with increased activity levels distributed unevenly among the different types of operations, the five operational areas, and within the 15-year timeframe. As such, effects under Alternative B would incrementally increase from those of Alternative A but would not differ fundamentally in type.

CO_2 and overall GHG emissions and the resultant social cost for GHGs from OMAO operations under Alternative B could potentially increase or decrease incrementally from those associated with Alternative A. Alternative B would offer more DAS which could potentially lead to somewhat greater emissions. On the other hand, since the newer vessels would be greener and more fuel-efficient than the older ships they are replacing, this would tend to drive down CO_2 emissions. Implementation of energy efficiency efforts across the fleet, such as replacing fluorescent lamps with LEDs would decrease the contribution to CO_2 emissions. Whether such improved efficiency would be sufficient to offset the increase in miles traveled, DAS, and projects is unknown. In any case, overall CO_2 and GHG emissions from OMAO operations under Alternative B would remain a miniscule percentage of overall U.S. and global CO_2 and overall GHG emissions.

Therefore, the impact of Alternative B on climate change would be essentially the same as Alternative A: **adverse, negligible, regional** to **global,** and **long-term** to **permanent,** and thus **insignificant**. And the effects of climate change on OMAO operations under Alternative B would be the same as those of Alternative A: **direct** and **indirect, adverse, negligible** to **minor, long-term** to **permanent,** of **high** likelihood, and **regional** to **global**, and therefore **insignificant** as well.

3.13.2.3 Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support

OMAO operations under Alternative C would implement the same measures as under Alternative B and take place in the same operational areas and timeframe as under Alternatives A and B. However, Alternative C would consist of an overall funding increase of 20 percent relative to Alternative B with additional measures including maximizing crew rotations and enhancing overall fleet performance by increasing DAS to 4,873, construction of two new ships in addition to those under Alternative B, increasing the number and use of uncrewed systems integrated into vessels, and shortening the timeframe for fleet improvement activities, implementation of greening techniques, and improvements to the small boat fleet as discussed in Section 2.5.

Under Alternative C, DAS would be approximately one-third (36 percent) greater than DAS under Alternative A. Assuming that OMAO vessel miles under this alternative were to increase by the same percentage, annual GHG emissions would increase to the approximate range of 5,440 to 6,440 CO_2e. However, this assumes no increase in fleet energy efficiency with newer vessels and newer engines; even so, these increased GHG emissions (without accounting for any energy efficiency improvements) would comprise about 0.008 percent of annual U.S. GHG emissions measured in CO_2e. The difference between the three alternatives is primarily a matter of scale with increased activity levels distributed among the different types of operations, the five operational areas, and within the 15-year timeframe. As such, effects on climate and from climate under Alternative C would incrementally increase from those of Alternatives A and B but would not differ fundamentally in type.

Therefore, the impact of Alternative C on climate change would be essentially the same as Alternatives A and B: **adverse, negligible, regional** to **global,** and **long-term** to **permanent,** and thus **insignificant**. And the effects of climate change on OMAO operations under Alternative C would also be the same as those of Alternatives A and B: **direct** and **indirect, adverse, negligible** to **minor, long-term** to **permanent**, of **high** likelihood, and **regional** to **global**, and therefore **insignificant** as well.

3.14 COMPARISON OF ALTERNATIVES

Table 3.14-1 presents a summary of the assessed environmental consequences associated with Alternatives A, B, and C for the resources that have been analyzed in Chapter 3 of this Draft PEA.

All environmental consequences from each of the alternatives are anticipated to be adverse, ranging from negligible to moderate, and insignificant for all resources except socioeconomics, for which the environmental consequences would be beneficial, moderate, and insignificant. While DAS would increase under Alternative B and C, resulting in an increase in overall impacts across all resource areas compared to the No Action Alternative, the deployment of new ships with greener, technically-advanced systems and infrastructure would likely reduce impacts across most, if not all, resource areas. However, the increased or decreased impacts would not change by an order of magnitude between alternatives (e.g., from minor to moderate or from minor to negligible).

Under Alternative A, the No Action Alternative, OMAO would continue to use the current NOAA fleet to conduct the activities listed in Section 2.2 to support NOAA's primary mission activities. Additionally, OMAO is constructing two oceanographic research vessels that are expected to come online by 2025 and awarded contracts for two new charting and mapping vessels that are expected to come online by 2027 and 2028 for a total of four new ships. Under Alternative A, OMAO would provide a maximum annual capacity of 3,568 DAS for scientific projects While greening techniques are currently being implemented across the existing NOAA fleet, up to seven ships could reach the end of their design service life by 2038.

Under Alternative B, OMAO would implement a phased approach to long-term modernization of the NOAA fleet and fleet management best practices, in addition to continuing current OMAO vessel operations. This would include the design and construction of up to four new ships in addition to the four new ships under Alternative A to replace vessels that would reach the end of their design service life for a total of eight new ships added to the NOAA fleet, extending the service life of aging fleet by conducting material condition assessment surveys and mid-life repairs, increasing NOAA's fleet utilization by 570 DAS compared to Alternative A's levels, and implementing new, greener technology across the fleet. New ships would be integrated with greener and more technically-advanced systems to improve the overall performance of the fleet. Some of these advancements include updated data collection technology, improvements to mechanical control systems and system efficiencies, and greener technologies, such as energy efficiency improvements, increased storage for treated waste and wastewater, OWSs and MSDs to minimize pollution discharges, and more efficient, EPA Tier IV generators.

Under Alternative C, OMAO would implement the measures in Alternative B with an overall funding increase of 20 percent relative to Alternative B, in addition to continuing OMAO vessel operations. Additional measures to those described under Alternative B would be adopted by OMAO under Alternative C, including two additional new ships for a total of ten new ships added to the NOAA fleet; increasing the number of uncrewed systems in the NOAA fleet; increasing NOAA's fleet utilization by 735 DAS beyond Alternative B levels; shortening the timeframe of fleet improvement activities, greening techniques, and improvements to the OMAO small boat fleet; and purchasing or developing a more efficient scheduling system for vessels, equipment, and personnel.

Table 3.14-1. Summary Comparison of Impacts

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
Air Quality	Impacts to air quality from diesel air emissions under Alternative A would be adverse and negligible to minor. Impacts to air quality from incinerator air emissions under Alternative A would be adverse and negligible to minor. Impacts to air quality from ozone depleting substances under Alternative A would be adverse and negligible to minor. Overall, impacts to air quality under Alternative A would be adverse, negligible to minor, and insignificant.	Impacts of Alternative B to air quality would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the deployment of new ships and integration of new and greener technology would likely reduce some impacts. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to air quality under Alternative B would be adverse, negligible to minor, and insignificant.	Impacts of Alternative C to air quality would be similar to those that would occur under Alternatives A and B. Overall, impacts to air quality under Alternative C would be adverse, negligible to minor, and insignificant.
Water Quality	Impacts to water quality from fuels, chemicals, and other contaminants under Alternative A would be adverse and minor to moderate. Impacts to water quality from wastewater under Alternative A	Impacts of Alternative B to water quality would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the	Impacts of Alternative C to water quality would be similar to those that would occur under Alternatives A and B. Overall, impacts to water quality under Alternative C would be

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	would be adverse and minor to moderate. Impacts to water quality from marine debris under Alternative A would be adverse and minor to moderate. Impacts to water quality from increases in sedimentation and/or turbidity under Alternative A would be adverse and negligible to minor. Although the effects of impact causing factors on water quality range from negligible to moderate, moderate impacts could occur in the rare event of an accidental discharge or spill of fuels, chemicals, wastewater, marine debris, or some other contaminants. Overall, impacts to water quality under Alternative A would be adverse, negligible to moderate, and insignificant.	deployment of new ships and integration of new and greener technology would likely reduce some impacts. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to water quality under Alternative B would be adverse, negligible to moderate, and insignificant.	adverse, negligible to moderate, and insignificant.
Acoustic Resources	Impacts to the acoustic environment from airborne sound	Impacts of Alternative B to the acoustic environment would be the same or slightly, but not appreciably, larger than	Impacts of Alternative C to the acoustic environment would be

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	under Alternative A would be adverse and minor. Impacts to the acoustic environment from underwater sound under Alternative A would be adverse and minor. Overall, impacts to the acoustic environment from underwater sound under Alternative A would be adverse, minor, and insignificant.	those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the deployment of new ships with greener technology that would likely incorporate quieter designs would likely reduce some impacts to the airborne and underwater acoustic environments. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to the acoustic environment under Alternative B would be adverse, minor, and insignificant.	similar to those that would occur under Alternatives A and B. Overall, impacts to the acoustic environment under Alternative C would be adverse, minor, and insignificant.
Habitats	Impacts to habitats from increased sedimentation, turbidity, and chemical contaminants; and from increased ambient sound under Alternative A would be adverse and negligible to minor. Impacts to habitats from activities involving physical disturbance to bottom substrate and from facilitated dispersal of invasive	Impacts of Alternative B to 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 habitats under Alternative B would not cause long-term changes in the availability of space, shelter, cover, or nutrients necessary for dependent species and would not substantially increase or	Impacts of Alternative C to habitats would be similar to those that would occur under Alternatives A and B. Overall, impacts to habitats under Alternative C would be adverse, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	species under Alternative A would be adverse and minor. Impacts to habitats from impacts to the water column under Alternative A would be adverse and negligible. Overall, impacts to habitat under Alternative A would be adverse, minor, and insignificant.	differ in intensity as compared to Alternative A. Overall, impacts to habitats under Alternative B would be adverse, minor, and insignificant.	
Biological Resources - Marine Mammals	Impacts to marine mammals (cetaceans, pinnipeds, sirenians, and fissipeds) from increased ambient sound levels under Alternative A would be adverse and minor. Impacts to marine mammals from vessel presence and movement of equipment in the water under Alternative A would be adverse and minor. Impacts to marine mammals from accidental leakage or spillage of oil, fuel, and chemicals under Alternative A would be adverse and negligible to minor.	Impacts of Alternative B to 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 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. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe.	Impacts of Alternative C to marine mammals would be similar to those that would occur under Alternatives A and B. Overall, impacts to marine mammals under Alternative C would be adverse, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	Impacts to marine mammals from trash and debris under Alternative A would 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 polar bears are disturbed at denning sites or if polar bear-human interactions occur, the impacts could be adverse and moderate. Overall, impacts to marine mammals under Alternative A would be adverse, minor, and insignificant.	Overall, impacts to marine mammals under Alternative B would be adverse, minor, and insignificant.	
Biological Resources - Sea Turtles	Impacts to sea turtles from increased ambient sound levels under Alternative A would be adverse and negligible. Impacts to sea turtles from vessel presence and movement under Alternative A would be adverse and negligible to minor.	Impacts of Alternative B to sea turtles 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 sea turtles resulting from Alternative B would not cause long-term changes in habitat availability and use, sea turtle behavior, or energy expenditures.	Impacts of Alternative C to sea turtles throughout the action area 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 sea turtles resulting from Alternative C would not cause long-term changes in

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	Impacts to sea turtles from accidental leakage or spillage of oil, fuel, and chemicals under Alternative A would be adverse and negligible to minor. Impacts to sea turtles from underwater activities under Alternative A would be adverse and negligible to minor. 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, given the protection status afforded to sea turtles by the ESA. Overall, impacts to sea turtles under Alternative A would be adverse, minor, and insignificant.	The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to sea turtles under Alternative B would be adverse, minor, and insignificant.	habitat availability and use, sea turtle behavior, or energy expenditures. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to sea turtles under Alternative C would be adverse, minor, and insignificant.
Biological Resources - Fish	Impacts to fish from increased ambient sound under Alternative A would be adverse and negligible to minor. Impacts to fish from vessel wake and underwater turbulence under	Impacts of Alternative B to fish 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 to fish would be similar to those that would occur under Alternatives A and B.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	Alternative A would be adverse and negligible to minor. Impacts to fish from accidental leakage or spillage of oil, fuel, and chemicals under Alternative A would be adverse and negligible. In the rare event that an accidental spill was to occur, the impacts would be minor. Impacts to fish from disturbance of the seafloor under Alternative A would be adverse and negligible to minor. Overall, impacts to fish under Alternative A would be adverse, minor, and insignificant.	While Alternative B would result in greater impacts overall from additional DAS, the deployment of new ships and integration of new and greener technology would likely reduce some impacts. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to fish under Alternative B would be adverse, minor, and insignificant.	Overall, impacts to fish under Alternative C would be adverse, minor, and insignificant.
Biological Resources - Aquatic Macroinvertebrates	Impacts to aquatic macroinvertebrates from increased ambient sound under Alternative A would be adverse and negligible. Impacts to aquatic macroinvertebrates from vessel wake and underwater turbulence under Alternative A would be adverse and negligible to minor.	Impacts of Alternative B to aquatic macroinvertebrates would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the deployment of new ships and integration of new and greener technology would	Impacts of Alternative C to aquatic macroinvertebrates would be similar to those that would occur under Alternatives A and B Overall, impacts to aquatic macroinvertebrates under Alternative C would be adverse, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	Impacts to aquatic macroinvertebrates from accidental leakage or spillage of oil, fuel, and chemicals under Alternative A would be adverse and negligible. In the rare event that an accidental spill was to occur, the impacts would be minor. Impacts to aquatic macroinvertebrates from disturbance of the seafloor under Alternative A would be adverse and negligible to minor. Overall, impacts to aquatic macroinvertebrates under Alternative A would be adverse, minor, and insignificant.	likely reduce some impacts. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to aquatic macroinvertebrates under Alternative B would be adverse, minor, and insignificant.	
Biological Resources - Seabirds, Shorebirds, Coastal Birds, and Waterfowl	Impacts to birds from increased ambient sound levels under Alternative A would be adverse and negligible. Impacts to birds from vessel presence and movement under Alternative A would be adverse and negligible to minor.	Impacts of Alternative B to birds 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 B to birds would generally persist only for the duration of an activity and would not be expected to cause any long-term changes in habitat use	Impacts of Alternative C to birds would be similar to those that would occur under Alternatives A and B. Overall, impacts to birds under Alternative C would be adverse, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	Impacts to birds from accidental leakage or spillage of oil, fuel, and chemicals under Alternative A would be adverse and minor. In the rare event that an accidental spill was to occur, the impacts would be moderate or greater. Impacts to birds from underwater activities under Alternative A would be adverse and negligible to minor. Overall, impacts to birds under Alternative A would be adverse, minor, and insignificant.	and availability or energy expenditure outside of the natural range of variation. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to birds under Alternative B would be adverse, minor, and insignificant.	
Cultural and Historic Resources	Impacts to cultural and historic resources from physical impacts to submerged cultural and historic under Alternative A would be both adverse and beneficial and negligible. Beneficial impacts would occur if a resource were discovered that led to the identification of a culturally-significant artifact, group of artifacts, or a previously undocumented historic site. Impacts to cultural and historic resources from visual and noise	Impacts of Alternative B to 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. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to cultural and historic resources under Alternative B would be adverse, minor, and insignificant.	Impacts of Alternative C to cultural and historic resources would be similar to those that would occur under Alternatives A and B. Overall, impacts to cultural and historic resources under Alternative C would be adverse, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	impacts to historic properties from the presence of NOAA vessels under Alternative A would not occur. Impacts to cultural and historic resources from visual and noise impacts to TCPs and subsistence hunting and fishing areas from the presence of NOAA vessels and operation of active acoustic sources under Alternative A would be adverse and negligible to minor. Overall, impacts to cultural and historical resources under Alternative A would be adverse, minor, and insignificant.		
Socioeconomic Resources	Impacts to socioeconomic resources from data acquired by the NOAA fleet under Alternative A would be beneficial and minor to moderate. The impacts would decrease in intensity from moderate at current fleet utilization levels to minor at reduced fleet utilization levels towards the end of the 15-year timeframe of this PEA. The quality and quantity of products and services to society would decrease	Impacts of Alternative B to socioeconomic resources would be an incremental increase in effects as compared to Alternative A that would be distributed unevenly among the different types of operations, the five operational areas, and within the 15-year timeframe. The deployment of newer, more technically-advanced ships along with service life extensions to NOAA ships would increase fleet utilization and data collection capabilities as compared to Alternative A. The quality and quantity of products and	Impacts of Alternative C to socioeconomic resources would be similar but increase beyond the level anticipated under Alternatives A and B. Overall, impacts to socioeconomic resources under Alternative C would be beneficial and moderate.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	under Alternative A, resulting in fewer benefits to society across economic sectors. Overall, impacts to socioeconomic resources under Alternative A would be beneficial and moderate.	services would increase under Alternative B, resulting in greater benefits to society across economic sectors as compared to Alternative A. Overall, impacts to socioeconomic resources under Alternative B would be beneficial and moderate.	
Environmental Justice	Impacts to environmental justice from increased ambient sound levels under Alternative A would be adverse and minor. Impacts to environmental justice from vessel strikes and movement of equipment under Alternative A would be adverse and minor. Impacts to environmental justice from accidental leakage or spillage of oil, fuel, and chemicals under Alternative A would be adverse and minor. Impacts to environmental justice from entanglement with equipment and marine debris and ingestion under Alternative A would be adverse and minor.	Impacts of Alternative B to 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. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe. Overall, impacts to environmental justice under Alternative B would be both adverse and beneficial, minor, and insignificant.	Impacts of Alternative C to environmental justice would be similar to those that would occur under Alternatives A and B. Overall, impacts to environmental justice under Alternative C would be both adverse and beneficial, minor, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	Impacts to environmental justice from the availability of ocean data acquired by the NOAA fleet under Alternative A would be beneficial and minor. Overall, impacts to environmental justice under Alternative A would be both adverse and beneficial, minor, and insignificant.		
Hazardous, Special, and Universal Waste	Impacts to hazardous waste from the generation of hazardous waste under Alternative A would be adverse and negligible to minor. Impacts to hazardous waste from the storage and handling of hazardous waste under Alternative A would be adverse and negligible to minor. In the rare event that an accidental discharge or spill were to occur, the impacts would be minor to moderate. Overall, impacts to hazardous waste under Alternative A would be adverse, negligible to moderate, and insignificant.	Impacts of Alternative B to hazardous waste would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the deployment of new ships and integration of new and greener technology would likely reduce some impacts. The impacts would not substantially increase in intensity as they would be distributed across the five operational areas and occur throughout the 15-year timeframe.	Impacts of Alternative C to hazardous waste would be similar to those that would occur under Alternatives A and B. Overall, impacts to hazardous waste under Alternative C would be adverse, negligible to moderate, and insignificant.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
		Overall, impacts to hazardous waste under Alternative B would be adverse, negligible to moderate, and insignificant.	
Human Health and Safety	Impacts to human health and safety from vessel movement under Alternative A would be adverse and minor. Impacts to human health and safety from chemical and biological hazards under Alternative A would be adverse and negligible to minor. Impacts to human health and safety from OTS handling, crane, davit, and winch operations under Alternative A would be adverse and minor. Overall, impacts to human health and safety under Alternative A would be adverse, minor, and insignificant.	Impacts of Alternative B to human health and safety would be the same or slightly, but not appreciably, larger than those that would occur under Alternative A for each impact causing factor. While Alternative B would result in greater impacts overall from additional DAS, the introduction of new ships and safer, more standardized technology would likely reduce some impacts. In addition, the types of activities and safety measures would remain the same. Overall, impacts to hazardous waste under Alternative B would be adverse, minor, and insignificant.	Impacts of Alternative C to human health and safety would be similar to those that would occur under Alternatives A and B. While Alternative C would result in greater impacts overall from additional DAS, the introduction of new ships and safer, more standardized technology would likely reduce some impacts. In addition, the types of activities and safety measures would remain the same. Overall, impacts to hazardous waste under Alternative C would be adverse, minor, and insignificant.
Climate Change	The effect of OMAO vessel operations on climate change under Alternative A would be adverse and negligible. The effect of climate change on OMAO vessel operations under	Impacts of Alternative B as it relates to climate change and OMAO vessel operations 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 as it relates to climate change and OMAO vessel operations would be similar to those that would occur under Alternatives A and B.

Resource	Alternative A: No Action – Continue Vessel Operations with Current NOAA Fleet	Alternative B: Vessel Operations with Fleet Modernization and Optimizing At-Sea Capabilities	Alternative C: Vessel Operations with Fleet Modernization and Optimization with Greater Funding Support
	Alternative A would be adverse and negligible to minor. Overall, the effects of both OMAO vessel operations on climate change and climate change on OMAO vessel operations under Alternative A would be adverse, negligible/negligible to minor (respectively), and insignificant.	While Alternative B would result in greater impacts overall from additional DAS, the deployment of new ships and integration of new and greener technology would likely reduce some impacts. However, it is unknown whether improved efficiency efforts would offset the increase in miles traveled, DAS, and projects. Overall, the effects of both OMAO vessel operations on climate change and climate change on OMAO vessel operations under Alternative B would be adverse, negligible/negligible to minor (respectively), and insignificant.	Overall, the effects of both OMAO vessel operations on climate change and climate change on OMAO vessel operations under Alternative C would be adverse, negligible/negligible to minor (respectively), and insignificant.

4.0 CUMULATIVE IMPACTS

Cumulative impact is defined by the Council on Environmental Quality (CEQ) regulations at 40 CFR § 1508.7 (1978) as the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other 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 (i.e., sunlight or incoming solar radiation) and thus cool the planetary 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 (Section 4.1). 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) (1978), cumulative actions 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). Due to the volume and diversity of the past, present, and reasonably foreseeable cumulative actions, this section identifies specific projects and programs, both public and private sector, but also environmental and economic trends.

In addition to the more significant or widespread cumulative actions described in Sections 4.1.1 – 4.1.10, the resources in the action area, particularly biological resources, are sensitive to other human actions and activities that should also be considered in the cumulative impact analysis, when appropriate. These additional actions and 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; and

- 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.

Despite the potential short- and long-term cumulative effects of the recent global COVID-19 pandemic on the resources evaluated in this Draft PEA, the pandemic is not widely considered in this analysis due to the uncertainty and variability of its effects.

4.1.1 Other Federal Fleets

Other federal fleets include but are not limited to the University-National Oceanographic Laboratory System (UNOLS) Academic Fleet, the United States (U.S.) Coast Guard's (USCG) Operational Assets, specifically their fleet of boats, and the U.S. Navy's Active Ship Battle Forces, specifically their surface fleet. Given the exceptional variability and vast number of projects and activities in the action area, it is not possible to provide an exhaustive list of all vessel operations and projects in the action area for each of these fleets. However, by identifying key trends in each fleet, such as how the number of vessels in a fleet has changed over time, ongoing and reasonably foreseeable actions regarding vessel operations can be described.

UNOLS

UNOLS was established in 1972 and currently consists of 58 academic institutions and National Laboratories involved in oceanographic research. The organization was created to provide a primary forum through which the ocean research and education community, research facility operators, and supporting federal agencies could work cooperatively to improve access, scheduling, operation, and capabilities of current and future academic oceanographic facilities, including ships. UNOLS facilitates access and utilization of these resources for academic research, and matches the needs of academic oceanographic programs to available resources (UNOLS, No Date-a).

Table 4.1-1 displays how UNOLS fleet utilization has fluctuated over time, with lower use occurring most recently, possibly due to the COVID-19 pandemic. From 2012 to 2021, UNOLS' total available fleet ranged from 25 to 28 vessels, with 21 to 25 vessels scheduled for projects over that time span. Vessel utilization averaged about 89 percent, which marks a relatively high rate of vessel efficiency within UNOLS (UNOLS, No Date-b). This trend demonstrates that vessels available to UNOLS will likely be deployed and operated for oceanographic research. Vessels no longer in service were either removed from the UNOLS fleet after a period of service, retired, or replaced by another vessel.

Table 4.1-1. UNOLS 2012 – 2021 Fleet Utilization

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	AVG.
Scheduled Total	23	23	25	25	25	24	25	24	21	21	**23.6**
Available Total	25	25	28	27	28	26	27	27	26	26	**26.5**
Utilization Percentage	92%	92%	89%	93%	89%	92%	93%	89%	81%	81%	**89%**

Source: UNOLS, No Date-b

United States Coast Guard

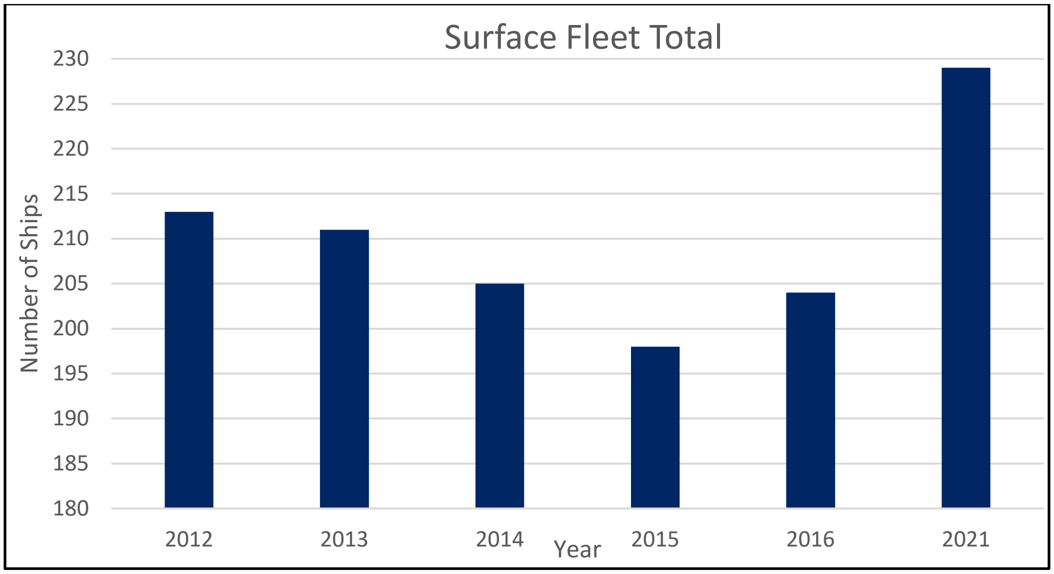
The USCG is the principal federal agency responsible for maritime safety, security, and environmental stewardship in U.S. ports and inland waterways. This includes more than 95,000 miles of U.S. coastline, throughout the 4.5 million square miles of U.S. Exclusive Economic Zone (EEZ), and on the high seas. USCG acts as a law enforcement organization, a regulatory agency, a member of the U.S. Intelligence Community, and a first responder to those in peril. Vessel operations are vested in two USCG geographic areas (Pacific and Atlantic), and five mission support logistics and service centers provide services for operational assets and shore facilities (USCG, No Date-e).

The USCG's operational assets include both aircraft and boats. Their surface fleet includes small and medium response boats, motor life boats, aids to navigation boats, cutters, and other various boat types. In 2016, their surface fleet totaled 1,650 boats, and that amount decreased by only three percent to 1,602 in 2021 (USCG, No Date-d). In 2018, the USCG published the 'Coast Guard Strategic Plan 2018-2022' which established the strategic framework for the organization during that four-year period and into the future. One of the objectives of the plan is to modernize assets, infrastructure, and mission platforms by continuing recapitalization efforts, including the timely acquisition and deployment of cutters and other boats. USCG will also invest in and employ shore- and cutter-based Uncrewed Aircraft Systems (UAS), and sustain service life extensions and improvement projects for their critical aviation and surface fleet. This will allow USCG to continue on their trajectory of modernizing their asset portfolio and enable them to better execute the full range of their missions (USCG, No Date-f).

United States Navy

The mission of the U.S. Navy is to protect America at sea by defending freedom, preserving economic prosperity, and keeping the seas open and free. The Navy performs continuous global operations, including counter narcotics, maritime security, regional operations, humanitarian assistance, and disaster relief. Major platforms include aircraft carriers, surface combatant ships, submarines, and aviation assets. These platforms allow the Navy to execute its missions around the world, while also deterring competitive naval powers from operating near U.S. waters (US Navy, 2021).

Figure 4.1-1 provides an estimate of the Navy's surface fleet from 2012 to 2016, and 2021. This includes aircraft carriers, cruisers, destroyers, frigates, littoral combat ships, amphibious ships, mine warfare ships, combat logistic ships, fleet support ships, and auxiliary ships. The fleet's size remained relatively consistent over this time span. In 2012, the surface fleet totaled 213 ships, but steadily decreased each year, down to 198 by 2015. The fleet size increased slightly to 204 in 2016, and by 2021, the fleet increased to 229 ships (Naval History and Heritage Command, No Date; Naval Vessel Register, No Date).



Sources: Naval History and Heritage Command, No Date; Naval Vessel Register, No Date.

Figure 4.1-1. U.S. Navy's Surface Fleet 2012 – 2016, 2021

Joint Federal Maritime Operations

The Navy, USCG, and U.S. Customs and Border Protection conduct operations and training exercises within the EEZ to ensure national security (NOS, 2016). Military activities can include various air-to-air, air-to-surface, and surface-to-surface naval fleet training, submarine and anti-submarine training, and Air Force exercises. Where naval vessels and aircraft conduct operations that are not compatible with commercial or recreational transportation, they are confined to Operating Areas (OPAREAs) away from commercially used waterways and inside Special Use Airspace (U.S. Fleet Forces, 2009). National defense and homeland security activities include 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).

The U.S. Navy, U.S. Marine Corps (USMC), and USCG are collectively known as the Naval Service, and work together to ensure free and open access to the world's oceans in order to provide global peace and prosperity. In 2020, the Naval Service published 'Advantage at Sea', which is a Tri-Service Maritime Strategy that focuses on the increasing competition, aggression, and military strength of rival nations that pose a comprehensive threat to the U.S., its allies, and all nations that support a free and open ocean system. The plan provides guidance to the Naval Service for the next decade, and specifically calls for the integration of naval forces and the modernization of each branch's service assets. The Navy would continue to commission destroyers and amphibious assault ships, and develop new, cost-effective platforms, including frigates and light amphibious warships. Aging ship models, such as the Nimitz-class aircraft carrier, would be replaced with newer models, such as the Gerald R. Ford-class aircraft carrier (USMC, US Navy, & USCG, 2020).

Overall, other federal fleets are expected to increase above the present level due to ongoing and planned programs. Impact causing factors associated with these activities would likely include vessel presence, vessel and equipment noise, seafloor disturbances, dredging, the use of active underwater acoustic sources, impacts to the water column, potential accidental discharges, and air emissions (BOEM, 2019a). Other federal fleets would likely contribute cumulative impacts to resource areas analyzed in this Draft

PEA, including water quality, air quality, acoustic resources, habitats, biological resources, hazardous waste, and human health and safety.

4.1.2 Offshore and Outer Continental Shelf Oil and Natural Gas Development

The Bureau of Ocean Energy Management (BOEM) manages the exploration and development of offshore energy and marine mineral resources by the Oil and Gas (O&G) industry on the 2.5 billion-acre U.S. outer continental shelf (OCS) (BOEM, 2018b). The U.S. OCS comprises the portion of the sea bed 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 OCS. Each lease covers up to 2,331 hectares (ha) (6.8 nm^2 [square nautical miles]) and is generally a square measuring 4.8 by 4.8 km (kilometer) (3 by 3 mi [miles]) (BOEM, 2019b). 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-c). Offshore oil and natural gas development generally involve the following phases with corresponding impact causing factors:

1) Exploration, 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, 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; sites must be restored to the same conditions that existed prior to development.

4.1.2.1 Oil and Gas Energy Programs

The National Outer Continental Shelf Oil and Gas Leasing Program (National OCS Program) specifies the size, timing, and location of potential leasing activity. For this reason, reviewing the program lease sale schedules provides a good understanding of previous, current, and reasonably foreseeable O&G projects. Currently, BOEM is working under the 2017-2022 National OCS Program. BOEM updates the program in five-year increments, and has published a Proposed National OCS Program for 2023-2028 (BOEM, 2023). The 2023-2028 Proposed Program Lease Sale Schedule is summarized in **Table 4.1-2**.

Table 4.1-2. BOEM 2023–2028 Proposed Program Lease Sale Schedule

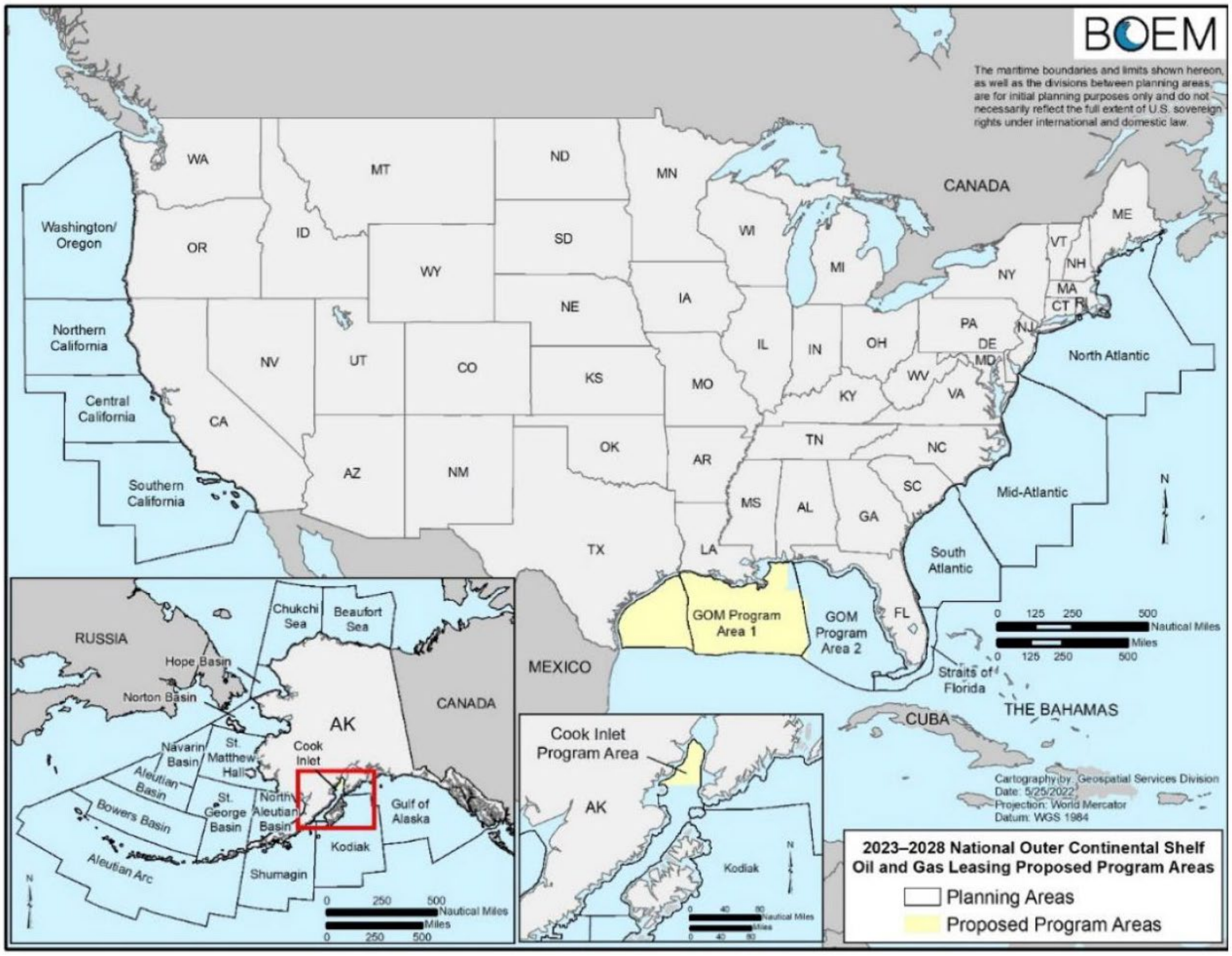
Sale Year	Region	Sale Number	Program Area
2023	Gulf of Mexico	262	GOM Program Area 1
2024	Gulf of Mexico	263	GOM Program Area 1
	Gulf of Mexico	264	GOM Program Area 1
2025	Gulf of Mexico	265	GOM Program Area 1
	Gulf of Mexico	266	GOM Program Area 1
2026	Alaska	267	Cook Inlet Program Area

Sale Year	Region	Sale Number	Program Area
	Gulf of Mexico	268	GOM Program Area 1
	Gulf of Mexico	269	GOM Program Area 1
2027	Gulf of Mexico	270	GOM Program Area 1
	Gulf of Mexico	271	GOM Program Area 1
2028	Gulf of Mexico	272	GOM Program Area 1

Source: BOEM, 2023

National Outer Continental Shelf Regions and Planning Areas

The National OCS Program consists of four regions: the Atlantic Region, the Pacific Region, the Gulf of Mexico Region, and the Alaska Region. Each of these regions are subdivided into planning areas (**Figure 4.1-1**). The Atlantic Region consists of the North Atlantic, Mid-Atlantic, South Atlantic, and Straits of Florida planning areas; the Pacific Region consists of the Washington/Oregon, Northern California, Central California, and Southern California planning areas; and the Gulf of Mexico Region has the Western, Central, and Eastern Gulf of Mexico planning areas. The Gulf's Central and Western planning areas (offshore from Texas, Louisiana, Mississippi, and Alabama) remain the nation's primary offshore source of oil and gas, generating about 97 percent of all offshore oil and gas 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 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, 2017d). The Alaska Region, which encompasses the Beaufort and Chukchi Seas, the Bering Sea, Cook Inlet, and the Gulf of Alaska, is another important resource for oil and gas; the Arctic Region contains an estimated 13 percent of the world's undiscovered oil and 30 percent of undiscovered natural gas (USCG, 2018).

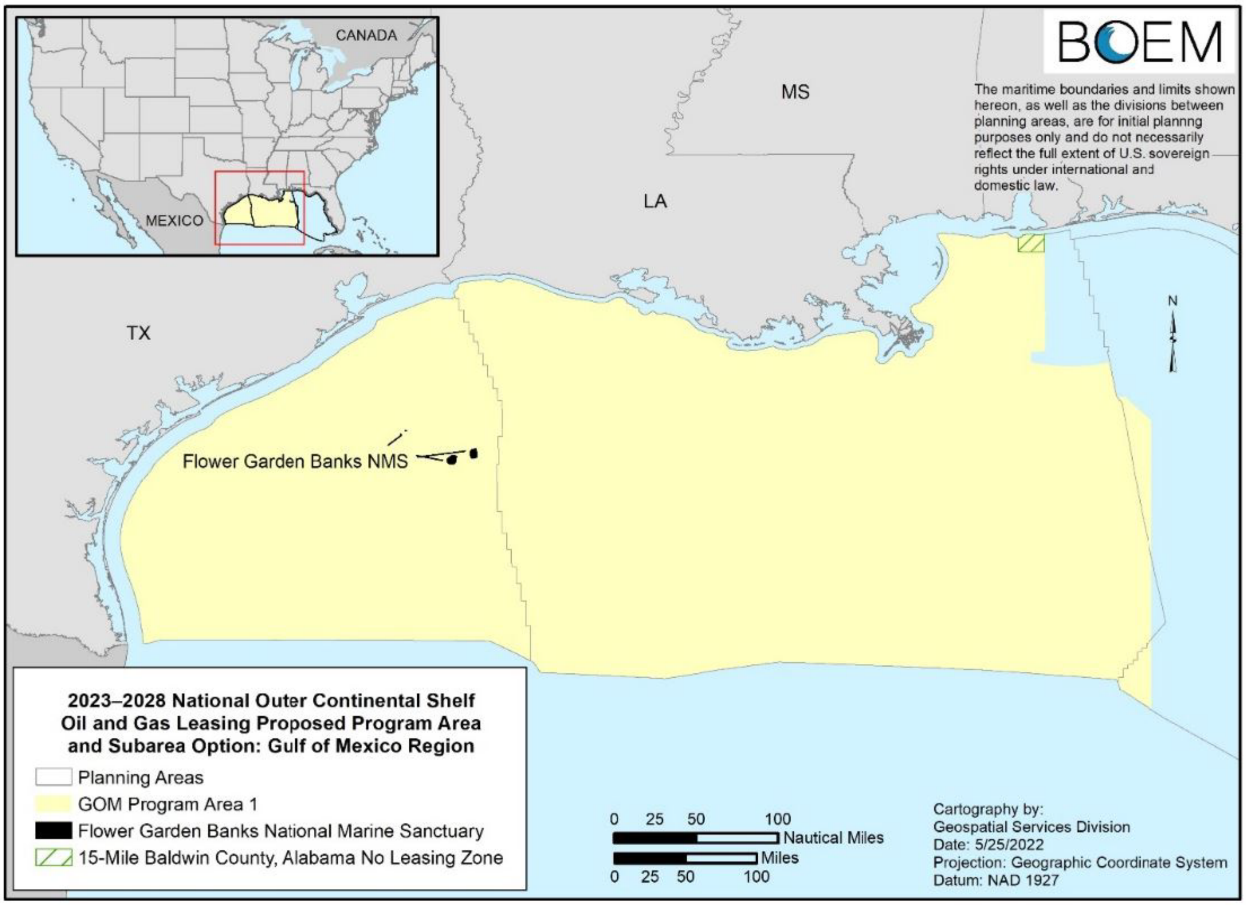


Source: BOEM, 2023

Figure 4.1-1. National Outer Continental Shelf Regions and Planning Areas

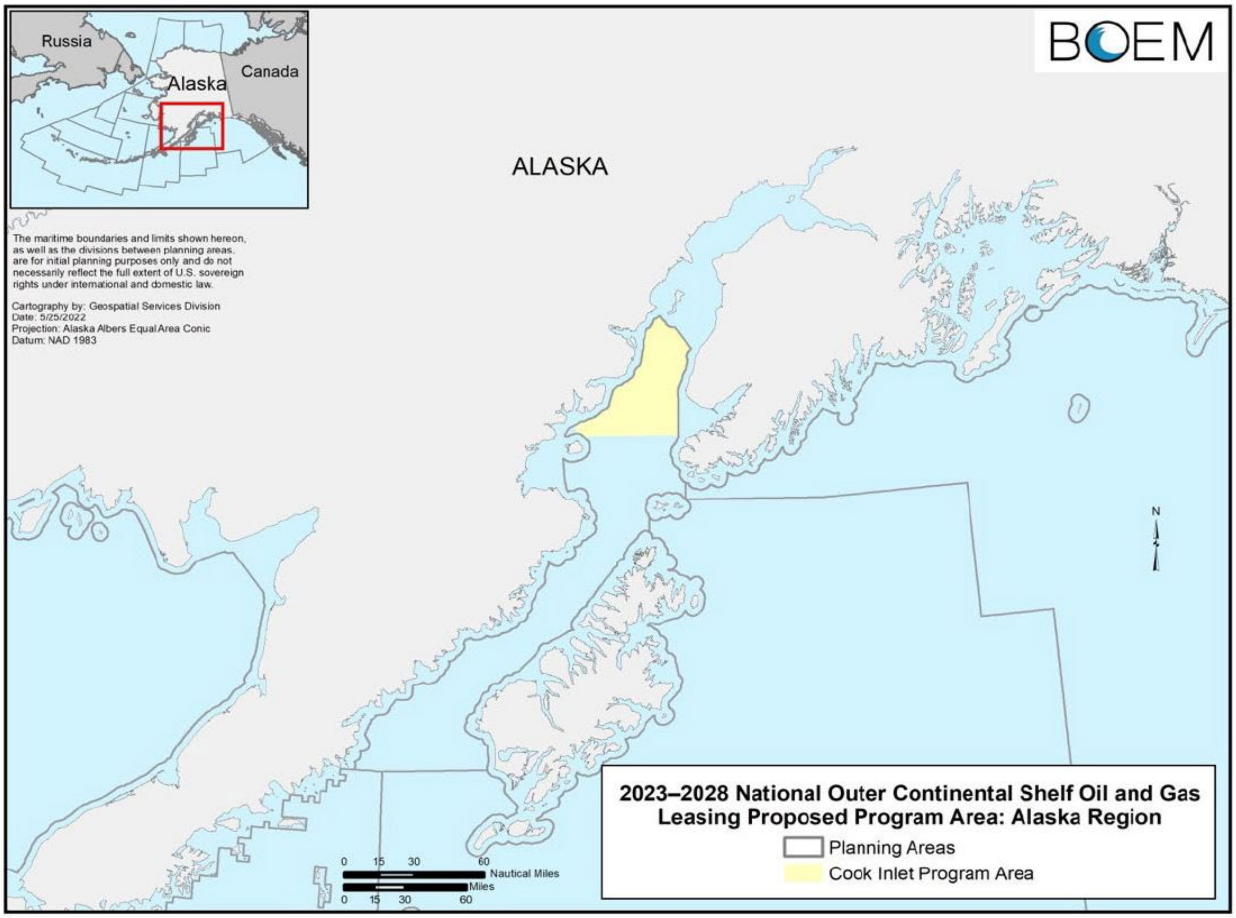
Program Areas Included in National OCS Proposed Program

National OCS program areas are parcels within each region's planning area that could be sold and developed for oil and gas. The 2023-2028 National OCS proposed program includes ten potential oil and gas lease sales in the Gulf of Mexico Region Program Area 1, which mainly focuses on the Western and Central Gulf of Mexico planning areas and a small portion of the Eastern Gulf of Mexico planning area. The proposed program also includes one potential lease sale in the northern portion of the Cook Inlet program area, which is located offshore of South-central Alaska. Program areas that are included in the proposed program are shown in **Figures 4.1-2** and **Figures 4.1-3** as the offshore parcels highlighted in yellow. These 11 potential lease areas were selected because of their preexisting offshore oil and gas infrastructure and commercial markets. More than 95 percent of current OCS production occurs in the Gulf of Mexico Program Area 1. The Cook Inlet planning area has significant existing natural gas production as well in adjacent state waters. These areas would require relatively less new infrastructure and exploratory effort. In addition, areas that have already been extensively explored and developed would provide more certainty and less risk regarding the amount of oil and gas that could be extracted compared to new, undeveloped sites with little or no exploratory efforts. As the global economy shifts its focus towards decarbonization, the oil and gas industry would likely concentrate its exploration efforts and investments into areas with the lowest costs, namely areas with recent or active lease sales that do not require extensive infrastructure installments (BOEM, 2023). That said, the November 2019 Presidential Memorandum on Ocean Mapping of the U.S. EEZ 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 completed mapping of the EEZ to support it. Sections 2 and 3 of the memoranda specifically address the need to develop a strategy for mapping the entire EEZ and Alaska, respectively (The White House, 2019). Therefore, the number and frequency of surveying and mapping projects for offshore O&G resource siting, specifically in the Alaska region, could potentially increase in the future.



Source: BOEM, 2023

Figure 4.1-2. Gulf of Mexico Region Program Area



Source: BOEM, 2023

Figure 4.1-3. Alaska Region Program Area

Program Areas Excluded in National OCS Proposed Program

The 2023-2028 National OCS Proposed Program excluded all planning areas in the Pacific and Atlantic Regions, in addition to all other planning areas in the Alaska Region and the Gulf of Mexico Region, including the Gulf of Mexico Program Area 2, which is comprised of the Eastern Gulf of Mexico Planning Area. Excluded planning areas can be seen in **Figure 4.1-1** as the offshore parcels not highlighted in yellow. These areas had minimal oil and gas infrastructure, relatively low resource potential, and limited interest from potential oil and gas producers. In addition, the development of these areas did not align with the goals and policies of certain affected states, and created potential conflicts with other uses of the seabed and surrounding waters, such as marine navigation, submarine cables, and deepwater ports. Ultimately, the potential benefits from exploration, development, and production of oil and gas in these areas would have been outweighed by the potential impacts to the marine, coastal, and human environments. In this way, no lease sales in these regions were offered in the Proposed Program (BOEM, 2023).

Overall, offshore and OCS oil and natural gas development are expected to generally remain the same or slightly increase above the present level in the Alaska and Gulf of Mexico Regions due to the ongoing and planned projects, and generally decrease below the present level in the Atlantic and Pacific Regions due to lack of interest, infrastructure, and investable lease areas in these regions. Impact causing factors associated with these activities would likely include vessel presence, vessel and equipment noise, seafloor disturbances including sampling and drilling, active underwater acoustic sources, construction, operation, and demolition of structures, impacts to the water column, potential accidental discharges and oil spills, and air emissions (BOEM, 2019a). Offshore and OCS oil and natural gas development would likely contribute cumulative impacts to resource areas analyzed in this Draft PEA, including water quality, air quality, hazardous waste, human health and safety, acoustic resources, habitats, biological resources, climate change, socioeconomic resources, cultural and historic resources, and environmental justice.

4.1.3 Assessment and Extraction of Marine Minerals

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. MMP projects include dredging to obtain sand and/or gravel, placing the resources onto the shoreline, and monitoring the dredging site and placement conditions (BOEM, 2019d).

