4 Cumulative Impacts

4 CUMULATIVE IMPACTS

4.1 INTRODUCTION

The analysis of cumulative impacts (or cumulative effects)[1] presented in this section follows the requirements of the National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ) guidance (Council on Environmental Quality 1997). The CEQ regulations (40 Code of Federal Regulations [C.F.R.] §§1500–1508) provide the implementing regulations for NEPA. The regulations define cumulative impacts as:

> "…the impact on the environment which results from the incremental impact of the action when added to the 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 (40 C.F.R. §1508.7)."

While a single project may have minor impacts, overall impacts may be collectively significant when the project is considered together with other projects on a regional scale. A cumulative impact is the additive effect of all actions in the geographic area. The CEQ provides guidance on cumulative impact analysis in *Considering Cumulative Impacts under the National Environmental Policy Act* (Council on Environmental Quality 1997). This guidance further identifies cumulative impacts as those environmental impacts resulting "from spatial and temporal crowding of environmental perturbations. The impacts of human activities will accumulate when a second perturbation occurs at a site before the ecosystem can fully rebound from the impacts of the first perturbation." This guidance observes that "no universally accepted framework for cumulative impacts analysis exists…" while noting that certain general principles have gained acceptance. The CEQ provides guidance on the extent to which agencies of the federal government are required to analyze the environmental impacts of past actions when they describe the cumulative environmental effect of an action. This guidance provides that an analysis of cumulative impacts might encompass geographic boundaries beyond the immediate area of an action and a timeframe that includes past actions and foreseeable future actions. Thus, the CEQ guidelines observe, "[it] is not practical to analyze cumulative impacts of an action on the universe; the list of environmental impacts must focus on those that are truly meaningful."

4.2 APPROACH TO ANALYSIS

4.2.1 OVERVIEW

Cumulative impacts were analyzed for each resource addressed in Chapter 3 (Affected Environment and Environmental Consequences) for the Proposed Action in combination with past, present, and reasonably foreseeable future actions. The cumulative impacts analysis included the following steps, described in more detail below:

1. Identify appropriate level of analysis for each resource.
2. Define the geographic boundaries and timeframe for the cumulative impacts analysis.
3. Describe current resource conditions and trends.
4. Identify potential impacts of the Proposed Action that might contribute to cumulative impacts.

[1] Council on Environmental Quality regulations provide that the terms "cumulative effects" and "cumulative impacts" are synonymous (40 C.F.R. § 1508.8[b]); the terms are used interchangeably by various sources, but the term "cumulative impacts" will be used in this document except for quotations, for continuity.

5. Identify past, present, and other reasonably foreseeable future actions that affect each resource.
6. Analyze potential cumulative impacts.

4.2.2 IDENTIFY APPROPRIATE LEVEL OF ANALYSIS FOR EACH RESOURCE

In accordance with guidance set forth by the CEQ, the cumulative impacts analysis focused on impacts that are "truly meaningful," (Council on Environmental Quality 1997). The level of analysis for each resource was commensurate with the intensity of the impacts identified in Chapter 3 (Affected Environment and Environmental Consequences). The rationale for the level of analysis applied to each resource is described in Section 4.4 (Resource-Specific Cumulative Impacts).

4.2.3 DEFINE THE GEOGRAPHIC BOUNDARIES AND TIMEFRAME FOR ANALYSIS

The geographic boundaries for the cumulative impacts analysis included the entire Gulf of Alaska (GOA) Navy Training Activities Supplemental Environmental Impact Statement (EIS)/Overseas EIS (OEIS) Study Area (Study Area) (Figure 2.1-1). The geographic boundaries for cumulative impacts analysis for marine mammals were expanded to include activities outside the GOA Supplemental EIS/OEIS Study Area that might impact migratory marine mammals. Primary considerations from outside the Study Area include impacts associated with maritime traffic (e.g., vessel strikes and underwater noise) and commercial fishing (e.g., bycatch and entanglement).

Determining the timeframe for the cumulative impacts analysis requires estimating the length of time the impacts of the Proposed Action would last and considering the specific resource in terms of its history of degradation (Council on Environmental Quality 1997). The Proposed Action includes ongoing and anticipated future training activities. While the United States (U.S.) Department of the Navy (Navy) training requirements change over time in response to global events, geopolitical events, or other factors, the general types of activities addressed by this Supplemental EIS/OEIS are expected to continue into the reasonably foreseeable future, along with the associated impacts. Likewise, some non-military activities addressed in this cumulative impacts analysis (e.g., oil and gas production, maritime traffic, commercial fishing) are expected to continue into the reasonably foreseeable future. Therefore, the cumulative impacts analysis is not bounded by a specific future timeframe. For past actions, the cumulative impacts analysis only considers those actions or activities that have ongoing impacts.

While the cumulative impacts analysis is not limited by a specific timeframe, it should be recognized that available information, uncertainties, and other practical constraints limit the ability to analyze cumulative impacts for the indefinite future. Navy environmental planning and compliance for training activities is an ongoing process. The Navy intends to submit applications to the National Marine Fisheries Service (NMFS) for Marine Mammal Protection Act (MMPA) authorizations supported by this Supplemental EIS/OEIS. The anticipated effective dates for these MMPA authorizations would be a 5-year period from April 2016 through April 2021. Future environmental planning documents will include cumulative impacts analysis based on information available at that time.

4.2.4 DESCRIBE CURRENT RESOURCE CONDITIONS AND TRENDS

In Chapter 3 (Affected Environment and Environmental Consequences), the Navy describes current resource conditions and trends, and discusses how past and present human activities influence each resource. The current aggregate impacts of past and present actions are reflected in the baseline information presented in Chapter 3 (Affected Environment and Environmental Consequences). This

information is used in the cumulative impacts analysis to understand how past and present actions are currently impacting each resource and to provide the context for the cumulative impacts analysis.

4.2.5 IDENTIFY POTENTIAL IMPACTS OF THE PROPOSED ACTION THAT MIGHT CONTRIBUTE TO CUMULATIVE IMPACTS

Direct and indirect impacts of the Proposed Action, presented in Chapter 3 (Affected Environment and Environmental Consequences), were reviewed to identify impacts relevant to the cumulative impacts analysis. Key factors considered included the current status and sensitivity of the marine mammal species and the intensity, duration, and spatial extent of the impacts for each stressor related to training activities. In general, long-term rather than short-term impacts and widespread rather than localized impacts were considered more likely to contribute to cumulative impacts. For example, for biological resources, population-level impacts were considered more likely to contribute to cumulative impacts than were individual-level impacts. Negligible impacts were not considered further in the cumulative impacts analysis. For marine mammals, any training activity that can be estimated by NAEMO and is expected to result in Level A harassment or Level B harassment, as defined by MMPA, was considered in the cumulative impacts analysis. For Endangered Species Act (ESA)-listed species, any training activity that may affect and is likely to adversely affect the species was considered in the cumulative impacts analysis. Training activities that were determined by the Navy to have no effect or that may affect but are not likely to adversely affect ESA-listed species were not analyzed in detail in the cumulative impacts analysis.

4.2.6 IDENTIFY OTHER ACTIONS AND OTHER ENVIRONMENTAL CONSIDERATIONS THAT AFFECT EACH RESOURCE

A list of other actions was compiled for the Study Area and surrounding areas based on information obtained during the scoping process (Appendix D, Public Participation), communications with other agencies, a review of other military activities, literature review, previous NEPA analyses for actions not included in this document, and other available information. Identified future actions were reviewed to determine if they should be considered further in the cumulative impacts analysis. Factors considered when identifying other actions to be included in the cumulative impacts analysis included the following:

- Whether the other action is reasonably foreseeable, rather than merely possible or speculative
- The timing and location of the other actions in relation to proposed training activities
- Whether the other action and the Proposed Action would affect the same resources
- The current conditions, trends, and vulnerability of resources affected by the other action
- The duration and intensity of the impacts of the other action
- Whether the impacts have been truly meaningful, historically significant, or identified previously as a cumulative impact concern

In addition to identifying reasonably foreseeable future actions, other environmental considerations for the cumulative impacts analysis were identified and described. These other considerations include major stressors or issues (e.g., ocean pollution, ocean noise, coastal development, etc.) that tend to be widespread and arise from routine human activities and multiple past, present, and future actions. Including these other environmental considerations allows an analysis of the current aggregate impacts of past and present actions, as well as reasonably foreseeable future actions.

4.2.7 Analyze Potential Cumulative Impacts

The current impacts of past and present actions and the anticipated impacts of reasonably foreseeable future actions were characterized and summarized. The incremental impacts of the Proposed Action were then added to the combined impacts of all other actions to describe the cumulative impacts that would result if the Proposed Action were implemented. The cumulative impacts analysis considered additive, synergistic, and antagonistic impacts. A qualitative analysis was conducted in most cases based on the available information.

4.3 Other Actions Analyzed in the Cumulative Impacts Analysis

4.3.1 Overview

Table 4.3-1 lists the other actions and other environmental considerations identified for the cumulative impacts analysis, including activities presented in the 2011 GOA Final EIS/OEIS with updated information. Descriptions of each action and environmental consideration carried forward for analysis are provided in the following sections.

Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis

#	Name of Action	Lead Agency or Proponent	Location in the Study Area	Timeframe	Retained or Dismissed for Further Analysis
Offshore Power Generation					
1	Marine Hydrokinetic Projects	Federal Energy Regulatory Commission	Turnagain Arm of Cook Inlet	Present and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
2	Feasibility Study for the Yakutat Alaska Wave Energy Project	Resolute Marine Energy	Yakutat, Alaska	Future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
Restoration, Research, and Conservation Projects and Programs					
3	Alaska Groundfish Harvest Specifications EIS**	NMFS	Bering Sea, Aleutian Islands, and Gulf of Alaska groundfish fisheries	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
4	Alaska Groundfish Fisheries Programmatic Supplemental EIS**	NMFS	Bering Sea, Aleutian Islands, and Gulf of Alaska groundfish fisheries	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
5	Alaska Predator Ecosystem Experiment**	NMFS	Prince William Sound, Cook Inlet, and northern Gulf of Alaska	Past	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
6	Cook Inlet Beluga Whale Subsistence Harvest – Supplemental EIS**	NMFS	Cook Inlet, Alaska	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
7	Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska	NMFS, Alaska Regional Office	Entire Study Area	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
8	GulfWatch Alaska Monitoring Plan	Alaska Ocean Observing System	Prince William Sound, lower Cook Inlet, outer Kenai Peninsula coast	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
9	Alaska Aerospace Corporation Kodiak Launch Complex**	Alaska Aerospace Corporation	Kodiak, Alaska	Past, present, and future	Retained
10	Alaska Region promotion of safety, protection of the environment, and conservation of resources through vigorous regulatory oversight and enforcement	Bureau of Safety and Environmental Enforcement	Arctic Ocean, Bering Sea and the northern Pacific Ocean	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action

Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis (continued)

#	Name of Action	Lead Agency or Proponent	Location in the Study Area	Timeframe	Retained or Dismissed for Further Analysis
Other Military Activities					
11	Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar**	U.S. Department of the Navy	Pacific-Indian and Atlantic-Mediterranean Ocean areas	Past, present, and future	Retained
12	Environmental Impact Statement for the Modernization and Enhancement of Ranges, Airspace, and Training Areas in the Joint Pacific Alaska Range Complex in Alaska*	U.S. Department of the Army U.S. Department of the Air Force	JPARC	Past, present, and future	Retained
13	Naval Special Warfare Maritime Training Activities**	U.S. Department of the Navy	Kodiak Island	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
14	U.S. Navy Climate Change Roadmap	U.S. Department of the Navy	All of Study Area	Present and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
U.S. Coast Guard					
15	North Pacific Regional Fisheries Training Center	U.S. Coast Guard	Kodiak, Alaska	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
16	Draft Programmatic Environmental Assessment Arctic Operations and Training Exercises Alaska	U.S. Coast Guard	Above the Arctic Circle – Proposed Forward Operating Locations are Barrow, Nome, Kotzebue, and Port Clarence, Alaska	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
Environmental Regulations and Planning					
17	Coastal and Marine Spatial Planning	Regional Ocean Commissions	All of Study Area	Future	Dismissed because action involves only planning and policy-related activities (discussed in Chapter 6, Additional Regulatory Considerations).

Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis (continued)

#	Name of Action	Lead Agency or Proponent	Location in the Study Area	Timeframe	Retained or Dismissed for Further Analysis
Other Environmental Considerations					
18	Commercial and Recreational Fishing	NMFS and private industry	All of Study Area and open ocean areas	Past, present, and future	Retained
19	Maritime Traffic	Not applicable	All of Study Area and open ocean areas	Past, present, and future	Retained
19a	Knik Arm Crossing**	Knik Arm Bridge and Toll Authority	Cook Inlet Knik Army	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
19b	Port MacKenzie Development**	Matanuska-Susitna Borough	Cook Inlet along the Knik Arm	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
19c	Port of Anchorage Expansion**	U.S. Army Corps of Engineers, Alaska District	Port of Anchorage	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
20	Shoreline Development	Local regulatory agencies	Northern coastline of Gulf of Alaska	Past, present, and future	Dismissed because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action
21	ShoreZone – Shoreline Mapping of the North Slope of Alaska	Bureau of Ocean Energy Management	Beaufort Sea, Chukchi Sea	Past, present, and future	Dismissed because action primarily involves collection and interpretation of aerial imagery of the intertidal zone, nearshore, and estuarine environments, which are outside the Study Area.
22	Oceanographic Research	Numerous	All of Study Area and open ocean areas	Past, present, and future	Retained
23	Academic Research	Numerous	All of Study Area and open ocean areas	Past, present, and future	Retained
24	Ocean Noise	Not applicable	All of Study Area and open ocean areas	Past, present, and future	Retained
25	Ocean Pollution, Tsunami Debris, and Other Marine Debris in Alaska	Not applicable	All of Study Area and open ocean areas	Past, present, and future	Retained

Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis (continued)

#	Name of Action	Lead Agency or Proponent	Location in the Study Area	Timeframe	Retained or Dismissed for Further Analysis
Other Environmental Considerations					
26	Non-Point Sources, Point Sources, and Atmospheric Deposition	Not applicable	All of Study Area and open ocean areas	Past, present, and future	Retained
27	Marine Tourism	Not applicable	All of Study Area and open ocean areas	Past, present, and future	Retained

*indicates this activity was found in the 2011 GOA Final EIS/OEIS; ** indicates this activity was found in both the JPARC EIS and the 2011 GOA Final EIS/OEIS

Notes: EIS = Environmental Impact Statement, GOA = Gulf of Alaska, JPARC = Joint Pacific Alaska Range Complex, LFA = Low Frequency Active, NMFS = National Marine Fisheries Service, OEIS = Overseas Environmental Impact Statement, SURTASS = Surveillance Towed Array Sensor System, U.S. = United States

4.3.2 ACTIONS CONSIDERED BUT DISMISSED

4.3.2.1 Offshore Power Generation

4.3.2.1.1 Marine Hydrokinetic Projects

As of April 2014, the Federal Energy Regulatory Commission (FERC) has issued 5 preliminary permits for marine and hydrokinetic projects and 16 pending preliminary permits; there are also three in pre-filing status for license. Four licenses have been issued for pilot projects. In Alaskan waters, one hydrokinetic preliminary permit has been issued at Yakuitat and will expire in December 2015; there are no pending permits. (Federal Energy Regulatory Commission 2014a, 2014b). Marine hydrokinetic projects were dismissed from consideration because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action and distance from the Study Area.