As of 2018, the MMP has 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 in New York to a depth of more than 1.8 meters (m) (6 feet [ft]) (BOEM, 2019d). 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 nearshore 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. In addition, the MMP and USCG are collaborating to research 35 critical minerals (i.e., minerals used in manufacturing, consumer products, or are otherwise economically important) along the OCS via December 2017's Executive Order (EO) 13817 (BOEM, 2019d).

Overall, assessment and extraction of marine minerals is expected to increase due to the continuing impacts of coastal erosion, storms, and sea level rise, and the growing need from coastal communities to address coastal restoration projects. Impact causing factors associated with these activities would likely include vessel presence, vessel and equipment noise, seafloor disturbance, dredging, impacts to the water column, and potential accidental discharges (BOEM, 2019a). The assessment and extraction of marine minerals would likely contribute cumulative impacts to resource areas analyzed in this Draft PEA, including water quality, human health and safety, habitats, biological resources, socioeconomic resources, and cultural and historic resources.

4.1.4 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, 2020).

4.1.4.1 Wind Energy

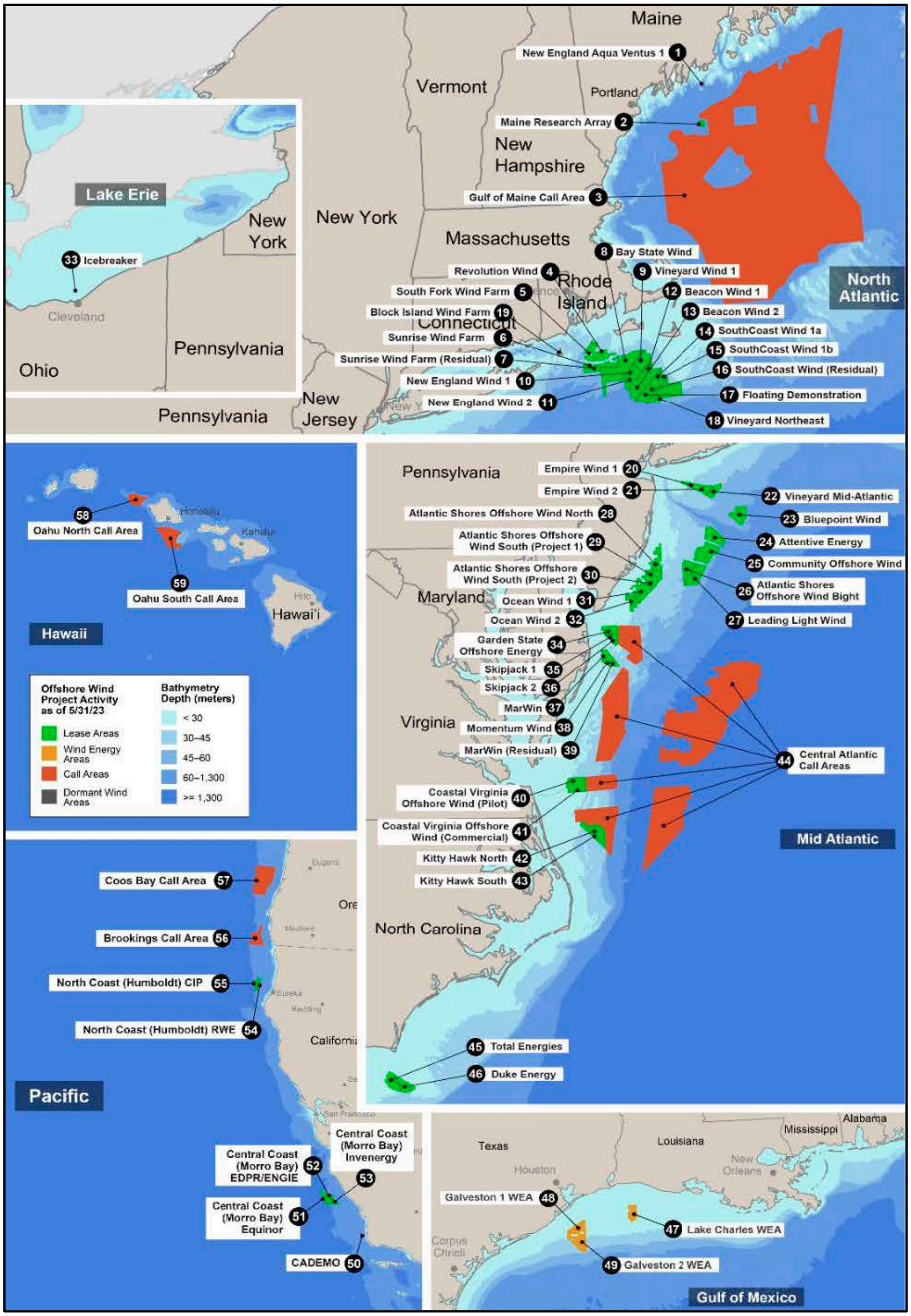
Both nationally and globally, wind power is one of the fastest growing forms of electricity generation. Wind turbines convert the kinetic energy of wind into electricity. Offshore winds tend to blow harder and more uniformly than on land given that there are no mountains, trees, or artificial structures to obstruct them. Since higher wind speeds can produce a lot 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-e).

Offshore wind facility design and engineering depends on site-specific conditions, particularly water depth, seabed geology, and wave loading. The four phases of a wind farm's life cycle generally involve the following phases with corresponding impact causing factors:

1) Pre-construction, which often includes geophysical and seismic surveys to assess site conditions, as well as increased vessel traffic to and from the proposed construction site;
2) Construction, which may include drilling, pile driving, use of explosives, dredging, cable laying, and continued ship and barge operations;
3) Operation, 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
4) Decommissioning, which may include mechanical cutting and explosive detonation as well as increased boat and barge traffic to and from the site.

As of May 2023, the U.S. generates about 42 megawatts (MW) of offshore wind energy per year. There are currently two offshore wind farms in operation: 1) Block Island Wind Farm in Rhode Island, began operating in 2016 with a capacity of 30 MW, and 2) Dominion Energy off the coast of Virginia, began operating in 2020 with a capacity of 12 MW (Musial et al., 2023).

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 towards the end of 2023. Ocean Wind 1 located off the coast of New Jersey has been approved for construction and would produce 1,100 MW once it is operational in 2025. There are 19 lease areas in development at the permitting stage, which means that the developers have surveyed the lease area, submitted the Construction and Operations Plans to BOEM, and are awaiting approval of the proposed project. These projects have the potential to yield about 20,978 MW of offshore wind energy once the sites become operational. Another 18 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 about 24,596 MW. Additionally, projects in the planning stages include three wind energy areas in the Gulf of Mexico (meaning these areas can be put up for a lease sale in the future), one unawarded lease area in the Gulf of Maine, and two proposed floating demonstrations in Massachusetts and California. These projects could potentially yield up to 5,039 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., 2023). 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., 2023; 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).

4.1.4.2 Marine and Hydrokinetic 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. These resources would be particularly useful off the coasts of large urban centers where there is high electricity demand. Marine and hydrokinetic (MHK) energy is an untapped resource for the U.S. Although it is still a new industry, the U.S. DOE’s Water Power Program is researching methods to accelerate wave, tidal, and current projects, and the 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). Alaska contains the largest number of locations with high kinetic power density for tidal power generation. Twelve other states, including all of the west coast and a large portion of the east coast, also contain a number of locations with significant kinetic power density (DOE, No Date-b). 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 be deployable on the OCS in the coming years to extract energy from ocean currents (BOEM, No Date-f).

4.1.4.3 Ocean Thermal Energy Conversion

Ocean Thermal Energy Conversion (OTEC) is a process that uses the temperature differences (i.e., thermal gradients) between surface ocean waters and deep ocean waters to power turbines to produce electricity. OTEC systems using seawater as the working fluid can also 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).

4.1.4.4 Summary

Overall, offshore renewable energy development is expected to increase due to ongoing and planned programs and investments, especially as the U.S. moves away from fossil fuels and towards renewable energy sources. 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 operation of structures and cables connected to the shore, and air emissions (BOEM, 2019a). Offshore renewable energy development would likely contribute cumulative impacts to resource areas analyzed in this Draft PEA, including water quality, air quality, habitats, biological resources, socioeconomic resources, human health and safety, and climate change.

4.1.5 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 (GHGs) 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 degrees Celsius (°C) (1.51 degrees Fahrenheit [°F]) above the 20^{th} 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, 2020b3). 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.

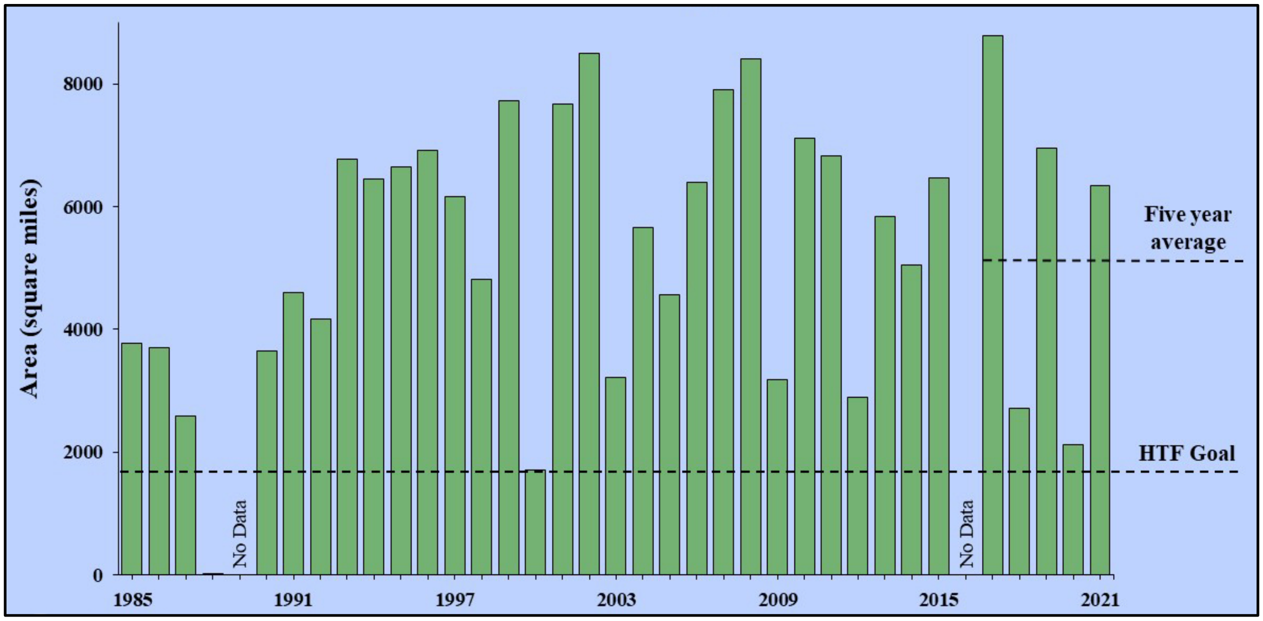
Warming. Between 1900 and 2016, global ocean surface waters have warmed on average 0.7 ± 0.08 °C (1.3 ± 0.14 °F) (USGCRP, 2018). In 2021, global ocean surface temperatures were 0.65 ± 0.16 °C (1.17 ± 0.29 °F) above average, which is the sixth highest average on record since 1880. This translates to an increase in the amount of energy absorbed by the ocean, also known as the ocean's heat content. Since records of the ocean's heat content started in 1955, the seven highest 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 m (2 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 16,405 km^2 (6,334 mi^2), which was larger than the five-year average of 13,934 km^2 (5,380 mi^2), 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 5,180 km^2 (2,000 mi^2) by 2035 (NOAA, 2021c).



Source: NOAA, 2021c

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 (H^+). Acidity is measured as a logarithmic function of the concentration of H^+ (pH), so the increased concentration of H^+ 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, 2020b).

A portion of the excess H^+ react with carbonate (CO_3^{2-}) to form bicarbonate (HCO_3^-), this causes carbonate ions to be relatively less abundant (Hardt and Safina, 2008; NOAA, 2020b). Carbonate ions are a critical component of calcium carbonate ($CaCO_3$), which many marine macroinvertebrates use to build 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, 2020b; USGCRP, 2018).

The processes (warming, acidification, and deoxygenation) interact with one another and with other agents of environmental stressors in the ocean environment (USGCRP, 2018). 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, 2019a). Climate change would likely contribute cumulative impacts to resource areas analyzed in this Draft PEA, including habitats, biological resources, socioeconomic resources, cultural and historic resources, and environmental justice.

4.1.6 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 (kg) (9.4 and 9.6 billion pounds [lb.], respectively) 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 lb.) (NMFS, No Date-f; 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-f).

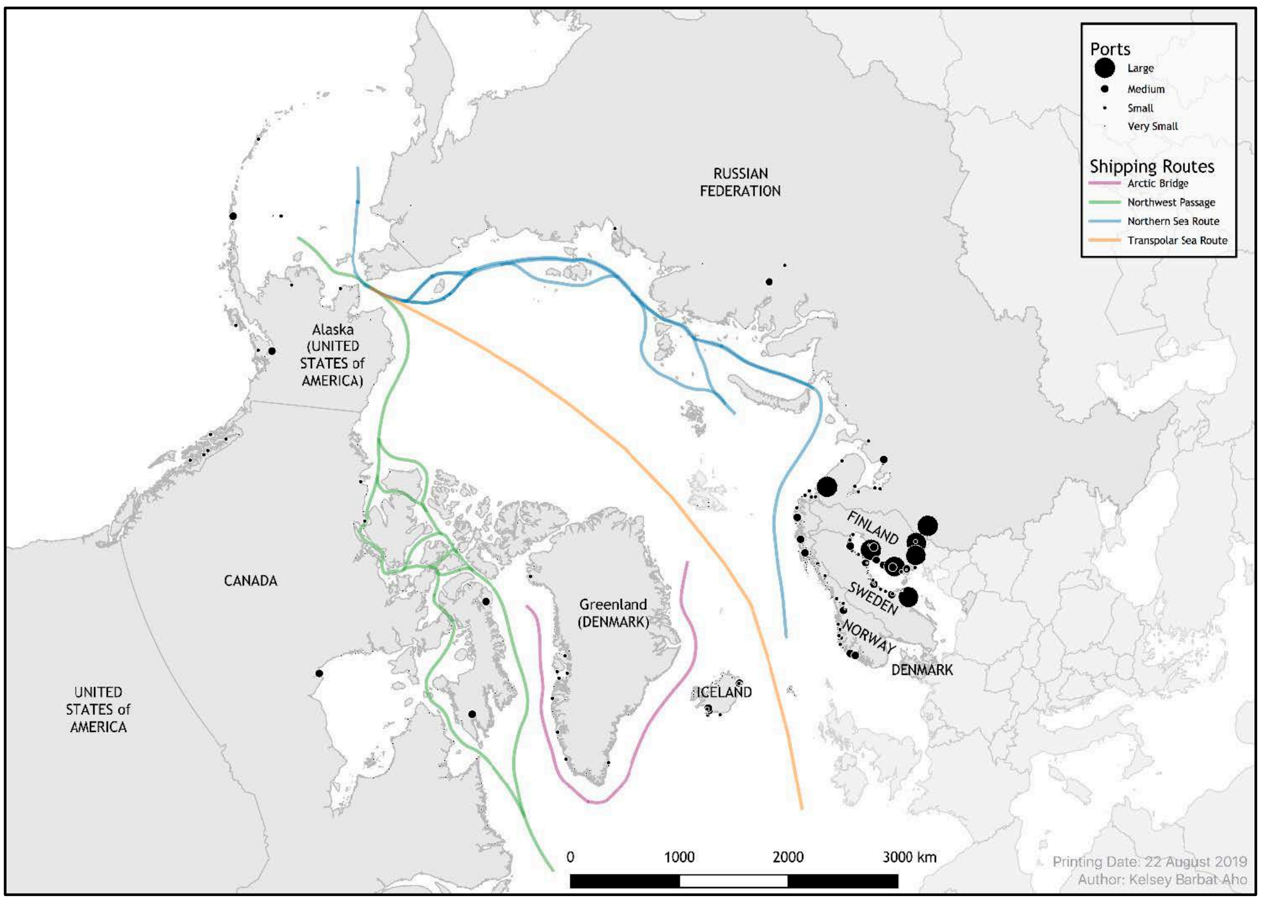
Recreational fishing includes fishing from private/rental boats, party/charter boats, and onshore (e.g., a dock or the shore). In 2018, recreational fishers took approximately 194 million saltwater fishing trips, with 55 percent in estuaries, 35 percent in state territorial seas, and 10 percent in the U.S. EEZ. Of the 163 million kgs (359 million lb.) 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.

Overall, commercial and recreational fishing are expected to remain the same or increase based on past and current trends, including increased aquaculture production in the last decade. Impact causing factors associated with commercial and recreational fishing include resource consumption, seafloor disturbance, bycatch (fish or marine species caught unintentionally), gear utilization such as trawl nets and longlines, dredging, vessel presence, vessel and equipment noise, impacts to the water column, potential accidental discharges, and air emissions (BOEM, 2019a). Commercial and recreational fishing would likely contribute cumulative impacts to resource areas analyzed in this Draft PEA, including habitats, biological resources, socioeconomic resources, cultural and historic resources, and environmental justice.

4.1.7 Commercial Shipping and Recreational Boating

About 90 percent of U.S. imports and exports enter or 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. 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 U.S. Army Corps of Engineers (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).

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 as illustrated in **Figure 4.1-6** (Boylan and Elsberry, 2019).



Source: Boylan and Elsberry, 2019

Figure 4.1-6. Arctic Vessel Routes

The Northwest Passage (shown in green in **Figure 4.1-6**) 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 4.1-6**) 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**

4.1-6) would represent a third Arctic 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 Arctic 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 estimated 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.

The nation's recreational boating industry is also growing and has an annual economic impact of more than $121 billion (USCG, 2018). Retail unit sales of new powerboats in the U.S. increased by an estimated 12 percent in 2020 compared to 2019. More than 310,000 new powerboats were sold in 2020, which are levels the recreational boating industry have not seen since before the Great Recession of 2008. Boat sales are expected to remain at historical levels into the future, as manufacturers continue to fill a backlog of orders from 2020 (NMMA, 2021).

Overall, commercial shipping and recreational boating are expected to increase above current levels due to global demand for waterborne commerce, new potential shipping lanes due to climate change, and a growing interest in safe outdoor recreation activities. Impact causing factors associated with these activities include vessel presence, vessel noise, impacts to the water column, potential accidental discharge, and air emissions (BOEM, 2019a). Commercial shipping and recreational boating would likely contribute cumulative impacts related to all resource areas analyzed in this Draft PEA.

4.1.8 Ocean Cruise Line Industry

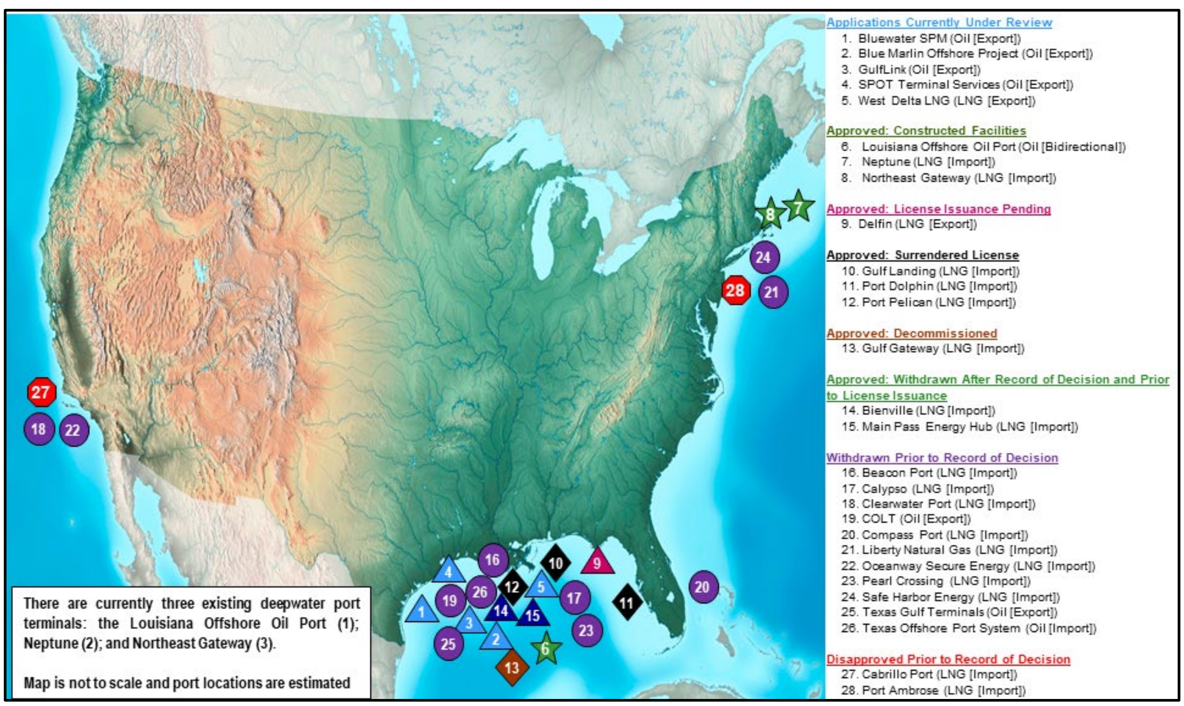
The ocean cruise line industry uses cruise ships or cruise liners to provide passengers with voyages that include onboard activities and shoreside excursions in ports of call. The cruise ship picks up and returns passengers to the same port and traverses a service route with pre-determined ports of call while underway. This type of maritime tourism provides passengers with a unique vacation experience that has grown in popularity over the last few decades (Wang et al., 2016). According to Cruise Lines International Association (CLIA), there were approximately 29.7 million global ocean cruise passengers in 2019. Those numbers drastically fell during 2020 and 2021 (5.8 and 4.8 million passengers, respectively) due to Covid-19 restrictions. The industry rebounded in 2022 with 20.4 million global ocean cruise passengers, which is expected to increase to 31.5 million cruise passengers by the end of 2023. Cruise passengers are projected to reach 39.5 million by 2027. The most popular cruise destination in 2019 was the Caribbean region, followed by the Mediterranean, Asia and China, and Northern Europe. Those trends continued into 2022, but with Asia and China becoming the second most popular cruise destination, followed by the Mediterranean and Northern Europe (CLIA, 2023). The cruise sector's economy was expected to rebound in 2023, with projections that estimated $155 billion to the global economy, 1.2 million jobs, and $50 billion in wages, which are levels similar to 2019.

Overall, the ocean cruise line industry is expected to remain at current levels or increase above current levels due to increased passenger growth rates and planned fleet expansion projects. Impact causing factors associated with these activities include vessel presence, vessel noise, impacts to the water column, potential accidental discharge, and air emissions (BOEM, 2019a). The ocean cruise line industry would likely contribute cumulative impacts to resource areas analyzed in this Draft PEA, including water quality, air quality, habitats, biological resources, socioeconomic resources, hazardous waste, human health and safety, and climate change.

4.1.9 Construction and Operation of Offshore Liquified Natural Gas Terminals

Liquefied natural gas (LNG) is a form of natural gas that has been cooled down so that it has a reduced volume (only 1/600th of its gaseous state) such that it can be more readily transported across the ocean via specialized ships (EIA, 2022b). 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 USCG and the Maritime Administration (MARAD) (BOEM, 2014).

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 4.1-7** (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 4.1-7. Deepwater Port Location and Status Map

LNG projects generally involve three phases: construction and installation, operation, and decommissioning (BOEM, 2019a). The design and construction activities required to build new offshore

LNG terminals vary 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 area must first be surveyed to determine if the sea bed is suitable for such infrastructure installations. The construction of the infrastructure includes activities that disturb the sea floor, such as drilling.

Overall, activities pertaining to the operation and construction of offshore LNG terminals are expected to continue at current levels or increase over the next five years in the Greater Atlantic, Southeast, and West Coast regions. The impact causing factors associated with these activities include seafloor disturbance, vessel presence, vessel and equipment noise, construction, operation, and demolition of structures, impacts to the water column, potential accidental discharges, and air emissions (BOEM, 2019a). The construction and operation of offshore LNG terminals would likely contribute cumulative impacts related to all resource areas analyzed in this Draft PEA.

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 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. Submarine cables typically have a 25-year lifespan, so the replacement and repair of existing cables is also expected to increase 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, 2019a).

Overall, construction of new submarine telecommunication cable infrastructure is expected to increase due to growing capacity demands, as well as the need to replace and repair existing cables in the next several years. Impact producing factors associated with these activities include seafloor disturbances, vessel presence, vessel and equipment noise, the construction and operation of structures and cables connected to the shore, impacts to the water column, potential accidental discharges, and air emissions (BOEM, 2019a). The construction of new submarine telecommunication cable infrastructure would likely contribute cumulative impacts to resource areas analyzed in this Draft PEA, including habitats, biological resources, cultural and historic resources, and environmental justice.

4.2 Cumulative Effects on the Environment

As described in Section 4.1, the Office of Marine and Aviation Operations (OMAO) is considering past, present, and reasonably foreseeable future actions taking place in the action area 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

Section 4.1, then considers how the OMAO-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 resources in the action area, including accumulation of marine debris; 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; illegal, unreported, and unregulated fishing; and accidental or illicit discharges of oil, fuel, chemicals, or waste.

4.2.1 Air Quality

All past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects to air quality. The following analysis considers how the OMAO-related incremental impacts of the Proposed Action and alternatives, when added to or acting synergistically with other non-OMAO related cumulative actions, would contribute to overall cumulative impacts on air quality from engine and generator emissions, incinerator emissions, and ozone depleting substances (ODS).

4.2.1.1 Engine and Generator Emissions

OMAO vessel operations that require power through the use of the vessel's main engines, emergency diesel generators, and small boat engines produce emissions that could affect air quality as discussed in Section 3.3 Air Quality. Other cumulative actions also produce air emissions that contribute to cumulative impacts, including:

- other federal fleets;
- commercial fishing and shipping vessels;
- recreational fishing and boating vessels;
- ocean cruise liners; and
- construction, operation, and decommissioning of long-term installations (oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure).

Vessels used by other cumulative actions conduct operations similar to OMAO operations. All of these vessel operations combust fuel to generate power for vessel movement, emitting diesel and gas combustion products such as particulate matter, ground level ozone, carbon monoxide, nitrogen dioxide, and sulfur dioxide into the atmosphere. These emissions would result in the aggregate cumulative degradation of air quality, creating smog or haze and causing harmful effects to human health and the environment. In addition, other cumulative actions would use vessels to access the construction, operation, and decommissioning sites of long-term installations to transport supplies, resources, and personnel. Some of these long-term installations may themselves also directly contribute to air emissions through the use of machinery and power equipment. Furthermore, the resources extracted at these installations would indirectly contribute to diesel emissions, including oil, gas, and liquified natural gas that would emit criteria pollutants during combustion. Offshore renewable energy development including wind, ocean wave, and current energy would likely provide cleaner sources of energy that would contribute beneficial cumulative impacts. Cleaner energy could reduce the overall consumption of fossil fuels along coastal communities if overall demand is constant or if the growth of renewables exceeds growth in overall demand.

Cumulative effects from OMAO vessel operations would be indistinguishable from other cumulative actions. The NOAA fleet currently consists of 15 ships (with new ships coming on-line while others reach their end of service life) and OMAO operations account for 0.01 percent per year of all nautical miles traveled within U.S. navigable waters. NOAA ships always burn low sulfur diesel, which contains 15-500 parts per million (ppm) sulfur, and frequently use a class of low sulfur diesels called ultra-low sulfur diesel (ULSD) that contains less than 15 ppm sulfur. This decreases both the sulfur content and the amount of other air pollutants emitted during combustion. Furthermore, NOAA vessels are required to abide by federal and NOAA policies, procedures, and regulations that limit emissions, as discussed in Section 3.3.1.2.1. Therefore, any cumulative impact to air quality that were to occur from air emissions contributed by OMAO vessel operations would be limited due to the size of the fleet and the distribution of miles traveled across the entire geographic scope of the action area. Note that cumulative effects on air quality would be relatively more concentrated at ports and choke points such as canals.

Other cumulative actions from ocean-going vessels, long-term installations, and marine-based facilities not related to OMAO operations would likely contribute the majority of the aggregate cumulative impacts to air quality from emissions. The distance traveled by the worldwide fleet greatly outnumbers and outpaces the size and distance traveled by the NOAA fleet. This would result in a higher fuel consumption rate and much larger amounts of associated emissions as compared to NOAA vessels. Long-term installations, marine-based facilities (which are generally stationary structures), and major ports (where vessel movements are concentrated) could contribute long-term, albeit typically ephemeral, cumulative impacts.

Overall, aggregate cumulative impacts to air quality from emissions would be temporary from individual actions but long term overall as activities would be continuously occurring, and would result in minor to moderate impacts on air quality throughout the action area. The contribution to these aggregate, adverse cumulative impacts from any of the three OMAO alternatives would be **negligible**.

4.2.1.2 Incinerator Emissions

OMAO operations under the Proposed Action, including waste handling and discharges, would contribute impacts on air quality from incinerator emissions. The contribution from other cumulative actions to incinerator emissions impacts would be associated with:

- the presence and movement of vessels (e.g., other federal fleets, commercial fishing and shipping vessels, recreational fishing and boating vessels, and ocean cruise liners); and
- the construction and operation of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, LNG terminals, and new submarine telecommunication cable infrastructure).

Incineration of wastes during OMAO operations, combined with other non-OMAO related cumulative actions, would create emissions that could affect air quality. These emissions and their effects would vary based on the type and amount of incinerated waste. These items could include paper products, food-contaminated containers, incidental plastics, oil or sludge (if approved), cooking oil, and oily rags, containers, filters, and other oil-soaked materials. Incineration would generate incinerator ash, which

OMAO stores until it can be properly disposed of according to policies and regulations. Incinerator emissions generally vent up an exhaust pipe and could contain compounds including, but not limited to, carbon, nitrogen and sulfur oxides, dioxins, and halogens.

Cumulative effects from OMAO operations would be indistinguishable from other non-OMAO related cumulative actions. OMAO operations account for 0.01 percent of all nautical miles traveled within U.S. navigable waters. Most other ocean-going vessels would produce more solid waste and more incinerator emissions compared to NOAA ships. In addition, only some ships in the NOAA fleet have shipboard incinerators installed onboard as part of their solid waste management. Some NOAA ships use garbage grinders, macerators, and trash compactors to help manage their solid waste. This is likely the case for other cumulative actions associated with ocean-going vessels, long-term installations, and marine-based facilities. The cumulative impact from incinerator emissions would be limited to only those cumulative actions that utilize incineration as a form of waste management. Through the policy and directives discussed in Section 3.3, OMAO voluntarily complies with MARPOL Annex VI, and it is probable that other ocean-transiting vessels would also abide by MARPOL Annex VI and any associated stipulations and regulations pertaining to shipboard incineration, thereby limiting their cumulative impact.

Similar to NOAA vessels, the cumulative impacts from incinerator operation on ocean-going vessels would be somewhat diminished given that these vessels would be moving throughout a wide geographic area and cumulative impacts would not generally be concentrated in a given area; note that cumulative impacts could be relatively more concentrated at ports and choke points such as canals if incinerators are operated in these areas. However, this would not be the case for long-term installations and marine-based facilities which are generally stationary structures and could contribute long-term cumulative impacts; however, the effects are typically short-lived due to dispersion and periodic, albeit recurring, operation over the long term. It is expected that these installations and facilities would abide by all permits and regulations based on their industry standards and that cumulative impacts would be further limited to only those select installations and facilities that utilize incinerators as a part of their solid waste management plan.

Overall, aggregate cumulative impacts to air quality from incinerator emissions would be temporary, and would result in minor impacts throughout the action area. The contribution to these aggregate, adverse cumulative impacts from the incinerator emissions from any of the three OMAO alternatives would be **negligible**.

4.2.1.3 Ozone Depleting Substances

OMAO operations under the Proposed Action, including distress, safety, and emergency response; spill response; and vessel repair and maintenance could contribute to impacts from ODS. The contribution from other cumulative actions to impacts from ODS are associated with the presence and movement of vessels and the construction, operation, and decommissioning of long-term installations. ODS compounds cumulatively contribute to the depletion of the ozone layer, which protects the earth from harmful ultraviolet solar radiation. Depletion of the ozone layer results in more harmful solar radiation reaching the earth's surface. The cumulative effect of ODS compounds from both OMAO and other cumulative actions would be synergistic, i.e., the combined effect of ozone depletion would be greater than the sum of each individual cumulative effect.

ODS compounds associated with OMAO operations and other cumulative actions come from older systems and equipment, including firefighting, refrigeration, or HVAC systems. MARPOL Annex VI prohibits any new equipment installations containing ODS on all ships, in addition to prohibiting the deliberate emissions of ODS during operation, maintenance, or repair. The EPA imposed a general ban on ODS in the mid-1990s. Although the number of vessels built before that time and in operation are limited, it is possible for some systems and equipment to still contain ODS. The NOAA fleet accounts for a very small fraction of overall vessel traffic and is required to abide by all federal and NOAA policies, procedures, and regulations related to ODS to prevent or minimize any cumulative impacts. The number of non-OMAO related vessels and installations greatly outnumber the NOAA fleet and, therefore, contribute a larger amount to ODS impacts. Furthermore, any potential discharge of ODS would only be expected to occur in extreme or rare cases, such as the discharging of a fire suppression system during an actual response to an emergency situation. An event of this nature is highly unlikely to occur.

Overall, aggregate cumulative impacts to air quality from ODS would result in negligible to minor impacts throughout the action area. The contribution to these aggregate, adverse cumulative impacts from ODS from any of the three OMAO alternatives under the OMAO Proposed Action would be **negligible**.

4.2.1.4 Conclusion

When considered in tandem, adverse cumulative impacts to air quality would be created by the OMAO Proposed Action and other cumulative actions, including:

- presence and movement of vessels (e.g., other federal fleets, commercial fishing and shipping vessels, recreational fishing and boating vessels, and ocean cruise liners) and
- construction, operation, and decommissioning of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure)

Adverse cumulative impacts would occur from engine and generator emissions, emissions from long-term installations, incinerator emissions, and ODS within the action area.

Distance traveled and the likely absence of certain equipment and substances (i.e., shipboard incinerators and ODS systems and equipment) from the NOAA fleet would result in a smaller, limited contribution from OMAO to cumulative impacts to air quality. NOAA ships abide by all federal and NOAA regulations, policies, and procedures related to air emissions, shipboard incinerator operation, and ODS, further limiting OMAO's contributions to aggregate cumulative impacts. Operations of vessels under other cumulative actions, as well as activities from long-term installations and marine-based facilities, also likely follow their own policies, procedures, and plans, as well as all applicable laws and regulations, to prevent or minimize cumulative impacts to air quality. Furthermore, other than at stationary installations and facilities and at ports or choke points such as canals, cumulative impacts from all past, present, and future actions would not be concentrated in any one particular area given the wide geographic scope of the action area, thereby minimizing cumulative impacts locally.

Cumulative impacts from any of the OMAO alternatives in combination with the other cumulative actions 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 action area and the combined effect of the cumulative actions is greater or less than the sum of each individual effect. Similarly, additive cumulative impacts could occur if activities or actions are conducted sequentially within adjacent locations of the action area and the combined effects were the same as the sum of each individual effect. The exact timing and location of OMAO operations are subject to change on a project-by-project basis. In addition, the action area covers a very wide geographic range, so it would be unlikely for cumulative impacts to occur sequentially and in close proximity. Therefore, synergistic or additive cumulative impacts would most likely be determined based on the timing and location of OMAO activities in relation to other cumulative actions. However, cumulative impacts from ODS would likely be synergistic regardless of timing and location because the combined effect of depleting the ozone layer is greater than the impacts of each cumulative action added together.

Overall, the aggregate, adverse cumulative impacts from other cumulative actions on air quality throughout the action area would be negligible to minor. The OMAO Proposed Action would contribute to and have the potential to increase these cumulative impacts, but their relative contribution would be **negligible**. These impacts would occur regardless of the chosen alternative since operations 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 days at sea (DAS) than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on air quality.

4.2.2 Water Quality

All past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects to water quality. The following analysis considers how the OMAO-related incremental impacts of the Proposed Action and alternatives, when added to or acting synergistically with other non-OMAO related cumulative actions, would contribute to overall cumulative impacts on water quality from fuels, chemicals, and other contaminants; wastewater; marine debris; and increased sedimentation and turbidity.

4.2.2.1 Fuels, Chemicals, and Other Contaminants

OMAO operations under the Proposed Action could contribute to overall cumulative impacts to water quality, including:

- vessel movement;
- waste handling and discharges;
- vessel repair and maintenance;
- Uncrewed Marine Systems (UMS) operations;
- small boat operations; and
- Over the Side (OTS) handling, crane, davit, and winch operations.

Other non-OMAO related actions would also contribute to water quality impacts from fuels, chemicals, and other contaminants entering the water, including:

- presence and movement of vessels (e.g., other federal fleets, commercial fishing and shipping vessels, recreational fishing and boating vessels, and ocean cruise liners) and the construction, operation, and

- decommissioning of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure).

Vessel operations and industrial activities require the use of fuels, chemicals, and potentially other contaminants to maintain their operations. Cumulative impacts could occur in the unlikely event of an accidental spill or leak. These substances could consist of fuels used during vessel movement; lubricants, grease, or paints used to repair and maintain machinery and equipment onboard; or other waste products managed through waste handling and disposal procedures. Vessels used by other cumulative actions conduct operations similar to OMAO's. These operations could cumulatively impact water quality if an accidental leak, spill, or unauthorized discharge were to occur. The cumulative impacts would be greater for tankers and cargo vessels transporting large quantities of these substances. Due to the quantity of the substances stored onboard, a larger spill would occur in the unlikely event of an accident or leak. Long-term installations and marine-based facilities would likely require vessel operations for access to transport supplies, resources, and personnel. While these operations could cumulatively impact water quality in the unlikely event of an accidental spill, leak, or discharge, the construction and operation of these facilities may also contribute to cumulative impacts. The construction, operation, and decommissioning of these installations would require fuels, chemicals, and other potential contaminants to power, maintain, and repair machinery and other operating equipment. Many of the resources produced, including oil, gas, LNG, and marine minerals, would be considered a hazardous contaminant if accidentally released into the environment.

Cumulative effects from OMAO operations would be indistinguishable from other cumulative actions. The NOAA fleet currently consists of 15 ships (with new ships coming on-line while others reach their end of service life), and OMAO operations account for a very small amount of all vessel activity within U.S. navigable waters. All NOAA vessels are required to abide by all federal and NOAA policies, procedures, and regulations related to fuels, chemicals, and other contaminants in order to prevent or minimize the unauthorized discharge accidental leakage or spillage of these substances. This includes OMAO procedures for:

- oil transfers;
- bunkering operations;
- oily material management;
- OWS maintenance;
- NPDES VGP & MARPOL Annex I voluntary compliance; and
- procedures for voluntary compliance with additional MARPOL Annex I mandates, such as the SOPEP/VRP.

NOAA vessels follow strict guidance for discharging any substances. Substances must be treated through the OWS and may only be discharged overboard at authorized distances from shore. These procedures further reduce the likelihood for accidental or unauthorized discharges. Furthermore, impacts would not be concentrated in any specific area given the wide geographic scope of the action area. Any cumulative impact to water quality from fuels, chemicals, and other contaminants contributed by OMAO operations would be extremely limited due to the small quantities of substances carried onboard and the very low likelihood for accidental spills or leaks to occur due to few miles travelled, well maintained equipment, and strict adherence to operational and emergency procedures. Comparably, other cumulative actions associated with ocean-going vessels, long-term installations, and marine-based facilities would likely contribute the majority of the aggregate cumulative impacts to water quality from fuels, chemicals, and other contaminants.

Overall, aggregate cumulative impacts to water quality from fuels, chemicals, and other contaminants would be temporary or short term and would result in minor to moderate impacts throughout the action area. The contribution to these aggregate, adverse cumulative impacts from fuels, chemicals, and other contaminants from any of the three OMAO alternatives would be **negligible**.

4.2.2.2 Wastewater

OMAO operations under the Proposed Action, including waste handling and discharge and small boat operations, could contribute to overall cumulative impacts from wastewater. The majority of these impacts would be contributed by other non-OMAO related cumulative actions associated with the presence and movement of vessels and the operation of long-term installations.

Wastewater generated by OMAO and other cumulative actions would vary based on the number of personnel and size of a vessel, installation, or facility. Cumulative impacts could occur in the unlikely event of an accidental discharge at an unauthorized distance from shore. NOAA vessels generate sewage and greywater during operations. The amount of wastewater generated depends on the wastewater system utilized, the number of persons on the vessel, and the duration; smaller ships and shorter voyages generally generate less wastewater than larger ships and longer voyages. While authorized discharge of wastewater is permitted at certain distances from shore and with proper treatment devices, unauthorized discharges could cumulatively impact water quality. Ocean-going vessels would also generate wastewater that requires storage, treatment, or discharge and could cumulatively contribute to impacts in the environment if an accidental discharge were to occur. Similarly, long-term installations and marine-based facilities would either have their own wastewater treatment system with restricted discharge stipulations, or the facility would store its wastewater until a certain volume is reached that required removal and transport to an appropriate treatment facility. In the latter scenario, the installations could indirectly contribute to cumulative impacts in the event that an accidental spill or leak occurs during transfer or transport of the wastewater to a treatment facility.

Cumulative effects from OMAO operations would be indistinguishable from other cumulative actions. OMAO operations account for a very small amount of all vessel activity within U.S. navigable waters. NOAA vessels are required to abide by all federal and NOAA policies, procedures, and regulations related to wastewater in order to prevent or minimize any unauthorized discharges. This includes OMAO procedures for wastewater storage and treatment systems, procedures for wastewater discharge, compliance with NPDES VGPs and voluntary compliance with MARPOL Annex VI, and maintaining Marine Sanitation Devices (MSDs) onboard. NOAA vessels implement waste handling and discharge procedures to store, treat, and discharge wastewaters in a manner that complies with federal and state regulations. Any cumulative impacts to water quality from wastewater produced during OMAO operations would be extremely limited due to the small quantity of wastewater storage capacity and the low likelihood for accidental spills or leaks to occur. NOAA vessels are strictly prohibited from discharging any wastewater, unless permission is granted by the bridge for certain waste streams at authorized distances from shore. Furthermore, cumulative impacts would not be concentrated in any specific area given the wide geographic scope of the action area.

Comparably, other cumulative actions would likely contribute the majority of the aggregate cumulative impacts to water quality from wastewater. Vessels and other ship traffic such as tankers, cargo ships, container ships, and cruise ships vary in size, the number of ships in their fleets, and the ship capacity. All of these characteristics drastically exceed the ship sizes, number of ships, and number of personnel of the NOAA fleet. This would result in a larger volume of wastewater generated and stored onboard these vessels, and a much larger potential cumulative impact from accidental discharge. In addition, if any accidental spill of wastewater were to occur, the cumulative impact would be somewhat diminished given that these vessels would be moving throughout a wide geographic area and cumulative impacts would not generally be concentrated in a given area, except in areas such as ports and canals where multiple ships can be located at the same time. Although long-term installations and marine-based facilities are generally stationary structures, they could contribute more concentrated cumulative impacts if multiple accidental wastewater discharges were to occur at a given location.

Overall, aggregate cumulative impacts to water quality from wastewater would be temporary or short term, and would result in minor to moderate impacts throughout the action area. The contribution to these aggregate, adverse cumulative impacts from wastewater from any of the three OMAO alternatives would be **negligible**.

4.2.2.3 Marine Debris

OMAO operations under the Proposed Action could contribute to overall cumulative impacts from marine debris from:

- waste handling and discharge;
- vessel repair and maintenance;
- other sensors and data collection systems operations;
- UMS; and
- small boat systems.

The majority of marine debris impacts would be contributed by other non-OMAO related cumulative actions. Marine debris generated from other cumulative actions would most likely occur in the event of an accidental discharge, rather than from deliberate disposal. Solid waste is generated during routine vessel and facility operations and could contribute to cumulative marine debris impacts if it ends up in the marine environment. The type of vessel or installation would likely indicate what solid waste could be generated during operations and potentially end up as marine debris. Recreation-based vessels, such as cruise liners or recreational boating and fishing vessels, may produce solid waste consisting of consumer goods, such as food waste, dry trash, and recyclables. Discharging of macerated food waste is permitted at certain distances from shore; all other solid waste is strictly prohibited from discharge. Other non-OMAO related larger, ocean-going vessels, such as other federal fleets, commercial shipping vessels, and commercial fishing vessels, may produce similar waste from consumer goods in addition to other items that are associated with their operations. Commercial fishing vessels could accidentally lose trawl nets, hooks, fishing pots, and other deployable equipment, while shipping vessels could lose containers and cargo during transits. Long-term installations and marine-based facilities utilize specialized equipment, machinery, deployable gear, tools, supplies, and other items. These items could cumulatively contribute to marine debris if accidentally disposed of in the environment. Vessels and installations may also generate incinerator ash; however, incinerator ash would be limited to only those operations that use incinerators.

Cumulative effects from OMAO operations would be indistinguishable from other cumulative actions. OMAO operations account for a very small amount of all vessel activity within U.S. navigable waters. OMAO operations would generate consumption-based solid waste during transits, such as food waste, plastics, recyclables, and dry trash. Certain operations would also deploy gear and equipment connected by cables, lines, and tethers, such as during sensors and data collection systems operations, UMS operations, and small boat operations, all of which could potentially become marine debris if accidentally detached from the vessel. NOAA vessels are required to abide by all federal and NOAA policies, procedures, and regulations related to solid waste in order to prevent or minimize any unauthorized disposal. This includes OMAO procedures for shipboard solid waste management, procedures for waste processing equipment, compliance with NPDES VGPs and compliance with MARPOL Annex V, and all Standard Operating Procedures (SOPs) for deployable equipment, gear, and instruments. NOAA vessels implement procedures to collect, sort, store, and dispose of solid waste in a manner that complies with federal and state regulations. Additionally, the Marine Protection, Research and Sanctuaries Act (MPRSA), also known as the Ocean Dumping Act, regulates the transportation and dumping of any material into ocean waters. These procedures help minimize the likelihood of any unauthorized or accidental disposal into the environment. Any cumulative impact to water quality that were to occur from marine debris contributed by OMAO operations would be extremely limited due to these policies and practices and because of the small quantities of solid wastes carried onboard. NOAA vessels are strictly prohibited from discharging any solid waste overboard unless communication takes place between the galley and the bridge to determine coordinates/location to allow discharge for food wastes at authorized distances from shore and macerated if necessary.

Comparably, other cumulative actions would likely contribute the majority of the aggregate cumulative impacts to water quality from wastewater. Vessels and other ship traffic such as tankers, cargo ships, container ships, and cruise ships vary in size, the number of ships in their fleets, and the ship capacity. All of these characteristics drastically exceed the ship sizes, number of ships, and number of personnel of the NOAA fleet. This would result in a larger volume of solid waste generated and stored onboard these vessels and a much larger potential cumulative impact from accidental discharge of marine debris. If any accidental disposal were to occur, the cumulative impact would be somewhat diminished given that these vessels would be moving throughout a wide geographic area and cumulative impacts would not generally be concentrated in a given area. Although long-term installations and marine-based facilities are generally stationary structures, they could contribute more concentrated cumulative impacts if multiple accidental marine debris disposal were to occur at a given location.

Overall, aggregate cumulative impacts to water quality from marine debris would be short term to long term, and would result in minor to moderate impacts throughout the action area. The contribution to these aggregate, adverse cumulative impacts from marine debris from any of the three OMAO alternatives would be **negligible**.

4.2.2.4 Increase in Sedimentation and/or Turbidity

OMAO operations under the Proposed Action could contribute to overall cumulative impacts from increased sedimentation and turbidity from:

- vessel movement;
- anchoring;
- waste handling and discharges;

- other sensors and data collection systems operations (specifically grab samplers and sediment corers);
- UMS; and
- small boat systems.

The majority of the impacts would be contributed by other non-OMAO related cumulative actions associated with the presence and movement of vessels and the operation of long-term installations.

Vessel operations and industrial activities could create physical disturbances in the water column or on the sea floor that cumulatively contribute to impacts from sedimentation and turbidity. NOAA vessels and deployable equipment could create wakes, wave action, cavitation, or other disturbances on the water's surface or within the water column that decrease water clarity. Deployable equipment that physically contacts the sea floor, such as anchors, grab samplers, and sediment corers could cumulatively contribute to sedimentation by causing bottom substrates to resuspend in the water column. Authorized ship discharges such as OWS, wastewater, or macerated food waste could also discolor and cloud surrounding waters. Other non-OMAO related vessels conduct similar operations and would cumulatively impact water quality in a similar way; impacts from other cumulative actions may potentially be more severe depending on the activity. Commercial fishing vessels would deploy larger and more widespread fishing equipment through the water column, including bottom trawls and dredges that may resuspend bottom sediments and decrease water clarity. Larger, ocean-going vessels such as cruise liners and commercial shipping vessels would create more wave action and larger wakes and discharge larger volumes of treated and/or authorized waste into the environment, cumulatively contributing to turbidity. Long-term installations and marine-based facilities could cumulatively contribute to sedimentation and turbidity during construction, operation, and decommissioning phases. Construction and decommissioning of these facilities would likely include various forms of heavy equipment, drilling and construction activities, and physical disturbance or alteration of the sea floor, which would disturb bottom sediments.

Cumulative effects from OMAO operations would be indistinguishable from other cumulative actions. OMAO operations account for a very small amount of all vessel activity within U.S. navigable waters. OMAO has the ability to select locations for testing, calibrating, and training with equipment onboard, limiting the amount of disturbance. Therefore, OMAO's contribution to cumulative impacts from sedimentation and turbidity would be fairly limited. Bottom disturbing activities would affect small areas, would not happen frequently, would dissipate relatively quickly, and would not occur over a wide geographic area. Wakes, wave action, cavitation, or other disturbances created by vessels or equipment moving along the water's surface or through the water column would also dissipate relatively quickly. Authorized discharges would be in permitted concentrations and authorized locations. Any cumulative impacts to water quality that occur from sedimentation and turbidity contributed by OMAO operations would be extremely minimal.

Comparably, other cumulative actions would likely contribute the majority of the aggregate cumulative impacts to water quality from sedimentation and turbidity. Vessels and other ship traffic such as tankers, cargo ships, container ships, and cruise ships vary in size, the number of ships in their fleets, and the ship capacity. All of these characteristics drastically exceed the ship sizes, number of ships, and number of personnel of the NOAA fleet. This would likely result in much larger wakes, wave action, cavitation, and other disturbances created by other vessels or equipment. Larger vessels would have larger anchors and more numerous, deployable equipment, creating more sea floor disturbance compared to NOAA vessels and contributing a much larger portion to aggregate cumulative impacts. Cumulative impacts would be somewhat diminished because these vessels would be moving throughout a wide geographic area and impacts would not generally be concentrated in a given area. This would not be the case for long-term installations and marine-based facilities, which are generally stationary structures that could contribute more concentrated cumulative impacts. However, cumulative impacts from sedimentation and turbidity generated by construction and decommissioning activities would be temporary or short-term depending on the duration of these phases, and any disturbed sediments would dissipate relatively quickly. The operation of some installations, especially oil and gas developments and extraction of marine minerals, would likely cause more substantial disturbances due to the physical nature of these actions and their location on the sea floor. However, once any drilling, excavation, or other physical disturbance to the sea floor from operational activities ceases, sedimentation and turbidity would be expected to dissipate relatively quickly.

Overall, aggregate cumulative impacts to water quality from increased sedimentation and turbidity would be temporary and would result in negligible to minor impacts throughout the action area. The contribution to these aggregate, adverse cumulative impacts from increased sedimentation and turbidity from any of the three OMAO alternatives would be **negligible**.

4.2.2.5 Conclusion

When considered in tandem with the OMAO Proposed Action, other non-OMAO related cumulative actions would contribute to adverse cumulative impacts to water quality from fuels, chemicals, and contaminants; wastewater; marine debris; and increased sedimentation and turbidity within the action area. OMAO operations would also contribute cumulative impacts by degrading water quality in the unlikely event that fuels, chemicals, contaminants, wastewaters, or marine debris are accidentally discharged or spilled into the marine environment, or if cumulative actions increased sedimentation and turbidity.

Cumulative impacts from any of the OMAO alternatives in combination with the other cumulative actions 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 action area and the combined effect of the cumulative actions is greater or less than the sum of each individual effect. Similarly, additive cumulative impacts could occur if activities or actions are conducted sequentially within adjacent locations of the action area and the combined effects were the same as the sum of each individual effect.

Cumulative impacts from NOAA vessels would consist of a smaller, limited contribution to the aggregate total due to the limited distance traveled, the smaller sizes of the ships, the smaller number of personnel onboard, and in some instances, the absence of shipboard incinerators. NOAA ships also follow all federal and NOAA regulations, policies, and procedures related to these impact causing factors, further limiting the contributions to aggregate cumulative impacts. Cumulative impacts from any of the OMAO alternatives in combination with the other cumulative actions 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 action area and the combined effect of the cumulative actions is greater or less than the sum of each individual effect. Similarly, additive cumulative impacts could occur if activities or actions are conducted sequentially within adjacent locations of the action area and the combined effects were the same as the sum of each individual effect. The exact timing and location of OMAO operations are subject to change on a project-by-project basis. In addition, the action area covers a very wide geographic range so it would be unlikely for cumulative impacts to occur in close proximity and sequentially, except potentially at ports and areas of concentration such as canals. Therefore, synergistic or additive cumulative impacts would most likely be determined by the timing and location of OMAO activities in relation to other cumulative actions.

Overall, the aggregate, adverse cumulative impacts from other cumulative actions on water quality throughout the action area would be negligible to moderate. The OMAO Proposed Action would contribute to and have the potential to increase these cumulative impacts, but the relative contribution would be **negligible**. These impacts would occur regardless of the chosen alternative since operations 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 DAS than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on water quality.

4.2.3 Acoustic Environment

With the exception of climate change, all past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects to the airborne and underwater acoustic environment. The following section addresses acoustic environments in general; discussion of cumulative impacts on more specific biological resources may be found in other sections of this chapter: 4.2.5.1 (Marine Mammals), 4.2.5.2 (Sea Turtles), 4.2.5.3 (Fish), 4.2.5.4 (Aquatic Macroinvertebrates), and 4.2.5.5 (Sea Birds, Shorebirds and Coastal Birds, and Waterfowl). The cumulative impacts analysis in the following subsections are categorized by their relevance to acoustic resources, receptors at sea and nearshore, as well as underwater acoustic resources and trends.

4.2.3.1 Impacts of Airborne Sound

OMAO operations under the Proposed Action would produce airborne sounds from the use of propellers, generators, motors, and other machinery. These sounds, along with other non-OMAO vessels and equipment noise from all other cumulative actions considered in Section 4.1 (with the exception of climate change), could contribute to the overall cumulative impacts on the airborne acoustic environment throughout the action area. These cumulative impacts could contribute to the anthropogenic sounds, or ambient noise level, that combine with natural biological and natural physical sounds to create a local acoustic environment as discussed in Section 3.5.1.2 (see **Table 3.5-2**). Cumulative changes to the airborne acoustic environment, or ambient noise levels, could be perceived by humans and wildlife at sea and nearshore. Cumulative impacts from increasing anthropogenic noise on wildlife are discussed as relevant by taxa in Section 4.2.5 (Biological Resources).

Vessels and equipment used during both OMAO operations and other cumulative actions would generate low-frequency noise that could be audible to people aboard the vessels. Crew members aboard NOAA vessels would only be able to hear noise produced by the other cumulative actions if the NOAA vessel were to pass close enough (the distance depends on the type of sound and how loud it is) to another federal fleet vessel or other installations and activities. In general, the likelihood of passing close to another vessel or activities associated with non-OMAO actions decreases the further away from shore the NOAA vessel travels. Additionally, given that NOAA vessels would maintain a safe distance from other vessels and activities, the noise from other vessels and activities heard by OMAO crew members would not be expected to exceed sound levels that would be higher than mildly noticeable.

Vessel and equipment use from both OMAO operations and other cumulative actions would generate low-frequency noise that would also be audible to people onshore and nearshore. Overlapping noise from these activities is most likely to occur in highly trafficked and developed coastal areas and ports where the concentration of the cumulative activities is expected to be greater. As discussed in Section 3.5.1.2, the most prevalent noise perceived by residents living near a port is caused by low frequency noise (≤ 160 hertz [Hz]) which is often interpreted as a humming or buzzing noise. Long-term exposure to this collective low-frequency noise could cause sleep disturbance, annoyance, noise-induced hearing loss, and other stress related health effects (Wolfert et al., 2019; Hammer et al., 2014). Although the noise contributions from each cumulative action cannot be discreetly quantified, anthropogenic noise is expected to continue to increase across the U.S., as are the related health effects (Hammer et al., 2014). However, NOAA vessel transits would be infrequent in any given area, and the noise would not be discernable in terms of sound level or frequency from other anthropogenic acoustic sources in highly trafficked areas. Along remote coastlines, NOAA vessel transits would be infrequent in any given area, and people onshore or nearshore would only hear a NOAA vessel if it were to pass within several thousand feet and if the noise only persists for the duration of vessel transit through the area. However, it is very unlikely that a NOAA vessel would be close to shore as ships need to maintain a safe distance, typically controlled by depth. As such, the cumulative contribution to ambient noise from NOAA vessels would not be substantial, and the exposure of people onshore and nearshore to these sounds, at the levels and lengths of time that may cause anything other than minimal disturbance, would be unlikely.

Sound from vessel operations (both OMAO and other non-OMAO vessels) and activities from other actions would be widely distributed geographically and likely to result in cumulative, mildly noticeable low-frequency noise in the vicinity of the vessel or activity. The above-described effects from OMAO operations can also occur from almost all anthropogenic on-water activities. These effects would be indistinguishable in type from other human uses. Overall, the cumulative impact of increased airborne anthropogenic noise throughout the action area would be adverse and minor and occur in the short- and long-term. The contribution to these aggregate, adverse cumulative impacts on the airborne acoustic environment from any of the three OMAO alternatives would be **negligible**.

4.2.3.2 Impacts of Underwater Sound

OMAO operations under the Proposed Action, including the operation of vessels (i.e., propeller, generator, motor, and other machinery use) and underwater active acoustic sources could contribute to overall cumulative impacts on the underwater acoustic environment throughout the action area along with other vessel and equipment noise and active acoustic sources from all other cumulative actions considered in Section 4.1 (with the exception of climate change). This anthropogenic noise combines with natural biological and natural physical sounds to create the ambient ocean sound levels as described in Section 3.5.1.3. However, increasing human activity along coastlines and farther offshore has led to rising levels of anthropogenic underwater noise. Some of these activities, particularly commercial shipping, have resulted in significant changes to background ocean noise levels (NOAA, 2016). Cumulative impacts from increasing anthropogenic noise on underwater marine wildlife are discussed as relevant by taxa in Section 4.2.5 (Biological Resources); this section discusses general underwater noise trends.

Vessel and equipment use from both OMAO operations and other cumulative actions would generate low-frequency noise. Commercial shipping is the major contributor to ocean noise at low frequencies (5 to 500 Hz), adding to ocean background noise over large geographic areas. From a distance, the sounds of individual vessels are spatially and temporally indistinguishable across this widespread vessel traffic noise. Increases in both the number of vessels and in the tonnage of goods shipped over the last 20 years indicates growth in vessel traffic, which is expected to continue to grow (Hildebrand, No Date). Due to the critical nature of addressing and understanding the increase in underwater anthropogenic noise, NOAA cooperated with the International Maritime Organization (IMO) to develop voluntary guidelines for reducing underwater sound from commercial shipping. These reductions provide recommendations for propeller design, hull design, onboard machinery selection considerations, and Operation and Maintenance (O&M) practices to decrease vessel sound (NOAA, 2016; IMO, 2014). The cumulative footprint of other sources of noise is more dynamic and varies widely in its frequency content, duration, and loudness. As such, these sources can disrupt the acoustic environment "locally for brief periods of time as well as chronically over large areas for long durations" (NOAA, 2016). For example, construction activities associated with other cumulative actions could involve intermittent impulsive sounds such as drilling, pile driving, dredging, and tunnel boring (Hildebrand, No Date). The cumulative contribution to background noise in the ocean from NOAA vessels would not be substantial because NOAA vessel transits would be infrequent in any given area, and noise would be expected to attenuate to background levels within several hundred to several thousand feet and only persist for the duration of vessel transit through the area.

Use of active acoustic sources from both OMAO operations and other cumulative actions would generate noise at various frequency ranges. Use of underwater active acoustic sources associated with other cumulative actions, such as offshore O&G development, would involve high intensity, directional, and brief repeated signals (Hildebrand, No Date). Given that OMAO typically only operates active underwater acoustic sources while a vessel is in transit for short periods of time during testing, training, and calibration, the sources are highly directional in nature, and the energy of their emitted acoustic signals drop off rapidly with distance from the source, the cumulative contribution to ocean background noise from OMAO active acoustic sources would be very small.

Sound from vessel operations and underwater active acoustic sources (both OMAO and other non-OMAO vessels) would be widely distributed geographically and would likely result in continued cumulative increases in anthropogenic underwater noise throughout the action area. However, contributions from OMAO activities would be limited to the vicinity of the vessel and be brief and transitory in nature. The above-described effects from OMAO operations can also occur from many anthropogenic on-water activities (e.g., other non-OMAO vessels, oil and natural gas development, extraction of marine minerals, offshore renewable energy development) and would be indistinguishable in type from other human uses. Overall, the cumulative impacts from increased underwater anthropogenic noise throughout the action area would be adverse and moderate and occur in the short- and long-term. The contribution to these aggregate, adverse cumulative impacts on the underwater acoustic environment from any of the three OMAO alternatives would be **negligible**.

4.2.3.3 Conclusion

When considered in tandem with the OMAO Proposed Action, airborne and underwater sound from vessel and equipment use, including:

- other federal fleets;
- offshore and outer continental shelf oil and natural gas development;
- assessment and extraction of marine minerals; offshore renewable energy development;
- commercial and recreational fishing;
- commercial shipping and recreational boating; ocean cruise line industry;

- construction and operation of offshore liquified natural gas terminals; and
- construction of new submarine telecommunication cable infrastructure

and from underwater active acoustic systems (e.g., other federal fleets and oil and natural gas development) would create adverse cumulative impacts to the airborne and underwater acoustic environment. Adverse impacts could occur through the addition of anthropogenic noise onshore, nearshore, and at sea. In both the short and long term, continuous noise, such as noise from the presence and movement of vessels, in conjunction with intermittent noise, such as noise from coastal construction activities, would continue to contribute to noise levels along the U.S. coast, including port cities and large coastal urban populations. In both the short and long term, continuous and intermittent noise from the presence and movement of vessels; use of active acoustic sources; and other sound producing activities associated with the cumulative actions would continue to increase background ocean noise.

Overall, the short- and long-term aggregate adverse cumulative impacts from other cumulative actions on the acoustic environment throughout the action area would be minor to moderate and are, therefore, expected to result in insignificant impacts to the acoustic environment.

Cumulative adverse impacts from the OMAO Proposed Action, in combination with the other cumulative actions, 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 the acoustic environment could occur if activities or actions are conducted sequentially within adjacent sections of the action area. Although the exact timing and location of OMAO vessel operations are subject to change, synergistic or additive cumulative impacts are most likely to occur in areas with greater human activity such as near port cities and large coastal urban populations.

The OMAO Proposed Action would contribute to and has the potential to increase these cumulative impacts, but OMAO's contribution to cumulative impacts would be **negligible** as compared to the aggregate contributions of other cumulative actions. These impacts would occur regardless of the chosen alternative since operations 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 DAS than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on the acoustic environment.

4.2.4 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 other sections of this chapter: 4.2.5.1 (Marine Mammals), 4.2.5.2 (Sea Turtles), 4.2.5.3 (Fish), 4.2.5.4 (Aquatic Macroinvertebrates), and 4.2.5.5 (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 habitats:

- 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.

4.2.4.1 Physical Impacts to Bottom Substrate

OMAO operations under the Proposed Action, including anchoring of vessels and testing of bottom grab samplers and sediment corers could contribute to overall cumulative impacts on the bottom substrate throughout marine, freshwater, and estuarine areas in the action area associated with:

- the presence and movement of vessels (e.g., other federal fleets and commercial fishing and shipping vessels, and recreational fishing and boating vessels), and
- construction, operation, and decommissioning of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure).

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 OMAO operations and from other cumulative actions requiring the presence and movement of 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 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 OMAO operations to bottom substrates would be temporary and would be mitigated by avoiding repeated operations in the same location; avoiding testing of bottom sampling equipment on coral reefs, shipwrecks, obstructions, or hard bottom areas; and while operating in shallow water, reducing speeds and proceeding with caution to avoid bottom disturbance. For both OMAO operations and other actions, these impacts would be largely confined to the immediate vicinity of their source and would not 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 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 from other actions on bottom substrates would be limited to the immediate vicinity of vessels, trailed equipment, or nearshore and offshore development and installations 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 variability. Effects from OMAO operations would be indistinguishable from other human uses. OMAO's impacts from anchoring and testing of bottom grab samplers and sediment corers would infrequently disrupt small areas of bottom substrate. Disruptions to the sea floor caused by OMAO activities would be expected to occur predominantly in muddy or sandy substrates, which would recover relatively quickly. Overall, aggregate cumulative bottom substrate impacts would occur regardless of the chosen alternative, would be short-term and long-term, and could result in 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 OMAO alternatives would be **negligible**.

4.2.4.2 Increase in Sedimentation, Turbidity, and/or Chemical Contaminants in Habitats

Vessel movement, anchoring, waste handling and discharges, uncrewed marine systems, operation of other sensors and data collection systems - specifically grab samplers and sediment corers, and operation of small boat systems under the Proposed Action could contribute to overall cumulative impacts from other actions associated with:

- presence and movement of other vessels (e.g., other federal fleets and commercial fishing and shipping vessels, and recreational fishing and boating vessels);
- construction, operation, and decommissioning of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure); and
- coastal erosion resulting from climate change.

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 of equipment during both OMAO operations and other cumulative actions, in conjunction with other underwater actions such as construction activities (including blasting and leveling), could 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 would also continually erode coastlines along the EEZ over the next 15 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.

Both OMAO operations and other cumulative actions 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 could harm seagrass ecosystems close to the water surface and 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 from both OMAO and other cumulative actions 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. The above-described effects from OMAO operations can also occur from almost all human use of water. These effects would be indistinguishable in type from other human uses. Additionally, small spills rarely occur during OMAO operations, and large spills are unlikely given the size of vessels, the amount of fuel, oil, and chemicals present onboard vessels, and the waste handling and discharge protocols that are in place. Overall, aggregate cumulative impacts to all aquatic habitat areas from increased sedimentation, turbidity, and/or chemical contamination would be adverse and minor. The contribution to these aggregate, adverse cumulative impacts from any of the three OMAO alternatives would be **negligible**.

4.2.4.3 Increased Ambient Sound Levels in Habitats

Vessel movement, active acoustic systems operations, uncrewed marine and aircraft systems operations, and small boat systems operations under the Proposed Action could contribute to overall cumulative impacts on ambient sound levels associated with:

- the presence and movement of other vessels (e.g., other federal fleets and commercial fishing and shipping vessels, and recreational fishing and boating vessels); and
- construction, operation, and decommissioning of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure).

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.

Vessel movement, uncrewed marine and aircraft systems operations, and small boat systems operations from both OMAO operations and other actions, as well as 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, NOAA 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 NOAA vessels 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. Sound sources operated by OMAO would be localized and short term and would not generally overlap with other sound sources.

The use of active underwater acoustic sources in 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 OMAO 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 OMAO sources, 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 are operated while a vessel is in motion, or when ships are stationary or anchored, impacts from underwater acoustic sounds would be very limited; therefore, habitat areas would only be exposed to emitted acoustic energy for a very short duration and the impacts would be minimal. 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 OMAO 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. A majority of the sounds generated by underwater acoustic sources are well above the hearing frequencies of 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 effects from OMAO operations can also occur from 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 minor. The contribution to these aggregate, adverse cumulative impacts on ambient underwater sound levels from any of the three OMAO alternatives would be **negligible**.

4.2.4.4 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., vessels, UMS operations; small boat systems; anchoring; and the use of various equipment), could contribute to cumulative impacts from all actions detailed in Section 4.1 and in conjunction with ongoing climate change. Cumulatively, these activities 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 OMAO and other entities would occur in all freshwater and marine regions of the action area and could involve transit and operations across large swaths of the action area using the same physical equipment and instrumentation. These longer voyages could potentially and 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 invasive species. These species and the resulting impacts would persist until all invasive organisms were removed from a given area (if even possible) 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 operations in disparate geographic 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 action 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, all OMAO operations would implement mandatory invasive species prevention procedures including, but not limited to, vessel and equipment washdown, cleaning, and deballasting (i.e., expelling of ballast water in open ocean waters for those vessels that have ballast tanks), as discussed in detail in Section 3.6.2.1.4, thus reducing the likelihood of invasive species propagation The above-described effects of OMAO operations can also occur from 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. Although OMAO equipment and instruments used or tested consecutively in disparate operational areas could potentially serve as transmission vectors for invasive species, OMAO crews would implement all policies, procedures, and regulations related to ballast and washdown water management, limiting the potential impact of invasive species on habitats in the action area. The contribution to these aggregate, adverse cumulative impacts on invasive species dispersal from any of the three OMAO alternatives would be **negligible**.

4.2.4.5 Impacts to the Water Column in Habitats

Vessel movement; anchoring; UMS operations; operation of sensors and data collection systems; and small boat systems operations under the Proposed Action could contribute to cumulative impacts from:

- the presence and movement of other vessels (e.g., other federal fleets and commercial fishing and shipping vessels, and recreational fishing and boating vessels) associated with all cumulative actions;
- raising and lowering of equipment; and
- construction, operation, and decommissioning of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure).

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 NOAA and other vessels and UMS 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. Propeller wash 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 action 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 other vessel-based activities within the affected area.

Instruments, gear, and personnel that interact with the water column, including anchors and chains, bottom sampling equipment, echo sounders, 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 the area of activity 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, from both OMAO operations and other cumulative actions, would likely be limited to the immediate vicinity of the source and would not persist beyond the conclusion of an operation. The above-described effects of OMAO operations can also occur from almost all human use of water. These effects would be indistinguishable in type from other human uses. Overall, aggregate impacts of all other actions 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. The contribution to these aggregate, adverse cumulative impacts from any of the three OMAO alternatives would be **negligible**.

4.2.4.6 Conclusion

When considered in tandem with the OMAO Proposed Action, the:

- presence and movement of vessels (e.g., other federal fleets and commercial fishing and shipping vessels, and recreational fishing and boating vessels), and
- construction, operation, and decommissioning of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure)

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 levels, facilitated dispersion of invasive species, and disturbances to the water column 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 OMAO activities. Disturbance and displacement resulting from activities are not expected to persist beyond the duration of activities. Nearshore and offshore development in conjunction with ongoing anthropogenic climate change would reduce the total amount of available 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 other cumulative actions on habitats throughout the action area would be negligible to moderate, 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 other cumulative actions, 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 habitat areas could occur if activities or actions are conducted sequentially within adjacent sections of the action area. Although the exact timing and location of OMAO operations are not precisely known at this time and are subject to change, the Southeast and Alaska operational areas contain relatively high levels of marine O&G development (which is not associated with OMAO operations). Therefore, synergistic or additive cumulative impacts are most likely to occur in either of these areas. The vast majority of cumulative impacts would be confined to the immediate vicinity of operations 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 OMAO 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 operations 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 DAS than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on habitats.

4.2.5 Biological Resources

All past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects on biological resources. The following sections address cumulative impacts on marine mammals, sea turtles, fish, aquatic macroinvertebrates, and birds (comprising sea birds, shorebirds and coastal birds, and waterfowl). The analysis also considers other actions and activities that can contribute to the existing conditions of biological resources, including accumulation of marine debris from marine or terrestrial sources; the accidental or illicit discharge of oil, fuel, chemicals, or waste; habitat encroachment from onshore and nearshore development; IUU fishing; and flows of non-point source pollutants.

The following analysis considers how the OMAO-related incremental impacts of the Proposed Action and alternatives, when added to or acting synergistically with other past, present, and reasonably foreseeable future actions, would contribute to overall cumulative impacts.

4.2.5.1 Marine Mammals

Based on the analysis presented in Section 3.7.2.1.1 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 due to underwater acoustic sources; exposure to oil, fuel, and other contaminants; entanglement and ingestion of marine debris; and a very low likelihood of vessel strikes; and
- Disturbance or behavioral modification from increased ambient sound levels; presence and movement of vessels and equipment; and marine trash and debris.

To a lesser degree, the Proposed Action could also contribute cumulative impacts to animal fitness, habitat alteration, and even animal mortality.

4.2.5.1.1 Injury and Mortality of Marine Mammals

Marine mammal injury and mortality 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 injury and mortality of marine mammals. Contact with spilled oil can lead to life-threatening injuries or loss of life for marine mammals. A significantly high level of debilitating injuries or mortality can seriously threaten and impact the continued viability of a population.

Vessel strikes have been and will continue to be a cause of marine mammal injury and mortality. In particular, the most vulnerable marine mammals are those that spend extended periods of time at or just below the surface of the water, 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 as a result of fisheries bycatch or fishing gear entanglement. OMAO does not expect any mortality and very little injury of marine mammals as a result of the Proposed Action. The probability of vessel collisions with most marine mammal species is unlikely to occur considering the relatively slow vessel speeds, constant visual observation, and the speed and agility of most marine mammal species.

Likewise, the likelihood of an accidental spill from a NOAA vessel 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 proper handling of all hazardous or regulated materials in accordance with applicable laws, as well as the small amounts of fuel and other chemicals onboard. Injury that might occur during OMAO operations would be additive to injury and mortality associated with other cumulative actions. OMAO does not anticipate mortalities to marine mammals as a result of any of the OMAO 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 injury and mortality 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 underwater drilling, underwater pile driving, and underwater use of explosives, all of which produce low to high frequency underwater noise. If they occurred at the same time and place, they would synergistically contribute to adverse cumulative sonic impacts on marine mammals; if they do not occur at the same time and place, they would additively contribute to adverse cumulative impacts. However, the vast majority of impacts expected from 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 Proposed Action could result in behavioral disruptions and have a low injury potential for individuals of some marine mammal species from underwater acoustic sources and vessel sounds. Although injury is possible under the OMAO alternatives, it would be additive to injuries associated with other cumulative actions. OMAO operations are not likely to occur at the same time and place as other cumulative actions. It is also possible that the Proposed Action could cause a more serious behavioral response in an animal already injured by another activity. However, injury exposures are not expected to be additive because other acoustic activities would not likely overlap in time and space with OMAO operations. In addition, acoustic activities are typically temporary and localized. Thus, 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 injury and mortality would likely be minor to moderate. The contribution to these aggregate, adverse cumulative impacts from all three OMAO alternatives would be **negligible**.

4.2.5.1.2 Marine Mammals Disturbance and Behavioral Modifications

Disturbance and behavioral modifications of marine mammals are associated with the presence and movement of other vessels (e.g., other federal fleets and commercial fishing and shipping vessels, and recreational fishing and boating vessels); and construction, operation, and decommissioning of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure). 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 construction, operation, and decommissioning of long-term installations. Increasing ambient sound levels may steadily erode marine mammals' abilities to communicate, find food, mate, and navigate. 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 OMAO operations. However, impacts are expected to be spatially localized and temporary or short-term in duration. Implementation of best management practices (BMPs) such as animal approach restrictions and low vessel speeds (see Appendix C) are expected to minimize potential impacts on animal behavior. Other cumulative actions are unlikely to overlap in time and space with OMAO operations because these activities are dispersed and the sound sources are intermittent. It is likely that distant vessel sound, which is more universal and continuous, would overlap in time and space with actions under the Proposed Action. However, the Proposed Action would likely only contribute negligible cumulative impacts which could cause 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 OMAO alternatives would be **negligible**.

4.2.5.1.3 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. Marine mammals with hair, such as fur seals or sea otters, would be at risk of fur contamination affecting insulation capabilities. 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 reducing or eliminating 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.

The amount of air emissions from OMAO operations would continue to be a small fraction of emissions from all vessel activity. The size of the NOAA fleet compared to the number of other vessels that could accidently spill oil, fuel, and chemical contaminants into the ocean, combined with the small amounts of fuel and other chemicals onboard would be minimal; therefore, the incremental increase in cumulative impacts of the OMAO alternatives on marine mammal health and fitness would be negligible. The potential also exists for the impacts of ocean pollution associated with the Proposed Action to be additive or synergistic as the response of a previously stressed animal could 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 OMAO alternatives would be **negligible**.

4.2.5.1.4 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 become reduced. Air and water pollution do not only cause potentially adverse impacts on marine mammals themselves, as discussed above, but can also affect habitat as air and water quality are degraded. Increased emissions of anthropogenic 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. The effects of climate change 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, reproductive success, and carrying capacity of marine mammals. Although the Proposed Action would have some adverse impacts on fish and aquatic macroinvertebrates that make up the prey/food sources for marine mammals (see Sections 3.7.2.1.3 Fish and 3.7.2.1.4 Aquatic Macroinvertebrates), these impacts would be very small 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 OMAO 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 OMAO alternatives would be **negligible**.

4.2.5.1.5 Conclusion

When considered in tandem with activities associated with the Proposed Action, other federal fleets, offshore oil and natural gas development, assessment and extraction of marine minerals, offshore renewable energy development, climate change, commercial and recreational fishing, commercial shipping and recreational boating, ocean cruise line industry, construction and operation of offshore LNG terminals, and construction of new submarine telecommunication cable infrastructure would create adverse cumulative impacts to marine mammals. These adverse impacts would occur through injury and mortality (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 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 from the activities 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 caused by OMAO's Proposed Action.

Cumulative, adverse impacts from any of the OMAO alternatives in combination with actions in 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 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 OMAO's Proposed Action. The Proposed Action would contribute to and have the potential to increase cumulative impacts, but its relative contribution would be **negligible** as compared to the aggregate contributions from other cumulative actions because the impacts from OMAO operations would be temporary or short-term, localized or regional depending on whether a vessel is moving, and would be small as compared to impacts from all other cumulative actions. OMAO impacts would occur regardless of the chosen alternative since 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 DAS than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on marine mammals.

4.2.5.2 Sea Turtles

Based on the analysis presented in Section 3.7.2.1.2 Sea Turtles, impacts of the Proposed Action would result in negligible to minor, or possibly moderate, impacts to sea turtles. The Proposed Action could contribute to cumulative impacts on sea turtles, including:

- injury and mortality from underwater sound; exposure to oil, fuel, and other contaminants; entanglement and ingestion of marine debris; and a very low likelihood of vessel strikes;
- disturbance and displacement from underwater sound, vessel wake and underwater turbulence, and bottom disturbance; and
- habitat alteration from vessel wake and underwater turbulence; bottom disturbance; and exposure to oil, fuel, and other contaminants.

4.2.5.2.1 Injury and Mortality to Sea Turtles

Vessel movement and active acoustic sources under the Proposed Action would contribute to cumulative impacts from the use of high intensity active underwater acoustic sources used by other actions, such as seismic surveys or piledriving, and the presence and movement of vessels associated with any of the past, present, or reasonably foreseeable actions. The combined actions could cumulatively contribute direct impacts in the form of injury to sea turtles or their prey. Sea turtles may be able to hear low frequency sources that are as low as 0.5 kHz. These low frequency sources are used in deeper water; thus, sea turtle exposure would likely occur farther away from the source. The frequencies produced by active underwater acoustic sources would likely be well above the documented sea turtle hearing range and would therefore be imperceptible to sea turtles. As such, there would not likely be cumulative effects related to OMAO sources even though active acoustic sources commonly used in other activities, such as offshore renewable energy development, have a propensity to injure sea turtles. The presence and movement of vessels within the action area, including all vessels used in conjunction with activities under the Proposed Action and all other past, present, and reasonably foreseeable actions, could also cumulatively contribute to collisions or entanglement of sea turtles or their prey.

Discharges of fuel, chemicals, or waste accompanying all vessel operations within the study area would contribute to the existing direct injury of turtles and prey. This could occur through ingestion and interaction with spilled substances, although the severity of the impact would be contingent upon the size and location of the spill. Contaminated prey or forage could also potentially serve as an additional source of spill exposure to sea turtles, especially of bioaccumulated hazardous materials. 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). Expanded commercial fishing operations would likely increase bycatch of sea turtles or 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 macroinvertebrate prey would likely be reduced.

Light pollution from onshore and nearshore commercial, residential, or O&G development in close proximity to sea turtle nesting beaches potentially interfere with nesting and reproduction, which would likely contribute to the reduced number of offspring surviving to reproductive maturity. OMAO night operations would contribute minimally to cumulative coastal light pollution. Light pollution disorients sea turtle hatchlings and nesting 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. These species are particularly sensitive to environmental conditions during their larval stages and climate change could potentially reduce their availability to sea turtles.

The majority of cumulative direct injury impacts would be limited to the immediate vicinity of vessels or development areas (e.g., O&G) 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 sea turtles, although impacts could continue to increase over time. Overall, the aggregate, adverse cumulative impacts to sea turtles from direct injury would be minor to moderate. The contribution to these aggregate, adverse cumulative impacts from all three OMAO alternatives would be **negligible** to **minor**.

4.2.5.2.2 Disturbance and Displacement of Sea Turtles

Sound from vessel operations under the Proposed Action could contribute to the disturbance of sea turtles in conjunction with other cumulative oceanic anthropogenic activities. Sound from other federal fleet vessels, shipping vessels, commercial fishing vessels, recreational boats, and cruise ships and from underwater construction activities in support of energy infrastructure, LNG terminals, and submarine telecommunications infrastructure could also cumulatively disturb and displace turtles and their prey 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 kilohertz [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 as low as 0.5 kHz. Low frequency underwater acoustic sources are used in deeper water; thus, sea turtle exposure would likely be farther away from the source. The frequencies produced by active underwater acoustic sources would likely be well 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 their high hearing sensitivity between 200 and 400 Hz is within the acoustic range of underwater vessel sound.

The OMAO Proposed Action would contribute to cumulative underwater disturbance from vessel movement, vessel operation, and bottom sampling. 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 and their prey. Climate change will continue to raise sea levels globally for the foreseeable future. This will lead to continual EEZ coastline erosion. The ongoing accidental or illicit discharges of fuel, chemicals, or waste from other vessel operations and marine infrastructure contributes to currently disturbed and displaced sea turtles and their prey from contaminated areas for the lifetime of the spill. The severity of the impact is contingent upon the size and location of the spill. Most small spills are dispersed and dissipated by ocean conditions on a timescale of minutes to hours. Offshore oil/gas installations, large tankers, and pipelines pose a higher risk and probability of large spills than OMAO operations and cannot dissipate quickly by ocean conditions.

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, 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 OMAO alternatives would be **negligible**.

4.2.5.2.3 Degradation and Reduction of Sea Turtle Habitat

Actions such as anchoring, bottom sampling, active underwater acoustic sources, and vessel sound and movement which would cause disturbance and displacement of prey populations under the Proposed Action could contribute to cumulative impacts associated with other actions (e.g., LNG terminals, energy infrastructure, and submarine telecommunications). Together, these actions would likely reduce the total amount of oceanic habitat available to sea turtles and their prey. Sea turtles and their prey would likely be displaced from these areas for the duration of the installation. This is 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 of the installation, the area could potentially be reclaimed and return to previous habitat conditions.

The recurring 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 severity of the impact would be contingent upon the size and distance of the spill in question from nesting beaches. Most small spills are dispersed and dissipated by ocean conditions on a timescale of minutes to hours. Offshore oil/gas installations with tankers, drilling rigs, production platforms, and pipelines pose a higher probability of large spills with larger and longer-lasting impacts than OMAO operations.

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 a result of climate change will continually erode coastlines along the EEZ over the next 15 years and could potentially destroy or degrade sensitive sea turtle nesting beaches. Rising global 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. Seagrass, an important turtle forage, and coral reefs which shelter 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 quality and availability or impact the overall structure or abundance of sea turtle or prey populations. Nesting habitat reductions could potentially impact the overall sea turtle population. Sea turtles often 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 OMAO alternatives would be **negligible**.

4.2.5.2.4 Conclusion

Activities associated with the Proposed Action and other past, present, and foreseeable future actions have the potential to contribute cumulatively to direct injury, disturbance and displacement, and habitat reduction 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 underwater 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 discharge of oil, fuel, chemicals, or waste would 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 activity locations 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 other actions 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 action 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 action area. The Proposed Action would contribute to and have the potential to increase these cumulative impacts, but their relative contribution would be negligible 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 DAS than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on sea turtles. The contribution to these aggregate, adverse cumulative impacts from all three OMAO alternatives would be **negligible**.

4.2.5.3 Fish

Based on the analysis presented in Section 3.7.2.1.3 Fish, impacts of the OMAO 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 sound);
- 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 exposure to oil, fuel, and other contaminants.

4.2.5.3.1 Injury and Mortality to Fish

Fish injury and mortality from other cumulative actions could result from vessel strikes, underwater sound, fishing bycatch, and entanglement. Ongoing accidental or illicit discharge of oil, fuel, chemicals, or waste could contribute to the existing injury and mortality of fish. All vessel operations, as well as other cumulative actions such as drilling, construction, and placement of structures within the action area could cumulatively contribute to the injury and mortality of fish through contact with and ingestion of spilled oil, fuel, or released contaminants. Although most adult fish are mobile enough to avoid areas with higher concentrations of contaminants, eggs, larvae, and juvenile fish are less mobile and would likely be more susceptible than adults. Adult fish are able to detect and avoid collisions with vessels and underwater equipment. However, early life stages of most fish are less mobile and could be displaced by a vessel's movement or propeller wash.

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 OMAO acoustic sources are generally outside of fish hearing ranges. These sources could affect shad, herring, and other fish that can hear these sounds if they are within several meters of the 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 fishes (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, OMAO does not expect any mortality and very little injury of fish as a result of implementing any of the alternatives. The likelihood of occurrence of an accidental spill from a NOAA vessel 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 project vessels 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 equipment 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 injury and mortality of fish would be minimal as compared to other cumulative actions. The aggregate, adverse cumulative impacts to fish from injury and mortality would likely be minor to major. The contribution to these aggregate, adverse cumulative impacts on injury and mortality of fish from all three OMAO alternatives would be **negligible**.

4.2.5.3.2 Fish Disturbance and Behavioral Modifications

Disturbance and behavioral modifications in fish from other cumulative actions are associated with vessel movement, 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 of fish. 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, 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, and dredging. 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 have 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 OMAO operations 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 exploration, offshore renewable energy, LNG terminals, and submarine telecommunication cable infrastructure 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. Towed underwater equipment continuously moves, and most fish are expected to move away from it or follow behind it in a manner similar to their response to a vessel. When the equipment is removed, most fish are expected to return to the area and resume normal activities.

NOAA vessels would represent a negligible proportion of all vessel traffic in the action area. Disturbance and behavioral modifications due to vessel presence and movement under the Proposed Action would be minimal. Sound from OMAO operations would occur on an intermittent basis over the period of interest. Only small sound impacts are expected from OMAO operations; therefore, impacts associated with the Proposed Action would only have a negligible incremental increase in ambient sound levels. OMAO would not place any structures under the Proposed Action. The mobile nature of OMAO operations and the propensity of fish to temporarily move away from water turbulence would lead to only 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 OMAO Proposed Action to the overall disturbance and behavioral modification of fish would be minimal as compared to other cumulative actions, and each of the three alternatives would be expected to contribute **negligible** cumulative impacts on fish behavior.

4.2.5.3.3 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 stress 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).

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.

The aggregate, adverse cumulative impacts on the fitness of fish would likely be moderate. The relative contribution of the OMAO Proposed Action to the overall fitness of fish would be minimal compared to other cumulative actions. Each of the three alternatives would be expected to contribute **negligible** cumulative impacts on fish fitness.

4.2.5.3.4 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 experience significant direct impacts to population reduction caused by overfishing. Indirect impacts caused by changes in water quality from increased turbidity and sedimentation alter the ecosystem that affect prey species and habitat. Spilled oil, fuel, and chemicals also put stress on 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 (e.g., bottom trawling), dredging and 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 only 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 at a faster rate 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 OMAO Proposed Action would be caused by bottom sampling; anchoring; accidental spills of oil, fuel, and contaminants; and underwater turbulence from vessels and underwater equipment. The small footprint of seafloor impacts under the Proposed Action would account for a tiny fraction of the total sea floor in the action area. This interaction would only contribute extremely small amounts of contaminants to the ocean environment, if any, as compared to all other cumulative actions, and NOAA vessels 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 each of the three OMAO alternatives to these impacts would be **negligible**.

4.2.5.3.5 Conclusion

All three of the OMAO alternatives would contribute to aggregate, adverse cumulative impacts on fish and fish habitat. This would occur through injury and mortality; disturbance and behavior modification; and habitat alteration. Other actions and activities would also contribute to the existing conditions 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; however, there may also be 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, thus 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 (MSA). 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 OMAO alternatives in combination with other actions in the cumulative effects scenario could be considered either synergistic or additive depending on the timing and location of the activities and impacts. Cumulative adverse impacts from other actions could be synergistic if they occur in close spatial or temporal proximity to activities associated with the OMAO Proposed Action. Similarly, additive effects on fish may occur if activities associated with the Proposed Action and other cumulative actions are considered sequentially. Overall, cumulative impacts to fish would range from minor to major. The OMAO 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, localized to regional depending on whether the vessel is moving, and would be small compared to impacts from all other cumulative actions. These impacts would occur regardless of the chosen alternative since operations 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 DAS than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on fish.

4.2.5.4 Aquatic Macroinvertebrates

Based on the analysis presented in Section 3.7.2.1.4 Aquatic Macroinvertebrates, impacts of the OMAO Proposed Action would result in negligible to minor impacts on aquatic macroinvertebrates 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 exposure to oil, fuel, and other contaminants.

4.2.5.4.1 Direct and Indirect Injury to Aquatic Macroinvertebrates

Sound from vessel operations under the OMAO Proposed Action would contribute to cumulative impacts from all of the past, present, or reasonably foreseeable actions. However, based on what is known of the ability of aquatic macroinvertebrates to detect underwater sound, the cumulative contribution of direct injury impacts would be unlikely to increase due to OMAO sound sources. OMAO's active acoustic underwater sources would likely be imperceptible to aquatic macroinvertebrates. However, other actions such as assessment and exploration of marine minerals may have a greater propensity to adversely affect some aquatic macroinvertebrates, at least at close range. This would be due to the high intensity and widespread propagation of the broadband sound generated. These high intensity sources, including airguns, could have somewhat greater effects on aquatic macroinvertebrates than the sources used by OMAO, especially when considered cumulatively. In addition, the presence and movement of vessels within the action area, including all vessels used in conjunction with activities under the Proposed Action and all other past, present, and reasonably foreseeable actions, would likely increase cumulative contributions to collisions or entanglement of certain aquatic macroinvertebrates in the water column.

Accidental or illicit discharge of fuel, chemicals, or waste accompanying all vessel operations within the action area contribute to the existing direct harm or injury to aquatic macroinvertebrates. This is due to ingestion and interaction with spilled substances, although the intensity of the impact would depend on the size and location of the spill. A major problem for aquatic macroinvertebrates is nutrient pollution from non-point sources onshore, particularly fertilizers applied to farmlands. These high nutrient loads can cause red tides in coastal waters on both the east and west coasts, as well as the large "dead zone" of hypoxic or anoxic waters at the mouth of the Mississippi River in the Gulf of Mexico.

Rising ocean temperatures as part of ongoing climate change will continue to damage coral reefs by thermal stressing of coral polyps, leading to bleaching (i.e., expelling their symbiotic algae known as zooxanthellae) and possible mortality. Ocean acidification accompanying climate change, especially the increase of atmospheric carbon dioxide concentrations, will interfere with shell and skeleton formation by certain marine calcifying macroinvertebrates using calcium carbonate.

Most cumulative direct injury impacts would occur in the immediate vicinity of vessels or development areas (e.g., O&G). Over the time period of analysis, climate-related impacts that have already led to the listing of many species of corals would continue to stress these species. Aggregate, cumulative direct and indirect injury impacts from all actions would range from short-term to long-term and could result in minor to major cumulative impacts on aquatic macroinvertebrates. The contribution to these aggregate, adverse cumulative impacts from all three OMAO alternatives would be **negligible**.

4.2.5.4.2 Disturbance and Displacement of Aquatic Macroinvertebrates

Sound-producing activities under the OMAO Proposed Action could potentially contribute to aggregate, adverse cumulative impacts along with other active underwater sound sources. Other high intensity sources, particularly used in O&G surveying, temporarily displace macroinvertebrates at sites throughout the EEZ. Sound from other federal fleet 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 invertebrates for the duration of the activity in question.

Underwater disturbance would be caused by vessel movement and presence, bottom sampling, and anchoring under the Proposed Action. This, 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. Climate change will continue to raise global sea levels for the foreseeable future and would result in continuous EEZ coastline erosion. The ongoing accidental or illicit discharges of fuel, chemicals, or waste from vessel operations and marine infrastructure contributes to currently disturbed and displaced macroinvertebrates from contaminated areas for the lifetime of the spill. Most small spills can dissipate quickly 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 aggregate, adverse impacts are not expected to cause long-term disturbance or overall behavioral patterns and would be considered minor. The contribution to these aggregate, adverse cumulative impacts from all three OMAO alternatives would be **negligible**.

4.2.5.4.3 Degradation and Reduction of Aquatic Macroinvertebrate Habitat

Actions such as anchoring and bottom sampling would cause disturbance of the sea floor under the Proposed Action. These would contribute to cumulative impacts related to the degradation and reduction of aquatic macroinvertebrate habitat 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 decommissioning of the installation, the development area may be reclaimed and could return to previous habitat conditions.

The ongoing accidental or illicit discharge of fuel, chemicals, or waste from 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 from aquatic macroinvertebrate habitat; most small spills are dispersed and dissipated by ocean conditions on a timescale of minutes to hours. Coastal population growth and elevated nutrient loads, other contaminants, and non-point source discharges and runoff contribute to currently degraded habitat conditions for aquatic macroinvertebrates. This is caused by a variety of factors, including coastal water quality reductions from urban/agricultural runoff, and encroachment by coastal development. Degradation is especially pronounced in bays and sounds with restricted water circulation, such as Chesapeake Bay in the Greater Atlantic Operational Area (OA) and Puget Sound in the West Coast OA. The 7,000-mi^2 (18,130-km^2) hypoxic (low-oxygen) “dead zone” that appears during the summer months in the Gulf of Mexico at the mouth of the Mississippi River is a resultant effect from widespread use of fertilizers (nitrogen and phosphorus nutrients) in the large Mississippi Basin.

Rising sea levels as a result of climate change will continue to erode coastlines along the EEZ and could potentially destroy or degrade habitat for aquatic macroinvertebrates. Global rising temperatures could also shift aquatic macroinvertebrate ranges northward towards cooler waters.

Generally, ongoing cumulative impacts to aquatic macroinvertebrate habitat would persist for the foreseeable future; these impacts would not substantially reduce overall habitat quantity or availability but would continue to substantially degrade habitat quality. It would be unlikely for aquatic macroinvertebrate populations to sustain further adverse effects in the near term. Aggregate cumulative impacts to aquatic macroinvertebrate habitat from other actions would be minor to major, and the contribution to these aggregate, adverse cumulative impacts from all three OMAO alternatives would be **negligible**.

4.2.5.4.4 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 entanglement and would likely disturb or displace nearby organisms for the duration of the activities. Similarly, vessel sound and underwater construction activities could displace aquatic macroinvertebrates in the immediate vicinity of activities. Disturbance and displacement 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 discharge of oil, fuel, chemicals, or waste all contribute to the currently reduced total amount of aquatic macroinvertebrate habitat. In conjunction with the OMAO 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 from other actions would range from minor to major.

Cumulative, adverse impacts from any of the three OMAO alternatives in combination with other activities in 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 action area. Similarly, additive cumulative impacts to aquatic macroinvertebrates, or their associated habitat, could occur if activities or actions are conducted sequentially within adjacent locations of the action area. For example, the Southeast and Alaska OAs contain relatively high levels of marine O&G development; thus, synergistic or additive cumulative impacts are most likely to occur in either of these OAs. Most cumulative impacts would be confined to the immediate vicinity of OMAO operations 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** adverse cumulative effects, depending on the timing and location of impacts. These impacts would occur regardless of the chosen alternative since 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 DAS than Alternative A, and would therefore have slightly greater cumulative impacts; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on aquatic macroinvertebrates.