4.3.2.1.2 Feasibility Study for the Yakutat Alaska Wave Energy Project

The FERC issued a preliminary permit in 2013 to Resolute Marine Energy, Inc. to develop a wave power project outside of Yakutat, Alaska. The conceptual project is a 500–750 kilowatt (kW) project consisting of several 50–100 kW units to be located near shore. The 2013 permit allows Resolute Marine Energy, Inc. to conduct pilot studies and assess the technical and economic feasibility of the project (National Marine Fisheries Service 2013a). The Feasibility Study for the Yakutat Alaska Wave Energy Project was dismissed from consideration because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action and distance from the Study Area.

4.3.2.2 Restoration, Research, and Conservation Projects and Programs

4.3.2.2.1 Alaska Groundfish Harvest Specifications Environmental Impact Statement

Analysis for the NMFS Alaska Groundfish Harvest Specifications Environmental Impact Statement is provided in the 2011 GOA Final EIS/OEIS, Chapter 4 (Cumulative Impacts). The effects and analysis have not changed.

4.3.2.2.2 Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement

Analysis for the NMFS Alaska Groundfish Fisheries Programmatic Supplemental EIS is provided in the 2011 GOA Final EIS/OEIS, Chapter 4 (Cumulative Impacts). The effects and analysis have not changed.

4.3.2.2.3 Alaska Predator Ecosystem Experiment

Analysis for the Alaska Predator Ecosystem Experiment is provided in the 2011 GOA Final EIS/OEIS, Chapter 4 (Cumulative Impacts). The effects and analysis have not changed, and additional studies from 2007 to the present are focused on specific and direct research on Steller sea lion and large whale foraging ecology and population dynamics around the Kodiak archipelago (National Marine Fisheries Service 2013b), which supports the original analysis in the 2011 GOA Final EIS/OEIS.

4.3.2.2.4 Cook Inlet Beluga Whale Subsistence Harvest – Supplemental Environmental Impact Statement

Analysis for the NMFS Supplemental EIS to assess the environmental impacts associated with National Oceanic and Atmospheric Administration's (NOAA's) implementation of a management plan to govern the subsistence harvest of Cook Inlet beluga whales is provided in the 2011 GOA Final EIS/OEIS, Chapter 4 (Cumulative Impacts). The effects and analysis have not changed.

4.3.2.2.5 Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska

The Final EIS for Essential Fish Habitat (EFH) Identification and Conservation in Alaska was completed in 2005. The Record of Decision (ROD) documented the selection of three actions:

- Describe and identify EFH as the revised general distribution;
- Adopt the site-based approach for identifying Habitat Areas of Particular Concern;
- Establish expanded closures in the Aleutian Islands and Gulf of Alaska to minimize the effects of fishing on EFH.

Additionally, the ROD documented the decision to proceed with associated fishery management plan amendments and rulemaking, and an EFH 5-year review by NOAA Fisheries and the North Pacific Marine Fisheries Commission resulted in revisions of the Fishery Management Plans. The EFH Omnibus Amendments were approved in October 2012.

Analysis for the NMFS reexamination of the effects of fishing on EFH is provided in the 2011 GOA Final EIS/OEIS, Chapter 4 (Cumulative Impacts). The effects and analysis have not changed.

4.3.2.2.6 GulfWatch Alaska Monitoring Plan

The Exxon Valdez Oil Spill Trustee Council and state and federal agencies are supporting a 5-year, $12 million long-term monitoring program in the Gulf of Alaska region affected by the 1989 Exxon Valdez oil spill. The primary goal of the GulfWatch Alaska long-term monitoring program is to provide sound scientific data on the marine ecosystem of the GOA and information products based on these data to management agencies and the public that will give the Navy the ability to detect change. This program is a collaborative long-term monitoring program that provides data that can be used to inform modeling and process studies, but it does not include direct funding of these kinds of activities. The data and data products from this program can be used to inform management decisions to accommodate changes in the environment and the impacts of these changes on resources and services that were injured by the Exxon Valdez oil spill. To accomplish the monitoring, more than 30 scientists in multiple teams are collecting data in the GOA at sites in Prince William Sound, lower Cook Inlet, and along the outer Kenai Peninsula coast. The GulfWatch Alaska program encompasses 15 field sampling projects across lower Cook Inlet, central Gulf of Alaska, and Prince William Sound. This monitoring effort is dismissed from further cumulative analysis because the monitoring plan is not invasive to resources in the Study Area, consists of observation and data on physical and biological environmental factors that drive ecosystem changes, and therefore will result in negligible to minor impacts on resources in the Study Area affected by the Proposed Action (Alaska Ocean Observing System 2013).

4.3.2.2.7 Alaska Region Promotion of Safety, Protection of the Environment, and Conservation of Resources Through Vigorous Regulatory Oversight and Enforcement (Alaska Region Bureau of Safety and Environmental Enforcement Activities)

The Bureau of Safety and Environmental Enforcement, Alaska Region, has regulatory oversight and enforcement responsibility for more than one billion acres on the Outer Continental Shelf and more than 6,000 miles (mi.) of coastline. Historically, lease sales have occurred in Cook Inlet, the Gulf of Alaska, Norton Sound, and in the Bering, Beaufort, and Chukchi Seas. Currently there are active leases in the Chukchi and Beaufort Seas. The Alaska Region Promotion of Safety, Protection of the Environment, and Conservation of Resources, Through Vigorous Regulatory Oversight and Enforcement, is dismissed from consideration because their inspections and safety requirements will have negligible to minor impacts on resources in the Study Area affected by the Proposed Action.

4.3.2.3 Other Military Activities

4.3.2.3.1 Naval Special Warfare Maritime Training Activities – Kodiak Island

Analysis of Naval Special Warfare (NSW) activities on Kodiak Island is provided in the 2011 GOA Final EIS/OEIS, Chapter 4 (Cumulative Impacts). The effects and analysis have not changed. A new Environmental Assessment for Naval Special Warfare Detachment Kodiak, Cold Weather Maritime Training, Kodiak, Alaska (U.S. Department of the Navy 2015) was conducted and finalized in August 2015, with a Finding of No Significant Impact (FONSI) issued by Chief of Naval Operations N45. Cumulative impacts from the Proposed Action in that document have been considered in this Supplemental EIS/OEIS. Based on the analysis and the FONSI, NSW Cold Weather Maritime Training on Kodiak Island is dismissed from consideration because impacts from activities on Kodiak Island would result in no significant impact on or harm to public health and safety, marine and terrestrial resources, cultural resources, regional economy, and recreation, and therefore would have no significant impacts on resources in the Study Area affected by the Proposed Action.