4.2.5.5 Sea Birds, 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. Based on the analysis presented in Section 3.7.2.1.5 Sea Birds, Shorebirds and Coastal Birds, and Waterfowl, impacts of the Proposed Action would result in negligible to minor, or possibly moderate, impacts to birds. The Proposed Action could contribute to cumulative impacts on birds, including:

- injury from underwater sound; exposure to oil, fuel, and other contaminants; entanglement and ingestion of marine debris; and a very low likelihood of vessel strikes;
- disturbance and displacement from underwater sound, vessel wake and underwater turbulence, and bottom disturbance; and
- habitat alteration from vessel wake and underwater turbulence; bottom disturbance; and exposure to oil, fuel, and other contaminants.

4.2.5.5.1 Direct Injury to Sea Birds, Shorebirds and Coastal Birds, and Waterfowl

Vessel presence and movement and active underwater acoustic sources under the OMAO 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 cumulatively contribute direct injury impacts to birds or their prey. Although exposure to the active underwater acoustic sources used by

OMAO would only occur for diving birds and would not likely be harmful, active acoustic sources commonly used in other actions, such as assessment and exploration of marine minerals, 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 sources used by OMAO, especially when considered cumulatively.

The presence and movement of 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 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 are often 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 prey would likely be reduced. Accidental or illicit discharge of fuel, chemicals, or waste accompanying all vessel operations within the study area contribute to the existing direct injury of birds and prey. This would be caused by ingestion and interaction with spilled substances, although the severity of the impact would be contingent upon the size and location of the discharge. 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 vessel operations 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 starvation and dehydration in the event they are unable to find their way back to sea.

Similarly, ongoing climate change will continuously alter environmental conditions throughout the timespan of this analysis. Although environmental conditions will not likely change to the point of direct injury to birds, ocean acidification accompanying climate change could potentially harm macroinvertebrate prey species (e.g., bivalves, gastropods, and cephalopods). This is due to sensitivity 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 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 development areas (e.g., for O&G) 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 have substantial effects on 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 and minor. The contribution to these aggregate, adverse cumulative impacts from all three OMAO alternatives would be **negligible**.

4.2.5.5.2 Disturbance and Displacement of Sea Birds, Shorebirds and Coastal Birds, and Waterfowl

Sound-producing activities under the OMAO Proposed Action would contribute to cumulative effects of other active underwater acoustic sources, especially from high intensity sources used in O&G surveying. Combined, these actions could temporarily displace diving birds and their prey throughout the EEZ and cause cumulative adverse impacts to birds. Sound from other federal fleet 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.

Underwater disturbance would be caused by vessel movement and presence, bottom sampling, and anchoring under the Proposed Action. This, combined 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 birds and their prey. Climate change will continue to raise global sea levels for the foreseeable future and will result in continuous EEZ coastline erosion. 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 foraging efforts by birds. 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. The ongoing accidental or illicit discharge of fuel, chemicals, or waste from vessel operations and marine infrastructure contributes to currently disturbed and displaced birds and their prey from contaminated areas for the lifetime of the spill. The severity of the impact is contingent upon the size and location of the spill in question. Most small spills are dispersed and 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 overall bird behavioral patterns or prey availability and would be considered minor. The contribution to these adverse cumulative impacts from all three OMAO alternatives would be **negligible**.

4.2.5.5.3 Degradation and Reduction of Habitat for Sea Birds, Shorebirds and Coastal Birds, and Waterfowl

Activities such as anchoring and bottom sampling would cause disturbance of the sea floor under the Proposed Action. These activities would contribute to cumulative impacts related to the degradation and reduction of bird habitat from 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. After the lifetime of the installation, the development area may be reclaimed and could return to previous or current habitat conditions.

The ongoing accidental or illicit discharge of fuel, chemicals, or waste from vessel operations and marine infrastructure contributes to currently degraded sensitive coastal nesting habitat. Coastal ground-nesting birds such as piping plovers and red knots breed and nest in areas below the high-water line. These areas are particularly susceptible to contamination from spilled materials. The overall severity of the impact is contingent upon the size and distance of the spill from nesting beaches. Most small spills are dispersed and 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. This is caused by 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. This could potentially destroy or degrade coastal nesting areas, particularly those areas for sensitive coastal ground-nesting species. However, the magnitude of these impacts is contingent upon the amount of coastal erosion within a given area and could potentially be mitigated in part by ongoing coastal restoration projects.

Reduced water quality would also displace 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. This could ultimately reduce the total amount of available prey if the bird dispersal rate is relatively low compared to 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 foreseeable future but would not substantially reduce overall habitat quality and availability or 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 introduce new species into their diet. Nesting areas are generally avoided by development given the federal protection of most birds under the Migratory Bird Treaty Act (MBTA). Adverse cumulative impacts to bird habitat would likely be minor. The contribution to the aggregate, adverse cumulative impacts from all three OMAO alternatives would be **negligible**.

4.2.5.5.4 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 underwater acoustic sources, vessel sound, underwater activities, and ongoing climate change would displace birds and their prey in the immediate vicinity of operations. Disturbance and displacement are not expected to persist beyond the duration of activities, and short-term cumulative impacts would range from negligible to moderate. Onshore and nearshore development and accidental discharge of oil, fuel, chemicals or waste already reduce the total amount of available bird habitat. 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 from other actions would likely be minor.

Cumulative adverse impacts from any of the alternatives in combination with the other actions 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, testing of underwater acoustic sources in close proximity to an operating offshore oil well could substantially disturb birds through the visual presence and sound from both the NOAA vessel and the installation. This could result in bird avoidance of certain areas for longer periods of time than would be expected 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 become additively degraded if bottom sampling was conducted shortly after the installation of a wind turbine. For example, the Southeast and Alaska OAs contain relatively high levels of marine O&G development; thus, synergistic or additive cumulative impacts are most likely to occur in either of these OAs. The vast majority of cumulative impacts are confined to the immediate vicinity of activity 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 **negligible** impacts to the aggregate cumulative effects from all other activities 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.

Construction, operation, and decommissioning of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure) 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 levels, facilitated dispersion of invasive species, and disturbances to the water column 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 OMAO activities. Disturbance and displacement resulting from activities are not expected to persist beyond the duration of activities. Nearshore and offshore development in conjunction with ongoing anthropogenic climate change would reduce the total amount of available 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 other cumulative actions on habitats throughout the action area would be negligible to moderate, 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 other cumulative actions, 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 habitat areas could occur if activities or actions are conducted sequentially within adjacent sections of the action area. Although the exact timing and location of OMAO operations are not precisely known at this time and are subject to change, the Southeast and Alaska operational areas contain relatively high levels of marine O&G development (which is not associated with OMAO operations). Therefore, synergistic or additive cumulative impacts are most likely to occur in either of these areas. The vast majority of cumulative impacts would be confined to the immediate vicinity of operations 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 OMAO 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 operations 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 DAS than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on birds.

4.2.6 Cultural and Historic Resources

Past, present, and reasonably foreseeable actions described in Section 4.1 that would contribute cumulative effects to cultural and historic resources include:

- offshore and outer continental shelf oil and natural gas development;
- assessment and extraction of marine minerals;
- climate change;
- commercial and recreational fishing;
- commercial shipping and recreational boating;
- construction and operation of offshore LNG terminals; and
- construction of new submarine telecommunication cable infrastructure.

The cumulative impacts in the following subsections are categorized by their relevance to the following types of cultural and historic resources characteristics:

- physical impacts to submerged cultural and historic resources;
- visual and noise impacts to historic properties; and

- visual and noise impacts to traditional cultural places (TCPs) and subsistence.

4.2.6.1 Physical Impacts to Submerged Cultural and Historic Resources

OMAO operations under the Proposed Action, including anchoring and operation of grab samplers and sediment corers could contribute to overall cumulative impacts associated with other cumulative actions that may disturb the sea floor throughout the action area, including:

- offshore and outer continental shelf oil and natural gas development;
- assessment and extraction of marine minerals;
- climate change;
- commercial and recreational fishing;
- commercial shipping and recreational boating;
- construction and operation of offshore LNG terminals; and
- construction of new submarine telecommunication cable infrastructure.

These cumulative impacts could increase the risk of damage to submerged cultural and historic resources.

Seafloor disturbance during OMAO operations and during other cumulative actions requiring the presence and movement of vessels or other activities such as the construction, operation, and decommissioning of long-term installations could cumulatively cause physical damage to submerged resources. Many cumulative actions requiring vessel operations could also entail anchoring, collecting bottom samples, and use of equipment used for underwater construction. Equipment, vessels, or displaced water from vessel wakes could potentially disturb protective sediment layers that cover submerged cultural resources or the cultural resources themselves, potentially causing permanent damage to submerged resources. A common practice for NOAA vessels and most other non-OMAO vessels would be to anchor whenever practicable in designated areas and avoid anchoring on known submerged resources such as shipwrecks or downed aircraft. The majority of cumulative impacts that cause damage to submerged cultural resources would be in locations where anchors are dropped or bottom sampling occurs, and in the immediate vicinity of offshore and outer continental shelf oil and natural gas development, assessment and extraction of marine minerals, and construction of submarine infrastructure. Inadvertent discovery of submerged cultural and historic resources during these activities is often associated with damage or destruction of the resource, resulting in adverse and permanent impacts. However, it is possible that the inadvertent discovery of a submerged cultural and historic resource could be considered a beneficial impact. The discovery would provide historical value to the site and allow research to be conducted if the submerged resource is 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 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. Therefore, impacts could be either adverse or beneficial, depending on whether the resources are damaged or destroyed or able to be documented and protected.

Submerged cultural and historic resources are constantly at risk due to accidental leakage or spillage of oil, fuel, and chemicals and the unintentional disposal of trash and debris from both OMAO operations and other cumulative actions, as well as from climate related changes to oceans. This stress has contributed to the existing condition of submerged cultural and historic resources. Submerged cultural and historic resources may be exposed to hydrocarbon contamination from oil spills. The effects of oil vary depending on the type of material and the condition it is in—material from a shipwreck, for example, may absorb the oil differently from shells in middens (NPS, 2010b). The absorption of oil by submerged cultural and historic resources can make radiocarbon dating impossible. Impacts from oil spills to submerged cultural and historic resources could be permanent. Other contaminants, sediments, and nutrients can adversely impact the structural integrity of submerged cultural and historic resources, with the greatest adverse effects occurring in waters with limited circulation such as bays, sounds, and estuaries. Impacts to submerged 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.

The majority of cumulative impacts to submerged cultural and historic resources from both OMAO and other cumulative actions would be limited to the immediate vicinity of vessels, trailed equipment, or nearshore and offshore development and installations. Overall, aggregate cumulative impacts to submerged cultural and historic resources would be short-term and long-term and could result in negligible to moderate impacts on cultural and historic resources throughout the action area. Moderate impacts would occur only in the unlikely event of permanent physical damage. The contribution to these aggregate, adverse cumulative impacts on submerged cultural and historic resources from all three OMAO alternatives would be **negligible**.

4.2.6.2 Visual and Noise Impacts to Historic Properties from the Presence of Vessels

OMAO operations under the Proposed Action, including vessel movement and presence could contribute to overall cumulative impacts associated with the presence and movement of vessels used by other cumulative actions throughout the action area. These cumulative impacts could disturb a purposefully designed view or vista of a historic property located onshore.

Vessel movement and presence during OMAO operations and during other non-OMAO cumulative actions requiring the movement and presence of vessels or equipment could cumulatively cause temporary visual and noise disturbances as the vessel transits through the viewshed of a historic property. Disturbance from these activities would not be expected to last beyond the completion of the activity necessitating the vessel and, as described in Section 3.8.2.1.2, the overall integrity of a coastal historic property's setting, feeling, association, or other historic characteristics would not be impacted by vessel presence and movement. However, long-term construction projects within viewsheds of a nearshore historic property or designed cultural landscape could cumulatively cause changes to 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. 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.

The majority of cumulative impacts to historic properties from visual and noise disturbances due to the presence of vessels would be limited to the immediate vicinity of vessels or nearshore and offshore development and installations but would be temporary and transitory in nature. Overall, aggregate cumulative impacts to historic properties would be short-term and long-term and could result in negligible to minor impacts on cultural and historic resources throughout the action area. The contribution to these aggregate, adverse cumulative impacts from all three OMAO alternatives would be **negligible**.

4.2.6.3 Disturbance to TCPs and Subsistence Hunting and Fishing Areas from the Presence of Vessels and Operation of Active Acoustic Sources

OMAO operations under the Proposed Action, including vessel movement and testing/calibrating active acoustic systems within or near a TCP, TCL, or subsistence hunting and fishing area, could contribute to overall cumulative impacts combined with those from other cumulative actions including:

- the presence and movement of other vessels used in offshore and outer continental shelf oil and natural gas development, assessment and extraction of marine minerals, commercial and recreational fishing, commercial shipping and recreational boating, construction and operation of offshore LNG terminals, and construction of new submarine telecommunication cable infrastructure;
- other use of underwater active acoustic sources during offshore and outer continental shelf oil and natural gas development; and
- climate change.

These cumulative impacts could disturb the activities for which the TCP, TCL, or subsistence hunting and fishing area was established to protect.

Vessel movement and presence during OMAO operations and other cumulative actions requiring the movement and presence of vessels or equipment could cumulatively cause temporary visual and noise disturbances as the vessel transits within or near a TCP, TCL, or subsistence hunting and fishing area. 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 during which a vessel is present. Disturbance from cumulative actions to subsistence activities and sociocultural systems are discussed in greater detail in Section 4.2.8 Environmental Justice. 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.

Federal actions could cause impacts within a reservation or Alaska Native village and affect tribal trust resources or the rights of a federally recognized tribe, facility, entity owned or operated by a tribal government, or a tribe’s traditional way of life; or affect TCPs or Traditional Use Areas. Any action would initiate the need for communication with tribes. OMAO activities 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.

When considered in tandem with all past, present, and reasonably foreseeable projects listed in Section 4.1, impacts that could occur as a result of 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 pattern shifts and seasonal availability changes, making access to subsistence resources more difficult. 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 4.2.8 Environmental Justice.

The majority of cumulative impacts to TCPs and subsistence hunting and fishing areas from visual and noise disturbance from the presence of vessels would be limited to the immediate vicinity of vessels or nearshore and offshore development and installations and would be temporary and transitory in nature. Overall, aggregate cumulative impacts to TCPs and subsistence hunting and fishing areas would be short-term and long-term and could result in negligible to minor impacts on cultural and historic resources throughout the action area. The contribution to these aggregate, adverse cumulative impacts from all three OMAO alternatives would be **negligible**.

4.2.6.4 Conclusion

When considered in tandem with the OMAO Proposed Action, other non-OMAO related sea floor disturbing activities, the presence and movement of other vessels, and other use of active acoustic sources would create adverse cumulative impacts to cultural and historic resources. Adverse impacts to cultural and historic resources could occur through physical impacts to submerged cultural and historic resources, visual and noise impacts to historic properties from the presence of vessels, and visual and noise disturbances to TCPs and subsistence hunting and fishing areas. Actions that may disturb the sea floor, such as anchoring, construction, and dredging, could adversely affect submerged cultural and historic resources by causing permanent physical damage to the resource. Visual and noise disturbances from vessel presence could impact cultural and historic resources such as TCPs and subsistence hunting and fishing areas; however, these impacts would be temporary and not expected to result in long-term impacts to these areas.

Overall, the short- and long-term aggregate adverse cumulative impacts from other cumulative actions on cultural and historic resources throughout the action area would be negligible to moderate. These moderate impacts would occur only in the unlikely event of permanent physical damage to a cultural and historic resource.

Cumulative adverse impacts from the OMAO Proposed Action, in combination with other cumulative actions, 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 could occur if activities or actions are conducted sequentially within adjacent sections of the action area. Although the exact timing and location of OMAO vessel operations are subject to change, known submerged cultural and historic resources (e.g., shipwrecks) tend to be concentrated along coastlines and subsistence hunting and fishing areas mostly around Alaska, the Pacific Northwest, and the Great Lakes. Therefore, synergistic or additive cumulative impacts are most likely to occur in these areas. The majority of cumulative impacts would be confined to the immediate vicinity of operations and would likely not impact the vast majority of cultural and historic resources.

The OMAO 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 operations 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 DAS than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on cultural resources.

4.2.7 Socioeconomic Resources

The other actions described in Section 4.1 that would contribute to beneficial cumulative impacts to socioeconomic resources are:

- assessment and extraction of marine minerals;
- offshore renewable energy development;
- commercial and recreational fishing;
- commercial shipping and recreational boating;
- ocean cruise line industry; and
- construction of new submarine telecommunication cable infrastructure.

4.2.7.1 Economic Benefits of the Data Acquired by the NOAA Fleet

Under the Proposed Action, the atmospheric, fisheries, hydrographic, and oceanographic data collected during OMAO operations would contribute to cumulative socioeconomic impacts, as well as to impacts from data collection efforts by the other cumulative actions listed above. In aggregate, these actions would likely contribute cumulative indirect economic benefits as described in Section 3.9.2 Socioeconomic Resources.

The data would be used by NOAA Line Offices (LOs), other U.S. government agencies, communities, and businesses around the nation to help keep U.S. ports open for maritime commerce, understand changes to the planet, monitor the health of fish stocks, and make economic and policy decisions. The increased accuracy and precision of the data collected with newer and more advanced technology integrated into the fleet would benefit all major sectors of the ocean economy, including health and safety activities (e.g., coastal or climate resilience planning), recreational activities, transportation, energy, and commercial fishing. These sectors would primarily benefit through the provision of:

- safe and efficient marine transportation and commerce;
- protection of vulnerable ecosystems such as coral reefs, special status species, and marine habitats;
- cost savings and reduced damages from quick and effective emergency response to natural disaster events such as tsunamis and hurricanes;

- targeting of O&G resources;
- sustainable management and harvest of fisheries and other marine resources; and
- increased revenues for commercial and recreational fishing industries, the energy sector, and tourism.

These impacts would persist as long as the collected data and resulting products are available for review by the public, and certainly the impacts would persist for the 15-year duration considered in this cumulative effects analysis. As such, OMAO operations would cumulatively contribute indirect, moderate, beneficial impacts to socioeconomic resources. The contribution to these aggregate cumulative impacts from all three OMAO alternatives would likewise be **indirect**, **moderate,** and **beneficial**.

4.2.7.2 Indirect Effects on Jobs and Revenue

Indirect economic benefits resulting from OMAO operations would contribute to cumulative effects on jobs and revenue from all past, present, and future reasonably foreseeable revenue-generating actions. In combination, the Proposed Action and other cumulative actions would 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 new economic activity in the action area in the form of employment, labor income, commodity prices, and property tax revenues (BOEM, 2017e).

Of particular importance is the fisheries data collected by NOAA vessels. This information is critical to the effective management of marine resources and is used to support sustainable fisheries for commercial and recreational industries, subsistence purposes, and protected species recovery (NMFS, No Date-i). Stock assessments are used to monitor the health of fisheries and set up annual catch limits to help reduce the chance of overfishing, which would ensure long-term biological and economic sustainability of U.S. commercial and recreational fisheries (NMFS, No Date-j). Similarly, habitat data collected by NOAA vessels would create employment opportunities to support habitat restoration projects and result in additional sociocultural benefits to impacted communities, such as in the form of increased recreational opportunities and flood mitigation benefits (NOAA, 2021).

Although the OMAO Proposed Action would not directly impact the energy sector, NOAA works in coordination with the BOEM to collect sophisticated ocean data to expedite and facilitate greater development of offshore renewable energy resources. For example, offshore wind energy development may overlap with fisheries that have recreational, economic, and cultural values, resulting in adverse effects to fishery activity, fishery resources, and fishery science and management. NOAA collects data about the health of fisheries and their occurrence so that the ecological effects of renewable energy development and the potential socioeconomic implications of such development on commercial and recreational fisheries could be minimized and such facilities could be sited at appropriate locations (Methratta et al., 2020). Such data would facilitate the leasing and development of future offshore/nearshore wind projects, which would entail large scale job creation and capital expenditures in coastal areas near project sites. These capital expenditures could increase local tax revenues, leading to expansion of capital budget projects and local infrastructure and services such as housing, water and sewage treatment, power supply, communication networks, road construction and maintenance, and healthcare (BOEM, 2017).

The climate data collected by NOAA vessels, particularly in the Arctic which is experiencing a long-term warming trend leading to melting of sea ice and sea level rise, could help expand other sectors of the ocean economy such as commercial fishing, recreational fishing, and tourism, which would require substantial levels of skilled labor (BOEM, 2017).

The enhanced accuracy and precision of the atmospheric, fisheries, hydrographic, and oceanographic data collected during OMAO operations would facilitate sustainable development of commercial and recreational fishing sectors and expand other sectors of the ocean economy. Overall cumulative impacts on socioeconomic resources would be moderate and beneficial; the contribution of any of the three OMAO alternatives to the beneficial cumulative impacts on socioeconomic resources would be indirect and moderate.

4.2.7.3 Conclusion

Cumulative impacts to socioeconomic resources would occur when the OMAO Proposed Action is considered along with other cumulative actions, including:

- assessment and extraction of marine minerals,
- offshore renewable energy development,
- commercial and recreational fishing,
- commercial shipping and recreational boating,
- ocean cruise line industry, and
- construction of new submarine telecommunication cable infrastructure

Impacts to socioeconomic resources could include impacts to the ocean economy and on jobs and revenue.

OMAO operations have the potential to contribute indirect cumulative impacts to socioeconomic resources with high-resolution atmospheric, fisheries, hydrographic, and oceanographic data collection. Products 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 products would enhance and facilitate revenue-producing activities by benefiting commercial and recreational fisheries, future offshore renewable energy projects, and tourism and shipping industries, 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 fishers, boaters, and tourists. All cumulative socioeconomic impacts would likely persist for the 15-year duration of this analysis and beyond. As such, the socioeconomic cumulative benefits of these actions would be indirect, short-term and long-term, regional, and **moderate**. No cumulative adverse impacts to socioeconomic resources are expected from any of the cumulative actions mentioned above.

Potential beneficial cumulative impacts from the Proposed Action in combination with the other non-OMAO cumulative actions 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 action area. For example, updated nautical 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. Commercial real estate and onshore/nearshore energy infrastructure developments can incorporate better local coastal or climate resilience planning due to improved ocean condition and weather forecasts. Additive socioeconomic cumulative impacts could also occur if activities or actions are conducted sequentially within adjacent locations within the action area. Although the exact timing and location of OMAO operations are subject to change, the Southeast and Alaska OAs contain relatively high levels of marine O&G development. Therefore, synergistic or additive cumulative impacts are most likely to occur in both of these OAs.

The contribution of the OMAO Proposed Action to beneficial aggregate cumulative impacts would be **moderate** depending on the timing and location of impacts within the 15-year timespan of this analysis. Though these impacts would occur regardless of the chosen alternative since vessel operations under each alternative would be composed of similar activities and take place in the same geographic areas and timeframes, the impacts from Alternatives B and C would be greater in magnitude due to an increase in DAS as compared to Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on socioeconomic resources.

4.2.8 Environmental Justice

All past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects on environmental justice (EJ). The cumulative effects analysis also considers other actions and activities contributing to the existing condition of subsistence resources, including:

- accumulation of marine debris (e.g., plastics, glass, metals, or rubber);
- accidental or illicit discharges (e.g., fuel or oil spills, or other introduction of contaminants);
- habitat encroachment from onshore and nearshore development (e.g., coastal development);
- IUU fishing; and
- flows of pollutants, contaminants, sediments, and nutrients, into coastal waters.

4.2.8.1 Disturbance to Subsistence Activities and Sociocultural Systems

Activities producing sound and visual disturbances under any of the three OMAO alternatives (e.g., the operation of navigational depth sounders and active underwater acoustic sources for vessel operations, vessel and equipment sound, and physical presence of vessels and equipment in water) would contribute to cumulative impacts in combination with any of the past, present, or reasonably foreseeable actions listed above. Combined, these actions would create short- and long-term adverse cumulative impacts to EJ communities. Activities creating sound and visual disturbances would cause marine 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 or prolonged, or subsistence resources could be unavailable for use. Communities primarily dependent on marine mammals for subsistence, such as the bowhead harvesters of northern and western Alaskan villages, could 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 OMAO alternatives (e.g., vessel and equipment sound, physical presence of vessels and equipment in water) 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 NOAA and other non-OMAO 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. IUU fishing activities also contribute to the reduced availability of fish, other marine species, or coral reefs important to subsistence cultures. However, the impact in the Gulf of Mexico from such activities on subsistence fishing communities would be negligible since their largest source of subsistence foods are from commercial fishery catches and from activities similar to recreational harvesting (BOEM, 2012c).

The cumulative impacts of past and present actions that cause disruptions to subsistence activities would adversely affect the rates of sharing between communities (NMFS, 2016). 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).

As discussed in Section 4.2.7.2 Socioeconomic Resources, the cumulative actions described in Section 4.1 could generate new economic activity in the form of employment, labor income, commodity prices, and property tax revenues, which could either beneficially or adversely impact sociocultural systems of EJ communities, particularly in Alaska where the majority of O&G and renewable energy development is expected to occur. Increased tax revenues from infrastructure development may be used to expand infrastructure and services (e.g., housing, water and sewage treatment, power supply, improved healthcare facilities, etc.) in coastal towns/villages located in the vicinity of project sites, thereby improving the quality of life for the locals. Increased employment opportunities could cause an influx of non-local workers, possibly resulting in increased competition for subsistence harvesters and subsistence resources (BOEM, 2017). OMAO operations are not expected to directly contribute to an increase in employment as they would not result in the hiring of personnel for OMAO.

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 used during OMAO operations. The ships in the NOAA fleet are smaller than most industrial and commercial vessels and would cause less disruption. The sound and visual impacts from vessels, equipment, and humans would create disturbances in their immediate vicinity and would not persist beyond the conclusion of the actions or activities. Due to historically limited exploration in the Alaska OA and the 2019 Presidential Memorandum on Ocean Mapping, the number and frequency of cumulative actions mentioned above (e.g., commercial shipping and fishing, ocean cruise line industry, and offshore energy exploration) are expected to increase over the next 15 years. Overall, cumulative impacts of the other cumulative actions described in Section 4.1 could result in minor to moderate, adverse aggregate cumulative impacts on communities with EJ concerns, and their magnitude would depend on the type of vessel operation, seasonal timing, and animal migration. The contribution of the OMAO Proposed Action to these adverse, cumulative impacts would be **minor**. Though impacts to subsistence species from OMAO activities would likely be temporary or short-term, cumulative adverse impacts from the other cumulative actions could occur in the long term. The extent of impacts would be regional.

4.2.8.2 Disturbance to Subsistence Activities and Sociocultural Systems from Climate Change

Air emissions from OMAO activities are not expected to impact subsistence resources and consequently EJ communities. GHG emissions associated with past, present, and reasonably foreseeable actions, particularly related to oil and natural gas development and operation of offshore LNG terminals, would cumulatively affect the climate. In aggregate, these actions would lead to long-term adverse cumulative impacts to EJ communities. 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 pattern shifts and seasonal availability changes; making access to subsistence resources more difficult (NMFS, 2016).

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 and melting of permafrost and sea ice could result in 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 the 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 (NMFS, 2016).

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 patterns of local and regional subsistence use areas. 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, 2016).

Climate change has decreased the amount of summer sea ice. The Northwest Passage and other shipping lanes have opened and will likely attract visitors associated with recreation and tourism industries. Commercial shipping and recreational boating along those routes are also likely to increase. 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 4.2.8.1 (BOEM, 2017).

Impacts as a result of climate change may include changes to water temperature and increased acidification of the ocean caused by dissolved CO_2. 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. It is expected that rising temperature 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, 2016). The impact of climate change on EJ communities could result in moderate to major effects on subsistence resources. However, the contribution of the OMAO Proposed Action to these adverse cumulative effects would be **negligible**. As noted in Section 3.13, at an estimated annual 4,000-4,700 metric tons CO_2e, OMAO GHG emissions constitute less than 0.01 percent of aggregate annual GHG emissions from all boating and shipping within the EEZ.

4.2.8.3 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. Such events associated with any of the other cumulative actions, particularly offshore and OCS oil and natural gas development, construction and operation of offshore LNG terminals, and commercial fishing would further stress subsistence resources.

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 (BOEM, 2016). 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 4.2.6 Cultural and Historic Resources.

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 (NCBI, 2009). 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, 2016).

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, 2012c). Similarly, in the North Slope region in Alaska, the contamination of waters with fuel, oil, antifreeze, and other chemicals from military and O&G 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 from other non-OMAO related actions would be moderately adverse. However, the contribution of the OMAO Proposed Action to these adverse cumulative effects would be

negligible as OMAO operations would only constitute a small fraction of the overall vessel operations in the action area.

4.2.8.4 Ocean Data Acquired by NOAA Fleet

OMAO operations under any of the three action alternatives would contribute to cumulative impacts from other data collection efforts in the action area associated with any of the other cumulative actions discussed in Section 4.1. In aggregate, these actions would lead to long-term beneficial cumulative impacts to EJ communities. The availability of new and updated charts, maps, and data would result in safer navigation, availability of better forecasts of local weather, storm surge events, 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 activity in the area, such as greater commercial and recreational fishing, commercial shipping, tourism, and offshore renewable energy and O&G development projects that 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 ocean data from other cumulative actions would be beneficial and adverse, minor, and would occur over a long term. The contribution of any of the three OMAO alternatives to the aggregate beneficial and adverse cumulative impacts would be **minor**.

4.2.8.5 Conclusion

When considered in tandem with activities associated with the OMAO Proposed Action, other cumulative actions would have both adverse and beneficial cumulative impacts to EJ communities, including:

- offshore and outer continental shelf oil and natural gas development;
- assessment and extraction of marine minerals;
- offshore renewable energy development;
- climate change;
- commercial and recreational fishing;
- commercial shipping and recreational boating;
- ocean cruise line industry;
- construction and operation of offshore LNG terminals; and
- construction of new submarine telecommunication cable infrastructure.

Adverse impacts would occur through a potential decrease in the total annual subsistence catches hunted by communities with EJ concerns, or increase in the time required and distance traveled to harvest the same amount compared to previous years, 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 creation of short-term and long-term employment opportunities and the subsequent improvement in quality of life of impacted individuals, and availability of new ocean data that would result in safer navigation and more accurate weather forecasts for subsistence harvesters.

These other cumulative 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 employment opportunities and 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 three OMAO alternatives in combination with the other cumulative actions 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 action area. Similarly, additive cumulative impacts to EJ communities could occur if activities or actions are conducted sequentially within adjacent locations of the action area. The Southeast and Alaska OAs contain relatively high levels of marine O&G development and have some of the highest documented numbers of subsistence communities and activities. Therefore, synergistic or additive cumulative impacts are most likely to occur in either of these OAs. For example, cumulative, adverse impacts would be synergistic and additive if OMAO and other cumulative actions take place at the same time in the Alaska OA (although the exact timing and location of OMAO operations are subject to change), such as:

- any OMAO producing sound and visual disturbances under the Proposed Action;
- O&G exploration;
- offshore and OCS oil and natural gas development;
- commercial shipping in the Northwest Passage; and
- other actions including the operation and presence of vessels and equipment by OMAO as well as other federal fleets, commercial shipping and recreational boating, etc.

Impacts to subsistence hunting or fishing patterns that affect the availability and/or the quality of subsistence resources, and 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 OMAO Proposed Action would contribute to and have the potential to increase these cumulative impacts, but the relative contribution would be **negligible** as compared to the aggregate contributions of other cumulative actions as OMAO operations would only constitute a small fraction of the overall vessel operations in the action area. OMAO impacts would be temporary or short-term, would be confined to the immediate vicinity of vessels, and would be small compared to impacts from all other cumulative actions. These impacts would occur regardless of the chosen alternative since operations 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 higher cumulative impacts because these alternatives include greater DAS compared to Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on EJ.

4.2.9 Hazardous, Universal, and Special Waste

Past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects to potentially hazardous, universal, and special waste. The following analysis considers how the OMAO-related incremental impacts of the Proposed Action and alternatives, when added to or acting synergistically with other non-OMAO related cumulative actions, would contribute to overall cumulative impacts on potentially hazardous, universal, and special waste from the generation, storage and handling, and transfer and disposal of these wastes.

4.2.9.1 Generation of Hazardous, Universal, and Special Waste

OMAO operations under the Proposed Action would contribute to impacts from the generation of potentially hazardous, universal, and special waste, including:

- vessel movement;
- waste handling and discharges;
- vessel repair and maintenance;
- UMS operations;
- small boat operations; and
- OTS handling, crane, davit, and winch operations.

The contribution from other cumulative actions to the generation of potentially hazardous, universal, and special waste, would be associated with:

- presence and movement of vessels (e.g., other federal fleets, commercial fishing and shipping vessels, recreational fishing and boating vessels, and ocean cruise liners); and
- construction, operation, and decommissioning of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure).

The majority of these impacts would be contributed by other non-OMAO related cumulative actions associated with the presence and movement of vessels and the operation of long-term installations.

Other cumulative actions conduct vessel operations similar to OMAO operations, including vessel movements, waste handling and discharges, and vessel repair and maintenance. These operations would cumulatively increase the amount of potentially hazardous, universal, and special waste generated in the action area by producing waste or used oil, oily rags and absorbents, fuel and oil filters, batteries, paint related materials, aerosol cans, and other contaminants. In addition, the construction, operation, and decommissioning of long-term installations would require vessel operations to access the project locations and transport supplies, resources, and personnel to and from project locations. Furthermore, some of the operational activities may generate potentially hazardous, universal, and special waste, especially offshore oil and gas developments, marine mineral extraction sites, LNG terminals, and submarine telecommunication cable infrastructure. The construction and operation of these installations would require the use of diesel-powered machinery and operating equipment which may generate waste or used oil, fuel and oil filters, oily rags and absorbents, and would require repair and maintenance which may generate lubricants, grease, antifreeze, and paints. The resources extracted at these installations would also directly and indirectly generate potentially hazardous, universal, and special waste; oil, gas, and liquified natural gas are all considered hazardous substances due to their flammability and toxicity. Cumulative actions in tandem with OMAO vessel operations would cumulatively increase the amount of potentially hazardous, universal, and special waste generated in the action area.

Effects from OMAO operations would be indistinguishable from other cumulative actions due to the comparably smaller size of the ships and the limited number of vessels in the NOAA fleet. NOAA ships are exempt from the storage, manifest, inspection, and recordkeeping requirements of any potentially hazardous waste generated onboard. NOAA shoreside support facilities identify hazardous waste once it is transferred shoreside from NOAA ships. NOAA shoreside support facilities maintain a status of Very Small Quantity Generator (VSQG), meaning they may not exceed 100 kilograms (200 pounds or approximately 22 gallons) of hazardous waste per calendar month or store more than 1,000 kilograms (2,200 pounds or approximately 220 gallons) at any time. NOAA ships must maintain communications with NOAA shoreside support facilities to make sure they minimize the amount of potentially hazardous, universal, and special waste generated onboard so that support facilities do not exceed 22 gallons each month. OMAO personnel minimize the generation of potentially hazardous, universal, and special waste by substituting with less hazardous products, purchasing materials only in quantities that will be completely used, and using existing stores before buying more. While some ships in other fleets may share the VSQG status, larger ocean-transiting vessels, such as tankers and commercial shipping vessels, or industrialized marine-based facilities, may be designated as small or large quantity generators which are allowed to produce up to or greater than 1,000 kilograms of hazardous waste per month. Compared to NOAA ships, these larger generators would be responsible for a much greater portion of the aggregate total of potentially hazardous, universal, and special waste generated in the action area.

The cumulative impacts from the generation of potentially hazardous, universal, and special waste would be limited to the immediate vicinity of vessels or nearshore and offshore development and installations and would not likely cause long-term changes. Resource Conservation and Recovery Act (RCRA) regulations require any person who creates or generates waste to determine if it is hazardous and to comply with all applicable federal regulations regarding its handling and management. While OMAO maintains its own policies and procedures to ensure compliance with RCRA, other federal fleets, commercial shipping and fishing fleets, ocean cruise liners, and recreational fishing and boating vessels, in addition to long-term installations and marine-based facilities, follow their own policies to remain in compliance with federal regulations.

Overall, aggregate cumulative impacts from the generation of potentially hazardous, universal, and special waste would be temporary and represent a small contribution to cumulative effects due to the limited number of ships in the NOAA fleet and their designation as VSQGs. The contribution to these aggregate, adverse cumulative impacts from the generation of potentially hazardous, universal, or special waste from the OMAO Proposed Action would be **negligible**.

4.2.9.2 Storage and Handling of Hazardous, Universal, and Special Waste

The OMAO operations and other cumulative actions that would contribute to overall cumulative impacts from the storage and handling of potentially hazardous, universal, and special waste are the same as those discussed under Section 4.2.9.1.

Potentially hazardous, universal, and special waste that is generated in the action area must be stored and handled properly; wastes not stored or handled properly during OMAO vessel operations or associated cumulative actions could contribute cumulative impacts to the marine environment and to human health and safety. Toxic substances could affect humans onboard vessels and within facilities or marine life through various pathways, including direct contact with the skin or other surfaces, inhalation, or ingestion either directly or indirectly through consumption of a contaminated prey species. Toxicity could result in sickness or mortality of the affected organism. Ignitable substances could produce fire safety hazards onboard vessels, within facilities, or on the water's surface depending on the size of the spill. Hazardous waste could also be corrosive or reactive based on the chemical nature of the substance. Corrosive substances could adversely affect ship pipes, fixtures, and other infrastructure, but could also cause severe and harmful burns and reactions if humans or marine life are exposed. Reactive substances could adversely affect the ship, facility, and the surrounding water based on the components of the substances and the nature of the reaction. These issues are of particular concern for commercial shipping vessels and chemical tankers that may carry large quantities of hazardous wastes, hazardous substances, universal wastes, or special wastes onboard. Oil and gas developments and LNG terminals present a similar set of concerns since the resources being extracted during these actions are hazardous, and the quantity of hazardous materials being stored and the length of time they are stored for would likely be much greater compared to OMAO and other cumulative actions.

Effects from OMAO vessel operations would be indistinguishable from other cumulative actions due to the comparably smaller size of the ships and the limited number of vessels in the NOAA fleet. NOAA ships are exempt from the storage, manifest, inspection, and recordkeeping requirements of any hazardous waste generated onboard; these responsibilities fall to NOAA shoreside support facilities once the waste is transferred from a NOAA ship. OMAO personnel on NOAA ships must maintain communications with NOAA shoreside support facilities to ensure they minimize the amount of potentially hazardous, universal, and special waste generated onboard so that support facilities can maintain their VSQG status. This would limit the amount of potentially hazardous, universal, and special waste stored and handled onboard NOAA ships, and therefore would limit the contribution of OMAO operations to the aggregate total of potentially hazardous, universal, and special waste stored and handled in the action area. While some ships in other fleets may share the VSQG status, larger ocean-transiting vessels, such as tankers and commercial shipping vessels, or industrialized marine-based facilities, may be designated as small or large quantity generators which are allowed to produce up to or greater than 1,000 kilograms of hazardous waste per calendar month. Compared to NOAA ships, these larger generators would be responsible for a much greater portion of the aggregate total of potentially hazardous, universal, and special waste to be stored and handled in the action area.

The cumulative impacts from the storage and handling of potentially hazardous, universal, and special waste would be limited to the immediate vicinity of vessels or nearshore and offshore development and installations and would not likely cause long-term changes. RCRA requires all hazardous waste generators to abide by proper storage, handling, and management protocols based on the type of hazardous waste. RCRA also regulates the amount of waste that can be generated and stored onboard to one calendar month, meaning all generators must limit the amount of accumulated waste stored onboard each month based on their generator status. While NOAA ships are exempt from the storage, manifest, inspection, and recordkeeping requirements of any hazardous waste generated onboard, OMAO maintains its own policies and procedures to ensure potentially hazardous, universal, and special wastes are properly stowed onboard in a manner that is consistent with RCRA. It is likely that other vessels and facilities associated with the cumulative actions abide by their own policies and procedures to remain in compliance with federal regulations such as RCRA and CERCLA, along with international mandates including MARPOL. In the event that an accidental spill was to occur, these impacts could potentially extend beyond these immediate vicinities. However, NOAA ships must also abide by the Shipboard Oil Pollution Emergency Plan (SOPEP) and Non-Tank Vessel Response Plan (VRP), which establishes the procedure for responding to an accidental discharge or spill of oil, hazardous substances, or marine pollutants; vessels and facilities associated with other cumulative actions would abide by their own spill prevention and response plan. Cumulative impacts from storage and handling would also not be concentrated spatially or temporally, as the action area covers a very wide geographic range.

Overall, aggregate cumulative impacts from the storage and handling of potentially hazardous, universal, and special waste would be temporary and would only result in substantial impacts in the event that an accidental discharge or spill were to occur. The contribution to these aggregate, adverse cumulative impacts from the storage and handling of potentially hazardous, universal, and special waste from the OMAO Proposed Action would be **negligible**.

4.2.9.3 Transfer and Disposal of Hazardous, Universal, and Special Waste

Once potentially hazardous, universal, and special waste is ready to be treated and disposed, it can be transferred to a NOAA shoreside support facility or hazardous waste transporter. The potentially hazardous, universal, and special waste must be handled, stored, and labeled according to the type of hazard in preparation for its transfer. Thus, the cumulative impacts from the transfer and disposal of potentially hazardous, universal, and special waste would be identical to the cumulative impacts from the storage and handling of hazardous waste as discussed in Section 4.2.9.2.

NOAA ships are exempt from the storage, manifest, inspection, and recordkeeping requirements of any hazardous waste generated onboard; these responsibilities fall to NOAA shoreside support facilities once the waste is transferred from a NOAA ship. In addition, the transfer and disposal of potentially hazardous, universal, and special waste would occur while ships are in port or at a shoreside facility. OMAO activities that occur in port or at a shoreside facility are not covered under this PEA. Therefore, the cumulative impacts of the transfer and disposal of potentially hazardous, universal, and special waste are not discussed further in this section.

4.2.9.4 Conclusion

When considered in tandem, adverse cumulative impacts to potentially hazardous, universal, and special waste would occur from the OMAO Proposed Action and other cumulative actions including:

- presence and movement of vessels (e.g., other federal fleets, commercial fishing and shipping vessels, recreational fishing and boating vessels, and ocean cruise liners); and
- construction, operation, and decommissioning of long-term installations (e.g., oil and natural gas development, extraction of marine minerals, offshore renewable energy development, construction and operation of LNG terminals, and construction and operation of new submarine telecommunication cable infrastructure).

OMAO vessel operations along with vessels and facilities associated with the cumulative actions would generate potentially hazardous, universal, and special waste from vessel operations, construction and operation of installations and marine-based facilities, and resource extraction. These wastes would subsequently be stored and handled according to federal regulations and international mandates.

Cumulative impacts from OMAO vessel operations would be small compared to the aggregate total from other cumulative actions due to the comparably smaller size of the NOAA ships and the limited number of vessels in the NOAA fleet. NOAA shoreside support facilities are VSQGs, so NOAA ships must minimize the amount of potentially hazardous, universal, or special waste transferred while alongside so that support facilities can maintain this status. NOAA ships also abide by all OMAO policies and procedures to properly store and handle potentially hazardous, universal, and special waste and execute the Shipboard Oil Pollution Emergency Plan & Non-Tank Vessel Response Plan in the event of an accidental spill. Vessel operations from other federal fleets, commercial fishing and shipping vessels, recreational fishing and boating vessels, and ocean cruise liners, in addition to operational activities from nearshore and offshore facilities, would be expected to abide by their own policies, procedures, and plans to prevent and minimize cumulative impacts from these wastes. Cumulative impacts from all past, present, and future actions would not be concentrated in any one particular area given the wide geographic scope of the action area.

Cumulative adverse impacts from the Proposed Action, in combination with other cumulative actions, could potentially be considered either interactive or additive depending on the timing and location of activities and impacts and on the nature of the potentially hazardous, universal, or special waste. The exact timing and location of OMAO vessel operations are not precisely known and are subject to change on a project-by-project basis, as would the type of potentially hazardous, universal, and special waste causing the cumulative impacts. The action area also covers a very wide geographic range, so it would be unlikely for cumulative impacts to occur in close proximity and sequentially. Therefore, interactive or additive cumulative impacts would most likely be determined based on project instructions and the timing and location of OMAO activities in relation to other cumulative actions.

Overall, the aggregate, adverse cumulative impacts from other cumulative actions on potentially hazardous, universal, and special waste throughout the action area would be negligible to moderate, with moderate impacts only occurring in the event of an accidental spill that extends beyond the immediate vicinity of the vessel or facility. The OMAO Proposed Action would contribute to these cumulative impacts, but the relative contribution would be **negligible** due to the limited number of ships in the NOAA fleet and their designation as VSQGs. These impacts would occur regardless of the chosen alternative since operations 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 DAS than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on hazardous, universal, and special waste.

4.2.10 Human Health and Safety

All past, present, and reasonably foreseeable actions described in Section 4.1 would contribute cumulative effects to human health and safety. The following section addresses occupational hazards on NOAA vessels during OMAO operations. Cumulative impacts to the human health and safety of OMAO personnel could occur by physical or chemical means; therefore, the analysis is organized into analyzing impacts from 1) physical; and 2) chemical hazards.

4.2.10.1 Physical Hazards

All cumulative actions described in Section 4.1, as well as the accumulation of marine debris from marine or terrestrial sources and IUU fishing, would contribute to cumulative impacts from physical hazards to human health and safety when combined with OMAO activities including:

- vessel movement; and
- OTS handling, crane, davit, and winch operations (e.g., from deploying and retrieving anchors, active acoustic systems, other sensors and data collection systems, UMS, and small boats).

As described in Section 3.12.2, vessel movement; and OTS handling, crane, davit, and winch operations could result in a wide range of human health and safety effects depending on the scenario, including but not limited to sprains, scrapes, lacerations, fractures, hypothermia, and drowning. However, minor injuries such as sprains, scrapes, and lacerations from slips, trips, and falls would be most common. Other cumulative actions would contribute to vessel presence and movement which could potentially create obstacles for the NOAA fleet, potentially resulting in vessel-to-vessel collisions if human errors or negligence occur. Additionally, the presence of marine debris would also create obstacles, particularly from large debris such as abandoned or derelict vessels. Moderate or greater impacts could only occur as a result of a substantial vessel-to-vessel collision. Grounding and other smaller incidents could also result in impacts to safety. However, the likelihood of large vessel-to-vessel collisions is very low due to the numerous precautions taken. For example, NOAA vessels are operated in accordance with the International Regulations for Preventing Collisions at Sea (COLREGs), published by the IMO, which establishes vessel navigation rules to prevent collisions. Furthermore, most modern vessels (including NOAA vessels) are equipped with multiple advanced and redundant navigational systems all designed to help with safe navigation and avoid collisions, including Global Positioning Systems (GPS), Automatic Radar Mapping Assistants, Automatic Identification Systems, and Electronic Chart Display and Information Systems (ECDIS).

Vessel movement associated with cumulative actions would create wakes, which would vary in amplitude based on the size of the vessels creating them. Wakes could intensify the rolling, pitching, and yawing of NOAA vessels already occurring from ocean conditions. Overall, the increase in vessel movement could result in increased injuries from slips, trips, and falls, but the additive cumulative contribution to the effects that would occur due to the Proposed Action would be minor because vessel wakes and their effects would be reduced by adherence to safety measures and BMPs. As stated in Section 3.12.2, non-slip textures are installed on decks, crew members wear non-slip footwear to prevent slipping, uneven surfaces are marked as hazards to prevent tripping, railings are installed where practical to prevent falling, and optimum ship routing is used to make ship routes as safe as possible with respect to storms. The effects of other vessel wakes would be localized and temporary as their effects generally dissipate or lessen very quickly. A safe practice for NOAA vessels is to maintain a Closest Point of Approach, no less than 0.5 nm (0.9 km) regardless of the size and orientation (i.e., if one vessel would overtake the other, or if their paths would cross) of another vessel, and recreational vessels should keep at least 91 m (300 ft) from military, cruise lines, and commercial ships (Hörteborn et al., 2019; USCG, 2023). Adverse impacts from wakes on NOAA vessels are unlikely to occur due to the extent of the action area and distance between vessels.

Increased physical impacts from cumulative actions on NOAA vessels during OMAO operations would be readily mitigated by using a variety of safety measures and BMPs, as well as well-prepared crewmembers. Overall, additive cumulative physical impacts to human health and safety would be adverse, negligible, and occur regardless of the chosen alternative in the short and long term, but the contribution to these impacts from OMAO activities under any of the three OMAO alternatives would be **negligible**.

4.2.10.2 Chemical Hazards

All cumulative actions aside from climate change would contribute to cumulative impacts from chemical hazards to human health and safety when combined with OMAO activities including vessel repair and maintenance, spill response, and waste handling and discharges. As described in Sections 3.12.2.1.2 and 3.12.2.1.3, personnel aboard NOAA vessels may come into contact with chemical hazards during activities such as vessel repair and maintenance; spill response; and waste handling and discharges. Contact with chemicals may result in a wide range of effects depending on factors such as the type of chemical, concentration and quantity, and exposure route, and could include headaches and irritation of the eyes, nose, skin, and throat.

Other federal fleets; offshore and outer continental shelf oil and natural gas development; assessment and extraction of marine minerals; offshore renewable energy development; commercial and recreational fishing; commercial shipping and recreational boating; the ocean cruise line industry; construction and operation of offshore liquified natural gas terminals; and construction of new submarine telecommunication cable infrastructure could potentially result in accidental discharges (e.g., oil spills); there would also be air emissions from third-party vessels and/or equipment used during these cumulative actions. While accidental discharges from these actions are a possibility, the likelihood of OMAO personnel coming into contact with these chemicals is extremely low because OMAO would not respond to these discharges. Under unique circumstances and if necessary, OMAO personnel could mitigate impacts by relying on spill response training and using personal protective equipment (PPE) and spill kits as applicable. Air emissions from third-party vessels and equipment would have no impact on human health and safety of personnel aboard NOAA vessels due to stack height, wind dispersion, and the distance maintained between NOAA vessels and third-party vessels and equipment. If ocean winds did transport air pollutants near NOAA vessels, temporary reductions in air quality would not be expected to cumulatively impact human health and safety due to the likely dispersion of the pollutants within seconds to minutes via wind currents.

Increased chemical hazards would predominantly be outside of the area of analysis (i.e., NOAA vessels during OMAO operations), and any hazards within the area of analysis would be reduced by relying on spill response training and drills, PPE, and spill kits for liquid chemical hazards; and stack height, wind dispersion, and the distance maintained between NOAA vessels and third-party vessels and equipment for airborne chemical hazards. Overall, additive cumulative chemical impacts to human health and safety would be adverse, negligible, and occur regardless of the chosen alternative in the short and long term, but the contribution to these impacts from OMAO vessel operations under any of the three OMAO alternatives would be **negligible**.

4.2.10.3 Conclusion

When considered in tandem with the OMAO Proposed Action, all other cumulative actions described in Section 4.1 would create additive, adverse, negligible cumulative impacts to human health and safety due to both physical and chemical hazards, but impacts are more likely to occur from physical hazards. Moderate or greater impacts would only occur in the unlikely event of a vessel-to-vessel collision. Therefore, the other cumulative actions are expected to result in insignificant impacts to human health and safety. Overall, the contribution to these cumulative impacts from any of the three OMAO alternatives would be **negligible**. These impacts would occur regardless of the chosen alternative since operations 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 greater contributions to cumulative impacts because these alternatives include more DAS than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on human health and safety.

4.2.11 Climate Change

Of the past, present, and reasonably foreseeable future actions and trends described in Section 4.1, the following actions and trends would contribute cumulative effects to global climate change:

- Habitat encroachment from onshore and nearshore development (e.g., as a function of coastal population growth);
- Operations of other federal fleets (UNOLS, USCG, U.S. Navy, joint federal maritime operations);
- Offshore and outer continental shelf oil and natural gas development;

- Assessment and extraction of marine minerals;
- Offshore renewable energy development (wind energy, marine and hydrokinetic energy, ocean thermal energy conversion);
- Commercial and recreational fishing;
- Commercial shipping and recreational boating;
- Ocean cruise line industry; and
- Construction and operation of offshore LNG terminals.

In addition to all of the above actions specific to the marine environment and described in Section 4.1, the 2022 *6th Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC) finds that, in general: "Globally, GDP per capita and population growth remained the strongest drivers of CO_2 emissions from fossil fuel combustion in the last decade" (IPCC, 2022; PRB, 2003).

4.2.11.1 Habitat Encroachment from Onshore and Nearshore Development

A side-effect of increasing population growth and development in the nation's coastal zone, both onshore and offshore, is the loss of natural habitats that serve as carbon sinks (e.g., vegetation, wetlands, soils) (NMFS, No Date-g; PRB, 2003; NOS, No Date-b; EEA, 2023). The net result is increasing anthropogenic carbon emissions, a faster rate of CO_2 accumulation in the atmosphere, and incrementally greater climate forcing (i.e., the difference between the rate of energy received by absorption of solar radiation and the rate of energy emitted by the earth's atmosphere) from higher atmospheric CO_2 levels.

The higher GHG emissions resulting from activities associated with habitat encroachment would combine additively in the atmosphere with GHG emissions from OMAO's Proposed Action, both contributing incrementally to anthropogenic global climate change.

4.2.11.2 Operations of Other Federal Fleets

As noted in Section 4.1.1, other federal fleets include but are not limited to vessels associated with UNOLS, USCG Operational Assets, specifically their fleet of boats, and the U.S. Navy's active battle force ships, specifically their surface fleet. Altogether, the number of ships and the miles traveled at sea annually by other federal fleets is much larger than OMAO's. These other vessels emit CO_2 to the atmosphere with the combustion of diesel or other fossil fuels in their engines. The GHG emissions from other federal fleets would combine additively in the atmosphere with GHG emissions from OMAO's Proposed Action, both contributing incrementally to anthropogenic global climate change. OMAO's GHG emissions are, and would continue to be, a small fraction of overall GHG emissions from combined federal fleets. As noted in Section 3.13, at an estimated annual 4,000-4,700 metric tons CO_2e, OMAO GHG emissions constitute less than 0.01 percent of aggregate annual GHG emissions from all boating and shipping within the EEZ.

4.2.11.3 Offshore and Outer Continental Shelf Oil and Natural Gas Development

As noted in Section 4.1.2, BOEM manages the exploration and development of offshore energy and marine mineral resources by the O&G industry on the 2.5 billion-acre U.S. OCS. Exploration and development consist of four main phases, namely exploration, development, production/extraction, and decommissioning/platform removal. Each of these phases entails the combustion of large quantities of fossil fuels to power the ships, drilling rigs, and other equipment used in finding, developing, and extracting oil and gas resources from the OCS. Moreover, the additional fossil fuels obtained through all of these energy-intensive processes are intended for sale and use in the global economy – facilitating energy-dependent economic activities that themselves emit CO_2 into the atmosphere. OCS oil and natural gas development contributes to GHG emissions in both the production and consumption sides of modern, industrialized economies.

The direct and indirect GHG emissions from OCS oil and natural gas development would combine additively in the atmosphere with GHG emissions from OMAO's Proposed Action, both contributing incrementally to anthropogenic global climate change. OMAO's GHG emissions are a small fraction of overall GHG emissions associated with OCS oil and natural gas development.

4.2.11.4 Assessment and Extraction of Marine Minerals

As noted in Section 4.1.3, BOEM manages non-energy minerals (primarily sand and gravel) for coastal restoration and commercial leasing of gold, manganese, and other hard minerals. BOEM's MMP projects include dredging to obtain sand and/or gravel, placing the resources onto the shoreline, and monitoring the dredging site and placement conditions (BOEM, 2019d). As of 2018, 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. Completing these projects requires fuel consumption to extract fossil fuels, both of which combust to release CO_2 emissions into the atmosphere.

The GHG emissions from the assessment and extraction of marine minerals would combine additively in the atmosphere with GHG emissions from OMAO's Proposed Action. Both actions would cumulatively contribute incrementally to anthropogenic global climate change.

4.2.11.5 Offshore Renewable Energy Development

As noted in Section 4.1.4, BOEM is the federal agency overseeing offshore renewable energy development in federal waters (BOEM, 2020). Offshore renewable energy includes wind energy, ocean wave and current (hydrokinetic) energy, and ocean thermal energy conversion (BOEM, 2020). Development of each of these potential marine renewable energy sources would require the use of fossil fuels, and would therefore emit CO_2 to the atmosphere, but once installed and implemented, these sources would generate relatively carbon-free electricity (NYSERDA, 2023) for the length of their service life, an estimated 20-25 years (TWI, No Date).

The GHG emissions from the development phase of offshore renewable energy would combine additively in the atmosphere with GHG emissions from OMAO's Proposed Action. Both actions would cumulatively contribute incrementally to anthropogenic global climate change.

4.2.11.6 Commercial and Recreational Fishing

As noted in Section 4.1.6, commercial and recreational fishing in U.S. coastal waters account for hundreds of millions of boat trips annually. Most of these trips depend on oil products to fuel boat and ship engines and motors, releasing CO_2 to the air in the process. GHG emissions from commercial and recreational fishing would combine additively in the atmosphere with GHG emissions from OMAO's Proposed Action. Both actions would cumulatively contribute incrementally to anthropogenic global climate change.

4.2.11.7 Commercial Shipping and Recreational Boating

As noted in Section 4.1.7, global demand for maritime commerce is expected to more than double, increasing the amount of vessel traffic. Overall, both commercial shipping and recreational boating are expected to increase above current levels due to global demand for maritime commerce, new potential shipping lanes due to climate change, and a growing interest in water-based, motorized recreation activities. GHG emissions from commercial shipping and recreational boating are thus expected to increase commensurately. These would combine additively in the atmosphere with GHG emissions from OMAO's Proposed Action. Both actions would cumulatively contribute incrementally to anthropogenic global climate change.

4.2.11.8 Ocean Line Cruise Industry

As noted in Section 4.1.8, the ocean cruise line industry is expected to remain at current levels or increase above these levels due to increased passenger growth rates and planned fleet expansion projects. GHG emissions from cruise ships would combine additively in the atmosphere with GHG emissions from OMAO's Proposed Action. Both actions would cumulatively contribute incrementally to anthropogenic global climate change.

4.2.11.9 Construction and Operation of Offshore LNG Terminals

As noted in Section 4.1.9, activities pertaining to the operation and construction of offshore LNG terminals in the U.S. are expected to continue at current levels or increase in the coming years. Growing interest from Europe in U.S. natural gas since the invasion of Ukraine in early 2022 and subsequent geopolitical difficulties with maintaining existing natural gas imports from Russia may intensify interest in importing natural gas from the U.S. and thus accelerate the construction of additional offshore LNG terminals in the U.S.

As with the development of offshore energy and marine mineral resources by the O&G industry discussed above, the process of constructing and operating new offshore LNG terminals uses energy. This activity also increases economic activity which requires combustion of additional hydrocarbon fuels and the resultant carbon emissions during the developmental process. The direct and indirect GHG emissions related to constructing and operating more LNG terminals would combine additively in the atmosphere with GHG emissions from OMAO's Proposed Action. Both actions would cumulatively contribute incrementally to anthropogenic global climate change.

4.2.11.10 Conclusion

When considered in combination with the OMAO Proposed Action, these other actions would contribute additively and incrementally to the global GHG emissions that contribute to anthropogenic climate change:

- habitat encroachment from onshore and nearshore development;
- operations of other federal fleets;
- offshore and OCS oil and natural gas development;
- assessment and extraction of marine minerals;
- offshore renewable energy development;
- commercial and recreational fishing;

- commercial shipping and recreational boating;
- the ocean cruise line industry; and
- construction and operation of offshore LNG terminals.

These other cumulative actions represent a very small share of global GHG emissions. At an estimated 4,000-4,700 metric tons CO_2e annually, or approximately 0.006 percent of annual U.S. GHG emissions measured in CO_2e, all three of the OMAO alternatives would contribute to and have the potential to increase these cumulative impacts, but the relative contribution would be **negligible**. These impacts would occur regardless of the chosen alternative since operations 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 DAS than Alternative A; more DAS would provide more opportunities for impact causing factors to occur which could have additional adverse impacts on climate change. The effects of projected climate change on OMAO actions associated with Alternatives A, B, and C would be **negligible** to **minor**.

5.0 REFERENCES

(ACHP, 2018). Advisory Council on Historic Preservation. 2018. Tribal Treaty Rights in the Section 106 Process. Accessed May 2023 at: https://www.achp.gov/native-american/information-papers/tribal-treaty-rights.

(ADF&G, 2007). Alaska Department of Fish and Game. 2007. A Student Guide to Seal Hunting and Safety. Available online at: https://www.adfg.alaska.gov/static/education/educators/curricula/pdfs/ice_seal_student_guide.pdf.

(ADF&G, 2008). Alaska Department of Fish and Game. 2008. Polar Bear. Available online at: https://www.adfg.alaska.gov/static/education/wns/polar_bear.pdf.

(ADF&G, 2009a). Alaska Department of Fish and Game. 2009. The Subsistence Harvest of Harbor Seals and Sea Lions by Alaska Natives in 2007. Available online at: http://www.adfg.alaska.gov/techpap/tp345.pdf.

(ADF&G, 2009b). Alaska Department of Fish and Game. 2009. The Subsistence Harvest of Harbor Seals and Sea Lions by Alaska Natives in 2008. Available online at: http://www.adfg.alaska.gov/techpap/TP347.pdf.

(ADF&G, 2013a). Alaska Department of Fish and Game. 2013. The Subsistence Harvest of Harbor Seals and Sea Lions in Southeast Alaska in 2012. Available online at: https://www.arlis.org/docs/vol1/G/896210864.pdf.

(ADF&G, 2013b). Alaska Department of Fish and Game. 2013. Sea Otter Numbers – and Harvest – On the Rise. Accessed May 2023 at: http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=637.

(ADF&G, 2016a). Alaska Department of Fish and Game. 2016. Traditional Knowledge Regarding Ringed Seals, Bearded Seals, and Walrus near Shishmaref, Alaska. Available online at: https://www.adfg.alaska.gov/static/research/programs/marinemammals/pdfs/2016_traditional_knowledge_shishmaref.pdf.

(ADF&G, 2016b). Alaska Department of Fish and Game. 2016. Alaska Wild Salmon Day. Accessed May 2023 at: https://www.adfg.alaska.gov/index.cfm?adfg=pressreleases.pr08102016.

(ADF&G, 2017a). Alaska Department of Fish and Game. 2017. Subsistence in Alaska: A Year 2017 Update. Available online at: https://www.adfg.alaska.gov/static/home/subsistence/pdfs/subsistence_update_2017.pdf.

(ADF&G, 2017b). Alaska Department of Fish and Game. 2017. Walrus Island State Game Sanctuary Annual Management Report 2016. Available online at: http://www.adfg.alaska.gov/static/lands/protectedareas/walrusislands/pdfs/ri_16report.pdf.

(ADF&G, 2018). Alaska Department of Fish and Game. 2018. Subsistence in Alaska: A Year 2017 Update. Available online at: https://www.adfg.alaska.gov/static/home/subsistence/pdfs/subsistence_update_2017.pdf.

(ADF&G, 2019). Alaska Department of Fish and Game. 2019. Alaska Subsistence and Personal Use Salmon Fisheries 2016 Annual Report. Available online at: https://www.adfg.alaska.gov/techpap/TP446.pdf.

(ADF&G, 2020). Alaska Department of Fish and Game. 2020. 2020-2021 Statewide Subsistence and Personal Use Fishing Regulations. Available online at: https://www.adfg.alaska.gov/static/regulations/fishregulations/pdfs/commercial/2019_2020_subsistence_pu_regs.pdf.

(ADF&G, No Date-a). Alaska Department of Fish and Game. No Date. Reptiles and Amphibians. Accessed May 2023 at: https://www.adfg.alaska.gov/index.cfm?adfg=animals.listreptiles.

(ADF&G, No Date-b). Alaska Department of Fish and Game. No Date. Beluga Whale Uses. Accessed May 2023 at: https://www.adfg.alaska.gov/index.cfm?adfg=beluga.uses.

(ADF&G, No Date-c). Alaska Department of Fish and Game. No Date. Harbor Seal Uses. Accessed May 2023 at: http://www.adfg.alaska.gov/index.cfm?adfg=harborseal.uses.

(ADF&G, No Date-d). Alaska Department of Fish and Wildlife. No Date. Pacific Walrus Uses. Accessed May 2023 at: http://www.adfg.alaska.gov/index.cfm?adfg=walrus.uses.

(ADF&G, No Date-e). Alaska Department of Fish and Game. No Date. Polar Bear uses. Accessed May 2023 at: http://www.adfg.alaska.gov/index.cfm?adfg=polarbear.uses.

(AEWC, 2021). Alaska Eskimo Whaling Commission. 2021. Our Whaling Villages. Accessed May 2023 at: https://www.aewc-alaska.org/our-villlages.

(AFMA, No Date). Australian Fisheries Management Authority. No Date. Trawling. Accessed May 2023 at: https://www.afma.gov.au/fisheries-management/methods-and-gear/trawling.

(AFN, 2021). Alaska Federation of Natives. 2021. Alaska Native Peoples. Available online at: https://www.nativefederation.org/alaska-native-peoples/.

(AKDOT, 2006). State of Alaska Department of Transportation and Public Facilities. 2006. Biological Assessment of the Northern Sea Otter *Enhydra lutris kenyoni* for the Akutan Airport Project. Available online at: https://www.fws.gov/alaska/fisheries/mmm/Chukchi_Sea/pdf/biological_assessment_northern_sea_otter.pdf.

(Alderfer, 2003). Alderfer, J. Auks, murres, puffins. In M. Baughman (Ed.), National Geographic Reference Atlas to the Birds of North America (pp. 176–185). Washington, DC: National Geographic Society.

(Ballou et al., 1987). Ballou, T.G., R.E. Dodge, S.C. Hess, A.H. Knap and T.D. Sleeter. 1987. Effects of a dispersed and undispersed crude oil on mangroves, seagrasses and corals. API 4460. American Petroleum Institute, Washington, DC. Available online at: https://www.researchgate.net/publication/264839961_Effects_of_a_Dispersed_and_Undispersed_Crude_Oil_on_Mangroves_Seagrasses_and_Corals.

(Barr et al., 2020). Barr, J. R., M.C. Green, S.J. DeMaso, and T.B. Hardy. 2020. Drone surveys do not increase colony-wide flight behaviour at waterbird nesting sites, but sensitivity varies among species. Scientific Reports, 10(1). Available online at: https://doi.org/10.1038/s41598-020-60543-z.

(Barrowclough et al., 2016). Barrowclough, G.F., J. Cracraft, J. Klicka, and R. Zink. 2016. How Many Kinds of Birds Are There and Why Does It Matter? PloS one, 11(11), e0166307. Available online at: https://doi.org/10.1371/journal.pone.0166307.

(BIA, No Date). Bureau of Indian Affairs. No Date. Subsistence Branch. Accessed May 2023 at: https://www.bia.gov/regional-offices/alaska/subsistence-branch.

(Black, 2005). Black, A. 2005. Light induced seabird mortality on vessels operating in the Southern Ocean: Incidents and mitigation measures. Antarctic Science 17:67-68. Available online at: https://www.cambridge.org/core/journals/antarctic-science/article/light-induced-seabird-mortality-on-vessels-operating-in-the-southern-ocean-incidents-and-mitigation-measures/8CA7FBA380A840736AA8814C4B97A720.

(BLM, No Date). Bureau of Land Management. No Date. Alaska Federal Subsistence. Accessed May 2023 at: https://www.blm.gov/programs/natural-resources/subsistence.

(BLS, 2018). Bureau of Labor Statistics. 2018. Table 1: Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, 2018. Washington DC: U.S. Department of Labor, Bureau of Labor Statistics. Accessed online May 2023 at: https://www.bls.gov/iif/nonfatal-injuries-and-illnesses-tables/soii-summary-historical/summary-table-1-2018-national.htm.

(BoatUS, 2023). Boat U.S. Foundation. 2023. Types of Marine Sanitation Devices (MSDs). Accessed May 2023 at: https://www.boatus.org/clean-boating/sewage/msd-types/.

(Boeger et al., 2006). Boeger, W.A., M.R. Pie, A. Ostrensky, and M.F. Cardoso. 2006. The effect of exposure to seismic prospecting on coral reef fishes. Brazilian Journal of Oceanography 54:235-239. Available online at: https://doi.org/10.1590/S1679-87592006000300007.

(Boelens, 2013). Boelens, R.D. 2013. Protecting Alaska's Coastal Ecosystems: The Story of the Cook Inlet Belugas. Seattle Journal of Environmental Law Vol. 3: Iss. 1, Article 7. Available online at: https://digitalcommons.law.seattleu.edu/sjel/vol3/iss1/7.

(BOEM, 2012a). Bureau of Ocean Energy Management. 2012. Inventory and Analysis of Archaeological Site Occurrence on the Atlantic Outer Continental Shelf. Available online at: https://espis.boem.gov/final%20reports/5196.pdf.

(BOEM, 2012b). Bureau of Ocean Energy Management. 2012. Evaluation of Visual Impact on Cultural Resources/Historic Properties: North Atlantic, Mid-Atlantic, South Atlantic, and Florida Straits Volume I: Technical Report of Findings. Available online at: https://espis.boem.gov/final%20reports/5249.pdf.

(BOEM, 2012c). Bureau of Ocean and Energy Management. 2012. Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017. Available online at: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Assessment/NEPA/BOEM-2012-019_v1.pdf.

(BOEM, 2013). Bureau of Ocean Energy Management. November 2013. Inventory and Analysis of Coastal and Submerged Archaeological Site Occurrence on the Pacific Outer Continental Shelf. Available online at: https://espis.boem.gov/final%20reports/5357.pdf.

(BOEM, 2014). Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. 2014. Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement. Available online at: https://www.boem.gov/Atlantic-G-G-PEIS/#Final%20PEIS.

(BOEM, 2015a). Bureau of Ocean Energy Management. 2015. Biological Assessment Oil and Gas Activities Associated with Lease Sale 193, Spectacled Eider, Spectacled Eider Critical Habitat, Alaska-breeding Steller's Eider, and Polar Bear. Alaska OCS Region. Available online at: https://www.boem.gov/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/2015-01-20-FWS-BA-LS193.pdf.

(BOEM, 2015b). Bureau of Ocean and Energy Management, U.S. Department of the Interior. February 2015. Final Second Supplemental Environmental Impact Statement Chukchi Sea Planning Area. Available online at: https://www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Leasing/Lease_Sales/Sale_193/2015_0127_LS193_Final_2nd_SEIS_Vol1.pdf.

(BOEM, 2016). Bureau of Ocean Energy Management. 2016. Outer Continental Shelf Oil and Gas Leasing Program 2017-2022 Environmental Impact Statement. Available online at: https://www.boem.gov/oil-gas-energy/leasing/2017-2022-ocs-oil-and-gas-leasing-program.

(BOEM, 2017a). Bureau of Ocean Energy Management. 2017. A Guidance Document for Characterizing Native Hawaiian Cultural Landscapes. Available online at: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Pacific-Region/Studies/2017-023.pdf.

(BOEM, 2017a). Bureau of Ocean Energy Management. 2017. Characterizing Tribal Cultural Landscapes Volume I: Project Framework. Available online at: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Pacific-Region/Studies/BOEM-2017-001_Vol1.pdf.

(BOEM, 2017c). Bureau of Ocean Energy Management. 2017. Characterizing Tribal Cultural Landscapes Volume II: Tribal Case Studies. Available online at: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Pacific-Region/Studies/BOEM-2017-001-Vol2.pdf.

(BOEM, 2017d). Bureau of Ocean Energy Management. 2017. U.S. Outer Continental Shelf Gulf of Mexico Region Oil and Gas Production Forecast: 2018-2027. Available online at: https://www.boem.gov/sites/default/files/about-boem/BOEM-Regions/Gulf-of-Mexico-Region/Resource-Evaluation/BOEM--2017--082.pdf.

(BOEM, 2017e). Bureau of Ocean Energy Management, U.S. Department of the Interior. 2017. Liberty Development Project. Development and Production Plan in Beaufort Sea, Alaska. Draft Environmental Impact Statement Volume 1. Available online at: https://www.boem.gov/sites/default/files/about-boem/BOEM-Regions/Alaska-Region/Leasing-and-Plans/Leasing/Liberty/2017_0707_Volume_1_Liberty_EIS.pdf.

(BOEM, 2018a). Bureau of Ocean and Energy Management. 2018. Final Environmental Impact Statement Liberty Development and Production Plan, Beaufort Sea, Alaska. Available online at: https://www.boem.gov/sites/default/files/about-boem/BOEM-Regions/Alaska-Region/Leasing-and-Plans/Plans/Vol-1-Liberty-FEIS.pdf.

(BOEM, 2018b). Bureau of Ocean Energy Management. 2018. Geological and Geophysical (G&G) Surveys Fact Sheet. Available online at: https://www.boem.gov/sites/default/files/about-boem/BOEM-Regions/Atlantic-Region/GandG-Overview.pdf.

(BOEM, 2019a). Bureau of Ocean Energy Management. 2019. National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Outer Continental Shelf. Available online at: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/IPFs-in-the-Offshore-Wind-Cumulative-Impacts-Scenario-on-the-N-OCS.pdf.

(BOEM, 2019b). Bureau of Ocean Energy Management. 2019. Alaska Lease Holdings by Owner. Available online at: https://www.boem.gov/sites/default/files/about-boem/BOEM-Regions/Alaska-Region/Leasing-and-Plans/Leasing/Alaska-Lease-Holdings-by-Owner.pdf.

(BOEM, 2019c). Bureau of Ocean Energy Management. 2019. Alaska OCS Region: Alaska Detailed Listing of Active Leases. Available online at: https://www.boem.gov/sites/default/files/about-boem/BOEM-Regions/Alaska-Region/Leasing-and-Plans/Leasing/Alaska-Detailed-Listing-of-Active-Leases.pdf.

(BOEM, 2019d). Bureau of Ocean Energy Management. 2019. Marine Minerals Program Fact Sheet. Available online at: https://www.boem.gov/sites/default/files/boem-newsroom/MMP_General-fact-sheet.pdf.

(BOEM, 2020). Bureau of Ocean Energy Management. 2020. Renewable Energy Fact Sheet. Available online at: https://www.boem.gov/sites/default/files/documents/renewable-energy/BOEM_FactSheet-Renewable-2-26-2020.pdf.

(BOEM, 2023). Bureau of Ocean Energy Management. 2023. 2023-2028 National Outer Continental Shelf Oil and Gas Leasing Proposed Program. Accessed September 5, 2023 at: https://www.boem.gov/sites/default/files/documents/oil-gas-energy/national-program/2023-2028_Proposed%20Program_July2022.pdf.

(BOEM, No Date-a). Bureau of Ocean Energy Management. No Date. Deepwater Shipwrecks. Accessed May 2023 at: https://www.boem.gov/environment/deepwater-shipwrecks.

(BOEM, No Date-b). Bureau of Ocean Energy Management. No Date. Managing Oil and Gas Leases - Pacific. Accessed May 2023 at: https://www.boem.gov/Managing-Oil-and-Gas-Leases-Pacific.

(BOEM, No Date-c). Bureau of Ocean Energy Management. No Date. Exploration and Development Plans. Accessed May 2023 at: https://www.boem.gov/oil-gas-energy/exploration-and-development-plans-0.

(BOEM, No Date-e). Bureau of Ocean Energy Management. No Date. Gulf of Mexico OCS Region. Accessed May 2023 at: https://www.boem.gov/regions/gulf-mexico-ocs-region.

(BOEM, No Date-f). Bureau of Ocean Energy Management. No Date. Renewable Energy on the Outer Continental Shelf. Accessed May 2023 at: https://www.boem.gov/Renewable-Energy-Program-Overview/.

(Bonjour, 2011). Bonjour, K. 2011. Legal Considerations for Possible Noise Ordinances for Newport Harbor. Sea Grant Law Fellow Publications. 27. Available online at: https://docs.rwu.edu/law_ma_seagrant/27.

(Boylan and Elsberry, 2019). Boyland, B.M. and D. Elsberry. 2019. Climate Change and Maritime Traffic in the Arctic. University of Alaska Fairbanks, Center for Arctic Policy Studies. Available online at: https://uaf.edu/caps/our-work/policy-perspectives-files/climate-change-and-maritime-traffic-in-the-arctic-pb4-final-12dec2019.pdf.

(Brake, 2019). Brake, D. 2019. Submarine Cables: Critical Infrastructure for Global Communications. Accessed May 2023 at: https://itif.org/publications/2019/04/19/submarine-cables-critical-infrastructure-global-communications/.

(Braund et al., 2018). Braund, S.R., P.B. Lawrence, E.G. Sears, R.K. Schraer, E.V. Regehr, B. Adams, R.T. Hepa, J.C. George, and A.L. Von Duyke. 2018. Polar Bear TEK: A Pilot Study to Inform Polar Bear Management Models. Technical Report, Number: NSB.DWM.RR.2018-01. Available online at: https://doi.org/10.13140/RG.2.2.16243.84008/1.

(Bricker et al., 2007). Bricker, S., B. Longstaff, W. Dennison, A. Jones, K. Boicourt, C. Wicks, and J. Woerner. 2007. Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change. NOAA Coastal Ocean Program Decision Analysis Series No. 26. National Centers for Coastal Ocean Science, Silver Spring, MD. 328 pp. Available online at: https://ian.umces.edu/site/assets/files/10833/effects-of-nutrient-enrichment-in-the-nations-estuaries-a-decade-of-change.pdf.

(Brisson-Curadeau et al., 2017). Brisson-Curadeau, É., D. Bird, C. Burke, D.A. Fifield, P. Pace, R.B. Sherley, and K.H. Elliott. 2017. Seabird species vary in behavioural response to drone census. Scientific Reports, 7(1). Available online at: https://doi.org/10.1038/s41598-017-18202-3.

(Brower and Taqulik, 2010). Brower, H. and H. Taqulik. 2010. Subsistence Hunting Activities and the Inupiat Eskimo. Accessed May 2023 at: https://www.culturalsurvival.org/publications/cultural-survival-quarterly/subsistence-hunting-activities-and-inupiat-eskimo.

(Buis, 2022). Buis, A. 2022. Steamy Relationships: How Atmospheric Water Vapor Supercharges Earth's Greenhouse Effect. NASA Jet Propulsion Laboratory. Global Climate Change, Vital Signs of the Planet. Accessed May 2023 at: https://climate.nasa.gov/ask-nasa-climate/3143/steamy-relationships-how-atmospheric-water-vapor-supercharges-earths-greenhouse-effect/.

(Bureau of Transportation Statistics, 2017). United States Department of Transportation, Bureau of Transportation Statistics. 2017. Table 1 Summary of Cruise Ship Waste Streams. Accessed May 2023 at: https://www.bts.dot.gov/bts/bts/archive/publications/maritime_trade_and_transportation/2002/environmental_issues_table_01.

(Burge et al., 2016). Burge, C.A., C. J. Closek, C.S. Friedman, M.L. Groner, C.M. Jenkins, A. Shore-Maggio, and J.E. Walsh. 2016. The Use of Filter-feeders to Manage Disease in a Changing World Integrative and Comparative Biology, Volume 56, Issue 4. Available online at: https://academic.oup.com/icb/article/56/4/573/2198269.

(Burns and Knap, 1989). Burns, K.A. and A.H. Knap. 1989. The Bahia Las Minas oil spill: Hydrocarbon uptake by reef building corals. Mar. Poll. Bull. 20: 391-8. Available online at: https://doi.org/10.1016/0025-326X(89)90317-2.

(CDC, 2022). Centers for Disease Control and Prevention. 2022. What Noises Cause Hearing Loss? Accessed May 2023 at: https://www.cdc.gov/nceh/hearing_loss/what_noises_cause_hearing_loss.html.

(CEE, 2006). Center for Energy Economics. 2006. Offshore LNG Receiving Terminals. Available online at: http://www.beg.utexas.edu/files/energyecon/global-gas-and-lng/CEE_offshore_LNG.pdf.

(CEQ, 1997a). Council on Environmental Quality. 1997. Environmental Justice Guidance Under the National Environmental Policy Act. Available online at: https://www.epa.gov/sites/default/files/2015-02/documents/ej_guidance_nepa_ceq1297.pdf.

(CEQ, 1997b). Council on Environmental Quality. 1997. Considering Cumulative Effects Under the National Environmental Policy Act. Available online at: https://www.energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/G-CEQ-ConsidCumulEffects.pdf.

(CEQ, 2013). Council on Environmental Quality. 2013. NEPA and NHPA: A Handbook for Integrating NEPA and Section 106. Available online at: https://www.achp.gov/sites/default/files/2017-02/NEPA_NHPA_Section_106_Handbook_Mar2013_0.pdf.

(CEQ, 2014). Effective Use of Programmatic NEPA Reviews. 2014. Memorandum for Heads of Federal 29 Departments and Agencies. Available online at: https://obamawhitehouse.archives.gov/sites/default/files/docs/effective_use_of_programmatic_nepa_reviews_final_dec2014_searchable.pdf.

(CFMC, 2023). Caribbean Fishery Management Council. 2023. Implemented Fishery Management Plans. Available online at: https://caribbeanfmc.com/fishery-management/fishery-management-plans.

(Cheung et al., 2007). Cheung, W.W.L., R. Watson, T. Morato, T.J. Pitcher, D. and Pauly. 2007. Intrinsic vulnerability in the global fish catch. Marine Ecology-Progress Series, 333, 1-12. Available online at: https://doi.org/10.3354/meps333001.

(Christensen, 2009). Christensen, E.P., CAPT. 2009. Guidelines for Ensuring Compliance with Annex VI to the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78; Prevention of Air Pollution from Ships. United States Coast Guard, Department of Homeland Security. Available online at: https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/cgpol0901.pdf.

(Christiansen et al., 2016). Christiansen, F., L. Rojano-Doñate, P.T. Madsen, and L. Bejder. 2016. Noise levels of multi-rotor unmanned aerial vehicles with implications for potential underwater impacts on marine mammals. Frontiers in Marine Science, 3. Available online at: https://doi.org/10.3389/fmars.2016.00277.

(City and County of Honolulu, No Date). City and County of Honolulu. No Date. Honolulu, Hawaii - Revised Ordinances of Honolulu. Accessed May 2023 at: https://www.nonoise.org/lawlib/cities/honolulu.htm.

(City of Ketchikan, 2023). City of Ketchikan. 2023. Chapter 19.05 Construction and Excavation Activities – Noise Restrictions. Accessed May 2023 at: https://www.codepublishing.com/AK/Ketchikan/#!/Ketchikan19/Ketchikan1905.html.

(City of Kodiak, 2023). City of Kodiak. 2023. Chapter 18.28 Port and Harbor Facilities. Accessed May 2023 at: https://www.codepublishing.com/AK/Kodiak/#!/Kodiak18/Kodiak1828.html.

(City of Newport OR, No Date). City of Newport, Oregon. No Date. City of Newport Municipal Code. Available online at: https://www.newportoregon.gov/dept/adm/documents/newportmunicipalcode.pdf.

(CLIA, 2023). Cruise Lines International Association. 2023. State of the Cruise Industry 2023. Available online at: https://cruising.org/-/media/clia-media/research/2023/2023-clia-state-of-the-cruise-industry-report_low-res.ashx#:~:text=Cruise%20passenger%20volume%20is%20forecast,to%2095%25%20of%202019%20levels.

(ClimeFish, No Date). ClimeFish. 2020. Climate change and impacts on fisheries. Accessed May 2023 at: https://climefish.eu/climate-change-and-impacts-on-fisheries/.

(Codarin et al., 2009). Codarin, A., L.E. Wysocki, F. Ladich, and M. Picciulin. 2009. Effects of ambient and boat noise on hearing and communication in three fish species living in a marine protected area (Miramare, Italy). Marine Pollution Bulletin, 58(12), 1880-1887. Available online at: https://doi.org/10.1016/j.marpolbul.2009.07.011.

(Columbia River Inter-Tribal Fish Commission, No Date). Columbia River Inter-Tribal Fish Commission. No Date. The Tribes' Treaty Reserved Fishing Rights. Accessed May 2023 at:

https://plan.critfc.org/2013/spirit-of-the-salmon-plan/about-spirit-of-the-salmon/the-tribes-treaty-reserved-fishing-rights/.

(Cook and Knap, 1983). Cook, C.B. and A.H. Knap. 1983. Effects of crude oil and chemical dispersant on photosynthesis in the brain coral Diploria strigosa. Mar. Biol. 78: 21-7. Available online at: https://link.springer.com/article/10.1007/BF00392967.

(Cornell Law School, No Date-a). Cornell Law School, Legal Information Institute. No Date. 33 CFR § 151.19 – International Oil Pollution Prevention (IOPP) Certificates. Accessed May 2023 at: https://www.law.cornell.edu/cfr/text/33/151.19.

(Cornell Law School, No Date-b). Cornell Law School. No Date. 42 U.S. Code § 6939d – Public vessel. Legal Information Institute. Accessed May 2023 at: https://www.law.cornell.edu/uscode/text/42/6939d.

(Cornell Law School, No Date-c). Cornell Law School. No Date. 40 CFR § 262.13 – Generator category determination. Legal Information Institute. Accessed May 2023 at: https://www.law.cornell.edu/cfr/text/40/262.13.

(Crain et al., 2009). Crain, C.M., B.S. Halpern, M.W. Beck, and C.V. Kappel.2009. Understanding and Managing Human Threats to the Coastal Marine Environment. In R. S. Ostfeld and W. H. Schlesinger (Eds.), The Year in Ecology and Conservation Biology 1162(1):39-62. Oxford, UK: Blackwell Publishing. Available online at: https://doi.org/10.1111/j.1749-6632.2009.04496.x.

(Cranor, 2003). Cranor, D. 2003. Cruise Passengers Demand Cruise Industry to End Dumping of Raw Sewage in the Ocean. OCEANA. Accessed May 2023 at: https://usa.oceana.org/press-releases/cruise-passengers-demand-cruise-industry-end-dumping-raw-sewage-ocean/.

(CRITFC, 2021). Columbia River Inter-Tribal Fish Commission. 2021. Salmon Culture of the Pacific Northwest Tribes. Accessed May 2023 at: https://www.critfc.org/salmon-culture/tribal-salmon-culture/.

(CRS, 2018). Congressional Research Service. 2018. U.S. Crude Oil and Natural Gas Production in Federal and Nonfederal Areas. Available online at: https://crsreports.congress.gov/product/pdf/R/R42432.

(De Robertis et al., 2007). De Robertis, A., V. Hjellvik, N.J. Williamson, and C.D. Wilson. 2007. Silent ships do not always encounter more fish: comparison of acoustic backscatter recorded by a noise-reduced and a conventional research vessel. Available online at: https://doi.org/10.1093/icesjms/fsn025.

(DeMaster et al., 2001). DeMaster, D.P., C.W. Fowler, S.L. Perry, and M.F. Richlen. 2001. Predation and competition: The impact of fisheries on marine-mammal populations over the next one hundred years. Journal of Mammalogy, 82(3), 641–651. Available online at: https://doi.org/10.1644/1545-1542(2001)082<0641:PACTIO>2.0.CO;2.

(Devaney, 2014). Devaney, M.S. 2014. Promoting Compliance with NOAA's Environmental Statutes. Memorandum. August 22, 2014.

(DHSS, 2014). Delaware Health and Social Services, Division of Public Health. 2014. Sewage. Available online at: https://dhss.delaware.gov/dph/files/sewagefaq.pdf.

(DoC, 2022). U.S. Department of Commerce. 2022. Five Ways NOAA Helped Make America Climate-Ready in 2021. Accessed May 2023 at: https://www.commerce.gov/news/blog/2022/01/five-ways-noaa-helped-make-america-climate-ready-2021.

(DOE, 2021). U.S. Department of Energy. 2021. Energy Secretary Granholm Announces Ambitious New 30GW Offshore Wind Deployment Target by 2030. Accessed May 2023 at:

https://www.energy.gov/articles/energy-secretary-granholm-announces-ambitious-new-30gw-offshore-wind-deployment-target.

(DOE, No Date-a). U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. No Date. Marine and Hydrokinetic Market Acceleration and Deployment. Accessed May 2023 at: https://www.energy.gov/eere/water/marine-and-hydrokinetic-market-acceleration-and-deployment.

(DOE, No Date-b). U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. No Date. Marine and Hydrokinetic Resource Assessment and Characterization. Accessed May 2023 at: https://www.energy.gov/eere/water/marine-and-hydrokinetic-resource-assessment-and-characterization.

(DOI, 2021). U.S. Department of the Interior. 2021. Federal Subsistence Management Regulations for the Harvest of Fish and Shellfish on Federal Public Lands and Waters in Alaska. Available online at: https://www.doi.gov/sites/doi.gov/files/uploads/2019-21_fisheries_regs_book_web.pdf.

(Dooling and Popper, 2000). Dooling, R.J. and A.N. Popper. 2000. Hearing in birds and reptiles: An overview. In: Dooling, R.J., A.N. Popper, and R.R. Fay, eds. Comparative Hearing: Birds and Reptiles. New York, NY: Springer-Verlag. Pp. 1-12. Available online at: https://link.springer.com/chapter/10.1007/978-1-4612-1182-2_1.

(Dooling and Therrien, 2012). Dooling, R.J. and S.C. Therrien. Hearing in Birds: What Changes from Air to Water. The Effects of Noise on Aquatic Life, eds. Popper, A.N. and Hawkins, A. 77–82. Advances in Experimental Medicine and Biology. New York, NY: Springer, 2012. Available online at: https://doi.org/10.1007/978-1-4419-7311-5_17.

(DOSITS, No Date-a). Discovery of Sound in the Sea. No Date. Echosounder. Accessed May 2023 at: https://dosits.org/galleries/technology-gallery/observing-the-sea-floor/echosounder/.

(DOSITS, No Date-b). Discovery of Sound in the Sea. No Date. Introduction to Decibels. Accessed May 2023 at: https://dosits.org/science/advanced-topics/introduction-to-decibels/.

(DOSITS, No Date-c). Discovery of Sound in the Sea. No Date. How fast does sound travel? Accessed May 2023 at: https://dosits.org/science/movement/how-fast-does-sound-travel/.

(DOSITS, No Date-d). Discovery of Sounds in the Sea. No Date. How does shipping affect ocean sound levels? Accessed May 2023 at: https://dosits.org/science/sounds-in-the-sea/how-does-shipping-affect-ocean-sound-levels/.

(DOSITS, No Date-e). Discovery of Sound in the Sea. No Date. Discovery of Sound in the Sea. Accessed May 2023 at: https://dosits.org.

(Dulvy et al., 2003). Dulvy, N.K., Y. Sadovy, and J.D Reynolds. 2003. Extinction vulnerability in marine populations. Fish and Fisheries, 4(1), 25-64. Available online at: https://doi.org/10.1046/j.1467-2979.2003.00105.x.

(Duncan et al., 2017). Duncan, E.M., Z.L.R. Botterell, A.C. Broderick, T.S. Galloway, P.K. Lindeque, A. Nuno, and B.J. Godley. 2017. A global review of marine turtle entanglement in anthropogenic debris: A baseline for further action. Endangered Species Research 34:431–448. Available online at: https://doi.og/10.3354/esr00865.

(Dunn, 2016). Dunn, T. 2016. This thousands-year-old Alaskan whaling ritual still exists…but maybe not much longer. Accessed May 2023 at: https://www.upworthy.com/this-thousands-year-old-alaskan-whaling-ritual-still-exists-but-maybe-not-much-longer.

(Durant et al., 2003). Durant, J. M., T. Anker-Nilssen, and N.C. Stenseth. 2003. Trophic interaction under climate fluctuations: The Atlantic puffin as an example. Proceedings of the Royal Society of London, 270(B)(1), 461–466. Available online at: https://doi.org/10.1098/rspb.2003.2397.

(eCFR, 2023). Electronic Code of Federal Regulations. 2023. 29 CFR 1910.95 Occupational noise exposure. Accessed May 2023 at: https://www.ecfr.gov/current/title-29/subtitle-B/chapter-XVII/part-1910/subpart-G/section-1910.95.

(ECOS, No Date-a). Environmental Conservation Online System, United States Fish and Wildlife Service. No Date. Generate Species List. Accessed May 2023 at: https://ecos.fws.gov/ecp0/reports/ad-hoc-species-report-input.

(ECOS, No Date-b). Environmental Conservation Online System, U.S. Fish and Wildlife Service. No Date. USFWS Threatened & Endangered Species Active Critical Habitat Report. Accessed May 2023 at: https://ecos.fws.gov/ecp/report/table/critical-habitat.html.

(EEA, 2023). European Environmental Agency. 2022. Carbon stocks and sequestration in terrestrial and marine ecosystems: a lever for nature restoration? Accessed online on May 2023 at: https://www.eea.europa.eu/publications/carbon-stocks-and-sequestration-rates.

(EIA, 2022a). U.S. Energy Information Administration. 2022. Gulf of Mexico Fact Sheet. Accessed May 2023 at: https://www.eia.gov/special/gulf_of_mexico/.

(EIA, 2022b). US Energy Information Administration. 2022. Natural Gas Explained: Liquefied natural gas. Accessed May 2023 at: https://www.eia.gov/energyexplained/natural-gas/liquefied-natural-gas.php.

(EIA, 2023a). U.S. Energy Information Administration. 2023. Data 1: Federal Offshore – Gulf of Mexico Field Production of Crude Oil (Thousand Barrels per Day). Accessed May 2023 at: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=mcrfp3fm2&f=a.

(EIA, 2023b). U.S. Energy Information Administration. 2023. Data 1: Federal Offshore – Gulf of Mexico Dry Natural Gas Production (Million Cubic Feet). Accessed May 2023 at: https://www.eia.gov/dnav/ng/hist/na1160_r3fm_2a.htm.

(Ellison et al., 2012). Ellison, W.T., B.L. Southall, C.W. Clark, and A.S. Frankel. 2012. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. Conservation Biology, 26(1), 21-28. Available online at: https://doi.org/10.1111/j.1523-1739.2011.01803.x.

(EPA, 1981). U.S. Environmental Protection Agency. 1981. Noise Effects Handbook: A Desk Reference to Health and Welfare Effects of Noise. Accessed May 2023 at: https://www.nonoise.org/library/handbook/handbook.htm.

(EPA, 2001). United States Environmental Protection Agency. 2001. Guidance for the EPA Halon Emission Reduction Rule (40 CFR Part 82, Subpart H). Available online at: https://www.epa.gov/sites/default/files/2015-07/documents/guidance_for_halon_emissions_reduction_rule_40_cfr_part_82_subpart_h.pdf.

(EPA, 2008). United States Environmental Protection Agency. 2008. Cruise Ship Discharge Assessment Report, Section 6: Hazardous Waste. Available online at: https://archive.epa.gov/water/test/web/pdf/2009_01_28_oceans_cruise_ships_section6_hazardouswaste.pdf.

(EPA, 2009). United States Environmental Protection Agency, Office of Transportation and Air Quality. 2009. Frequently Asked Questions About How to Obtain an Engine International Air Pollution

Prevention (EIAPP) Certificate. Available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100F3YM.PDF?Dockey=P100F3YM.PDF.

(EPA, 2010). United States Environmental Protection Agency, Office of Transportation and Air Quality. 2010. Regulatory Announcement: Designation of North American Emission Control Area to Reduce Emissions from Ships. Available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100AU0I.PDF?Dockey=P100AU0I.PDF.

(EPA, 2012). United States Environmental Protection Agency. 2012. National Coastal Condition Report IV. EPA-842-R 10-003. Office of Research and Development/Office of Water. Washington, DC 20460. Available online at: https://www.epa.gov/sites/default/files/2014-10/documents/0_nccr_4_report_508_bookmarks.pdf.

(EPA, 2012). Environmental Protection Agency. 2012. Toluene. Available online at: https://www.epa.gov/sites/default/files/2016-09/documents/toluene.pdf.

(EPA, 2020). United States Environmental Protection Agency. 2020. Our Nation's Air: Trends Through 2020. Accessed on May 2023 at: https://gispub.epa.gov/air/trendsreport/2021/#home.

(EPA, 2022a). United States Environmental Protection Agency. 2022. MARPOL Annex VI and the Act to Prevent Pollution from Ships (APPS). Accessed May 2023 at: https://www.epa.gov/enforcement/marpol-annex-vi-and-act-prevent-pollution-ships-apps.

(EPA, 2022b). United States Environmental Protection Agency. 2022. Choosing and Using a Retrofit Refrigerant for a CFC-12 MVAC. Accessed March 22, 2022 at: https://www.epa.gov/mvac/choosing-and-using-retrofit-refrigerant-cfc-12-mvac.

(EPA, 2022c). U.S. Environmental Protection Agency. 2022. National Aquatic Resource Surveys: Indicators: Benthic Macroinvertebrates. Accessed May 2023 at: https://www.epa.gov/national-aquatic-resource-surveys/indicators-benthic-macroinvertebrates.