4.3.2.3.2 United States Department of the Navy Climate Change Roadmap, Department of Defense 2014 Climate Change Adaptation Roadmap, and United States Department of the Navy Arctic Roadmap 2014–2030

The Navy Climate Change Roadmap outlined the Navy's approach to observing, predicting, and adapting to climate change by providing a chronological list of Navy-associated action items, objectives, and desired effects for Fiscal Year (FY) 2010–2014. The Navy Climate Change Roadmap focused on strategy, policy, and plans; operations and training; investments in capability and infrastructure; strategic communications and outreach; and environmental assessment and prediction. The Roadmap had five main objectives.

1. The Navy is fully mission-capable through changing climatic conditions, while actively contributing to national requirements for addressing climate change.
2. The Naval force structure and infrastructure are capable of meeting combatant commander requirements in all probable climatic conditions over the next 30 years.
3. The Navy understands the timing, severity, and impact of current and projected changes in the global environment.
4. The media, public, government, Joint, interagency, and international community understand how and why the Navy is effectively addressing climate change.
5. For the Navy to be recognized as a valuable joint, interagency, and international partner in responding to climate change (U.S. Department of the Navy 2010).

Every 4 years, the director of Task Force Climate Change reviews and revises the roadmap following promulgation of the Quadrennial Defense Review, and incorporates the review's guidance as appropriate. In 2014 the Navy released the updated Department of Defense 2014 Climate Change Adaptation Roadmap, which established three broad adaptation goals:

1. Identify and assess the effects of climate change on the Department.
2. Integrate climate change considerations across the Department and manage associated risks.
3. Collaborate with internal and external stakeholders on climate change challenges (U.S. Department of Defense 2014).

The updated Roadmap uses plans and operations, training and testing, built and natural infrastructure, and acquisition and supply chain to accomplish its goals (U.S. Department of Defense 2014). The Roadmap is broken into four sections: (1) policy framework for climate change adaptation planning,

(2) goals, (3) an overview for each goal, and (4) specific details on the current and future status of the Department's adaptation is currently ongoing, and is to occur in the future.

The U.S. Navy Arctic Roadmap discusses the opening of the Arctic Ocean to infrastructure development and commercial investment, resource exploitation, fishing, and tourism (U.S. Department of the Navy 2014). The Roadmap concludes that ice conditions in the Arctic Ocean are changing more rapidly than anticipated, prepares the U.S. Navy to respond effectively to future contingencies, delineates the leadership role of the U.S. Navy Arctic Region, and articulates the Navy's support of national priorities (U.S. Department of the Navy 2014). Lastly, the document outlines the strategic approach that the Navy will take for the Arctic Ocean and the ways and means to support the national end states (U.S. Department of the Navy 2014).

The Department of Defense (DoD) Directive 4715.21 Climate Change Adaptation and Resilience helps to facilitate federal, state, local, tribal, private sector, and nonprofit sector efforts to improve climate preparedness and resilience; implement the 2014 DoD Climate Change Adaptation Roadmap; safeguard the U.S. economy, infrastructure, environment, and natural resources; and provide for the continuity of DoD operations, services, and programs (U.S. Department of Defense 2016).

Climate change is discussed further for cumulative impacts in Section 4.4.2 (Climate Change). The U.S. Navy Climate Change Roadmap and U.S. Navy Arctic Roadmap are dismissed from further consideration, as guidance within the Roadmaps are Standard Operating Procedures for the Navy and would have negligible to minor cumulative impacts on resources in the Study Area affected by the Proposed Action.

4.3.2.4 United States Coast Guard

4.3.2.4.1 North Pacific Regional Fisheries Training Center

The United States Coast Guard (USCG) training center located in Kodiak, Alaska, instructs 13 different courses to 750–1,000 students per year. Instruction includes fisheries-related topics, both international and domestic.

4.3.2.4.2 Draft Programmatic Environmental Assessment Arctic Operations and Training Exercises

The Proposed Action is to conduct increased operations and training exercises in the Arctic to meet Coast Guard mission responsibilities due to the increase of national and international activities in the area. This would provide a shore, air, and sea Coast Guard presence to meet the seasonal surge mission requirements, typically mid-March through mid-November. The Preferred Alternative consists of five main elements:

1. Shore Operations: Forward Operating Locations and logistics/staging locations would serve as temporary Coast Guard homebases for sea and air support during the seasonal surge of Arctic activities. The locations include Barrow, Nome, Kotzebue, Port Clarence, and various air strips and Distant Early Warning line sites. The Coast Guard would conduct inspections of commercial and non-commercial vessels in major ports in Alaska to ensure compliance with law and further the missions of drug and migrant interdiction and marine safety.
2. Air Operations: The Coast Guard would execute air searches to locate missing persons and vessels. Routine patrols and Arctic Domain Awareness Flights serve to locate, identify, and document human contacts north of the Arctic Circle.
3. Sea Operations: The Coast Guard would search for missing vessels, and operate two icebreakers to support oceanographic and meteorological research, search and rescue, and law

enforcement missions. Conducting routine patrols, establishing safety zones around offshore oil exploration, and providing at-sea berthing and support facilities are being considered.

4. Training Exercises: Rescue exercises, flight crew training, small boat training, and oil recovery training exercises would be conducted.
5. Building Partnerships: Tribal/Local Government Engagement: Formal and informal government-to-government and community engagement with tribes and local community leadership is vital to all of the Coast Guard's missions (U.S. Homeland Security 2014).

The proposed Coast Guard operations and training exercises are dismissed from consideration because no significant adverse impacts would occur due to the implementation of the Coast Guard's Proposed Action, and therefore, cumulative impacts due to Coast Guard operations in the Study Area would result in negligible to minor impacts on resources in the Study Area affected by the Proposed Action.

4.3.2.5 Environmental Regulations and Planning

4.3.2.5.1 Coastal and Marine Spatial Planning

Dismissed because action involves only planning and policy-related activities.

4.3.2.6 Other Environmental Considerations

4.3.2.6.1 Knik Arm Crossing

Analysis for the Knik Arm Crossing is provided in the 2011 GOA Final EIS/OEIS, Chapter 4 (Cumulative Impacts). The effects and analysis have not changed although construction was originally expected to begin in 2013 and be completed in 2017. Construction is currently expected to begin in 2014 and be completed in 2018 (Knik Arm Bridge and Toll Authority 2013a, b).

4.3.2.6.2 Port MacKenzie Development

Analysis for the Port MacKenzie Development is provided in the 2011 GOA Final EIS/OEIS, Chapter 4 (Cumulative Impacts). The effects and analysis have not changed.

4.3.2.6.3 Port of Anchorage Expansion

Analysis for the Port of Anchorage Expansion is provided in the 2011 GOA Final EIS/OEIS, Chapter 4 (Cumulative Impacts). The effects and analysis have not changed.

4.3.2.6.4 Shoreline Development

Shoreline development adjacent to the Study Area is prompted for commercial, industrial, transportation, and residential purposes. Development has impacted and continues to impact coastal resources through point and nonpoint source pollution, concentrated recreational use, and ship traffic using major port facilities. The Study Area also includes coastal tourism development (e.g., hotels, resorts, restaurants, food industry, and residential homes) and the infrastructure supporting coastal development (e.g., retail businesses, marinas, fishing tackle stores, dive shops, fishing piers, recreational boating harbors, beaches, and recreational fishing facilities). However, the Study Area is greater than 12 nautical miles off the coast of Alaska, and therefore shoreline development will have minimal impact on resources in the Study Area. Shoreline development is dismissed from consideration because of negligible to minor impacts on resources in the area affected by this activity and the Proposed Action.

4.3.2.6.5 ShoreZone-Shoreline Mapping of the North Slope of Alaska

ShoreZone-Shoreline Mapping of the North Slope of Alaska is dismissed from consideration because of negligible to minor impacts on resources in the Temporary Maritime Activities Area (TMAA). The action primarily involves collection and interpretation of aerial imagery of the intertidal zone, nearshore, and estuarine environments, which are outside the TMAA.

4.3.3 ACTIONS CONSIDERED AND RETAINED

4.3.3.1 Restoration, Research, and Conservation Projects and Programs

4.3.3.1.1 Alaska Aerospace Corporation Kodiak Launch Complex

Kodiak Launch Complex is the nation's only high-latitude, full-service spaceport. It was specifically designed to provide support for space launches to polar orbit and is an all-indoor, all-weather processing facility (Alaska Aerospace Corporation 2013). In 2011, a Letter of Authorization was issued to the Alaska Aerospace Corporation to take species of seals and sea lions incidental to space vehicle and missile launch operations at the Kodiak Launch Complex (National Marine Fisheries Service 2011 – Federal Register (FR) 76(91), 27308-27309).

4.3.3.2 Other Military Activities

4.3.3.2.1 Surveillance Towed Array Sensor System Low Frequency Active Sonar

In August 2011, the Navy released a Draft Supplemental EIS/Supplemental OEIS that evaluated the potential environmental impacts of employing the Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) Sonar (U.S. Department of the Navy 2011). The Navy currently plans to operate up to four SURTASS-LFA Sonar systems for routine training, testing, and military operations. Based on current Navy national security and operational requirements, routine training, testing, and military operations using these sonar systems could occur in the Pacific Ocean, although outside the TMAA.

4.3.3.2.2 Environmental Impact Statement for the Modernization and Enhancement of Ranges, Airspace, and Training Areas in the Joint Pacific Alaska Range Complex in Alaska

The Army and Air Force, through Alaskan Command, proposed to modernize and enhance the JPARC to enable realistic joint training for the Army, Navy, Marine Corps, and Air Force. The JPARC Modernization and Enhancement EIS analyzed potential environmental consequences to airspace, biological resources, cultural resources, hazardous materials, land use, safety, socioeconomics, physical resources/water resources, and subsistence that are associated with expanding and establishing new Military Operations Areas, restricted airspace, airspace corridors, ground maneuver training areas, and training complexes. The Final EIS was published in June 2013, for which a Record of Decision (U.S. Departments of the Army and Air Force 2013) was approved and signed on 6 August 2013. Mitigation measures and management actions are specified as part of the decision, which takes into account direct, indirect, and cumulative impacts from the alternatives on all resource areas analyzed. The Army decision is to implement Battle Area Complex Restricted Area (R) Addition Alternative B (Preferred Alternative), Restricted Area Expansion of R-2205 including the Digital Multi-Purpose Training Range Proposed Action (Preferred Alternative), and Unmanned Aerial Vehicle Access Alternative A (Preferred Alternative). The Air Force decision is to implement Fox 3 Military Operations Area (MOA) Expansion and New Paxon MOA Alternative E (Preferred Alternative), Realistic Live Ordnance Delivery (Alternative A), and Night Joint Training Alternative B (Preferred Alternative).

4.3.3.3 Other Environmental Considerations

4.3.3.3.1 Commercial and Recreational Fishing

Commercial and recreational fishing constitutes an important and widespread use of the ocean resources throughout the Study Area. Fishing can adversely affect fish populations, other species, and habitats. Potential impacts of fishing include overfishing of targeted species, bycatch, entanglement, and habitat destruction, all of which negatively affect fish stocks and other marine resources. Bycatch is the capture of fish, marine mammals, sea turtles, seabirds, and other nontargeted species that occur incidentally to normal fishing operations. Use of mobile fishing gear, such as bottom trawls, disturbs the seafloor and reduces habitat structural complexity. Indirect impacts of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (i.e., lost fishing gear continuing to ensnare fish and other marine animals), habitat destruction, and the generation of marine debris. Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats and have the potential to entangle or be ingested by marine animals.

Fishing can also have a profound influence on individual targeted species populations. In a study of retrospective data, Jackson et al. (2001) analyzed paleo-ecological records of marine sediments from 125,000 years ago to present, archaeological records from 10,000 years before the present, historical documents, and ecological records from scientific literature sources over the past century. Examining this longer-term data and information, they concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance of coastal ecosystems, including pollution and anthropogenic climatic change. Fisheries bycatch has been identified as a primary driver of population declines in several marine species, including sharks, mammals, seabirds, and sea turtles (Wallace et al. 2010).

4.3.3.3.2 Maritime Traffic

In 2012, 30 cruise ships were scheduled to make 450 voyages through Southeast Alaska. Cruise ships comprise 19 percent of the vessel activity in Southeast Alaska. Ferries, passenger vessels with overnight accommodations, and cruise ships comprise 68 percent of the vessel activity, although cruise ships only operate during the 5-month period from May through September. Dry freight cargo barges, tank barges, and freight ships (log and ore carriers) comprise the other 32 percent of the vessel activity (Alaska Department of Environmental Conservation 2012).

The Alaska Marine Highway is a ferry service operated by the State of Alaska, headquartered in Ketchikan, Alaska. The Highway is composed of 3,500 mi. of routes that go as far south as Bellingham, Washington and as far west as Unalaska/Dutch Harbor, Alaska. The highway system operates along the south-central coast of the state, the eastern Aleutian islands, and the inside passage of Alaska and British Columbia. There are 32 terminals located in Washington, British Columbia, and Alaska. Primary concerns for the cumulative impacts analysis include vessels striking marine mammals, introduction of non-native species through hull fouling and ballast water, and underwater sound from ships and other vessels.

Figure 4.3-1 and Figure 4.3-2 depict commercial vessel density provided by the automated identification system data for the area from Alaska to the Pacific Northwest in 2011 and 2014 respectively. As evident from the graphics, commercial vessel use is highest in the U.S. Exclusive Economic Zone, at straits and passages, and along least-distance line routes between ports. Also evident from the figures, is that some of those commercial vessel routes pass through the TMAA. Navy vessels during a Carrier Strike Group exercise are a small, infrequent, and short duration component of overall vessel traffic in Gulf of Alaska.