(EPA, 2022d). United States Environmental Protection Agency. 2022. Learn the Basics of Hazardous Waste. Accessed May 2023 at: https://www.epa.gov/hw/learn-basics-hazardous-waste.

(EPA, 2022e). United States Environmental Protection Agency. 2022. Special Wastes. Accessed May 2023 at: https://www.epa.gov/hw/special-wastes.

(EPA, 2022f). Environmental Protection Agency. 2022. Health and Environmental Effects of Particulate Matter. Accessed May 2023 at: https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm.

(EPA, 2023a). United States Environmental Protection Agency. 2023. NAAQS Table. Accessed on May 2023 at: https://www.epa.gov/criteria-air-pollutants/naaqs-table.

(EPA, 2023b). United States Environmental Protection Agency. 2023. About Diesel Fuels. Accessed May 2023 at: https://www.epa.gov/diesel-fuel-standards/about-diesel-fuels.

(EPA, 2023c). United States Environmental Protection Agency. 2023. Learn about Dioxin. Accessed May 2023 at: https://www.epa.gov/dioxin/learn-about-dioxin.

(EPA, 2023d). United States Environmental Protection Agency. 2023. Overview of Greenhouse Gases. Accessed May 2023 at: https://www.epa.gov/ghgemissions/overview-greenhouse-gases.

(EPA, 2023e). United States Environmental Protection Agency. 2023. Vessel Sewage Discharges: Statutes, Regulations, and Related Laws and Treaties. Accessed May 2023 at: www.epa.gov/vessels-marinas-and-ports/vessel-sewage-discharges-statutes-regulations-and-related-laws-and.

(EPA, 2023f). United States Environmental Protection Agency. 2023. Vessels – VGP. Accessed May 2023 at: https://www.epa.gov/vessels-marinas-and-ports/vessels-vgp#.

(EPA, 2023g). United States Environmental Protection Agency. 2023. Overview of the Asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP). Accessed May 2023 at: https://www.epa.gov/asbestos/overview-asbestos-national-emission-standards-hazardous-air-pollutants-neshap.

(EPA, 2023h). United States Environmental Protection Agency. 2023. Hazardous Waste Transportation. Accessed May 2023 at: https://www.epa.gov/hw/hazardous-waste-transportation.

(EPA, 2023i). United States Environmental Protection Agency. 2023. Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2021. EPA-430-R-23-002. Accessed May 2023 at: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021.

(Erbe, 2013). Erbe, C. 2013. Underwater Noise of Small Personal Watercraft (Jet Skis). The Journal of the Acoustical Society of America. 133, no. 4: EL326–30. Available online at: https://doi.org/10.1121/1.4795220.

(Erbe et al., 2019). Erbe, C., S.A. Marley, R.P. Schoeman, J.N. Smith, L.E. Trigg, and C.B. Embling. 2019. The Effects of Ship Noise on Marine Mammals—A Review. Frontiers in Marine Science. 6. Available online at: https://doi.org/10.3389/fmars.2019.00606.

(Esslinger et al., 2014). Esslinger, G.G., J.L. Bodkin, A.R. Breton, J.M. Burns, and D.H. Monson. 2014. Temporal patterns in the foraging behavior of sea otters in Alaska. Journal of Wildlife Management, 78(4), 689-700. Available online at: https://doi.org/10.1002/jwmg.701.

(EWC, 2018). Eskimo Walrus Commission. 2018. Eskimo Walrus Commission. Accessed May 2023 at: https://kawerak.org/natural-resources/eskimo-walrus-commission/.

(Fall and Chythlook, 2010). Fall, J.A. and M.B. Chythlook. Cultural Survival. 2010. The Round Island Walrus Hunt: Reviving a Cultural tradition. Available online at: https://www.culturalsurvival.org/publications/cultural-survival-quarterly/round-island-walrus-hunt-reviving-cultural-tradition.

(Ferguson et al., 2015). Ferguson, M.C., C. Curtice, J. Harrison, and S.M. Van Parijs. 2015. Biologically Important Areas for Cetaceans Within U.S. Waters – Overview and Rationale. Aquatic Mammals 41(1), 2-16. Available online at: DOI: 10.1578/AM.41.1.2015.2.

(FHA, 2017). Federal Highway Administration. 2017. Noise Barrier Design Handbook. Accessed May 2023 at: https://www.fhwa.dot.gov/Environment/noise/noise_barriers/design_construction/design/design03.cfm.

(Finneran et al., 2017). Finneran, J.J., E.E. Henderson, D. Houser, K. Jenkins, S. Kotecki, and J. Mulsow. 2017. Technical Report: Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Department of the Navy. SSC Pacific, San Diego, California. 194 p. Available online at: http://www.chamorro.com/docs/Criteria_and_Thresholds_for_U.S._Navy_Acoustic_and_Explosive_Effects_Analysis_June2017.pdf.

(Fischer, 2010). Fischer, R. 2010. Acoustic Design, Construction and Testing of NOAA's Fisheries Research Vessels. Accessed May 2023 at: https://www.researchgate.net/publication/236134216_Acoustic_Design_Construction_and_Testing_of_NOAA's_Fisheries_Research_Vessels.

(Foster, 2023). Foster, J.W. 2019. California's Ancient Maritime Heritage. Accessed May 2023 at: https://www.parks.ca.gov/?page_id=23712

(Francis and Barber, 2013). Francis, C.D. and J.R. Barber. 2013. A framework for understanding noise impacts on wildlife: An urgent conservation priority. Front. Ecol. Environ. 11(6):305–313. Available online at: https://doi.org/10.1890/120183.

(Friedman, 2017). Friedman, B. 2017. Optimizing Compliance with NOAA's Trust Resource Statutes. Memorandum. August 30, 2017.

(FSB, 2021). Federal Subsistence Board. 2017. Federal Subsistence Management Regulations for the Harvest of Fish and Shellfish on Federal Public Lands and Waters in Alaska. Available online at: https://www.doi.gov/sites/doi.gov/files/2021-2023-fisheries-regulations-book-web-reduced.pdf.

(Gaffield et al., 2003). Gaffield, S.J., R.L. Goo, L.A. Richards, and R.J. Jackson. 2003. Public health effects of inadequately managed stormwater runoff. American Journal of Public Health, 93(9), 1527–1533. Available online at: https://doi.org/10.2105/ajph.93.9.1527.

(Gaufin and Tarzwell, 1952). Gaufin, A.R. and C.M. Tarzwell. 1952. Aquatic Invertebrates as Indicators of Stream Pollution. Public Health Reports. Vol. 67, No. 1, January. Available online at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2030707/pdf/pubhealthreporig01073-0095.pdf.

(Gerstein, 2002). Gerstein, E.R. 2002. Manatees, bioacoustics and boats: hearing tests, environmental measurements and acoustic phenomena may together explain why boats and animals collide. American Scientist, 90(2), 154-163. Accessed May 2023 at: https://go.gale.com/ps/anonymous?id=GALE%7CA83241185&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=00030996&p=AONE&sw=w.

(GESAMP, 2007). Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. 2007. Estimates of Oil Entering the Marine Environment from Sea-Based Activities. Available online at: https://wedocs.unep.org/bitstream/handle/20.500.11822/12477/gesamp_rs75e.pdf?sequence=1&isAllowed=y.

(Ghoul and Reichmuth, 2014). Ghoul, A. and C. Reichmuth. 2014. Hearing in the sea otter (Enhydra lutris): auditory profiles for an amphibious marine carnivore. J Comp Physiol A Neuroethol Sens Neural Behav Physiol, 200(11), 967–981. Available online at: https://doi.org/10.1007/s00359-014-0943-x.

(GLFHT, No Date). Great Lakes Fisheries Heritage Trail. No Date. Chippewa Ottawa Resource Authority (CORA). Accessed May 2023 at: http://www.greatlakesfisheriestrail.org/organization.asp?ait=ov&oid=7.

(GLIFWC, No Date). Great Lakes Indian Fish & Wildlife Commission. No Date. Boozhoo. Accessed May 2023 at: https://glifwc.org/.

(GPS.GOV, 2021). GPS.GOV. 2021. Marine. Accessed May 2023 at: https://www.gps.gov/applications/marine/.

(Gregory, 2009). Gregory, M.R. July 2009. Environmental implications of plastic debris in marine settings – entanglements, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. Available online at: https://doi.org/10.1098/rstb.2008.0265.

(Guam SHPO, 2007). Guam State Historic Preservation Office. 2007. Na' Nina' etnunen Linahyan Ni' Manmaloffan Connecting the Community to the Past: A Comprehensive Historic Preservation Plan for Guam 2007–2011. Available online at: http://guampreservationtrust.org/wp-content/uploads/Guam-Historic-Preservation-Plan-Current.pdf.

(Gulf Council, 2023). Gulf of Mexico Fishery Management Council. 2023. Implemented Fishery Management Plans. Available online at: http://gulfcouncil.org/fishery-management/implemented-plans/.

(Halvorsen et al., 2012). Halvorsen, M.B., B.M. Casper, F. Matthews, T.J. Carlson, and A.N. Popper. 2012. Effects of exposure to pile-driving sounds on the lake sturgeon, Nile tilapia and hogchoker. Proceedings of the Royal Society B: Biological Sciences, 279(1748), 4705–4714. Available online at: https://doi.org/10.1098/rspb.2012.1544.

(Hammer et al., 2014). Hammer, M.S., T.K. Swinburn, and R.L. Neitzel. 2014. Environmental Noise Pollution in the United States: Developing an Effective Public Health Response. Environmental Health Perspectives, 122(2). Available online at: http://dx.doi.org/10.1289/ehp.1307272.

(Hardt and Safina, 2008). Hardt, M. and C. Safina. 2008. Covering Ocean Acidification: Chemistry and Considerations. Yale Climate Connections. Accessed May 2023 at: https://www.yaleclimateconnections.org/2008/06/covering-ocean-acidification-chemistry-and-considerations/.

(Hastings and Popper, 2005). Hastings, M.C. and A.N. Popper. 2005. Effects of Sound on Fish. Sacramento, CA: California Department of Transportation. Available online at: https://www.nrc.gov/docs/ML1434/ML14345A573.pdf.

(Haver et al., 2018). Haver, S.M., J. Gedamke, L.T. Hatch, R.P. Dziak, S. Van Parijs, M.F. McKenna, J. Barlow, C. Berchok, E. DiDonato, B. Hanson, J. Haxel, M. Holt, D. Lipski, H. Matsumoto, C. Meinig, D.K. Mellinger, S.E. Moore, E.M. Oleson, M.S. Soldevilla, and H. Klinc. 2018. Monitoring long-term soundscape trends in U.S. Waters: The NOAA/NPS Ocean Noise Reference Station Network. Available online at: https://doi.org/10.1016/j.marpol.2018.01.023.

(Hawkins et al., 2015). Hawkins, A.D., A.E. Pembroke, and A.N. Popper. 2015. Information gaps in understanding the effects of noise on fishes and invertebrates. Reviews in Fish Biology and Fisheries, 25:39–64. Available online at: https://doi.org/10.1007/s11160-014-9369-3.

(Hazel et al., 2007). Hazel, J., I.R. Lawler, H. Marsh, and S. Robson. 2007. Vessel speed increases collision risk for the green turtle Chelonia mydas. Endangered Species Research 3:105–113. Available online at: https://www.int-res.com/articles/esr2007/3/n003p105.pdf.

(Heinz Center, 2000). The H. John Heinz III Center for Science, Economics, and the Environment. 2000. Evaluation of Erosion Hazards. Available online at: https://www.fema.gov/pdf/library/erosion.pdf.

(Heller, 2023). Heller, L. 2023. Effects of invasive species on water quality in freshwater ecosystems. Soka University. Accessed May 2023 at: https://www.soka.edu/student-life/20th-anniversary-anthology/creative-coexistence-nature-humanity/effects-invasive#:~:text=Invasive%20or%20non%2Dnative%20species,erosion%20leading%20to%20hyper%2Deutrophication.

(Henry et al., 2020). Henry, A.G, M. Garron, D. Morin, A. Reid, W. Ledwell, W., and T.V.N. Cole. 2020. Serious Injury and Mortality Determinations for Baleen Whale Stocks along the Gulf of Mexico, United States East Coast, and Atlantic Canadian Provinces, 2013-2017. Northeast Fisheries Science Center, Reference Document 20-06; 53 p. Available online at: http://marineanimals.ca/wp-content/uploads/2020/07/Henry.-2020.-Serious-Injury-and-Mortality-Determinations-for-Baleen-

Whale-Stocks-along-the-Gulf-of-Mexico-United-States-East-Coast-and-Atlantic-Canadian-Provinces-2013-2017.pdf.

(Henry, 2022). Henry, A. 2022. Serious Injury and Mortality Determinations for Baleen Whale Stocks along the Gulf of Mexico, United States East Coast, and Atlantic Canadian Provinces, 2015-2019. NOAA Technical Memorandum NMFS-NE-280. Available online at: https://repository.library.noaa.gov/view/noaa/38941.

(Hetherington, 2008). Hetherington T. Comparative Anatomy and Function of Hearing in Aquatic Amphibians, Reptiles, and Birds. In: Sensory Evolution on the Threshold: Adaptations in Secondarily Aquatic Vertebrates. Eds. Thewissen, J.G.N. and S. Nummela. Available online at: https://www.google.com/books/edition/Sensory_Evolution_on_the_Threshold/dt0dhi5qB4YC?hl=en&gbpv=1&dq=hetheringto+n+2008+bird+hearing&pg=PA183&printsec=frontcover#v=onepage&q=hetherington%202008%20bird%20hearing&f=false.

(Hildebrand, No Date). Hildebrand, J. No Date. Sources of Anthropogenic Sound in the Marine Environment. Available online at: https://www.mmc.gov/wp-content/uploads/hildebrand.pdf.

(Hitt et al., 2015). Hitt, N.P, L.K. Bonneau, K.V. Jayachandran, and M.P. Marchetti. 2015. Freshwater Ecosystems and Biodiversity. Lessons in Conservation, the official journal of the Network of Conservation Educators and Practitioners. Available online at: https://www.amnh.org/content/download/141379/2285479/file/LinC5_Freshwater.pdf.

(Hoegh-Guldberg and Bruno, 2010). Hoegh-Guldberg, O. and J.F. Bruno. 2010. The impact of climate change on the world's marine ecosystems. Science 328(5985):1523-8. Available online at: https://doi.org/10.1126/science.1189930.

(Hooker et al., 2001). Hooker, S.K., R.W. Baird, S. Al-Omari, S. Gowans, and H. Whitehead. 2001. Behavioural reactions of northern bottlenose whales (*Hyperoodon ampullatus*) to biopsy darting and tag attachment procedures. Fishery Bulletin 99:303-308. Available online at: https://www.researchgate.net/publication/289221375_Behavioral_reactions_of_northern_bottlenose_whales_Hyperoodon_ampullatus_to_biopsy_darting_and_tag_attachment_procedures.

(Hörteborn et al., 2019). Hörteborn, A., J. Ringsberg, M. Svanberg, and H. Holm. 2019. A Revisit of the Definition of the Ship Domain based on AIS Analysis. Journal of Navigation, 72(3), 777-794. https://doi.org/10.1017/S0373463318000978.

(Hyrenbach, 2002). Hyrenbach, K.D, A. Fernandez, and D.J. Anderson. 2002. Oceanographic habitats of two sympatric North Pacific albatrosses during the breeding season. Marine Ecology Progress Series. Vol.233: 283 – 301. Available online at: https://www.int-res.com/articles/meps2002/233/m233p283.pdf.

(ICES, 1995) ICES. 1995. Underwater noise of research vessels: review and recommendations. ICES Cooperative Research Report No. 209. pp. 61. Available online at: https://doi.org/10.17895/ices.pub.5317.

(IMC, 2018). Invasive Mussel Collaborative. November 2018. Strategy to Advance Management of Invasive Zebra and Quagga Mussels. Available online at: https://invasivemusselcollaborative.net/wp-content/uploads/2018/11/IMC-Strategy-Nov-2018-final.pdf.

(IMO, 2014). International Maritime Organizations. 2014. Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life. Available online at: https://www.nrdc.org/sites/default/files/wat_14050501a.pdf.

(IMO, No Date). International Maritime Organization. No Date. IMO 2020 – cutting sulphur oxide emissions. Accessed May 2023 at: https://www.imo.org/en/MediaCentre/HotTopics/Pages/Sulphur-2020.aspx.

(International Chamber of Shipping, No Date). International Chamber of Shipping. No Date. Tankers. Accessed May 2023 at: https://www.ics-shipping.org/explaining/ships-ops/tankers/.

(IPCC, 2021). Intergovernmental Panel on Climate Change. 2021. Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Available online at: https://www.ipcc.ch/report/ar6/wg1/.

(IPCC, 2022). Intergovernmental Panel on Climate Change. 2022. Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Available online at: https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/.

(IPHC, 2017). International Pacific Halibut Commission. 2017. Subsistence Fisheries. Accessed May 2023 at: https://iphc.int/management/fisheries/subsistence-fisheries.

(ISC, 2019). Ice Seal Committee. May 2019. The Subsistence Harvest of Ice Seals in Alaska – a Compilation of Existing Information, 1960-2017. Available online at: http://www.adfg.alaska.gov/static/research/programs/marinemammals/pdfs/ice_seal_comm_2019_compilation_subs_harvet_report.pdf.

(IWC, 2023). International Whaling Commission. 2023. Description of the USA Aboriginal Subsistence Hunt: Alaska. Accessed May 2023 at: https://iwc.int/alaska.

(IWC, No Date). International Whaling Commission. No Date. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2016. Available online at: https://www.north-slope.org/wp-content/uploads/2022/03/SC_67A_AWMP_02_rev1_2016_bowhead_harvest.pdf.

(Jackson et al., 2001). Jackson, J.B.C., M.X. Kirby, W.H. Berger, K.A. Bjorndal, L.W. Botsford, B. Bourque, and R.R. Warner. 2001. Historical Overfishing and the Recent Collapse of Coastal Ecosystems. Science, New Series, Vol. 293, No. 5530, pp. 629-638. Available online at: http://www.jstor.org/stable/3084305.

(Jones, 2001). Jones, I. L. 2001. Auks. In C. Elphick, J. B. Dunning, Jr., and D. A. Sibley (Eds.), The Sibley Guide to Bird Life and Behavior (pp. 309–318). New York, NY: Alfred A. Knopf, Inc.

(Jørgensen et al., 2004). Jørgensen, R., N.O. Handegard, H. Gjøsæter, and A. Slotte. 2004. Possible vessel avoidance behaviour of capelin in a feeding area and on a spawning ground. Fisheries Research, 69(2), 251-261. Available online at: https://doi.org/10.1016/j.fishres.2004.04.012.

(Kane et al., 2010). Kane, A.S., J. Song, M.B. Halvorsen, D.L. Miller, J.D. Salierno, L.E. Wysocki, D. Zeddies, and A.N. Popper. 2010. Exposure of fish to high intensity sonar does not induce acute pathology. Journal of Fish Biology, 76(7), 1825–1840. Available online at: https://doi.org/10.1111/j.1095-8649.2010.02626.x.

(Kappel, 2005). Kappel, C.V. 2005. Losing pieces of the puzzle; threats to marine, estuarine, and diadromous species. Frontiers in Ecology and the Environment, 3(5), 275-282. Available online at: https://doi.org/10.1890/1540-9295(2005)003[0275:LPOTPT]2.0.CO;2.

(Kawerak Inc., 2013). Kawerak, Inc. 2013. Seal and Walrus Harvest and Habitat Areas for Nine Bering Strait Region Communities. Available online at: https://eskimowalruscommission.org/wp-content/uploads/2016/01/Seal-and-Walrus-Harvest-and-Habitat-Areas.pdf.

(Ketten, 2000). Ketten, D.R. 2000. Cetacean ears. In: Au, W.W.L., A.N. Popper, and R.R. Fay, eds. Hearing by whales and dolphins. New York, NY: Springer. Pp. 43-108. Available online at: https://link.springer.com/chapter/10.1007/978-1-4612-1150-1_2.

(Laidre et al., 2009). Laidre, K.L., R.J. Jameson, E. Gurarie, S.J. Jeffries, and H. Allen. 2009. Spatial Habitat Use Patterns of Sea Otters in Coastal Washington. Journal of Mammalogy, 90(4):906–917. Available online at: http://www.otterproject.org/wp-content/uploads/2012/05/Laidre_etal_2009_Spatial_habitat_use_patterns_of_sea_otters_in_coastal_WA.pdf.

(Laist, 1997). Laist, D. 1997. Impacts of marine debris: Entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. In: Coe, J.M. and D.B. Rogers, eds. Marine debris: Sources, impacts, and solutions. Springer, New York. 99-139p. Available online at: https://doi.org/10.1007/978-1-4613-8486-1_10.

(Lehigh University, No Date). Lehigh University, EnviroSci Inquiry. No Date. The environmental effects of dumping raw sewage. Accessed May 2023 at: https://ei.lehigh.edu/envirosci/enviroissue/lawsregs/sewage.htm.

(Lenhardt, 1994). Lenhardt, M. L. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*). Southeast Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SEFSC-351, Miami, Florida. Available online at: http://seaturtle.org/library/LenhardtML_1994_InProceedingsoftheFourteenthAnnualSym_p238-241.pdf.

(Liberman, 2016). Liberman, M. C. 2016. Noise-induced hearing loss: Permanent versus temporary threshold shifts and the effects of hair cell versus neuronal degeneration. Advances in Experimental Medicine and Biology, 875, 1–7. Available online at: https://doi.org/10.1007/978-1-4939-2981-8_1.

(Limburg and Waldman, 2009). Limburg, K.E. and J.R Waldman. 2009. Dramatic declines in North Atlantic diadromous fishes. BioScience, 59(11), 955-965. Available online at: https://doi.org/10.1525/bio.2009.59.11.7.

(Limpinsel et al., 2017). Limpinsel, D.E., M.P. Eagleton, and J.L Hanson. 2017. Impacts to Essential Fish Habitat from Non-Fishing Activities in Alaska. EFH 5 Year Review: 2010 through 2015. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-F/AKR-14, 229p. Available online at: https://repository.library.noaa.gov/view/noaa/17256.

(Lin, 2002). Lin, J. 2002. Animal diversity web: *Alca torda*. Accessed May 2023 at: https://animaldiversity.org/accounts/Alca_torda/.

(Lombarte et al., 1993). Lombarte, A., H.Y. Yan, A.N. Popper, J.C. Chang, and C. Platt. 1993. Damage and regeneration of hair cell ciliary bundles in a fish ear following treatment with gentamicin. Hearing Research, 66, 166–174. Available online at: https://doi.org/10.1016/0378-5955(93)90002-i.

(MAFMC, 2023). Mid-Atlantic Fishery Management Council. 2023. Fishery Management Plans and Amendments. Available online at: http://www.mafmc.org/fishery-management-plans.

(Malins and Hodgins, 1981). Malins, D.C. and H.O. Hodgins. 1981. Petroleum and Marine Fishes: A Review of Uptake, Disposition, and Effects. Environmental Science and Technology, 15(11):1272-1280. Available online at: https://doi.org/10.1021/es00093a001.

(Mann et al., 1997). Mann D.A, Z. Lu, and A.N. Popper. 1997. A clupeid fish can detect ultrasound. Nature 389(6649):341. Available online at: https://doi.org/10.1038/38636.

(Mann et al., 2001). Mann, D.A., D.M. Higgs, W.N. Tavolga, M.J. Souza, and A.N. Popper. 2001. Ultrasound detection by clupeiforme fishes. Journal of the Acoustical Society of America 109:3048-3054. Available online at: https://doi.org/10.1121/1.1368406.

(Mann, 2016). Mann, D. A. 2016. Acoustic Communications in Fishes and Potential Effects of Noise. In A. N. Popper and A. D. Hawkins (Eds.), The Effects of Noise on Aquatic Life II, pp. 673–678. New York, NY: Springer. Available online at: https://doi.org/10.1007/978-1-4939-2981-8_81.

(MARAD, 2021). U.S. Maritime Administration. 2021. Deepwater Ports Map. Accessed May 2023 at: https://www.maritime.dot.gov/ports/deepwater-ports-and-licensing/deepwater-ports-map.

(Marine Insight, 2021a). Marine Insight. 2021. Marine Radars and Their Use in the Shipping Industry. Accessed May 2023 at: https://www.marineinsight.com/marine-navigation/marine-radars-and-their-use-in-the-shipping-industry/.

(Marine Insight, 2021b). Marine Insight. 2021. Gyro Compass on Ships: Construction, Working, and Usage. Accessed May 2023: https://www.marineinsight.com/marine-navigation/gyro-compass-on-ships-construction-working-and-usage/.

(Marine Insight, 2021c). Marine Insight. 2021. What is Electronic Chart Display and Information System (ECDIS)? Accessed May 2023 at: https://www.marineinsight.com/marine-navigation/what-is-electronic-chart-display-and-information-system-ecdis/.

(Marine Insight, 2022). Marine Insight. 2022. What is Automatic Identification System (AIS)- Types And Working (FAQs). Accessed May 2023 at: https://www.marineinsight.com/marine-navigation/automatic-identification-system-ais-integrating-and-identifying-marine-communication-channels/.

(MarineBio, No Date). MarineBio Conservation Society. No Date. Marine Invertebrates. Accessed May 2023 at: https://marinebio.org/creatures/marine-invertebrates/.

(McCauley et al., 2000a). McCauley R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. Curtin University of Technology, Western Australia. Available online at: https://cmst.curtin.edu.au/wp-content/uploads/sites/4/2016/05/McCauley-et-al-Seismic-effects-2000.pdf.

(McCauley et al., 2000b). McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch and K. McCabe. 2000. Marine seismic surveys – a study of environmental implications. APPEA Journal 40:692-706. Available online at: http://www.cwr.org.au/wp-content/uploads/appea2000.pdf.

(McCoy and Bregman, 2017). McCoy, M. and Bregman, L. 2017. Options for OMAO Environmental Compliance Approach. Memorandum. December 12, 2017.

(McMahan, 2007). McMahan, D.J. 2007. Management of Alaska's Submerged Cultural Resources: A Current Assessment. Alaska Journal of Anthropology vol. 5, no. 2. Available online at: http://www.alaskaanthropology.org/wp-content/uploads/2017/08/Vol_5_2-McMahan.pdf.

(MD DOE, No Date). Maryland Department of the Environment. No Date. Diesel Emissions Health and Environmental Effects. Accessed May 2023 at: https://mde.maryland.gov/programs/air/mobilesources/pages/dieselhealthandenvironmentaleffects.aspx.

(MDC, No Date). Missouri Department of Conservation. No Date. Aquatic Invertebrate Facts Overview. Accessed May 2023 at: https://education.mdc.mo.gov/discover-nature/general-species-information/aquatic-invertebrate-facts.

(Methratta et al., 2020). Methratta, E.T., A. Hawkins, B.R. Hooker, A. Lipsky, and J.A. Hare. 2020. Offshore wind development in the Northeast US Shelf Large Marine Ecosystem: Ecological, human, and fishery management dimensions. Oceanography 33(4):16–27. Available online at: https://tos.org/oceanography/assets/docs/33-4_methratta.pdf.

(Miccosukee Tribe of Indians, 2010). Miccosukee Tribe of Indians. 2010. 2010 Everglades Invasive Species Summit. Available online at: https://bugwoodcloud.org/mura/ECISMA/assets/File/summit10/11Miccosukee.pdf.

(Microwave & RF, 2017). Microwave & RF. 2017. System Combines X- and S-Band Radars. Accessed May 2023 at: https://www.mwrf.com/technologies/systems/article/21847059/system-combines-x-and-sband-radars.

(Milton et al., 2003). Milton, S., P. Lutz, and G. Shigenaka. 2003. Oil toxicity and impact on sea turtles. In: Oil and sea turtles: Biology, planning, and response. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration. Available online at: https://www.reefrelief.org/wp-content/uploads/oil-turtle1.pdf.

(Misund, 1997). Misund, O.A. 1997. Underwater acoustics in marine fisheries and fisheries research. Reviews in Fish Biology and Fisheries, 7, 1-34. Available online at: https://doi.org/10.1023/A:1018476523423.

(MMS, 2002a). Minerals Management Service. 2002. Outer Continental Shelf Oil & Gas Leasing Program: 2002-2007. Final Environmental Impact Statement. Available online at: https://www.boem.gov/sites/default/files/oil-and-gas-energy-program/Leasing/Five-Year-Program/FEISVol1.pdf.

(MMS, 2002b). Minerals Management Service, U.S. Department of the Interior. 2002. Programmatic Environmental Assessment for Grid 15. Available online at: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Assessment/NEPA/grid15ea.pdf.

(MMS, 2007). Minerals Management Service, U.S. Department of the Interior. May 2007. Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea Final Environmental Impact Statement. Available online at: https://www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/2007-026-Vol%20I.pdf.

(MMS, 2010). Minerals Management Service. 2010. Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow. Available online at: http://www.north-slope.org/assets/images/uploads/Braund%202010%20Beaufort%20maps%20MMS_MP_Final_Report_Apr2010.pdf.

(Mooney et al., 2010). Mooney, T.A. Mooney, R.T. Hanlon, J. Christensen-Dalsgaard, P. T. Madsen, D.R. Ketten, and P.E. Nachtigall. 2010. Sound detection by the longfin squid (*Loligo pealeii*) studied with auditory evoked potentials: Sensitivity to low-frequency particle motion and not pressure. The Journal of Experimental Biology 213, 3748-3759. Available online at: https://doi.org/10.1242/jeb.048348.

(Moore, 2008). Moore, C.J. 2008. Synthetic polymers in the marine environment: A rapidly increasing, long-term threat. Environmental Research, 108(2), 131-139. Available online at: https://doi.org/10.1016/j.envres.2008.07.025.

(MPA Federal Advisory Committee, No Date). Marine Protected Areas Federal Advisory Committee. No Date. Legal Authorities. Accessed May 2023 at: https://marineprotectedareas.noaa.gov/toolkit/legal.html.

(Musial et al., 2023). Musial W., P. Spitsen, P. Duffy, P. Beiter, M. Shields, D.M. Hernando, R. Hammond, M. Marquis, J. King, and S. Sriharan. 2023. Offshore Wind Market Report: 2023 Edition. Department of Energy, Office of Energy Efficiency & Renewable Energy. Available online at: https://www.energy.gov/sites/default/files/2023-08/offshore-wind-market-report-2023-edition_0.pdf.

(Musick et al., 2009). Musick, J.A., M.M Harbin, S.A. Berkeley, G.H. Burgess, A.M. Eklund, L. Findley, and S.G. Wright. 2009. Marine, estuarine, and diadromous fish stocks at risk of extinction in North America (exclusive of Pacific salmonids). American Fisheries Society, 25(11), 6-30. Available online at: https://doi.org/10.1577/1548-8446(2000)025<0006:MEADFS>2.0.CO;2.

(Myers and Worm, 2003). Myers, R.A. and B. Worm. 2003. Rapid worldwide depletion of predatory fish communities. Nature, 423, 280–283. Available online at: https://doi.org/10.1038/nature01610.

(Nachtigall et al., 2007). Nachtigall, P.E., A.Y. Supin, M. Amundin, B. Roken, T. Moller, T.A. Mooney, K.A. Taylor, and M. Yuen. Polar bear *Ursus maritimus* hearing measured with auditory evoked potentials. The Journal of Experimental Biology. 210: 1116-1122. Available online at: https://doi.org/10.1242/jeb.02734.

(NAP, 2010). National Academies Press. 2010. Overview of Ecosystem Services Provided by Bivalve Molluscs. In: Ecosystem Concepts for Sustainable Bivalve Mariculture. Available online at: https://www.nap.edu/read/12802/chapter/9.

(National Academies, 1996). National Academies of Sciences, Engineering, and Medicine. 1996. Shipboard Pollution Control: U.S. Navy Compliance with MARPOL Annex V. Washington, DC: The National Academies Press. Available online at: https://doi.org/10.17226/9190.

(Naval History and Heritage Command, No Date). Naval History and Heritage Command. No Date. US Ship Force Levels 1886 – present. Accessed May 2023 at: https://www.history.navy.mil/research/histories/ship-histories/us-ship-force-levels.html#2000.

(Naval Vessel Register, No Date). Naval Vessel Register. No Date. Ship Battle Forces. Accessed December 23, 2021 at: https://www.nvr.navy.mil/NVRSHIPS/SHIPBATTLEFORCE.HTML.

(Navy, 2017). U.S. Department of the Navy. 2017. Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Space and Naval Warfare Systems Command, U.S Navy, Department of Defense, San Diego, California. Available online at:

https://www.nwtteis.com/portals/nwtteis/files/technical_reports/Criteria_and_Thresholds_for_U.S._Navy_Acoustic_and_Explosive_Effects_Analysis_June2017.pdf.

(Navy, 2018). U.S. Department of the Navy. 2018. Hawaii-Southern California Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement. Available online at: https://www.hstteis.com/Documents/2018-Hawaii-Southern-California-Training-and-Testing-Final-EIS-OEIS/Final-EIS-OEIS.

(NCEI, 2022). NOAA National Centers for Environmental Information. 2022. State of the Climate: Monthly Global Climate Report for Annual 2021. Accessed May 2023 at: https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202113.

(Neenan et al., 2016). Neenan, S.T.V., R. Piper, P.R. White, P. Kemp, T.G. Leighton, and P.J. Shaw. 2016. Does Masking Matter? Shipping Noise and Fish Vocalizations. In A.N. Popper and A.D. Hawkins (Eds.), The Effects of Noise on Aquatic Life II (pp. 747–754). New York, NY: Springer. Available online at: https://doi.org/10.1007/978-1-4939-2981-8_91.

(Neff et al., 2000). Neff, J.M., S. Ostazeski, W. Gardiner, and I. Stejskal. 2000. Effects of weathering on the toxicity of three offshore Australian crude oils and a diesel fuel to marine animals. Environ. Toxicol. 19: 1809-21. Available online at: https://doi.org/10.1002/etc.5620190715.

(NEFMC, 2016). New England Fishery Management Council. 2016. Omnibus Essential Fish Habitat Amendment 2 Volume 2: EFH and HAPC Designation Alternatives and Environmental Impacts. Amendment 14 to the Northeast Multispecies FMP, Amendment 14 to the Atlantic Sea Scallop FMP, Amendment 4 to the Monkfish FMP, Amendment 3 to the Atlantic Herring FMP, Amendment 2 to the Red Crab FMP, Amendment 2 to the Skate FMP, Amendment 3 to the Atlantic Salmon FMP, Including a Final Environmental Impact Statement. Available online at: https://s3.amazonaws.com/nefmc.org/OA2-FEIS_Vol_2_FINAL_171025.pdf.

(NEFMC, 2018). New England Fishery Management Council. 2018. Framework Adjustment 57 To the Northeast Multispecies FMP. Available online at: https://s3.amazonaws.com/nefmc.org/180302_Groundfish_FW57__EA_formal_sub.pdf.

(NEFMC, 2023). New England Fishery Management Council. 2023. View Management Plans. Available online at: https://www.nefmc.org/.

(Nelms et al., 2016). Nelms, S.E., W.E.D. Piniak, C.R. Weir, and B.J. Godley. 2016. Seismic surveys and marine turtles: An underestimated global threat? Biological Conservation 193:49–65. Accessed February 2020 at: https://doi.org/10.1016/j.biocon.2015.10.020.

(Nelson et al., 2019) Nelson, M.A., L.T. Quakenbush, B.D. Taras, and Ice Seal Committee. 2019. Subsistence harvest of ringed, bearded, spotted, and ribbon seals in Alaska is sustainable. Endangered Species Research Volume 40: 1-16. Available online at: https://doi.org/10.3354/esr00973.

(Nelson, 2016). Nelson, J.S. 2016. The Fishes of the World, 5th Edition. John Wiley and Sons, New York, NY. Available online at: https://www.wiley.com/en-us/Fishes+of+the+World,+5th+Edition-p-9781118342336.

(NERACOOS, No Date). Northeastern Regional Association of Coastal Ocean Observing Systems. No Date. Ocean Observing 101. Accessed May 2023 at: https://neracoos1.org/what-we-do/.

(New and Yen, 1995). New, T.R. and A.L. Yen. 1995. Ecological Importance and Invertebrate Conservation. Oryx, 29(3):187-191. Available online at: https://doi.org/10.1017/S0030605300021116.

(New Castle, 2014). Town of New Castle, New Hampshire. 2014. New Castle Town Ordinances. Available online at: https://www.newcastlenh.org/sites/g/files/vyhlif956/f/uploads/ord_0.pdf.

(Newman, 2019). Newman, M.C. 2019. Uptake, biotransformation, detoxification, elimination, and accumulation. Fundamentals of Ecotoxicology. 5th Edition. CRC Press. Available online at: https://www.taylorfrancis.com/chapters/mono/10.1201/9781351133999-3/uptake-biotransformation-detoxification-elimination-accumulation-michael-newman.

(Nguyen and Khoo, 2013). Nguyen, T. and I. Khoo. 2013. Noise Mapping of Container Terminals at the Port of Los Angeles. Available online at: https://www.metrans.org/assets/research/11-26_Nguyen-Khoo_Final_0_0.pdf.

(Nichols and Wilcox, 2004). Nichols, S. J. and D. A. Wilcox. 2004. Great Lakes Clams Find Refuge from Zebra Mussels in Restored, Lake-Connected Marsh (Ohio). Ecological Restoration. 22(1):51-52. Available online at: http://hdl.handle.net/20.500.12648/7543.

(NIOSH, 2020). The National Institute for Occupational Safety and Health. 2020. Maritime Industries: Marine Transportation. Accessed online May 2023 at: https://www.cdc.gov/niosh/maritime/industries/marine_transportation.html.

(NJDOH, 2008). New Jersey Department of Health. 2008. Hazardous Substance Fact Sheet: Lithium. Available online at: https://nj.gov/health/eoh/rtkweb/documents/fs/1119.pdf.

(NLA, No Date). Native Languages of the Americas. No Date. Native American Halibut Mythology. Accessed May 2023 at: http://www.native-languages.org/legends-halibut.htm.

(NMFS, 2015a). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2015. Our Living Oceans: Habitat. Status of the habitat of U.S. living marine resources. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-F/SPO-75. Available online at: https://spo.nmfs.noaa.gov/sites/default/files/tm75.pdf.

(NMFS, 2015b). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2015. Draft Environmental Impact Statement on the Makah Tribe Request to Hunt Gray Whales. Available online at: https://media.fisheries.noaa.gov/dam-migration/2015-makah-deis-508.pdf.

(NMFS, 2015c). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2015. Subsistence Halibut Program: Small Entity Compliance Guide. Available online at: https://media.fisheries.noaa.gov/dam-migration/subsistence-halibut-overview.pdf.

(NMFS, 2015d). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2015. Draft Programmatic Environmental Assessment for Fisheries and Ecosystem Research Conducted and Funded by the Pacific Islands Fisheries Science Center. Available online at: https://media.fisheries.noaa.gov/dam-migration/pifsc_2015loa_dpea.pdf.

(NMFS, 2016). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2016. Effects of Oil and Gas Activities in the Arctic Ocean Final Environmental Impact Statement. Available online at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/environmental-impact-statement-eis-effects-oil-and-gas-activities.

(NMFS, 2017). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2017. Draft Supplemental Environmental Impact Statement for Management of the Subsistence

Harvest of Northern Fur Seals on St. Paul Island, Alaska. Available online at: https://www.alaskapublic.org/wp-content/uploads/2019/03/NOAA-NMFS-2017-0117-0002.pdf.

(NMFS, 2018a). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2018. 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0) Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. Available online at: https://www.fisheries.noaa.gov/resource/document/technical-guidance-assessing-effects-anthropogenic-sound-marine-mammal.

(NMFS, 2018c). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2018. 2018 Report to Congress on the Status of U.S. Fisheries. Accessed May 2023 at: https://www.fisheries.noaa.gov/national/2018-report-congress-status-us-fisheries.

(NMFS, 2019). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2019. Final Supplemental Environmental Impact Statement for Management of the Subsistence Harvest of Northern Fur Seals on St. Paul Island, Alaska. Available online at: https://www.fisheries.noaa.gov/resource/document/final-supplemental-environmental-impact-statement-management-subsistence-0.

(NMFS, 2020). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2020. Fisheries of the United States 2018 Report. Available online at: https://www.fisheries.noaa.gov/resource/document/fisheries-united-states-2018-report.

(NMFS, 2021a). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2021. Essential Fish Habitat Data Inventory. Available online at: https://www.habitat.noaa.gov/application/efhinventory/index.html.

(NMFS, 2021b). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2021. Alaska Region Marine Mammal Annual Stranding Summary Reports. Accessed May 2023 at: https://www.fisheries.noaa.gov/resource/document/alaska-region-marine-mammal-annual-stranding-reports.

(NMFS, 2021c). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2021. NOAA Fisheries Updated Impact Assessment of the COVID-19 Crisis on the U.S. Commercial Seafood and Recreational For-Hire/Charter Industries. Available online at: https://media.fisheries.noaa.gov/2021-02/Updated-COVID-19-Impact-Assessment-webready.pdf.

(NMFS, 2021d). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2021. Fisheries Economics of the United States 2017. Available online at: https://media.fisheries.noaa.gov/2021-09/FEUS2017-final-v1.3.pdf.

(NMFS, 2021e). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2021. Alaska Marine Mammal Stock Assessments, 2020. Available online at: https://media.fisheries.noaa.gov/2021-07/NOAA-TM-AFSC-421.pdf?null%09.

(NMFS, 2022a). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2022. Formal Rulemaking on Proposed MMPA Waiver and Hunt Regulations Governing Gray Whale Hunts by the Makah Tribe. Accessed May 2023 at: https://www.fisheries.noaa.gov/action/formal-rulemaking-proposed-mmpa-waiver-and-hunt-regulations-governing-gray-whale-hunts-makah.

(NMFS, 2022b). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2022. Makah Tribe Whale Hunt Chronology. Accessed May 2023 at: https://www.fisheries.noaa.gov/west-coast/makah-tribal-whale-hunt-chronology.

(NMFS, 2023a). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2023. Atlantic HMS Fishery Management Plans and Amendments. Available online at: https://www.fisheries.noaa.gov/atlantic-highly-migratory-species/atlantic-hms-fishery-management-plans-and-amendments.

(NMFS, 2023b). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2023. Sovereign Relations on the West Coast. Accessed May 2023 at: https://www.fisheries.noaa.gov/west-coast/partners/sovereign-relations-west-coast.

(NMFS, 2023c). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2023. Agreement between the National Marine Fisheries Service and the Alaska Beluga Whale Committee. Accessed May 2023 at: https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska.

(NMFS, 2023d). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 2023. Makah Tribe Whale Hunt. Accessed May 2023 at: https://www.fisheries.noaa.gov/west-coast/makah-tribal-whale-hunt.

(NMFS, No Date-a). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. No Date. Find a Species. Accessed May 2023 at: https://www.fisheries.noaa.gov/find-species.

(NMFS, No Date-b). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. No Date. Science & Data. Accessed May 2023 at: https://www.fisheries.noaa.gov/resources/data-and-maps?title=critical+habitat&field_species_vocab_target_id=&sort_by=created.

(NMFS, No Date-c). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. No Date. Sovereign Relations on the West Coast. Available online at: https://www.fisheries.noaa.gov/west-coast/partners/sovereign-relations-west-coast.

(NMFS, No Date-d). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. No Date. Frequently Asked Questions: Alaska Subsistence Halibut Program. Accessed May 2023 at: https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/frequently-asked-questions-alaska-subsistence-halibut-program#1.-how-many-halibut-can-i-catch-and-have-in-my-possession?

(NMFS, No Date-e). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. No Date. Subsistence Halibut Maps. Accessed May 2023 at: https://alaskafisheries.noaa.gov/portal/apps/webappviewer/index.html?id=dc1cc9077f1c490a8145ec76f9d0ad2d.

(NMFS, No Date-f). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. No Date. U.S. Aquaculture. Accessed May 2023 at: https://www.fisheries.noaa.gov/national/aquaculture/us-aquaculture.

(NMFS, No Date-g). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. No Date. Coastal Wetland Habitat. Accessed 7May 2023 at: https://www.fisheries.noaa.gov/national/habitat-conservation/coastal-wetland-habitat#:~:text=Habitat%20Loss,rise%2C%20development%2C%20and%20drainage.

(NMFS, No Date-h). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. No Date. Recorded Fatal Ship Strikes on Endangered Whales in CA 2007-2020.

Available online at: https://nmsfarallones.blob.core.windows.net/farallones-prod/media/docs/2007-2020-recorded-fatal-strikes-on-endangered-whales-in-ca.pdf.

(NMFS, No Date-i). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. No Date. Commercial Fishing: How Do We Use Observer Data? Accessed May 2023 at: https://www.fisheries.noaa.gov/insight/how-do-we-use-observer-data.

(NMFS, No Date-j). National Marine Fisheries Service, National Oceanic and Atmospheric Administration. No Date. Sustainable Seafood: Setting an Annual Catch Limit. Accessed May 2023 at: https://www.fisheries.noaa.gov/insight/setting-annual-catch-limit.

(NMMA, 2021). National Marine Manufacturers Association. 2021. U.S. Boat Sales Reached 13-Year High in 2020, Recreational Boating Boom to Continue Through 2021. Accessed May 2023 at: https://www.nmma.org/press/article/23527.

(NOAA and BOEM, 2017). National Oceanic and Atmospheric Administration Maritime Heritage Program and Bureau of Ocean Energy Management, Pacific OCS Region. 2017. The Unseen Landscape: Inventory and Assessment of Submerged Cultural Resources in Hawai`i. Available online at: https://espis.boem.gov/final%20reports/5620.pdf.

(NOAA, 2008a). National Oceanic and Atmospheric Administration. 2008. Cook Inlet Beluga Whale Subsistence Harvest Final Supplemental Environmental Impact Statement. Available online at: https://repository.library.noaa.gov/view/noaa/4948.

(NOAA, 2008b). National Oceanic and Atmospheric Administration. 2008. Recovery Plan for the Steller Sea Lion. Available online at: https://repository.library.noaa.gov/view/noaa/15974.

(NOAA, 2013). National Oceanic and Atmospheric Administration. 2013. NOAA Procedures for Government-to-Government Consultation with Federally Recognized Indian Tribes and Alaska Native Corporations. Available online at: https://www.noaa.gov/sites/default/files/2021-11/NOAA-Tribal-consultation-handbook-2016.pdf.

(NOAA, 2014a). National Oceanic and Atmospheric Administration. 2014. Entanglement of Marine Species in Marine Debris with an Emphasis on Species in the United States. Available online at: https://marinedebris.noaa.gov/sites/default/files/mdp_entanglement.pdf.

(NOAA, 2014b). National Oceanic and Atmospheric Administration. 2014. Development of Island-Based Fishery Management Plans (FMPs) in the U.S. Caribbean. Available online at: https://repository.library.noaa.gov/view/noaa/10213.

(NOAA, 2016). National Oceanic and Atmospheric Administration. 2016. Ocean Noise Strategy Roadmap. Available online at: https://cetsound.noaa.gov/Assets/cetsound/documents/Roadmap/ONS_Roadmap_Final_Complete.pdf.

(NOAA, 2017). National Oceanic and Atmospheric Administration. 2017. FY 2018 AMMC/NMFS Steller Sea Lion and Harbor Seal Co-Management Action Plan. Available online at: https://aleutmarinemammal.org/wp-content/uploads/2020/10/AMMC-NMFS-co-management-action-plan-2018.pdf.

(NOAA, 2018a). National Oceanic and Atmospheric Administration. 2018. NOAA Small Boat Standards and Procedures Manual, 4.1 Edition.

(NOAA, 2018b). National Oceanic and Atmospheric Administration. 2018. Final Supplemental Environmental Impact Statement For issuing annual catch limits to the Alaska Eskimo Whaling

Commission for a subsistence hunt on bowhead whales for the years 2019 and beyond. Available online at: https://repository.library.noaa.gov/view/noaa/19482.

(NOAA, 2018c). Office of Coast Survey, National Oceanic and Atmospheric Administration. 2018. NOAA surveys the unsurveyed, leading the way in the U.S. Arctic. Accessed May 2023 at: https://www.nauticalcharts.noaa.gov/updates/noaa-surveys-the-unsurveyed-leading-the-way-in-the-u-s-arctic/.

(NOAA, 2020a). National Oceanic and Atmospheric Administration. 2020. Fact sheet: Small diesel spills (500-5,000 gallons). NOAA Scientific Support Team, Hazardous Materials Response and Assessment Division. Available online at: https://response.restoration.noaa.gov/sites/default/files/Small-Diesel-Spills.pdf.