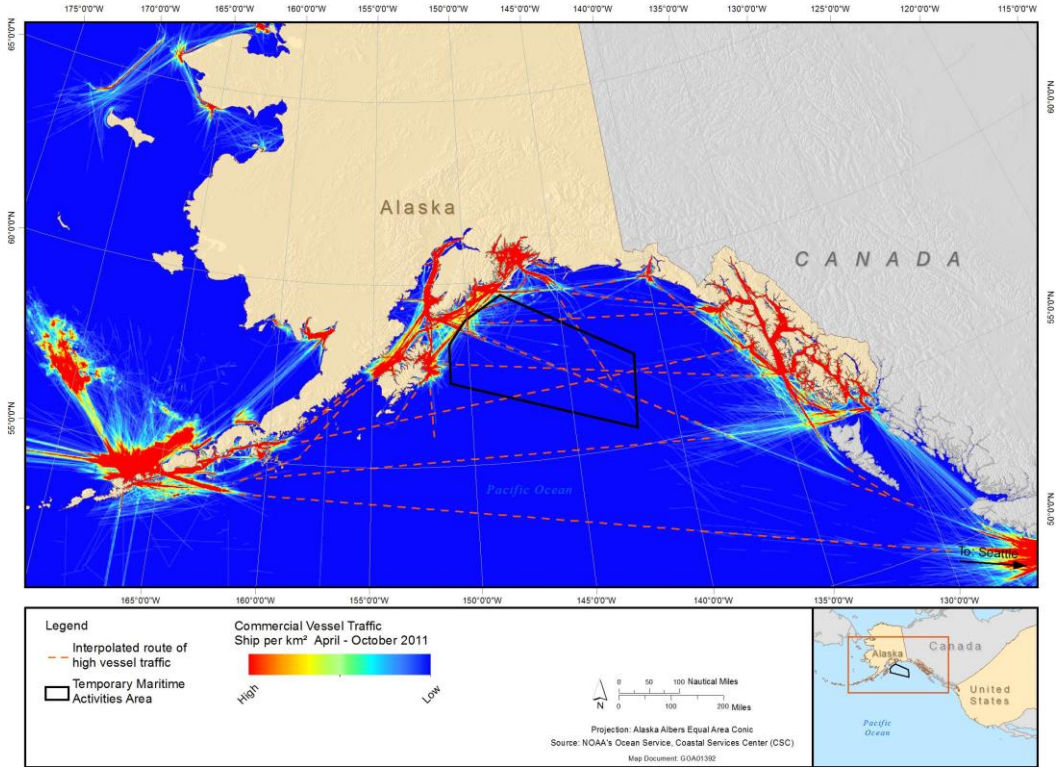

Figure 4.3-1: Commercial Vessel Density Involving the Study Area in 2011

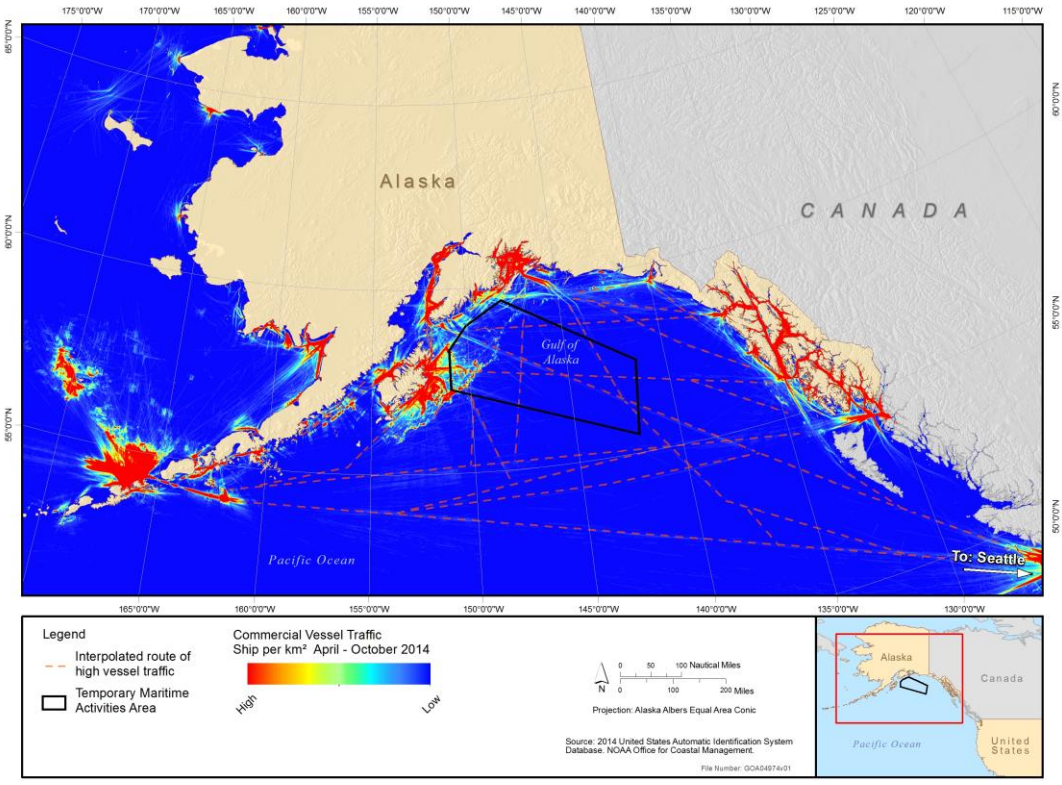

Figure 4.3-2: Commercial Vessel Density Involving the Study Area in 2014

4.3.3.3.3 Oceanographic Research

There are currently scientific research permits and General Authorizations for research issued by NMFS for cetacean work in the North Pacific. The most invasive research involves tagging or biopsy while the remainder focuses on vessel and aerial surveys and close approach for photo-identification. Species covered by these permits and authorizations include small odontocetes, sperm whales and large mysticetes. One permit issued to the Office of Protected Resources of NMFS allows for responses to strandings and entanglements of listed marine mammals. NMFS has also issued General Authorizations for commercial photography of non-listed marine mammals, provided that the activity does not rise to Level A Harassment of the animals. These authorizations are usually issued for no more than 1 or 2 years, depending on the project.

The Bureau of Ocean Energy Management (BOEM) awarded one seismic survey permit in 2013 to Norwegian geosciences company TGS. In October 2013, TSG completed an open water marine seismic survey to acquire 2D data, using an airgun array as the energy source, and collected magnetic and gravity data in the Chukchi Sea Outer Continental Shelf Planning Area (Bureau of Ocean Energy Management 2013). For 2014 SAExploration Inc. has submitted an application for a permit to conduct an on-ice seismic survey to acquire 3D seismic data, using vibrators as the energy source, in the Beaufort Sea Outer Continental Shelf Planning Area. The proposed program was to start on or after 1 January 2014.

A typical seismic survey lasts 2–3 weeks and covers a range of about 300–600 mi. The intensity of sound waves produced by the firing of seismic airguns can reach up to 250 decibels (dB) near the source and can be as high as 117 dB over 20 mi. away. Additionally, Russian and Canadian exploration permits on the Outer Continental Shelf are anticipated although there is no collaboration between governments. Since 1973, BOEM has spent $425 million studying the Outer Continental Shelf environment off Alaska and subsequently generated more than 500 technical reports. In the last decade, more than $15 million has been focused on marine acoustic studies. Based upon that data, BOEM has concluded that multiple seismic surveys could yield some likelihood of cumulative effects on marine life, but these effects are expected to be temporary and unlikely to cause population level effects (National Marine Fisheries Service and Bureau of Ocean Energy Management 2013; Heimbruch 2013).

The impacts of this type of research are largely unmeasured. However, given the analysis and scrutiny given to permit applications, it is assumed that any adverse effects are largely transitory (e.g., inadvertent harassment, biopsy effects, etc.). Data to assess population level effects from research are not currently available, and it is uncertain that research effects could be separately identified from other adverse effects on cetacean populations in the Study Area.

4.3.3.3.4 Academic Research

The University of Alaska Fairbanks is ranked in the top 150 of nearly 700 institutions in the United States that conduct research, and is listed in the top 11 of more than 10,000 institutions worldwide for number of citations in climate change publications and fourth among United States universities. It is associated with research centers that include a wide array of interests (e.g., air and space, climate change, environmental and natural disasters, energy and mineral extraction, health and biomedical sciences, and national security sustainable management).

The University of Alaska Anchorage devotes sponsored programs and research to special concerns and opportunities associated with northern populations. Research areas include public decision making, ecosystem studies and conservation biology, earth and climate processes, human ecology and coupled

human-environment interactions, health research, behavioral and physical health, biomedical programs, and rural health issues.

The impacts of this type of research are largely unmeasured. However, given the analysis and scrutiny given to permit applications, it is assumed that any adverse effects are largely transitory (e.g., inadvertent harassment, biopsy effects, etc.). Data to assess population-level effects from research are not currently available, and it is uncertain that research effects could be separately identified from other adverse effects on cetacean populations in the Study Area.

4.3.3.3.5 Ocean Noise

Noise is generally described as unwanted sound—sound that clutters and masks other sounds of interest (Richardson et al. 1995). Anthropogenic sources of noise that are most likely to contribute to increases in ocean noise are vessel noise from commercial shipping and general vessel traffic, oceanographic research, oil and gas exploration, underwater construction, and naval and other use of sound navigation and ranging (sonar).

Any potential for cumulative impact should be put into the context of recent changes to ambient sound levels in the world's oceans as a result of anthropogenic activities. However, there is a large and variable natural component to the ambient noise level as a result of events such as earthquakes, rainfall, waves breaking, and lightning hitting the ocean as well as biological noises such as those from snapping shrimp and the vocalizations of marine mammals.

Sound emitted from large vessels, such as shipping and cruise ships, is the principal source of low frequency noise in the ocean today (Hatch and Wright 2007; Hildebrand 2005; Richardson et al. 1995). Acoustic monitoring conducted under Navy funding in the TMAA has detected ship noise with some regularity at a recording site mid-shelf off of the Kenai Peninsula site and relatively infrequently at a site farther offshore near the shelf-break (for the locations of these passive acoustic monitoring buoys, see Baumann-Pickering et al. 2012).

Andrew et al. (2002) compared ocean ambient sound from the 1960s to the 1990s from a receiver approximately 25 mi. (40 kilometers [km]) west of Point Sur, California. The data showed an increase in ambient noise of approximately 10 dB in the frequency ranges of 20–80 Hertz (Hz) and 200–300 Hz, and about 3 dB at 100 Hz over a 33-year period. Each 3 dB increase is noticeable to the human ear as a doubling in sound level. A possible explanation for the rise in ambient noise is the increase in shipping noise. There are approximately 11,000 supertankers worldwide, each operating 300 days per year, producing constant broadband noise at source levels of 198 dB (Hildebrand 2004). Navy vessels during a Carrier Strike Group exercise are a small, infrequent, and short duration component of overall vessel noise in Gulf of Alaska. In addition, Navy combatant vessels have been designed to generate minimal noise and use ship quieting technology to elude detection by enemy passive acoustic devices (Mintz and Filadelfo 2011; Southall et al. 2005).

Appendix C (Acoustic Primer) provides additional information about sources of anthropogenic sound in the ocean and other background information about underwater noise. This appendix describes the different types of effects that are possible and the potential relationships between sound stimuli and long-term consequences for individual animals and populations. A variety of impacts may result from exposure to sound-producing activities. The severity of these impacts can vary greatly between minor impacts that have no real cost to the animal, to more severe impacts that may have lasting

consequences. The major categories of potential impacts are: behavioral reactions, physiological stress, auditory fatigue, auditory masking, and direct trauma.

4.3.3.3.5.1 Ocean Acidification Effects on Noise in the Ocean

Since the Industrial Revolution in the mid-19th century, the world's oceans have become increasingly acidic as a result of anthropogenic emissions of carbon (e.g., carbon dioxide [CO2]) from the burning of fossil fuels (Reeder and Chiu 2010). Public comments received by the Navy on recently published Environmental Impact Statements (EISs) have expressed concerns that the increase in the acidity of ocean waters could potentially lead to an increase in the propagation of underwater sound associated with Navy activities (e.g., ship noise, sonar) and then have a greater potential to acoustically impact marine species (e.g., marine mammals, fish, turtles).

Although an increase in the acidity of seawater reduces the availability of boron ions that absorb sound (see Urick 1983), the effect that ionic absorption has on sound propagation is very small and overall transmission loss is dominated by other mechanisms (see Hester et al. 2008; Ilyina et al. 2010; Reeder and Chiu 2010). Reeder and Chiu (2010) demonstrated that even if there is a continual increase in ocean acidity over decades, there would still be no significant changes to average background noise levels in the ocean. Furthermore, they conclude that even with a large increase in acidity, there would be no change in ocean noise levels in shallow water and in near surface habitats frequented by marine mammals. The Navy's proposed actions in the GOA Study Area would not significantly contribute to ocean acidification, and the potential cumulative effects of ocean acidification would not perceptively change ocean noise levels; therefore, the effect of ocean acidification need not be considered further in this analysis.

4.3.3.3.6 Ocean Pollution, Tsunami Debris, and Other Marine Debris in Alaska

Pollution is the introduction of harmful contaminants that are outside the norm for a given ecosystem. Ocean pollution has and will continue to have serious impacts on marine ecosystem. Common ocean pollutants include toxic compounds such as metals, pesticides, and other organic chemicals; excess nutrients from fertilizers and sewage; detergents; oil; plastics; and other solids. Pollutants enter oceans from non-point sources (i.e., storm water runoff from watersheds), point sources (i.e., wastewater treatment plant discharges), other land-based sources (i.e., windblown debris), spills, dumping, vessels, and atmospheric deposition.

The Government of Japan estimates that 5 million tons of debris was swept into the Pacific Ocean after the March 2011 earthquake and tsunami that struck Japan. An estimated 70 percent sank right away and 1.5 million tons were left floating off the coast. While there are no estimates of how much is still floating, some debris has already reached the Alaskan coast. Marine debris is typically non-hazardous material; however, the tsunami debris is composed of materials found in urban areas (e.g., bottles, building fragments, boats, plastics, and docks). The National Oceanic and Atmospheric Administration works closely with state agencies and local authorities to systematically survey Alaska's coast. NOAA models predict an increase in debris in the next several years; however, very little is anticipated to be hazardous.

Marine debris is any anthropogenic object intentionally or unintentionally discarded, disposed of, or abandoned in the marine environment. Common types of marine debris include various forms of plastic and abandoned fishing gear, as well as clothing, metal, glass, and other debris. Marine debris degrades marine habitat quality and poses ingestion and entanglement risks to marine life and birds (National Marine Fisheries Service 2006).

Plastic marine debris is a major concern because it degrades slowly and many plastics float, allowing the debris to be transported by currents throughout the oceans. Currents in the oceanic convergence zone in the North Pacific Subtropical Gyre act to accumulate the floating plastic marine debris. These debris carrying currents include the south-flowing California Current, and the north-flowing Gulf of Alaska Current. These currents distribute debris throughout the Study Area.

Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants such as polychlorinated biphenyl (PCB) and dichlorodiphenyltrichloroethane (DDT), which accumulate up to one million times more in plastic than in ocean water (Mato et al. 2001). Fish, marine animals, and birds can mistakenly consume these wastes containing elevated levels of toxins instead of their prey. In the North Pacific Subtropical Gyre, it is estimated that the fishes in this area are ingesting 12,000 to 24,000 U.S. tons (10,886,216 to 21,772,433 kilograms) of plastic debris a year (Davison and Asch 2011).

Marine mammals have been documented ingesting marine debris from commercial and recreation sources, sometimes with fatal effects (Barco et al. 2010, Good et al. 2010, Jacobsen et al. 2010, Allen et al. 2011, Cassoff et al. 2011, Denuncio et al. 2011, Williams et al. 2011, Baulch and Perry 2012, de Stephanis et al. 2013, Jauniaux et al. 2013).