(NOAA, 2020b). National Oceanic and Atmospheric Administration. 2020. Ocean Acidification. Accessed May 2023 at: https://www.noaa.gov/education/resource-collections/ocean-coasts-education-resources/ocean-acidification.

(NOAA, 2021a). National Oceanic and Atmospheric Administration. 20121. Climate change impacts. Accessed online May 2023 at: https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts.

(NOAA, 2021b). National Oceanic and Atmospheric Administration. 2021. NOAA: Carbon Dioxide Peaks at 420 ppm at Mauna Loa Observatory. Accessed May 2023 at: https://cires.colorado.edu/news/noaa-carbon-dioxide-peaks-near-420-ppm-mauna-loa-observatory.

(NOAA, 2021c). National Oceanic and Atmospheric Administration. 2021. Larger-than-average Gulf of Mexico 'dead zone' measured. Accessed May 2023 at: https://www.noaa.gov/news-release/larger-than-average-gulf-of-mexico-dead-zone-measured.

(NOAA, 2022a). National Oceanic and Atmospheric Administration. 2022. Fishing Gear: Bottom Trawls. Accessed May 2023 at: https://www.fisheries.noaa.gov/national/bycatch/fishing-gear-bottom-trawls.

(NOAA, 2022b). National Oceanic and Atmospheric Administration, Office of Response and Restoration. 2022. The Toxicity of Oil: What's the Big Deal? Accessed May 2023 at: https://response.restoration.noaa.gov/about/media/toxicity-oil-whats-big-deal.html#:~:text=All%20crude%20oil%20contains%20VOCs,to%20being%20potentially%20cancer%2Dcausing.

(NOAA, 2023a). National Oceanic and Atmospheric Administration, Office of Response and Restoration, Marine Debris Program. 2023. Microplastics. Accessed May 2023 at: https://marinedebris.noaa.gov/what-marine-debris/microplastics.

(NOAA, 2023b). National Oceanic and Atmospheric Administration, Office of Response and Restoration. 2023. How Much Oil Is On That Ship? Accessed November 2023 at: https://response.restoration.noaa.gov/about/media/how-much-oil-ship.html#:~:text=Large%20cruise%20ship%20(900%E2%80%931%2C100,)%3A%201.5%E2%80%932%20million%20gallons.

(NOAA, No Date-a). National Oceanic and Atmospheric Administration. Ocean Exploration Facts. No Date. What does "CTD" stand for? Accessed May 2023 at: https://oceanexplorer.noaa.gov/facts/ctd.html.

(NOAA, No Date-b). National Oceanic and Atmospheric Administration. Atlantic Oceanographic and Meteorological Laboratory. No Date. Thermosalinograph Introduction. Accessed May 2023 at: https://www.aoml.noaa.gov/phod/tsg/webpage_sections/tsg_background.php.

(NOAA, No Date-c). National Oceanic and Atmospheric Administration, National Ocean Service. No Date. What is marine debris? Accessed May 2023 at: https://oceanservice.noaa.gov/facts/marinedebris.html.

(NOAA, No Date-d). National Oceanic and Atmospheric Administration, NOAA Fisheries. No Date. Invasive and Exotic Marine Species. Accessed May 2023 at: https://www.fisheries.noaa.gov/insight/invasive-and-exotic-marine-species#what-are-the-effects-from-invasive-species-introduction?-why-are-they-harmful?

(NOAA, No Date-e). National Oceanic and Atmospheric Administration. No Date. Are Corals Animals or Plants. Accessed May 2023 at: https://oceanservice.noaa.gov/facts/coral.html.

(NOAA, No Date-f). National Oceanic and Atmospheric Administration. No Date. Intergovernmental Policy Council. Accessed May 2023 at: https://olympiccoast.noaa.gov/management/intergovernmentalpolicy.html.

(NOAA, No Date-g). National Oceanic and Atmospheric Administration. No Date. Summary of Management Authorities Applied to Submerged Cultural Resources in U.S. Waters and in The Area/High Seas. Available online at: https://nmsmarineprotectedareas.blob.core.windows.net/marineprotectedareas-prod/media/docs/us-cultural-heritage-laws.pdf.

(NOAA, No Date-h). National Oceanic and Atmospheric Administration. No Date. National Water Level Observation Network (NWLON). Available online at: https://tidesandcurrents.noaa.gov/nwlon.html.

(NOS, 2016). NOAA National Ocean Service. 2016. U.S. Integrated Ocean Observing System (IOOS) Program Programmatic Environmental Assessment. Available online at: https://cdn.ioos.noaa.gov/media/2017/12/IOOS_PEA-with-Appendices_FINAL_June-2016.pdf.

(NOS, No Date-a). National Ocean Service, National Oceanic and Atmospheric Administration. No Date. Cultural Heritage Resources and Marine Protected Areas. Available online at: https://nmsmarineprotectedareas.blob.core.windows.net/marineprotectedareas-prod/media/archive/pdf/helpful-resources/factsheets/cultural_heritage_mpas_mar2011x2.pdf.

(NOS, No Date-b). National Ocean Service. No date. Coastal Blue Carbon. Accessed May 2023 at: https://oceanservice.noaa.gov/ecosystems/coastal-blue-carbon/.

(Nowacek et al., 2004). Nowacek, D., M. Johnson, and P.L. Tyack. 2004. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alarm stimuli. Proceedings of the Royal Society of London Series B 271: 227-231. Available online at: https://doi.org/10.1098/rspb.2003.2570.

(NPFMC, 2023). North Pacific Fishery Management Council. 2023. Fisheries and Issues. Available online at: https://www.npfmc.org/fisheries-issues/.

(NPS, 1998). National Park Service. 1998. Guidelines for Evaluating and Documenting Traditional Cultural Properties. Available online at: https://www.energy.gov/sites/default/files/2016/02/f30/nrb38.pdf.

(NPS, 2010a). National Park Service. 2010. Determination of Eligibility Notification: Nantucket Sound. Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/Studies/NPS-to-MMS-Nantucket-Sound-Determination.pdf.

(NPS, 2010b). National Park Service. 2010. Oil Spill Response. Available online at: http://npshistory.com/publications/eq/oil-spill/cult-res.pdf.

(NPS, 2012). National Park Service. 2012. Tribal Historic Preservation Officer (THPO): A Quick Guide for Preserving Native American Cultural Resources. Available online at: https://www.nps.gov/history/tribes/Documents/THPO.pdf.

(NPS, 2016). National Park Service. 2016. Channel Islands Shipwrecks. Accessed May 2023 at: https://www.nps.gov/chis/learn/photosmultimedia/shipwreck.htm.

(NPS, 2018). National Park Service. 2018. Understanding Sound. Accessed May 2023 at: https://www.nps.gov/subjects/sound/understandingsound.htm.

(NPS, 2020). National Park Service. 2020. Aquatic Invertebrates. Accessed May 2023 at: https://www.nps.gov/im/htln/aquatic-invertebrates.htm.

(NPS, 2023). National Park Service. 2023. Maritime Heritage at the Virgin Islands. Accessed September 23, 2021 at: https://www.nps.gov/articles/000/maritime-heritage-at-the-virgin-islands.htm.

(NPS, No Date-a). National Park Service. No Date. Archeology Program: State Submerged Resources. Accessed August 26, 2021 at: https://www.nps.gov/archeology/SITES/stateSubmerged/index.htm.

(NPS, No Date-b). National Park Service. No Date. Traditional Cultural Properties – Questions & Answers. Available online at: http://npshistory.com/publications/tcp-qa.pdf.

(NRCM, 2019). Natural Resources Council of Maine. 2019. Landmark Bill Would Protect Sustenance Fishing Rights in Maine's Tribal Waters. Accessed May 2023 at: https://www.nrcm.org/news/landmark-bill-protect-sustenance-fishing-rights/.

(NSB, No Date-a). North Slope Borough. No Date. Bowhead Whale Subsistence Harvest Research. Accessed May 2023 at: https://www.north-slope.org/departments/wildlife-management/studies-research-projects/bowhead-whales/bowhead-whale-subsistence-harvest-research/.

(NSB, No Date-b). North Slope Borough. No Date. Documentation of Beluga Harvest. Accessed May 2023 at: https://www.north-slope.org/departments/wildlife-management/co-management-organizations/alaska-beluga-whale-committee/abwc-research-projects/documentation-of-beluga-harvest/.

(NSB, No Date-c). North Slope Borough. No Date. Ice Seal Committee. Accessed May 2023 at: http://www.north-slope.org/departments/wildlife-management/co-management-organizations/ice-seal-committee/.

(NSF and USGS, 2011). National Science Foundation and United Sates Geological Survey. 2011. Final Programmatic Environmental Impact Statement / Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey. Available online at: https://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis_3june2011.pdf.

(NSF, No Date). National Science Foundation. No Date. OCE Environmental Compliance. Accessed May 2023 at: https://www.nsf.gov/geo/oce/envcomp/index.jsp.

(NWF, No Date). The National Wildlife Federationi. No Date. Leatherback Sea Turtle. Accessed May 2023 at: https://www.nwf.org/Educational-Resources/Wildlife-Guide/Reptiles/Sea-Turtles/Leatherback-Sea-Turtle.

(NWIFC, No Date). Northwest Indian Fisheries Commission. No Date. About Us. Accessed May 2023 at: https://nwifc.org/about-us/.

(NYSERDA, 2023). New York State Energy Research and Development Authority. 2023. Climate Change and Offshore Wind: Tackling the climate crisis. Accessed May 2023 at: https://www.nyserda.ny.gov/All-Programs/Offshore-Wind/Focus-Areas/Climate-Change-and-Offshore-Wind.

(OCM, 2013). Office for Coastal Management, National Oceanic and Atmospheric Administration. 2013. National Coastal Population Report Population Trends from 1970 to 2020. Available online at: https://aambpublicoceanservice.blob.core.windows.net/oceanserviceprod/facts/coastal-population-report.pdf.

(OCM, 2018a). Office for Coastal Management, National Oceanic and Atmospheric Administration. 2018. Economics: National Ocean Watch (ENOW) data by Ocean Sector. Coastal USA. Available online at: https://coast.noaa.gov/quickreport/#/index.html.

(OCM, 2018b). Office for Coastal Management, National Oceanic and Atmospheric Administration. 2018. Economics: National Ocean Watch (ENOW) data by Ocean Sector. Great Lakes; Gulf of Mexico; Mid-Atlantic; North Pacific; Northeast; Pacific; Southeast; West. Available online at: https://coast.noaa.gov/quickreport/#/index.html.

(OCM, 2021). Office for Coastal Management, National Oceanic and Atmospheric Administration. 2021. NOAA Report on the U.S. Marine Economy. Available online at: https://coast.noaa.gov/data/digitalcoast/pdf/econ-report.pdf.

(OCM, 2023). Office for Coastal Management, National Oceanic and Atmospheric Administration. 2023. Economics and Demographics. Accessed May 2023 at: https://coast.noaa.gov/states/fast-facts/economics-and-demographics.html.

(OCS, No Date). Office of Coast Survey, National Oceanic and Atmospheric Administration. No Date. Wrecks and Obstructions Database. Accessed May 2023 at: https://nauticalcharts.noaa.gov/data/wrecks-and-obstructions.html.

(OIG, 2018). U.S. Department of Commerce. Office of Inspector General. 2018. NOAA Office of Marine and Aviation Operations Does Not Fully Utilize the Shipboard Automated Maintenance Management System to Coordinate Ship Maintenance and Repairs. Accessed online at: https://www.oig.doc.gov/OIGPublications/2018-01-08_NOAA_Ship_Fleet_Maintenance_Final_Report.pdf.

(Oldenburg et al., 2020). Oldenburg, M., C. Felten, J. Hedtmann, and H.J. Jensen. 2020. Physical influences on seafarers are different during their voyage episodes of port stay, river passage and sea passage: A maritime field study. Available online at: https://doi.org/10.1371/journal.pone.0231309.

(OMAO, 2011). Office of Marine and Aviation Operations. 2011. SAMM: Maintenance, Modification, and Repair, Procedure 0601-15.

(OMAO, 2012). Office of Marine and Aviation Operations. 2012. Management of Shipboard Ozone Depleting Substances and Refrigerants, Procedure 0701-17.

(OMAO, 2013a). Office of Marine and Aviation Operations. 2013. Shipboard Solid Waste Management, Document 0701-19.

(OMAO, 2013b). Office of Marine and Aviation Operations. 2013. National Pollutant Discharge Elimination System Vessel General Permit Compliance Procedures, Procedure 0701-03.

(OMAO, 2013c). Office of Marine and Aviation Operations. 2013. National Pollutant Discharge Elimination System (NPDES) Vessel General Permit Ship-Specific Instruction (SSI), Procedure 0701-03 A.

(OMAO, 2015). Office of Marine and Aviation Operations. 2015. Marine Operations Hazard Communication, Procedure 0701-04.

(OMAO, 2016). Office of Marine and Aviation Operations. 2016. Shipboard Waste Water Management, Procedure 0701-18.

(OMAO, 2017a). Office of Marine and Aviation Operations. National Oceanic and Atmospheric Administration. 2017. NOAA Unmanned Aircraft Systems (UAS) Handbook. Available online at: https://www.omao.noaa.gov/sites/default/files/documents/NOAA%20UAS%20Handbook.pdf.

(OMAO, 2017b). Office of Marine and Aviation Operations. 2017. Shipboard Oil Pollution Emergency Plan & Non-Tank Vessel Response Plan (VRP/SOPEP), Procedure 0701-06.

(OMAO, 2017c). Office of Marine and Aviation Operations. 2017. Visiting Scientists' Chemical and Related Hazardous Materials (Mission Hazmat), Document 0701-22.

(OMAO, 2018). Office of Marine and Aviation Operations, National Oceanic and Atmospheric Administration. 2018. NOAA Fleet Societal Benefit Study. Available online at: https://www.omao.noaa.gov/sites/default/files/documents/Final%20Societal%20Benefit%20Study%20Report%203.19.2018.pdf.

(OMAO, 2020a). Office of Marine and Aviation Operations, National Oceanic and Atmospheric Administration. 2020. Strategic Plan 2021-2025.

(OMAO, 2020b). Office of Marine and Aviation Operations. 2020. Oil Transfer, Procedure 0601-01.

(OMAO, 2020c). Office of Marine and Aviation Operations. 2020. Hearing Conservation Program. Accessed March 2022 at: https://www.omao.noaa.gov/learn/headquarters/health-services/marine-medicine/hearing-conservation-program.

(OMAO, 2020d). Office of Marine and Aviation Operations. 2020. Lithium Battery Safety Procedures, Procedure 1102-04.

(OMAO, 2020e). Office of Marine and Aviation Operations. 2020. Management of Asbestos, Procedure 0701-21.

(OMAO, 2021a). Office of Marine and Aviation Operations. 2021. Ballast Water Management, Procedure 0701-02.

(OMAO, 2021b). Office of Marine and Aviation Operations. 2021. Ballast Water Management Plan & Ship-Specific Instruction, Procedure 0701-02 A.

(OMAO, 2021c). Office of Marine and Aviation Operations. 2021. Hazardous, Universal, and Special Waste Management, Procedure 0701-05.

(OMAO, 2021d). Office of Marine and Aviation Operations. 2021. Hazardous, Universal, and Special Waste Management, Procedure 0701-05, Attachment A.

(OMAO, 2021e). Office of Marine and Aviation Operations. 2021. Hazardous, Universal, and Special Waste Management, Procedure 0701-05, Attachment B.

(OMAO, 2022). Office of Marine and Aviation Operations. 2022. Ship Energy Efficiency Management Plan (SEEMP).

(OMAO, No Date-a). Office of Marine and Aviation Operations. No Date. Oily Material Management Plan, Procedure 0601-02.

(OMAO, No Date-b). Office of Marine and Aviation Operations. No Date. Oscar Dyson. Accessed May 2023 at: https://www.omao.noaa.gov/mo/ships/oscar-dyson.

(OMAO, No Date-c). Office of Marine and Aviation Operations. No Date. Henry B. Bigelow. Accessed May 2023 at: https://www.omao.noaa.gov/mo/ships/henry-b-bigelow.

(OMAO, No Date-d). Office of Marine and Aviation Operations. No Date. Bell M. Shimada. Accessed May 2023 at: https://www.omao.noaa.gov/mo/ships/bell-m-shimada.

(OMAO, No Date-e). Office of Marine and Aviation Operations. No Date. Pisces. Accessed May 2023 at: https://www.omao.noaa.gov/mo/ships/pisces.

(OMAO, No Date-f). Office of Marine and Aviation Operations. No Date. Ronald H. Brown. Accessed May 2023 at: https://www.omao.noaa.gov/mo/ships/ronald-h-brown.

(ONMS, 2007). Office of National Marine Sanctuaries. 2007. American Samoa Maritime Heritage Inventory. Available online at: https://nmsamericansamoa.blob.core.windows.net/americansamoa-prod/media/docs/as_heritage.pdf.

(ONMS, 2014). Office of National Marine Sanctuaries. 2014. Thunder Bay National Marine Sanctuary Final Environmental Impact Statement: Boundary Expansion. Available online at: https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/archive/library/pdfs/tb-eis-expansion2014.pdf.

(ONMS, 2021a). Office of National Marine Sanctuaries. 2021. Wisconsin Shipwreck Coast National Marine Sanctuary Designation; Final Regulations. Available online at: https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/docs/2021-12846.pdf.

(ONMS, 2021b). Office of National Marine Sanctuaries. 2021. Proposed Lake Ontario National Marine Sanctuary Draft Environmental Impact Statement and Draft Management Plan. Available online at: https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/docs/20210701-proposed-lake-ontario-national-marine-sanctuary-draft-environmental-impact-statement.pdf.

(ONMS, No Date). Office of National Marine Sanctuaries. No Date. Maritime History. Accessed May 2023 at: https://stellwagen.noaa.gov/maritime/maritimehistory.html.

(OSHA, No Date). Occupational Safety and Health Administration. No Date. Occupational Noise Exposure. Accessed May 2023 at: https://www.osha.gov/noise.

(Owen and Bowles, 2011). Owen, M.A. and A.E. Bowles. 2011. In-Air Auditory Psychophysics and the Management of a Threatened Carnivore, the Polar Bear (Ursus maritimus). International Journal of Comparative Physiology. 24: 244-254. Available online at: https://doi.org/10.46867/IJCP.2011.24.03.05.

(PBI, No Date). Polar Bears International. No Date. Living with Polar Bears. Accessed May 2023 at: https://polarbearsinternational.org/polar-bears-changing-arctic/living-with-polar-bears/.

(Pews Oceans Commission, 2003). Pews Oceans Commission. 2003. America's Living Oceans: Charting a Course for Sea Change. pp. 166. Arlington, VA: Pew Oceans Commission. Available online at: https://www.pewtrusts.org/-/media/assets/2003/06/02/poc_summary.pdf.

(PFMC, No Date-a). Pacific Fishery Management Council. No Date. Fishery Management Plans. Available online at: https://www.pcouncil.org/fishery-management-plans/.

(PFMC, No Date-b). Pacific Fishery Management Council. No Date. Who We Are and What We Do. Accessed May 2023 at: https://www.pcouncil.org/about-the-council-2/.

(PFMC, No Date-c). Pacific Fishery Management Council. No Date. Salmon: Background. Available online at: https://www.pcouncil.org/managed_fishery/salmon/.

(Phipps, 2012). Phipps, A. 2012. Aboard NOAA Ship Oscar Dyson. Accessed March 25, 2022 at: https://noaateacheratsea.blog/tag/acoustic-insulation/.

(Pierce et al., 2004). Pierce, K.E., R.J. Harris, L.S. Larned, and M.A. Porkas. 2004. Obstruction and starvation associated with plastic ingestion in a Northern Gannet *Morus bassanus* and a Greater Shearwater *Puffinus gravis*. Marine Ornithology 32:187–189. Available online at: http://www.marineornithology.org/PDF/32_2/32_2_187-189.pdf.

(Piniak et al., 2012). Piniak, W.E.D., S.A. Eckert, C.A. Harms, and E.M. Stringer. 2012.Underwater hearing sensitivity of the leatherback sea turtle (*Dermochelys coriacea*): Assessing the potential effect of anthropogenic noise. Prepared for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Herndon, VA. Available online at: https://www.researchgate.net/publication/280559013_Underwater_hearing_sensitivity_of_the_leatherback_sea_turtle_Dermochelys_coriacea_Assessing_the_potential_effect_of_anthropogenic_noise.

(Platt, 2018). Platt, J.R. 2018. America's Freshwater Mussels Are Going Extinct. Scientific American. Accessed May 2023 at: https://blogs.scientificamerican.com/extinction-countdown/americas-freshwater-mussels-are-going-extinct-heres-why-that-sucks.

(Popper and Hawkins, 2019). Popper A.N. and A.D. Hawkins. 2019. An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes. Journal of Fish Biology. 2019;1–22. Available online at: https://doi.org/10.1111/jfb.13948.

(Popper et al., 2003). Popper, A.N., R.R. Fay, C. Platt, and O. Sand. 2003. Sound detection mechanisms and capabilities of teleost fishes. In Sensory Processing in Aquatic Environments, edited by S. P. Collin and N. J. Marshall. Springer-Verlag, New York, pp. 3-38. Available online at: https://doi.org/10.1007/978-0-387-22628-6_1.

(Popper et al., 2005). Popper, A.N., M.E. Smith, P.A. Cott, B.W. Hanna, A.O. MacGillivray, M.E. Austin, and D.A. Mann. 2005. Effects of exposure to seismic airgun use on hearing of three fish species. The Journal of the Acoustical Society of America, 117(6), 3958–3971. Available online at: https://doi.org/10.1121/1.1904386.

(Popper et al., 2007). Popper, A.N., M.B. Halvorsen, A. Kane, D.L. Miller, M.E. Smith, J. Song, P. Stein, and L.E. Wysocki. 2007. The effects of high-intensity, low-frequency active sonar on rainbow trout. The Journal of the Acoustical Society of America, 122(1), 623–635. Available online at: https://doi.org/10.1121/1.2735115.

(Popper et al., 2014). Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, M.B. Halvorsen, S. Lokkeborg, P.H. Rogers, B.L. Southall, D.G. Zeddies, and W.N. Tavolga. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014. Available online at: https://www.researchgate.net/profile/Arthur_Popper/publication/279347068_Sound_Exposure_Guidelines/links/5596735d08ae99aa62c777b9/Sound-Exposure-Guidelines.pdf.

(PRB, 2003). Population Reference Bureau. 2003. Ripple Effects: Population in Coastal Regions. Accessed May 2023 at: https://www.prb.org/resources/ripple-effects-population-and-coastal-regions/.

(Reeves et al., 2002). Reeves, R.R., B.S. Stewart, P.J. Clapham, and J.A. Powell. 2002. Guide to Marine Mammals of the World. Chanticleer Press, New York, NY.

(Reichmuth et al., 2020). Reichmuth, C., J.M. Sills, A. Brewer, L. Triggs, R. Ferguson, E. Ashe, and R. Williams. 2020. Behavioral assessment of in-air hearing range for the Pacific walrus (*Odobenus rosmarus divergens*). Polar Biology volume 43, pages767–772. Available online at: https://link.springer.com/article/10.1007/s00300-020-02667-6.

(Reijnders et al., 2008). Reijnders, P.J.H., A. Aguilar, and A. Borrell. 2008. Pollution and marine mammals. In W.F. Perrin, B. Wursig and J.G.M. Thewissen (Eds.), Encyclopedia of Marine Mammals (2nd ed., pp. 890-898). San Diego, CA: Academic Press. Available online at: https://doi.org/10.1016/B978-0-12-373553-9.00205-4.

(Reinert et al., 2017). Reinert, T.R., A.C. Spellman, and B.L. Bassett. 2017. Entanglement in and ingestion of fishing gear and other marine debris by Florida manatees, 1993–2012. Endangered Species Research 32(1). Available online at: https://doi.org/10.3354/esr00816.

(RFF, 2023). Resources for the Future. 2023. Updated Estimates of the Social Cost of Greenhouse Gases for Use in Regulatory Analysis. Public Comment. February. Accessed online at: https://www.rff.org/publications/testimony-and-public-comments/updated-estimates-of-the-social-cost-of-greenhouse-gases-for-usage-in-regulatory-analysis/.

(Richardson et al., 1995). Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego, CA, USA. 576 p. Available online at: https://www.sciencedirect.com/book/9780080573038/marine-mammals-and-noise.

(Ronconi, 2001). Ronconi, R. 2001. Animal Diversity Web: *Cepphus grylle* Black Guillemot. Accessed May 2023 at: https://animaldiversity.org/site/accounts/information/Cepphus_grylle.html.

(Rostad et al., 2006). Rostad, A., S. Kaartvedt, T.A. Klevjer, and W. Melle. 2006. Fish are attracted to vessels. ICES Journal of Marine Science, 63(8), 1431-1437. Available online at: https://doi.org/10.1016/j.icesjms.2006.03.026.

(Ruppel et al., 2022). Ruppel, C.D., T.C. Weber, E.R. Staaterman, S.J. Labak, and P.E. Hart. 2022. Categorizing Active Marine Acoustic Sources Based on Their Potential to Affect Marine Animals. Journal of Marine Science and Engineering, 10(9): 1278, https://doi.org/10.3390/jmse10091278.

(SAFMC, No Date). South Atlantic Fishery Management Council. No Date. Fishery Management. Available online at: https://safmc.net/fishery-management/.

(Salerno, 2009). Salerno, B.M. 2009. Navigation and Vessel Inspection Circular No. 1-09. United States Coast Guard, Department of Homeland Security. Available online at: https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/5ps/NVIC/2009/NVIC_1-09.pdf.

(Sánchez et al., 2016). Sánchez, M.I., I. Paredes, M. Lebvouvier, and A.J. Green. 2016. Functional Role of Native and Invasive Filter Feeders, and the Effect of Parasites: Learning from Hypersaline Ecosystems. PLOS One. Available online at: https://doi.org/10.1371/journal.pone.0161478.

(Schneider et al., 2021). Schneider, J.M., S.L. VanBElleghem, and D. O'Connor. 2021. White House Rescinds Trump Climate-Related NEPA Guidance. Latham & Watkins LLP. Accessed online May 2023 at: https://www.globalelr.com/2021/02/white-house-rescinds-trump-climate-related-nepa-guidance/.

(Schytte Blix, 2018). Schytte Blix, A. 2018. Adaptations to deep and prolonged diving in phocid seals. Journal of Experimental Biology 221. Available online at: https://doi.org/10.1242/jeb.182972.

(SDWF, No Date). Safe Drinking Water Foundation. No Date. Oil Spills. Accessed May 2023 at: https://www.safewater.org/fact-sheets-1/2017/1/23/oil-spills.

(Sea Around Us, 2016). Sea Around Us. 2016. Fisheries, Ecosystems, and Biodiversity. Accessed May 2023 at: http://www.seaaroundus.org/.

(Sea Grant, 2015). Sea Grant Alaska. 2015. Marine Education: Marine Mammals of Alaska Field Guide. Accessed May 2023 at: https://seagrant.uaf.edu/marine-ed/mm/fieldguide/index.html.

(Shaban et al., 2021). Shaban, B., R. Campos, M. Villarreal, N. Hsu, E. Isleta, A. Rutanashoodech, and M. Horn. 2021. Ship Strikes' Killing Whales Despite Govt. Program to Slow Down Vessels. Accessed May 2023 at: https://www.nbcbayarea.com/investigations/ship-strikes-kill-whales-at-highest-levels-in-more-than-a-decade-despite-govt-program-to-slow-down-vessels/2238072/.

(Shane et al., 1986). Shane, S.H., R.S. Wells, and B. Würsig. 1986. Ecology, behavior, and social organization of the bottlenose dolphin: A review. Marine Mammal Science 2(1):34-63. Available online at: https://doi.org/10.1111/j.1748-7692.1986.tb00026.x.

(Simard et al., 2016). Simard, Y., N. Roy, C. Gervaise, and S. Giard. 2016. Analysis and Modeling of 255 Source Levels of Merchant Ships from an Acoustic Observatory along St. Lawrence Seaway. The Journal of the Acoustical Society of America 140(3):2002-18. Available online at: https://doi.org/10.1121/1.4962557.

(Simpson et al., 2016). Simpson, S.D., A.N. Radford, S.L. Nedelec, M.C.O. Ferrari, D.P. Chivers, M.I. McCormick, and M.G. Meekan. 2016. Anthropogenic noise increases fish mortality by predation. Nat. Comm. 7: 10544. Available online at: https://doi.org/10.1038/ncomms10544.

(Slabbekoorn et al., 2010). Slabbekoorn, H., N. Bouton, I. van Opzeeland, A. Coers, C. ten Cate, and A.N. Popper. 2010. A noisy spring: the impact of globally rising underwater sound levels on fish. Trends Ecol. Evol. 25: 419-27. Available online at: https://doi.org/10.1016/j.tree.2010.04.005.

(Smith et al., 2006). Smith, M.E., A.B. Coffin, D.L. Miller, and A.N. Popper. 2006. Anatomical and functional recovery of the goldfish (Carassius auratus) ear following noise exposure. The Journal of Experimental Biology, 209(21), 4193–4202. Available online at: https://doi.org/10.1242/jeb.02490.

(Solé et al., 2016). Solé, M., M. Lenoir, J.M. Fortuño, M. Durfort, M. van der Schaar, and M. André. 2016. Evidence of Cnidarians sensitivity to sound after exposure to low frequency underwater sources. Scientific Reports. Available online at: https://www.nature.com/articles/srep37979.

(Southall et al., 2007). Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, J.W. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals, 33(4), 411-521. Available online at: https://doi.org/10.1080/09524622.2008.9753846.

(Southall et al., 2019). Southall, B.L., J.J. Finneran, C. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 2019, 45(2):125-232. Available online at: https://doi.org/10.1578/AM.45.2.2019.125.

(Southwood et al., 2008). Southwood, A., K. Fritsches, R. Brill.; and Y. Swimmer. 2008. Sound, chemical, and light detection in sea turtles and pelagic fishes: sensory-based approaches to bycatch reduction in longline fisheries. Journal of Endangered Species Research 5: 225-238. Available online at: https://doi.org/10.3354/esr00097.

(Statistica.com, 2023). Statistica.com. 2023. Greenhouse gas emissions from ships and boats in the United States from 1990 to 2021. Accessed May 2023 at: https://www.statista.com/statistics/1120541/us-shipping-ghg-emissions/.

(Stone, 2018). Stone, D. 2018. Meet the bowhead whale hunters of northern Alaska. National Geographic. Accessed May 2023 at: https://www.nationalgeographic.com/magazine/article/proof-whale-hunters-northern-alaska.

(Sullivan et al., 2018). Sullivan, R.G., M.E. Meyer, and D. J. O'Rourke. 2018. Comparison of Visual Impact Analysis Under the National Environmental Policy Act and Section 106 of the National Historic Preservation Act. In: Gobster, P.H. and R.C. Smardon, eds. Visual resource stewardship conference proceedings: landscape and seascape management in a time of change. Gen. Tech. Rep. NRS-P-183. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station: 201-212. Available online at: https://www.fs.usda.gov/nrs/pubs/gtr/gtr-nrs-p-183papers/20-sullivan-VRS-gtr-p-183.pdf.

(SWOT, No Date). The State of the World's Sea Turtles Online Database. No Date. Data provided by the SWOT Team and hosted on OBIS-SEAMAP. Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group, and Marine Geospatial Ecology Lab, Duke. Accessed May 2023 at: http://seamap.env.duke.edu/swot.

(Terrill, 1978). Terrill, J.B., R.R. Montgomery, and C.F. Reinhardt. 1978. Toxic gases from fires. Science, 200(4348), 1343–1347. Available online at: https://doi.org/10.1126/science.208143.

(The City of Charleston, 2022). The City of Charleston. 2022. Article II. - Noise. Accessed May 2023 at: https://library.municode.com/sc/charleston/codes/code_of_ordinances?nodeId=CICO_CH21OF_ARTIINO_DIV1GE_S21-17BUCOOPNO.

(The City of Newport RI, 2023). City of Newport, Rhode Island. 2023. Code of Ordinances: Title 8. - Health And Safety. Accessed May 2023 at: https://library.municode.com/ri/newport/codes/code_of_ordinances?nodeId=COOR_TIT8HESA_CH8.12NOAB_8.12.010STPUPO.

(The City of Norfolk, 2023). The City of Norfolk. 2023. Chapter 26 – Noise. Accessed May 2023 at: https://library.municode.com/va/norfolk/codes/code_of_ordinances?nodeId=COCI_CH26NO.

(The City of Pascagoula, 2022). The City of Pascagoula. 2022. Chapter 54 - Offenses and Miscellaneous Provisions. Accessed May 2023 at: https://library.municode.com/ms/pascagoula/codes/code_of_ordinances?nodeId=COOR_CH54OFMIPR.

(The City of San Diego, No Date). The City of San Diego. No Date. Article 9.5: Noise Abatement and Control. Available online at: https://docs.sandiego.gov/municode/MuniCodeChapter05/Ch05Art09.5Division05.pdf.

(The Guardian, 2015). The Guardian. 2015. Why would anyone want to shoot a sea otter? Accessed May 2013 at: https://www.theguardian.com/world/2015/mar/10/why-would-anyone-want-to-shoot-a-sea-otter.

(The Seattle Times, 2018). The Seattle Times. 2018. Quota raised for subsistence hunting of Chukchi polar bears. Accessed May 2023 at: https://www.seattletimes.com/nation-world/quota-raised-for-subsistence-hunting-of-chukchi-polar-bears/.

(The White House, 2019). The White House. 2019. Memorandum on Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska. Available online at: https://oeab.noaa.gov/wp-content/uploads/2021/01/2019-pres-memo.pdf.

(Tinker et al., 2008). Tinker, M.T., G. Bentall, and J.A. Estes. 2008. Food limitation leads to behavioral diversification and dietary specialization in sea otters. Proceedings of the National Academy of Sciences, 105 (2). Available online at: www.pnas.orgcgidoi10.1073pnas.0709263105.

(TISI, 2014). Texas Invasive Species Institute. 2014. Quagga Mussel. Accessed May 2023 at: http://www.tsusinvasives.org/home/database/dreissena-bugensis.

(Turnpenny and Nedwell, 1994). Turnpenny, A.W.H. and J.R. Nedwell. 1994. The effects on marine fish, diving mammals and birds of underwater sound generated by seismic surveys. Fawley Aquatic Research Laboratories Ltd. FCR 089/94. 40p. Available online at: https://www.pge.com/includes/docs/pdfs/shared/edusafety/systemworks/dcpp/turnpenny_and_nedwell_1994_the_effects_on_marine_fish_diving_mammals_and_birds_of_seismic_surveys.pdf.

(TWI, No Date). TWI Ltd. No Date. How Long Do Wind Turbines Last? Can Their Lifetime Be Extended? Accessed May 2023 at: https://www.twi-global.com/technical-knowledge/faqs/how-long-do-wind-turbines-last#:~:text=A%20good%20quality%2C%20modern%20wind,increase%20as%20the%20structure%20ages.

(Tyack, 2009). Tyack, P. 2009. Human-generated sound and marine mammals. Physics Today, 39–44. Available online at: https://marine.rutgers.edu/dmcs/ms320/tyack_et_al_2009.pdf.

(UCAR, 2023a). University Corporation for Atmospheric Research, Center for Science Education. No Date. Nitrogen Oxides. Accessed May 2023 at: https://scied.ucar.edu/learning-zone/air-quality/nitrogen-oxides.

(UCAR, 2023b). University Corporation for Atmospheric Research, Center for Science Education. No Date. Sulfur Oxides. Accessed May 2023 at: https://scied.ucar.edu/learning-zone/air-quality/sulfur-oxides.

(UNOLS, No Date-a). University-National Oceanographic Laboratory System. No date. Major Issues and Guiding Principles for UNOLS. Accessed May 2023 at: https://www.unols.org/what-unols/vision-mission-and-top-issues.

(UNOLS, No Date-b). University-National Oceanographic Laboratory System. No date. Ship Time Request System, Ship Schedules. Accessed May 2023 at: https://strs.unols.org/public/Search/diu_all_schedules.aspx?ship_id=0&year=2012.

(US Fleet Forces, 2009). United States Fleet Forces. 2009. Virginia Capes Range Complex, Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) Volume 1. Available online at: https://www.nepa.navy.mil/Portals/20/Documents/aftteis1/virginia-capes/nepa-eo/vacapes-feis-vol1-full.pdf.

(US Navy, 2021). United States Navy. 2021. U.S. Navy 101. Available online at: https://media.defense.gov/2021/Feb/10/2002580594/-1/-1/0/NAVY101_PRESENTATION_V13.PDF/NAVY101_PRESENTATION_V13.PDF.

(USACE, 2012a). U.S. Army Corps of Engineers. May 2012. Inland Waterways and Export Opportunities. Available online at: https://www.lrd.usace.army.mil/Portals/73/docs/Navigation/PCXIN/Inland_Waterways_and_Export_Opportunities-FINAL_2013-01-03.pdf.

(USACE, 2012b). U.S. Army Corps of Engineers. 2012. Treaty Rights and Subsistence Fishing in the U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins. Available online at: https://glmris.anl.gov/documents/docs/Subsistence_Fishing_Report.pdf.

(USACE, 2019). U.S. Army Corps of Engineers. 2019. The Great Lakes and Mississippi River Interbasin Study - Brandon Road Integrated Feasibility Study and Environmental Impact Statement - Will County, Illinois. Available online at: https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/11394.

(USACE, No Date). U.S. Army Corps of Engineers. No Date. Navigation. Accessed May 2023 at: https://www.sam.usace.army.mil/Missions/Civil-Works/Navigation/.

(USCG, 2017). U.S. Department of Homeland Security, United States Coast Guard. 2017. MARPOL Annex V. Accessed May 2023 at: https://homeport.uscg.mil/Lists/Content/DispForm.aspx?ID=896&Source=/Lists/Content/DispForm.aspx?ID=896.

(USCG, 2018). U.S. Coast Guard. 2018. Maritime Commerce Strategic Outlook. Available online at: https://media.defense.gov/2018/Oct/05/2002049100/-1/-1/0/USCG%20MARITIME%20COMMERCE%20STRATEGIC%20OUTLOOK-RELEASABLE.PDF.

(USCG, 2023). U.S. Coast Guard Boating Safety Division. 2023. Frequently asked questions. Accessed May 2023 at: https://uscgboating.org/content/frequently-asked-questions.php#:~:text=A%3A%20Boaters%20should%20keep%20their,of%20any%20U.S.%20naval%20vessel.

(USCG, No Date-a). U.S. Coast Guard. U.S. Department of Homeland Security. No Date. U.S. VHF Channel information. Accessed May 2023 at: https://www.navcen.uscg.gov/us-vhf-channel-information.

(USCG, No Date-b). U.S. Coast Guard. U.S. Department of Homeland Security. No Date. Radio Information for Boaters. Accessed May 2023 at: https://www.navcen.uscg.gov/radio-information-for-boaters#:~:text=Boater%20Calling%20Channel%20(VHF%20Channel%209)&text=Recreational%20boaters%20would%20continue%20to,distress%2C%20safety%20and%20calling%20frequency.

(USCG, No Date-c). United States Coast Guard. No Date. Office of Commercial Vessel Compliance (CG-CVC), International Convention for the Prevention of Pollution by Ships - MARPOL 73/7. Accessed May 2023 at: https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Inspections-Compliance-CG-5PC-/Commercial-Vessel-Compliance/Domestic-Compliance-Division/MARPOL/.

(USCG, No Date-d). Deputy Commandant for Operations, United States Coast Guard. No date. Annex I. Available online at: https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/CG-5PC/CG-CVC/Marpol/annexone.pdf.

(USCG, No Date-e). United States Coast Guard. No Date. Organizational Overview. Accessed May 2023 at: https://www.uscg.mil/About/.

(USCG, No Date-f). United States Coast Guard. No Date. Coast Guard Strategic Plan 2018 – 2022. Available online at: https://media.defense.gov/2018/Nov/16/2002063979/-1/-1/0/USCG_STRATEGIC%20PLAN__LORES%20PAGE_20181115_VFINAL.PDF.

(USDOC et al., 2008). U.S. Department of Commerce, National Marine Fisheries Service, and U.S. Department of the Interior Fish and Wildlife Service. 2008. Recovery plan for the Northwest Atlantic population of the loggerhead sea turtle (*Caretta caretta*), second revision. National Marine Fisheries Service, Silver Spring, MD. Available online at: https://repository.library.noaa.gov/view/noaa/3720.

(USFWS, 2007). U.S. Fish and Wildlife Service. 2007. Hunting and Use of Sea Otters by Alaska Natives Fact Sheet. Available online at: https://www.kfsk.org/wp-content/uploads/2018/12/Federal-regulations.pdf.

(USFWS, 2014a). U.S. Fish and Wildlife Service. April 2014. Pacific Walrus (*Odobenus rosmarus divergens*): Alaska Stock. Available online at: https://www.fws.gov/sites/default/files/documents/pacific-walrus-stock-assessment-report.pdf.

(USFWS, 2014b). U.S. Fish and Wildlife Service. 2014. Stock Assessment Report Northern Sea Otter (*Enhydra lutris kenyoni*): Southeast Alaska Stock. Available online at: https://www.fws.gov/sites/default/files/documents/northern-sea-otter-southeast-alaska-stock-assessment-report.pdf.

(USFWS, 2016). U.S. Fish and Wildlife Service. 2016. Programmatic Biological Opinion for Polar Bears (*Ursus maritimus*), Polar Bear Critical Habitat, and Conference Opinion for the Pacific Walrus (*Odobenus rosmarus divergens*) on Beaufort Sea Incidental Take Regulations. Fairbanks Fish and Wildlife Field Office. Available online at: https://www.fws.gov/alaska/fisheries/endangered/pdf/BeaufortITRs%20BO%202011%20-%20Final%20Corrected.pdf.

(USFWS, 2020). United States Fish and Wildlife Service. 2020. Personal Communication with Jenipher Cate, Marine Mammals Management, Alaska Region. Technical Review, September 2020.

(USFWS, 2021a). United States Fish and Wildlife Service. 2021. Listing and Critical Habitat | Critical Habitat | Frequently Asked Questions. Accessed August 2021 at: https://www.fws.gov/endangered/what-we-do/critical-habitats-faq.html.

(USFWS, 2021b). United States Fish and Wildlife Service. 2021. Personal Communication from Jennifer Spegon, Alaska ESA Section 7 Consultation Coordinator. Subject: NOS Meeting with USFWS Alaska. March 15, 2021.

(USFWS, 2023a). U.S. Fish and Wildlife Service. 2023. Northern Sea Otter (Southwest Alaska) Sea Otter Stock. Available online at: https://www.fws.gov/sites/default/files/documents/Northern-Sea-Otter-Stock-Assessment-Report-Southwest-Alaska-2023.pdf.

(USFWS, 2023b). U.S. Fish and Wildlife Service. 2023. Northern Sea Otter (Southcentral Alaska) Sea Otter Stock. Available online at: https: https://www.fws.gov/sites/default/files/documents/Northern-Sea-Otter-Stock-Assessment-Report-%20Southcentral-Alaska-2023.pdf.

(USFWS, 2023c). U.S. Fish and Wildlife Service. 2023. Northern Sea Otter (Southeast Alaska) Sea Otter Stock. Available online at: https: https: https://www.fws.gov/sites/default/files/documents/Northern-Sea-Otter-Stock-Assessment-Report-Southeast-Alaska-2023.pdf.

(USFWS, No Date-a). U.S. Fish and Wildlife Service. No Date. Pacific Walrus Hunting and Handicrafting. Accessed October 2021 at: https://www.fws.gov/Alaska-Native-handicrafts.

(USFWS, No Date-b). U.S. Fish and Wildlife Service. No Date. Marking, Tagging & Reporting. Accessed May 2023 at: https://www.fws.gov/alaska-MTRP.

(USFWS, No Date-c). U.S. Fish and Wildlife Service. No Date. Alaska Sea Otter Hunting & Handicrafting. Accessed October 2021 at: https://www.fws.gov/alaska/pages/marine-mammals/alaska-sea-otter-hunting-handicrafting.

(USGCRP, 2009). U.S. Global Change Research Program. 2009. Global Climate Change Impacts in the United States. Available online at: https://www.globalchange.gov/browse/reports/global-climate-change-impacts-united-states.

(USGCRP, 2018). U.S. Global Change Research Program. 2018. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. Available online at: https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf.

(USGS, No Date-a). United States Geological Service. No Date. Turbidity and Water. Accessed May 2023 at: https://www.usgs.gov/special-topics/water-science-school/science/turbidity-and-water#overview.

(USGS, No Date-b). United States Geological Survey. Overview. Water Quality Information by Topic. Accessed May 2023 at: https://www.usgs.gov/special-topics/water-science-school/science/water-quality-information-topic.

(USGS, No Date-c). U.S. Geological Survey. No Date. NAS – Nonindigenous Aquatic Species. Accessed May 2023 at: https://nas.er.usgs.gov/default.aspx.

(USMC, US Navy, & USCG, 2020). United States Marine Corps, United States Navy, United States Coast Guard. 2020. Advantage at Sea: Prevailing with Integrated All-Domain Naval Power. Available online at: https://media.defense.gov/2020/Dec/16/2002553074/-1/-1/0/TRISERVICESTRATEGY.PDF.

(USU, No Date). Utah State University. No Date. Water Quality – Aquatic Macroinvertebrates. Accessed May 2023 at: https://extension.usu.edu/waterquality/learnaboutsurfacewater/propertiesofwater/aquaticmacros.

(van der Oost et al., 2003). van der Oost, R., J. Beyer, and N.P.E. Vermeulen. 2003. Fish bioaccumulation and biomarkers in environmental risk assessment: a review. Environmental Toxicology and Pharmacology, 13(2), 57-149. Available online at: https://doi.org/10.1016/s1382-6689(02)00126-6.

(Vasconcelos et al., 2007). Vasconcelos, R.O., M.P. Amorim, and F. Ladich. 2007. Effects of ship noise on the detectability of communication signals in the Lusitanian toadfish. J. Exp. Biol.210:2104-2112. Available online at: 10.1242/jeb.004317.

(Vavrek et al., No Date). Vavrek,R.J., R. Kithil, R.L. Holle, J. Allsopp, and M.A. Cooper. No Date. The Science of Thunder. Accessed October 2021 at: http://lightningsafety.com/nlsi_info/thunder2.html.

(VeriSTAR, No Date) VeriSTAR. No Date. MARPOL Annex VI – Summary of Requirements. Available online at: https://www.veristar.com/rest/jcr/repository/collaboration/sites/veristarinfo/web%20contents/bv-content/news/bvNewsEvents/MARPOLANNEXVI/documents/2536.4.Summary%20of%20requirements.pdf.

(Voorhees et al., 2014). Voorhees, H., R. Sparks, H.P. Huntington, and K.D. Rode. 2014. Traditional Knowledge about Polar Bears (*Ursus maritimus*) in Northwestern Alaska. Arctic 67(4): 523-536.

Available online at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1016.3127&rep=rep1&type=pdf.

(Vox, 2013). Vox. 2013. What's it's like to hunt sea otters. Accessed May 2023 at: https://www.vox.com/2014/5/2/5671548/i-hunt-otters-ama.

(WA DOE, No Date). State of Washington, Department of Ecology. No Date. Pre-booming, alternative measures, and equivalent compliance. Accessed May 2023 at: https://ecology.wa.gov/Regulations-Permits/Compliance-enforcement/Pre-booming-requirements.

(Walker et al., 2018). Walker, T.R., O. Adebambo , M.C. Del Aguila Feijoo, E. Elhaimer, T. Hossain, S. J. Edwards , C.E. Morrison , J. Romo , N. Sharma , S. Taylor and S. Zomorodi. 2018. Environmental Effects of Marine Transportation. In: Word Seas: An Environmental Evaluation, pp. 505-530, 2nd Edition, Chapter 27. Available online at: https://doi.org/10.1016/B978-0-12-805052-1.00030-9.

(Wang et al., 2016). Wang, K., S. Wang, L. Zhen, and X. Qu. 2016. Cruise shipping review: operations planning and research opportunities. Maritime Business Review 1: 133 – 148. Available online at: https://doi.org/10.1108/MABR-04-2016-0007.

(Wardle et al., 2001). Wardle, C.S., T.J. Carter, G.G. Urquhart, A.D.F. Johnstone, A.M. Ziolkowski, G. Hampson, and D. Mackie. 2001. Effects of seismic airguns on marine fish. Continental Shelf Research 21:1005-1027. Available at: https://doi.org/10.1016/S0278-4343(00)00122-9.

(WDC, 2017). Workforce Development Council of Seattle-King County. 2017. Washington State Maritime Sector Economic Impact Study. Available online at: https://www.maritimefederation.com/uploads/2/9/9/6/29962189/cai.wmf.maritime_cluster_study_2017_update.2017_0413.pdf.

(Whatcom Land Trust, No Date). Whatcom Land Trust. No Date. Chelhtenem Lily Point Story. Accessed May 2023 at: http://www.jackex.com/lilypoint/story.html.

(Wiese et al., 2001). Wiese, F.K., W.A. Montevecchi, G.K. Davoren, F. Huettmann, A.W. Diamond, and J. Linke. 2001. Seabirds at risk around offshore oil platforms in the North-west Atlantic. Marine Pollution Bulletin 12:1285-1290. Available online at: http://www.opc.ca.gov/webmaster/_media_library/2016/01/Wiese-et-al-2001-offshore-lighting-and-seabirds.pdf.

(Wigglesworth, 2021). Wigglesworth, A. 2021. 2000 Eggs Abandoned After Drone Crash at California Reserve. Los Angeles Times. Accessed online May 2023 at: https://www.latimes.com/california/story/2021-06-07/thousands-of-eggs-abandoned-after-drone-crash-at-orange-county-nature-reserve.

(Wolfert et al., 2019). Wolfert, H., M. Ottink, R. Witte, R. Gunnewijk, and P. Harteveld. 2019. Best Practice Guide Version 1.0 Mitigation of Noise from Ships at Berth. Available online at: https://neptunes.pro/downloads/19.0043_BestPracticeReport_Geheel.pdf.

(World Bank, 2022). World Bank. 2022. Total greenhouse gas emissions (kt of C02 equivalent). Accessed online May 2023 at: https://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE.

(WP Council, 2019). Western Pacific Fishery Management Council. 2019. Fishery Ecosystem Plans + Amendments. Available online at: http://www.wpcouncil.org/fishery-ecosystem-plans-amendments/.

(WP Council, 2021). Western Pacific Fishery Management Council. 2021. 2021 Annual Stock Assessment and Fishery Evaluation Reports. Available online at: http://www.wpcouncil.org/annual-reports/##.

(WP Council, 2009). Western Pacific Regional Fishery Management Council. 2009. Fishery Ecosystem Plan for the Mariana Archipelago. Available online at: http://www.wpcouncil.org/fep/WPRFMC%20Mariana%20FEP%20(2009-09-22).pdf.

(Würsig et al., 1998). Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquatic Mammals 24:41-50. Available online at: https://aquaticmammalsjournal.org/share/AquaticMammalsIssueArchives/1998/AquaticMammals_24-01/24-01_Wursig.pdf.

(Wynne, 2013). Wynne, K. 2013. Guide to Marine Mammals of Alaska. Fourth Edition. University of Chicago Press. 80 pp. Available online at: https://seagrant.uaf.edu/bookstore/pubs/MAB-44.html.

(Yeates et al., 2007). Yeates, L.C., T.M. Williams, and T.L. Fink. 2007. Diving and foraging energetics of the smallest marine mammal, the sea otter (*Enhydra lutris*). The Journal of Experimental Biology 210, 1960-1970. Available online at: https://doi.org/10.1242/jeb.02767.

(Zieman et al., 1984). Zieman, J.C., R. Orth, R.C. Phillips, G. Thayer, and A. Thorhaug. 1984. The effects of oil on seagrass ecosystems. In Restoration of Habitats Impacted by Oil Spills (J. Crains and A. L. Buikema, eds.) Butterworth, Boston, MA. pp. 37-64. Available online at: https://www.researchgate.net/publication/242651053_The_effects_of_oil_spills_on_seagrass_ecosystems.

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7.0 GLOSSARY

Abalone: The common name for any of a group of small to very large marine gastropod molluscs in the family Haliotidae.

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.

Action Area: The geographic location where the Office of Marine and Aviation Operations Proposed Action would occur. It includes rivers, states' offshore waters, the United States territorial sea, the contiguous zone, United States portions of the Great Lakes, the United States Exclusive Economic Zone, and coastal and riparian lands.

Active Acoustic System: Refers to underwater sound sources including deepwater and shallow navigational echo sounders and acoustic systems beyond those for safety of navigation (e.g., multibeam echo sounders or side-scan sonar).

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 Impact: 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 Bloom: Colonies of algae i.e., simple plants that live in the sea and freshwater.

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.

Alongside: The position of a vessel when securely moored on a berth in port.

Amphipod: An order of crustaceans, resembling shrimp, with no carapace (i.e., hard upper shell) and ranging from 1 to 340 millimeters 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.

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: 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.

Articulating Frame: A basic structure designed to bear a load in a lightweight economical manner.

At-Sea: On the sea, far away from land.

Atoll: A ring-shaped coral reef, island, or series of islets.

Auditory Masking: The reduction in an animal's ability to perceive, recognize, or decode biologically relevant sounds because of interfering sounds.

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) to a value that better quantifies how loud a noise is perceived by humans. Corresponds to M-weighting functions for marine mammals.

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.

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 beneath the surface, with little or no sunlight present in the ecosystem. Above lies the mesopelagic zone; below the abyssopelagic zone.

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.

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.

Boom: A boom is a floating barrier used to contain marine spills and protect the environment; pre-booming is the deployment of that device before an oil transfer occurs.

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).

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.

Bulkhead: The walls or barriers that separate compartments of a vessel.

Bycatch: Fish or shellfish caught unintentionally or inadvertently while pursuing other target species.

Calibration: The process of configuring an instrument to provide a result for a sample within an acceptable range.

Capital: Human-created assets that can enhance one's power to perform economically useful work.

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.

Chlorophyll: The natural compound present in green plants and algae that gives them their color. It helps plants to absorb energy from the sun as they undergo the process of photosynthesis.

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.

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.

Conductivity, Temperature and Depth (CTD) Sensor: A CTD sensor refers to a package of electronic instruments that measure the CTD of water.

Contiguous Zone: A band of water extending farther from the outer edge of the territorial sea to up to 24 nautical miles (44.4 kilometers) 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.

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.

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 United States. Fish and Wildlife Service or National Marine Fisheries Service under the Endangered Species Act, 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.

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.

Davit: A crane-like devices used on a ship for supporting, raising, and lowering equipment such as boats and anchors.

Day at Sea (DAS): Any day in which a National Oceanic and Atmospheric Administration ship is at sea for at least one hour during a 24-hour period. Total number of ship DAS include mission, time anchored (except during port calls), maintenance, training, and calibration.

De-ballast: Exchange of ballast water (see definition above) in open ocean waters (for vessels that have ballast tanks).

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 Marine Mammal Protection Act): Status of a species under the Marine Mammal Protection Act when its population falls below the optimum sustainable population level.

Designed Cultural Landscape: A setting that includes purposefully planned views or vistas.

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.

Dissolved Oxygen (DO): A measure of how much oxygen is dissolved in the water and available to living aquatic organisms.

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.

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.

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 that share the same or related business activity, product, or service, such as agriculture, manufacturing, information technology, and finance.

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.

Emission Control Area (ECA): Sea areas of stringent international emission standards as designated by International Maritime Organization.

Endangered: A species is considered endangered under the Endangered Species Act 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.

Ensonify: To fill with sound, for example, a given volume of water of a given shape and configuration.

Environmental Justice (EJ): 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 meters (650 feet).

Escarpment: An area of ground surface at which elevation changes suddenly. It usually refers to a cliff, precipice, or steep slope.

Essential Fish Habitat (EFH): Those waters and substrate necessary for fish for spawning, breeding, feeding, or growth to maturity, as designated by the National Marine Fisheries Service.

Estuary: A partially enclosed coastal body of brackish water with one or more rivers or streams flowing into it, and with a free connection to the open sea. Estuaries form a transition zone between river environments and maritime environments.

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 United States and other coastal nations have jurisdiction over natural resources. The United States 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 United States, including the Commonwealth of Puerto Rico, Guam, American Samoa, the United States 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.

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: 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 United States Exclusive Economic Zone.

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.

Fledgling: A young bird which has developed wing feathers that are large and strong enough for flight.

Fleet: A group of ships under the same ownership or command.

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.

Frequency (): Rate of oscillation of a sound wave as the number of cycles per second: f [unit is Hz: Hertz]; 1 Hz = 1/s [per 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.

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.

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).

Greenhouse Gases (GHGs): Gases in the earth's atmosphere that trap heat.

Greywater: Water that has been used for washing dishes, laundering clothes, or bathing. Essentially, any water, other than toilet wastes.

Gross Domestic Product (GDP): The total value of goods produced and services provided in a country during one year.

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 or sea turtle that has recently emerged from its egg.

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 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.

Hull: A ship's watertight enclosure, engineered to provide sufficient protection for the cargo, machinery, and passenger accommodations. Its most basic purpose is to safeguard against weather, flooding, and/or structural damage.

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).

Hydrophone: An underwater microphone designed to detect, record, and listen to underwater sound waves from either natural sources or active acoustic systems for monitoring and research purposes.

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.

Impact Causing Factor: Activities that occur during Office of Marine and Aviation Operations vessel operations that could impact a given resource in the action area.

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.

In situ: Situated in the original place.

Isobath: An imaginary line or a line on a map or chart that connects all points having the same depth below the water surface.

Insolation: Sunlight or incoming solar radiation.

Intermittent Sound: A sound that is periodically present, in contrast to one that is constant or continuous.

Intertidal: Area where the ocean meets the land between high and low tides.

Invertebrate: Animal lacking a backbone.

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 (approximately 1.15078 miles per hour or 0.514 meters per second).

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.

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.

Longline: A fishing angling technique that uses a long main line with baited hooks attached at intervals via short branch lines.

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.

Macroinvertebrate: An animal lacking a backbone that can be seen without the aid of a microscope and captured by a 500--micrometer 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).

Magnetometer: A passive instrument that measures changes in the Earth's magnetic field. In ocean exploration, it can be used to survey cultural heritage sites such as ship and aircraft wrecks and to characterize geological features on the seafloor.

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.

Marine Sanitation Device (MSD): Any equipment on board a vessel which is designed to receive, retain, treat, or discharge sewage, and any process to treat such sewage.

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.

International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL): An international protocol developed to provide regulatory requirements and guidelines to minimize and prevent pollution from ships.

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.

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 1000 meters (3300 feet) deep.

Microplastic: Fragments of any type of plastic less than 5 millimeters in length.

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.

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.

Mysticete: A taxonomic suborder of cetaceans; whales that have two blowholes and baleen plates instead of teeth.

National Ambient Air Quality Standards (NAAQS): Limits on the atmospheric concentration of six pollutants that cause smog, acid rain, and other health hazards as established by the United States Environmental Protection Agency under authority of the Clean Air Act.

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.

Nearshore: Extending outward an indefinite but usually short distance from shore.

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.

Nursery Grounds: 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 ions concentration, of seawater increases as a result of absorbing carbon dioxide.

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.

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.

Oily Water Separator (OWS): A piece of equipment on a marine vessel used to separate oil and water mixtures into their separate components.

Operational Area (OAs): The geographic areas in which Office of Marine and Aviation Operations operations are conducted.

Otariid: Eared seals. This family includes sea lions and fur seals.

Over the Side (OTS) Handling: The deployment, positioning, and recovery of equipment.

Overwinter: The process of organisms adapting to and surviving winter conditions, such as freezing temperatures, ice, snow, and less available food.

Ozone-Depleting Substance (ODS): Chemicals that destroy the earth's protective ozone layer, such as chlorofluorocarbons.

Pack Ice: An expanse of large pieces of floating ice driven together into a nearly continuous mass, as occurs in polar seas.

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.

Particulate Matter (PM): Microscopic particles of solid or liquid matter suspended in the air.

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.

Pelagic: Relating to, living in, or found on the open sea, away from land, where water is deep; oceanic.

Permanent Threshold Shift: 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.

Personal Protective Equipment (PPE): Protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection.

Petroglyph: Prehistoric rock carving.

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.

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.

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.

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.

Porifera: Macroinvertebrate animal phylum composed of sponges.

Precision: The degree to which separate measurements or models of the same subject are close in value.

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.

Programmatic: Describes any broad or high-level National Environmental Policy Act review; it is not limited to a National Environmental Policy Act review for a particular project. Programmatic National Environmental Policy Act 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 National Environmental Policy Act reviews tiered from the programmatic review (e.g., a site- or project- specific document).

Propagule: 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.

Radar: Marine radars are equipment used in the identification, tracking, and positioning of vessels for safe navigation.

Red Tide: A common term used for harmful algal blooms (HABs), 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.

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.

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.

Sea Floor: The solid surface underlying a sea or ocean.

Seagrass: The only flowering plants which grow in marine environments; there are about 60 species of marine seagrasses.

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.

Sensitive Receptor: Receptors which are potentially sensitive to noise and vibration. Examples include hospitals, schools, daycare facilities, elderly housing, places of worship, areas designated for nature conservation/preservation, and parks.

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.

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.

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. In underwater sound, decibels are referenced to a pressure of 1 microPascal; thus, sound level is reported in units of dB re 1 microPascal at 1 meter.

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.

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.

Stormwater Runoff: Water that is generated from rain and snowmelt that flows over land or impervious surfaces, such as paved streets, parking lots, and building rooftops, and does not soak into the ground.

Strike Quota: Under international agreement, refers to the limitation on the number of 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.

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.

Thermosalinograph: A measuring instrument mounted near the water intake of ships to continuously measure sea surface temperature and conductivity while the ship is in motion.

Threatened: A species is considered threatened if it is likely to become an endangered species under the Endangered Species Act within the foreseeable future.

Tonal Sound: Sounds with discrete frequencies, such as music notes.

Traditional Cultural Places (TCPs): 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.

Trawling: A method of fishing that involves pulling a fishing net, or trawl, through the water or along the sea floor behind a boat.

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 United States 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.

Tunicate: Macroinvertebrate animal phylum including sea squirts or sea pork.

Turbidity: The measure of relative clarity of a liquid. It is an optical characteristic of water and is a measurement of the amount of light that is scattered by material in the water when a light is shined through the water sample. The higher the intensity of scattered light, the higher the turbidity.

Umiak: Seal skin boat.

Uncrewed Marine System (UMS): Marine vehicles without a person on board (e.g., Uncrewed Surface Vehicles, Autonomous Underwater Vehicles, Remotely Operated Vehicles, and gliders). Uncrewed vehicles can either be under telerobotic control—remote controlled or remote guided vehicles—or they can be autonomously controlled—autonomous vehicles—which are capable of sensing their environment and navigating on their own.

Uncrewed Aerial System (UAS): Aerial vehicles (e.g., flying drones) without a person on board. Uncrewed vehicles can either be under telerobotic control—remote controlled or remote guided vehicles—or they can be autonomously controlled—autonomous vehicles—which are capable of sensing their environment and navigating on their own.

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.

Underway: The condition of a vessel that is moving in open water or secured to a specific location in open water. The vessel is not made fast to the shore nor is it aground.

Unregulated Fishing (under Illegal, Unreported, and 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 (under Illegal, Unreported, and Unregulated 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 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.

Viewshed: A subset of a landscape unit that consists of all the surface areas visible from an observer's viewpoint.

Wastewater: Water that contains a waste byproduct. On the National Oceanic and Atmospheric Administration vessels, wastewater includes sewage, which contains human waste, and graywater, which could contain food scraps, oils, soaps, or chemicals from showers, kitchens, and bathroom sinks.

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.

Wetland: A distinct ecosystem that is flooded or saturated by water, either permanently or seasonally.

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.

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.

APPENDIX A: MISSION CAPABILITIES OF NOAA SHIPS

Appendix A: Mission Capabilities of NOAA Ships

Fisheries/Coastal Science Vessels (Medium Endurance)					
Ship Specifications	**Oregon II**	**Oscar Elton Sette**	**Gordon Gunter**	**Ferdinand R. Hassler**	**Nancy Foster**
Fleet Group	MOC-A	MOC-PI	MOC-A	MOC-A	MOC-A
Home Port	Pascagoula, MS	Ford Island, HI	Pascagoula, MS	New Castle, NH	Charleston, SC
Age (years, FY 2023)	56	36	34	14	33
Length (feet)	170	224	224	123	187
Displacement (tons)	729	2,014	2,328	744	1,190
Berthing Capacity	31	42	35	14	37
Vessel Movement, Navigation and Communication Systems	- Radars (X and S Band) - Gyro Compass - DGPS - Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Deepwater and Shallow Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - GPS - Navigational echo sounder	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Deepwater and Shallow Navigational echo sounder - ECDIS
Anchors	- Bow (2)	- Bow (2)	- Bow (2)	- Bow (2)	- Bow (2)
Waste Handling and Discharges	- Municipal potable as ballast - OWS - MSD	- Ballast Water Treatment System - OWS - MSD	- Municipal potable as ballast - OWS - MSD	- Exempt from ballasting - OWS - MSD	- Does not ballast - OWS - MSD
Active Acoustic Systems	N/A	- ADCP equipped	- ADCP equipped	- Multibeam echo sounder equipped - Side scan sonar equipped - Sound speed sensor equipped	- Single beam and multibeam echo sounder equipped - ADCP equipped
Other Sensors and Data Collection Systems	- CTD - Meteorology sensors	- CTD - Thermosalinograph	- CTD - Hydrophone	- CTD - Thermosalinograph - Meteorology sensors	- CTD - Thermosalinograph - Meteorology sensors
Uncrewed Marine Systems	N/A	- ROV support - AUV support	N/A	N/A	- ROV support - AUV support
Uncrewed Aircraft Systems	N/A	N/A	N/A	N/A	- UAS support

Fisheries/Coastal Science Vessels (Medium Endurance)					
Ship Specifications	**Oregon II**	**Oscar Elton Sette**	**Gordon Gunter**	**Ferdinand R. Hassler**	**Nancy Foster**
Small Boats	- Rescue Boats (1)	- Rescue Boats (1) - RHIBs (1) - Inflatable (non RHIB) (1)	- Rescue Boats (1) - RHIBs (1)	- Rescue Boats (1) - RHIBs (2)	- Rescue Boats (1) - RHIBs (3)
OTS, Cranes, Davits, And Winches	- Winches (4) - Cranes (2) - J Frames (1) - Boat Davits (1)	- Winches (4) - Cranes (2) - A or J Frames (3) - Boat Davits (1)	- Winches (4) - Cranes (2) - A or J Frames (2) - Boat Davits (1)	- Winches (4) - Cranes (1) - A Frames (1) - Boat Davits (2) - Windlass (2)	- Winches (3) - Cranes (2) - A or J Frames (2) - Boat Davits (1)

Fisheries/Coastal Science Vessels (High Endurance)					
Ship Specifications	**Oscar Dyson**	**Henry B. Bigelow**	**Bell M. Shimada**	**Reuben Lasker**	**Pisces**
Fleet Group	MOC-P	MOC-A	MOC-P	MOC-P	MOC-A
Home Port	Kodiak, AK	Newport, RI	Newport, OR	San Diego, CA	Pascagoula, MS
Age (years, FY 2023)	20	18	15	11	16
Length (feet)	209	209	209	209	209
Displacement (tons)	2,479	2,479	2,479	2,524	2,218
Berthing Capacity	39	41*	41*	39	34*
Vessel Movement, Navigation and Communication Systems	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Deepwater and Shallow Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - DGPS - Deepwater and Shallow Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - DGPS - Deepwater and Shallow Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Deepwater and Shallow Navigational echo sounder - ECDIS	- Gyro Compass - Navigational GPS
Anchors	- Bow (2) - Stern (1)	- Bow (2)	- Bow (2)	- Bow (2)	- Bow (2)
Waste Handling and Discharges	- Ballast Water Treatment System - OWS - MSD	- Municipal potable as ballast - OWS - MSD	- Municipal Potable as ballast - OWS - MSD	- Municipal potable as ballast - OWS - MSD	- Municipal potable as ballast - OWS - MSD

Fisheries/Coastal Science Vessels (High Endurance)					
Ship Specifications	**Oscar Dyson**	**Henry B. Bigelow**	**Bell M. Shimada**	**Reuben Lasker**	**Pisces**
Active Acoustic Systems	- Multibeam echo sounder equipped - ADCP equipped	- Multibeam echo sounder equipped - ADCP equipped	- Multibeam echo sounder equipped - ADCP equipped	- Multibeam echo sounder equipped - ADCP equipped	- Single beam and multibeam echo sounder equipped (including split beam) - ADCP equipped
Other Sensors and Data Collection Systems	- CTD - Thermosalinograph - Meteorology sensors	- CTD - Thermosalinograph - Meteorology sensor	- CTD - Thermosalinograph - Meteorology sensor	- CTD - Hydrophone - Thermosalinograph - Meteorology sensor	- CTD - Hydrophone - Thermosalinograph - Meteorology sensor
Uncrewed Marine Systems	N/A	- ROV support	- ROV support	N/A	N/A
Uncrewed Aircraft Systems	N/A	- UAS support	- UAS support	- UAS support	N/A
Small Boats	- Rescue Boats (1) - Survey Launches (2)	- Rescue Boats (1) - Work Boats (1)	- Rescue Boats (1)	- Rescue Boats (1) - RHIBs (1)	- Rescue Boats (1)
OTS, Cranes, Davits, And Winches	- Winches (6) - Cranes (3) - A Frames (2)	- Winches (6) - Cranes (3) - A Frames (2) - Boat Davits (2)	- Winches (6) - Cranes (3) - A Frames (2) - Boat Davits (1)	- Winches (6) - Cranes (2) - A Frames (1) - Boat Davits (2) - Stern Gantry (1)	- Winches (10) - Cranes (3) - A or J Frames (2) - Boat Davits (1)

Charting and Mapping Vessels				Oceanographic Research Vessels	
Ship Specifications	**Rainier**	**Fairweather**	**Thomas Jefferson**	**Ronald H. Brown**	**Okeanos Explorer**
Fleet Group	MOC-P	MOC-P	MOC-A	MOC-A	MOC-A
Home Port	Newport, OR	Ketchikan, AK	Norfolk, VA	Charleston, SC	Newport, RI
Age (years, FY 2023)	56	56	32	27	35
Length (feet)	231	231	208	274	224
Displacement (tons)	1,800	1,800	2,000	3,250	2,062
Berthing Capacity	64	57	38	60	49

	Charting and Mapping Vessels			Oceanographic Research Vessels	
Ship Specifications	**Rainier**	**Fairweather**	**Thomas Jefferson**	**Ronald H. Brown**	**Okeanos Explorer**
Vessel Movement, Navigation and Communication Systems	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Deepwater and Shallow Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - GPS - Deepwater and Shallow Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Deepwater and Shallow Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Shallow Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Deepwater and Shallow Navigational echo sounder - ECDIS
Anchors	- Bow (2)	- Bow (2)	- Bow (2)	- Bow (2)	- Bow (2)
Waste Handling and Discharges	- Does not ballast - OWS - MSD	- Does not ballast - OWS - MSD	- Municipal potable as ballast - OWS - MSD	- Ballast Water Treatment System - OWS - MSD	- Ballast Water Treatment System - OWS - MSD
Active Acoustic Systems	- Multibeam echo sounder equipped	- Multibeam echo sounder equipped	- Single beam and multibeam echo sounder equipped - Side scan sonar equipped	- Multibeam echo sounder equipped - ADCP equipped	- Single beam and multibeam echo sounder equipped (including split beam)
Other Sensors and Data Collection Systems	- CTD - Meteorology sensors	- CTD - Meteorology sensors	- CTD - Meteorology sensors - Bottom sampling equipment	- CTD - Thermosalinograph - Meteorology sensors	- CTD - Thermosalinograph - Meteorology sensors
Uncrewed Marine Systems	N/A	N/A	N/A	N/A	- ROV support
Uncrewed Aircraft Systems	N/A	N/A	N/A	N/A	N/A
Small Boats	- Rescue Boats (1) - Survey Launches (5) - SAFE Boat (1) - SeaArk (1)	- Rescue Boats (1) - Survey Launches (4) - RHIBs (1) - Skiffs (1)	- Rescue Boats (1) - Survey Launches (2)	- Rescue Boats (1) - RHIBs (1)	- Rescue Boats (1) - RHIBs (1)

	Charting and Mapping Vessels			Oceanographic Research Vessels	
Ship Specifications	**Rainier**	**Fairweather**	**Thomas Jefferson**	**Ronald H. Brown**	**Okeanos Explorer**
OTS, Cranes, Davits, And Winches	- Cranes (3) - Boat Davits (6) - MVP Towfish (1)	- Winches (2) - Cranes (3) - A or J Frames (2) - Boat Davits (6)	- Winches (2) - Cranes (2) - J Frames (1) - Boat Davits (3)	- Winches (3) - Cranes (3) - A Frames (1) - Boat Davits (1) - Hydro Boom (1)	- Winches (1) - Cranes (2) - A or J Frames (2) - Boat Davits (2)

	New Oceanographic Research Builds		New Charting and Mapping Builds[1]	
Ship Specifications	**Discoverer**	**Oceanographer**	**B-One**	**B-Two**
Fleet Group	MOC-A	MOC-PI	MOC-P	MOC-PI
Home Port	Newport, RI	Ford Island, HI	unknown	unknown
Age (years, FY 2023)	-1	-1	-4	-4
Length (feet)	244	244	268	268
Displacement (tons)	2,865	2,865	~3,000	~3,000
Berthing Capacity	48	48	48	48
Vessel Movement, Navigation and Communication Systems	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Shallow Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Deepwater and Shallow Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Shallow Navigational echo sounder - ECDIS	- Radars (X and S Band) - Gyro Compass - GPS and DGPS - Deepwater and Shallow Navigational echo sounder - ECDIS
Anchors	- Bow (2)	- Bow (2)	- Bow (2)	- Bow (2)
Waste Handling and Discharges	- Ballast Water Treatment System - OWS - STP	- Ballast Water Treatment System - OWS - STP	- Ballast Water Treatment System - OWS - STP	- Ballast Water Treatment System - OWS - STP
Active Acoustic Systems	- Single beam and multibeam echo sounder equipped (including split beam) - ADCP equipped	- Single beam and multibeam echo sounder equipped (including split beam) - ADCP equipped	- Single beam and multibeam echo sounder equipped (including split beam) - ADCP equipped - Sub-bottom Profiler	- Single beam and multibeam echo sounder equipped (including split beam) - ADCP equipped - Sub-bottom Profiler

[1] OMAO awarded contracts to build two new charting and mapping vessels in July 2023. Some ship specifications for these vessels are not yet available.

New Oceanographic Research Builds			New Charting and Mapping Builds[1]	
Ship Specifications	**Discoverer**	**Oceanographer**	**B-One**	**B-Two**
Other Sensors and Data Collection Systems	- CTD - Thermosalinograph - Meteorology sensors	- CTD - Thermosalinograph - Meteorology sensors	- CTD - Thermosalinograph - Meteorology sensors	- CTD - Thermosalinograph - Meteorology sensors
Uncrewed Marine Systems	- ROV support	- ROV support	unknown	unknown
Uncrewed Aircraft Systems	N/A	N/A	unknown	unknown
Small Boats	- Rescue Boats (1) - RHIBs (1)	- Rescue Boats (1) - RHIBs (1)	unknown	unknown
OTS, Cranes, Davits, And Winches	- Winches (3) - Cranes (2) - A Frames (1) - Boat Davits (2) - J-Arms (2)	- Winches (3) - Cranes (2) - A Frames (1) - Boat Davits (2) - J-Arms (2)	unknown	unknown

* Maximum complement was used in place of total berthing (total berthing not listed).

ADCP = Acoustic Doppler Current Profiler; AUV = Autonomous Underwater Vehicles; CTD = Conductivity, Temperature, and Depth; DGPS = Differential Global Positioning System; ECDIS = Electronic Chart Display and Information System; FY = Fiscal Year; GPS = Global Positioning System; MOC = Marine Operations Center; MSD = Marine Sanitation Device; MVP = Moving Vessel Profiler; RHIB = Rigid Hull Inflatable Boat; ROV = Remotely Operated Vehicles; OTS = Over-the-side; OWS = Oily Water Separator; STP = Sewage Treatment Plan; UAS = Uncrewed Aircraft Systems

APPENDIX B: NOAA MARINE OPERATION CENTERS

Appendix B: NOAA Marine Operation Centers

NOAA and OMAO headquarters, located in Silver Spring, Maryland, is staffed by civilians and NOAA Corps Officers. NOAA also operates three marine operations centers (MOC). These MOCs serve as homeports to some of NOAA's ships and provide administrative, engineering, maintenance, and logistical support to that region's fleet.

Marine Operations Center-Atlantic (MOC-A)

MOC-A is located in Norfolk, Virginia[2]. It serves as the homeport for NOAA Ship *Thomas Jefferson* and supports NOAA's Atlantic fleet. Facilities and ports include:

- Charleston Marine Support Facility, Charleston, South Carolina;
- Gulf Marine Support Facility, Pascagoula, Mississippi;
- Naval Station Newport, Newport, Rhode Island[2];
- New England Marine Support Facility, Middletown, Rhode Island; and
- University of New Hampshire, Judd Gregg Marine Research Pier, New Castle, New Hampshire.

Marine Operations Center-Pacific (MOC-P)

MOC-P is located in Newport, Oregon. It serves as a homeport for NOAA Ships *Rainier* and *Bell M. Shimada* and supports NOAA's Pacific fleet. Facilities and ports include:

- Ketchikan Marine Support Facility, Ketchikan, Alaska;
- Kodiak Marine Support Facility, Kodiak, Alaska; and
- Port of San Diego, San Diego, California.

Marine Operations Center-Pacific Islands (MOC-PI)

MOC-PI is located in Oahu, Hawai'i. It serves as a homeport for NOAA Ship *Oscar Elton Sette* and supports NOAA's Pacific Islands fleet. Facilities and ports include:

- Inouye Regional Center on Ford Island, Oahu, Hawai'i.

[2] MOC-A will be relocating to Naval Station Newport in Newport, Rhode Island. A timeline for relocation has not yet been announced.

APPENDIX C: OMAO VESSEL OPERATIONS BEST MANAGEMENT PRACTICES

Appendix C: OMAO Vessel Operations Best Management Practices

Triggering Event	Crew Response
At all times while in transit or conducting drills or training	Do not attempt to feed, touch, ride, or otherwise intentionally interact with any marine protected species.
	Avoid areas where Navy exercises are being conducted and other hazards using information from Local Notice to Mariners.
	Maintain a watch for protected species at all times. OMAO follows the Standards of Training, Certifications, and Watchkeeping for Seafarers (STCW) and maintains watch standers at all times while underway.
	Have species identification keys for corals, ESA-listed fishes, abalone, and seagrasses available on all vessels.
One or more cetaceans (whales, dolphins, or porpoises) are sighted while a vessel is underway	Attempt to remain parallel to the animal's course if feasible. Avoid excessive speed or abrupt changes in direction until the cetacean has left the area.
An Endangered Species Act (ESA)-listed marine mammal is identified while a vessel is underway	Remain at least 100 yards from large whales, and 50 yards from dolphins, porpoises, seals, and sea lions. Federal law requires vessels to remain 100 yards away from humpback whales in Hawaii and Alaska waters, 200 yards from killer whales in Washington State inland waters, and 500 yards away from North Atlantic right whales throughout U.S. waters.
An ESA-listed whale is sighted within 100 yards of the forward path of a vessel	Reduce speed if moving. Maintain distance from the whale. If possible, steer a course that increases the distance from the whale at a speed of 10 knots or less until a 457 m (500 yd) separation distance has been established. Continue to monitor the whale until it has moved outside of the vessel's path, and proceed with caution. A single cetacean at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures should continue to be exercised after the whale has moved away.
One or more sea turtles are sighted or sargassum is sighted while a vessel is underway	Attempt to maintain a distance of 50 yards (45 meters) or greater whenever possible.
	Avoid sargassum if possible, to prevent impact on sea turtle hatching habitat.
Nighttime vessel operation	Vessel operators operating at night would use the appropriate lighting to comply with navigation rules and best safety practices. Crewmembers are posted during vessel operations at nighttime.

Triggering Event	Crew Response
Entry into North Atlantic right whale critical habitat	Report into the Mandatory Ship Reporting System.
Before proceeding with operations onboard a vessel 65 feet or longer in any North Atlantic right whale seasonal management areas, when those areas are active. See maps and coordinates at https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-vessel-strikes-north-atlantic-right-whales	Maintain a vessel speed of 10 knots or less.
	Check with various communication media for general information regarding avoiding ship strikes and specific information regarding North Atlantic right whale sighting locations. These include NOAA weather radio, U.S. Coast Guard NAVTEX broadcasts, the WhaleAlert app (www.whalealert.org), and Notices to Mariners.
Transit areas cross North Pacific right whale habitat	Avoid transit through North Pacific right whale critical habitat. For unavoidable transits, maintain a vessel speed of 10 knots or less.
Entry into Rice's whale areas (Core Distribution Area [CDA] and the 100 m to 400 m isobath in the Gulf of Mexico)	a. Minimize all transits b. Do not exceed 10 knots c. Do not enter at night. If vessels are present in the CDA/isobath at night, the vessel must be anchored, moored, or otherwise immobile.
Entry into sensitive Steller sea lion areas	Maintain a vessel distance of at least 3 nm from Steller sea lion rookeries, major haulouts, and other critical habitats listed in 50 CFR 223.202 or Marmot Island.
Entry into sturgeon and sawfish critical habitat as shown at https://www.fisheries.noaa.gov/resource/map/atlantic-sturgeon-critical-habitat-map-and-gis-data https://www.fisheries.noaa.gov/resource/map/smalltooth-sawfish-critical-habitat-map-and-gis-data https://data.noaa.gov/dataset/dataset/green-sturgeon-critical-habitat-gis-data1	All vessels in coastal waters will operate in a manner to minimize propeller wash and sea floor disturbance, and transiting vessels should follow deep-water routes (e.g., marked channels), as practicable, to reduce disturbance to sturgeon and sawfish critical habitat.
Sighting of any injured, dead, or entangled ESA-listed species, especially right whales	Report sighting immediately to the U.S. Coast Guard at VHF Ch. 16 and the appropriate Marine Mammal Health and Stranding Response Network. Contact information is available at https://www.fisheries.noaa.gov/report

Triggering Event	Crew Response
Sightings of critically endangered cetaceans including North Atlantic right whale, North Pacific right whale, Southern Resident killer whale, Main Hawaiian Island insular false killer whale, and Rice's whale	Report sighting within two hours of occurrence when practicable and no later than 24 hours after occurrence (to https://www.fisheries.noaa.gov/report). Right whale sightings in any location may also be reported to the U.S. Coast Guard and through the WhaleAlert App (http://www.whalealert.org/).
Sighting of any protected marine species within 100 yards of the vessel	Do not discharge.
Vessel and equipment maintenance	Implement mandatory invasive species prevention procedures including, but not limited to, vessel and equipment washdown, cleaning, and de-ballasting. Seawater ballast is limited to only those ships with ballast water treatment systems, and the seawater must be treated before it can be discharged.
Operating or maintaining a vessel, in conjunction with the Vessel General Permit	Use anti-fouling coatings.
	Clean hull regularly to remove aquatic nuisance species.
	Avoid cleaning of hull in critical habitat.
	Use minimally toxic, biodegradable, phosphate-free cleaners.
Operating or maintaining a vessel	Avoid discharging any material not expressly allowed in national marine sanctuaries (see 15 CFR 922 for list of regulations for each sanctuary).
	Rinse anchor with high-powered hose after retrieval.
	Maintain a contingency plan to control toxic materials.
	Store appropriate materials aboard to contain and clean potential spills.
	All materials and equipment placed in the water will be free of pollutants.
	Operators should perform daily pre-work equipment inspections for cleanliness and leaks. All heavy equipment operations should be postponed or halted should a leak be detected, and will not proceed until the leak is repaired and equipment cleaned.
Sighting of any protected marine species within 100 yards of the work area	Suspend deployment of all instruments and autonomous systems. Work already in progress may continue if that activity is not expected to adversely affect the animal(s).
Anchoring	Use designated anchorage areas when available. If a designated anchorage area is not available, anchor in mud or sand, and avoid anchoring on corals and hard bottom, in seagrass, and in abalone critical habitat as defined at https://media.fisheries.noaa.gov/2022-05/ch_2021mapseries_AbaloneBlack.jpg.

Triggering Event	Crew Response
	Minimize anchor drag (i.e., provide adequate anchor scope).
Bottom sampling for sediment verification	Avoid testing of bottom sampling equipment on coral reefs, shipwrecks, obstructions, or hard bottom areas.
Equipment/Autonomous Systems Deployment	Stiffer line materials should be used for towing and kept taut during operations to reduce the potential for entanglement in bottom features such as coral habitats and shipwrecks.
	In the event entanglements occur, prepare a written summary with photographs to document the incident for NMFS.
AUV operation	Equipment such as AUVs would be programmed and operated to avoid sea floor disturbance during testing and training.
Small boat operations	While operating in shallow water, reduce speeds and proceed with caution to avoid bottom disturbance; avoid critical habitat.
Operating vessels in polar bear habitat	Ensure that vessels maintain a 1.6-kilometer (km) (1 mile [mi]) separation distance from polar bears observed on ice, land, or water.
	Be alert to potential presence of polar bears, visually monitor the area and adjacent waters. Be especially vigilant for swimming bears. 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.
Operating vessels in Pacific walrus habitat	Maintain an appropriate minimum distance from walruses hauled out on ice or land: Marine vessels less than 15 m (50 ft) in length – 1 km (0.5 nm); Marine vessels 15 m or more but less than 30 m (100 ft) in length – 1.8 km (1 nm); and Marine vessels 30 m (100 ft) or more in length – 5.5 km (3 nm).
	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

Triggering Event	Crew Response
	water and often reverberates off of cliffs and bluffs adjacent to coastal walrus haulouts, amplifying noise.
	Reduce speed and maintain a minimum distance of 0.8 km (0.5 mi) from groups of walruses in the water. Do not operate the vessel in such a way as to separate members of a group of walruses from other members of the group.
	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.
Operating vessels in northern sea otter habitat	Do not operate vessels in such a way as to separate 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 yd). If the group size is greater than 10, do not approach within 500 m (547 yd).
Operating vessels in manatee habitat (U.S. Gulf coast and Atlantic Coast as far north as the Chesapeake Bay)	All personnel associated with the project shall be instructed about the presence of manatees and manatee speed zones, and the need to avoid collisions with and injury to manatees. All crews shall be advised that there are civil and criminal penalties for harming, harassing, or killing manatees.
	All vessels associated with the project shall operate at "Idle Speed/No Wake” at all times 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.
	Observe water-related activities for the presence of manatee(s). 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 vessel, or until 30 minutes elapses if the manatee(s) has not reappeared within 15 m (50 ft) of the vessel. Animals must not be herded away or harassed into leaving.
	Any collision with or injury to a manatee shall be reported immediately. To report dead, debilitated, or distressed manatees, call 1-877-WHALE HELP (1-877-942-5343). NOAA

Triggering Event	Crew Response
	Fisheries also has created a Dolphin & Whale 911 telephone app that can be used to direct calls to the nearest stranding response helpline.

General Notes:

OMAO follows all laws and regulations as they pertain to vessel operations; the following Best Management Practices (BMPS) are implemented to further reduce environmental impacts.

These requirements do not apply when (1) compliance would create an imminent threat to a person or vessel, or (2) to the extent that a vessel cannot comply because it is restricted in its ability to maneuver.

Projects involving direct take of protected species are NOT included in the scope of the OMAO Programmatic Environmental Assessment or these BMPs. NOAA Line Offices would be required to complete the regulatory compliance requirement for such projects on their own.

OMAO has discretion on the location and duration of the following activities: transiting, training, calibration and testing of equipment, and small boat operations.

APPENDIX D: REGULATIONS FOR SHIP DISCHARGES IN STATE-SPECIFIC OR OTHER PROTECTED WATERS

Appendix D: Regulations for Ship Discharges in State-Specific or Other Protected Waters

The following are regulations that pertain to NOAA Fleet vessel discharges in addition to their National Pollution Discharge Elimination System (NPDES) Vessel General Permit (VGP). These restrictions must be followed within state-specific waters and other protected waters (e.g., national marine sanctuaries and monuments), and are included in each vessel's NPDES VGP Ship Specific Instructions (SSI):

Alaska

- Permittees must be aware of impaired waters before traveling through prior to discharge activity; The Clean Water Act (CWA) 303(d) list includes Dutch Harbor for Petroleum Products; Skagway for Metals (cadmium, copper, lead, mercury, zinc); and Prince of Wales Islands for Metals (copper).
- Discharges shall not be in violation of Alaska water quality criteria (18 Alaska Administrative Code [AAC] 70); vessels must treat waste water and/or implement Best Management Practices (BMPs) in their VGP.
- All vessels shall undertake immediate corrective actions; VGP does not preclude the Department of Environmental Conservation from regulating or enforcing under Alaska law.

California

- All discharges are prohibited in state water quality protection areas, including: Redbook National Park Area of Special Biological Significance (ASBS); Trinidad Head ASBS; King Range ASBS; Saunders Reef ASBS; Del Mar Landing ASBS; Gerstle Cove ASBS; Bodega ASBS; Bird Rock ASBS; Point Reyes Headlands ASBS; Double Point ASBS; Duxbury Reef ASBS; James V. Fitzgerald ASBS; Farallon Islands ASBS; Ano Nuevo ASBS; Pacific Grove ASBS; Carmel Bay ASBS; Point Lobos ASBS; Julia Pfeiffer Burns ASBS; Salmon Creek Coast ASBS; San Miguel, Santa Rosa and Santa Cruz Islands ASBS; San Nicholas Island and Begg Rock ASBS; Santa Barbara Island and Anacapa Island ASBS; Laguna Point to Latigo Point ASBS; San Clemente Island ASBS; North West Santa Catalina Island ASBS; Western Santa Catalina Island ASBS; Farnsworth Bank ASBS; Southeast Santa Catalina Island ASBS; Robert E. Badham (Newport Coast) ASBS; Irvine Coast (Crystal Cove) ASBS; Heisler Park ASBS; San Diego-Scripps ASBS; and La Jolla ASBS.
- The following wastes are prohibited from discharge: sewage sludge, used or spent oil, garbage or trash (including plastic), photo-developing wastes, dry cleaning wastes, noxious liquid substance residues, and medical wastes. Graywater discharge is also prohibited in state waters if the vessel has sufficient holding capacity. Detergents must not be used to disperse hydrocarbon sheens in any waste streams.
- Ships with sufficient holding tank capacity shall notify Cal Emergency Management Agency (EMA) immediately (no longer than 30 minutes) after the discovery of a release of graywater, sewage, hazardous waste, other waste, sewage sludge, or oily bilge water into the marine waters of the state or a marine sanctuary.
- Submit National Ballast Information Clearinghouse (NBIC) Ballast Water Reports to the State. A hull husbandry reporting form must be submitted upon request by the State of California. Propeller cleaning is allowed until the biofouling management regulations for vessels are adopted by the SLC and become effective. All other in water hull cleaning is prohibited unless

conducted using the best available technologies economically feasible. This prohibition includes underwater ship husbandry discharges.

- Any vessel owner or operator must submit the fee and a copy of US Environmental Protection Agency's (EPA) Notice of Intent (NOI) acknowledgement letter to California Water Resources Control Board.

Connecticut

- Any vessel that discharges or intends to discharge into CT waters must submit a copy of the NOI to the Department of Energy and Environmental Protection (DEEP). All other reports required by the EPA must also be submitted to DEEP. All VGP violations or instances of non-compliance must be reported immediately to DEEP.
- Discharge of treated or untreated bilge water, treated or untreated graywater, waste waters from pressure washing the bottom of vessels, any point source or non-point source pollution from spillage, sanding, sand blasting, or scraping of vessels is prohibited.
- Vessels must minimize the loading of nutrients.
- Any discharge from any vessel covered under the VGP or sVGP that results in further degradation of the chemical, physical, or biological integrity of CT waters classified as Impaired Waters in the most recent State of Connecticut Integrated Water Quality Report to Congress is prohibited. Areas affective OMAO vessels include, but are not limited to: Norwalk Islands, Norwalk, CT.

Hawai'i

- The Marine Operations Center Environmental Compliance Officer (ECO) must submit the NPDES VGP NOI for Hawai'i vessels through the Department of Health (DOH) Clean Water Branch (CWB) website.

Maine

- Prior to entering Maine waters, if the voyage originated outside the US Economic Exclusive Zone (EEZ), ensure that Ballast Water Management Procedures have been followed even if a vessel is equipped with a Ballast Water Treatment System, including ballast water exchange beyond 200 nautical miles (nm) of shore.
- No vessel covered by the VGP may discharge pollutants to Class GPA (lake or pond less than 10 acres in size) or Class SA (estuarine and marine waters with outstanding natural resources) waters.
- No vessel covered by the VGP may conduct underwater hull cleaning except as part of emergency hull repairs necessary to secure the vessel or saving a life at sea. This prohibition includes removal of biological growth, debris, or scrubbing the hull to reveal fresh antifouling coatings.

New Hampshire

- All vessel sewage discharge (including graywater containing sewage), whether treated or untreated, is prohibited in No Discharge Zones. These zones include the entirety of New Hampshire's coastline within 3 nm of shore.

- Discharge of graywater is prohibited west of the Interstate 95 Bridge over the Piscataqua River. Graywater without sewage should be discharged at pump out facilities or beyond 3 nm of the New Hampshire shoreline and the Isles of Shoals wherever feasible.
- Discharge of treated bilge water should be avoided within 3 nm of shore. If discharging, ensure that discharge does not result in visible impact to water.

New York

- Prior to entering New York waters, if the voyage originated outside the US EEZ, ensure that Ballast Water Management Procedures have been followed even if a vessel is equipped with a Ballast Water Treatment System, including ballast water exchange beyond 200 nm of shore. After a Ballast Water Treatment System is installed, annual sampling and analysis results must be submitted to the state of New York.
- Discharge of bilge water is prohibited in New York waters, unless the safety and stability of the vessel is threatened.

Rhode Island

- Prior to entering Rhode Island waters, if the voyage originated outside the US EEZ, ensure that Ballast Water Management Procedures have been followed even if a vessel is equipped with a Ballast Water Treatment System, including ballast water exchange beyond 200 nm of shore. After a Ballast Water Treatment System is installed, annual sampling and analysis results must be submitted to the state of New York.
- Vessels whose voyages originate outside the US EEZ must discharge all existing bilge water through the oily water separator (OWS) prior to entering Rhode Island, or hold bilge water within state waters.
- Discharge of graywater is restricted per the permit in these areas, but are not limited to: West Passage in Narragansett Basin; and Newport Harbor/Coddington Cove in Narragansett Basin.

Washington

- Report any of the following non-compliant discharges within 24 hours of occurrence to the Washington State Department of Health (WDOH), including discharge location, volume, type, date, time, and duration of discharge: graywater discharge in violation of VGP Parts 2.2.15, 5.1.1, or 5.2.1; raw sewage discharges or discharges from marine sanitation device (MSD) when MSD is not functioning properly 40 Code of Federal Regulations (CFR) § 140.3(d), or any upset in a disinfection system, such as MSD failure.
- Hull cleaning in state waters must be approved by the WA Department of Fish and Wildlife.
- Discharges to state waters that would cause a sheen, film, sludge, foam, turbidity, color, or odor are prohibited, except for discharges from firefighting foam conducted in accordance with VGP Part 2.2.5.

Other Protected Waters

- Other protected waters include all currently designated national marine sanctuaries and marine national monuments. Regulations for these sanctuaries and monuments must be consulted prior to entry into these waters:

  - Channel Islands National Marine Sanctuary;
  - Cordell Bank National Marine Sanctuary;
  - Greater Farallones National Marine Sanctuary;
  - Florida Keys National Marine Sanctuary;
  - Flower Garden Banks National Marine Sanctuary;
  - Gray's Reef National Marine Sanctuary;
  - Hawaiian Islands Humpback Whale National Marine Sanctuary;
  - Mallows Bay-Potomac River National Marine Sanctuary;
  - Monitor National Marine Sanctuary;
  - Monterey Bay National Marine Sanctuary;
  - National Marine Sanctuary of American Samoa (including Rose Atoll Marine National Monument);
  - Olympic Coast National Marine Sanctuary;
  - Papahanaumokuakea Marine National Monument;
  - Stellwagen Bank National Marine Sanctuary;
  - Thunder Bay National Marine Sanctuary; and
  - Wisconsin-Shipwreck Coast National Marine Sanctuary.
- NOAA ships periodically update their NPDES VGP SSI to determine if newly designated protected waters are within their operating areas. Any new sanctuary or monument would be included in each ship's respective NPDES VGP SSI as they become designated.