Debris that sinks to the seafloor is also a concern for ingestion and entanglement by fish, invertebrates, sea turtles, marine mammals, and marine vegetation. In addition, sunken debris contributes to marine habitat degradation. In the U.S. west coast Groundfish Bottom Trawl Surveys of 2007 and 2008, anthropogenic debris was observed at depths of 55–1,280 meters (180.5–4,199.5 feet). The density of debris increased with depth, and the majority of the debris was plastic and metallic, while the rest of it was fabric and glass (Keller et al. 2010).

4.3.3.3.7 Non-Point Sources, Point Sources, and Atmospheric Deposition

Storm water runoff, wastewater, and nonpoint source pollution, are considered major causes of impairment of ocean waters. Storm water runoff from coastal urban areas and beaches carries waste such as plastics and Styrofoam into coastal waters. Sewer outfalls also are a source of ocean pollution. Sewage can be treated to eliminate potentially harmful releases of contaminants; however, releases of untreated sewage occur due to malfunctions or overloads to the infrastructure, resulting in releases of bacteria usually associated with feces, such as *Escherichia coli* and *Enterococci spp*. Bacteria levels are used routinely to determine the quality of water at recreational beaches and as indicators of the possible presence of other harmful microorganisms. In the past, toxic chemicals have been released into sewer systems. While such dumping has long been forbidden by law, the practice left ocean outflow sites contaminated. Sewage treatment facilities generally do not treat or remove persistent organic pollutants, such as PCB and DDT, or other toxins.

Hypoxia (low dissolved oxygen concentration) is a major impact associated with point and non-point sources of pollution. Hypoxia occurs when waters become overloaded with nutrients from pesticides such as nitrogen and phosphorus, which enter oceans from non-point source runoff, wastewater treatment plants, and atmospheric deposition. Too many nutrients can stimulate algal blooms—the rapid expansion of microscopic algae (phytoplankton). When excess nutrients are consumed, the algae population dies off and the remains are consumed by bacteria. Bacterial consumption causes dissolved oxygen in the water to decline to the point where marine life that depends on oxygen can no longer survive (Boesch et al. 1997).

Almost 200 million tons of criteria pollutants (sulfur dioxide, nitrogen dioxide, carbon monoxide, lead, volatile organic compounds, and particulate matter) were emitted into the U.S. atmosphere in 1997

(U.S. Environmental Protection Agency 1998). Through the process of wet and dry atmospheric deposition, these and other pollutants can return to the earth and the waters. Wet deposition removes gases and particles from the atmosphere and deposits them on the surface of the earth through rain, sleet, snow, and fog. Dry deposition is a process through which particles and gases are deposited in the absence of precipitation, such as through dust (U.S. Geological Survey 2000). This atmospheric deposition also contributes to the buildup of pollutants in the Study Area. Non-point sources, point sources, and atmospheric deposition also contribute toxic pollutants such as metals, pesticides, and other organic compounds to the marine environment. Toxic pollutants may cause lethal or sublethal effects if present in high concentrations, and can build up in tissues over time and suppress immune system function, resulting in disease and death for marine organisms. The main causes of water pollution in the Study Area are predation by invasive species, discharges of oil products (refined oil products, crude oil, and hazardous substances), and industrial and agricultural contaminants (Encyclopedia of Earth 2013).

4.3.3.3.8 Marine Tourism

Tourism is Alaska's second biggest industry in terms of employment, and is the main industry of many small and isolated communities. The coast and some major rivers are the center of Alaska's tourism. Sport fishing is one of the biggest industries along with the growing number of ecotourists visiting the state. A total of 1,932,600 out-of-state visitors traveled to Alaska between October 2013 and September 2014. Cruise ship passengers accounted for one-half (50 percent) of the annual total, while 46 percent traveled to and from Alaska by air. The remainder (4 percent) traveled to and/or from Alaska by highway and/or ferry. Summer visitors represented 86 percent of the 12-month total. Overall, visitor volume was up by 5 percent in 2013–2014 as compared to the 2008–2009 timeframe, up 6 percent as compared to the 2011–2012 timeframe, and down 1.5 percent as compared to the 2012–2013 timeframe (Economic Impact of Alaska's Visitor Industry 2013–14 update, February 2015).

4.4 Resource-Specific Cumulative Impacts

4.4.1 Resource Areas Dismissed from Cumulative Impacts Analysis

In accordance with CEQ guidance (Council on Environmental Quality 2010), the cumulative impacts analysis focused on impacts that are "truly meaningful." The level of analysis for each resource was commensurate with the intensity of the impacts identified in Chapter 3 (Affected Environment and Environmental Consequences). The analysis focused on marine mammals. Detailed analysis of cumulative impacts on the following resources was not necessary as the incremental contribution of the Proposed Action to cumulative impacts would be low and was assessed in the 2011 GOA Final EIS/OEIS. Further analysis of cumulative impacts is not warranted on the following resources:

- Air quality
- Expended materials
- Water resources
- Acoustic environment (airborne)
- Marine plants and invertebrates
- Fish
- Birds
- Cultural resources
- Transportation and circulation
- Socioeconomics

- Environmental justice and protection of children
- Public safety

4.4.2 CLIMATE CHANGE

This section provides background information and an analysis of the cumulative impacts of climate change and greenhouse gas emissions for the Proposed Action. Climate change is also considered in the overall cumulative impacts analysis as another environmental consideration. The Intergovernmental Panel on Climate Change (2007) reports that physical and biological systems on all continents and in most oceans are already being affected by recent climate changes. Global-scale assessment of observed changes shows that it is likely that the increase in greenhouse gas emissions from anthropogenic activities over the last three decades has resulted in an increased temperature, which had a discernible influence on many physical and biological systems. Some of the major potential concerns for the marine environment include sea temperature rise, melting of polar ice, rising sea levels, changes to major ocean current systems, and ocean acidification.

4.4.2.1 Greenhouse Gases

Greenhouse gases are compounds that contribute to the greenhouse effect. The greenhouse effect is a natural phenomenon in which these gases trap heat within the surface-troposphere (lowest portion of the earth's atmosphere) system, causing heating (radiative forcing) at the surface of the earth. The projected warming and more extensive climate-related changes could dramatically alter the region's economy, landscape, character, and quality of life (Le Treut et al. 2007). Scientific evidence indicates a trend of increasing global temperature over the past century due to an increase in greenhouse gas emissions from human activities (U.S. Environmental Protection Agency 2012). Without greenhouse gases the planet's surface would be about 60 degrees Fahrenheit (°F) cooler than present; according to the NOAA and National Aeronautics and Space Administration data, the average surface temperature has increased by about 1.2–1.4°F since 1900. If greenhouse gases continue to increase, models predict that the average temperature at the earth's surface could increase from 2.0 to 11.5°F above the 1990 levels by the end of this century (Le Treut et al. 2007).

Predictions of long-term negative environmental impacts due to global warming include sea level rise, changing weather patterns with increases in the severity of storms and droughts, changes to local and regional ecosystems (including the potential loss of species), melting glaciers and sea ice, thawing permafrost, a longer growing season, and shifts in plant and animal ranges.

In 2011, the United States generated an estimated 6,702.3 teragrams carbon dioxide equivalent (Tg CO_2Eq (U.S. Environmental Protection Agency 2013). The 2011 inventory data (U.S. Environmental Protection Agency 2013) show that CO_2, methane (CH_4), and nitrous oxide (N_2O) contributed from fossil fuel combustion processes from mobile and stationary sources (all sectors) include approximately:

- 5,612.9 Tg CO_2,
- 587.23 Tg CH_4, and
- 356.9 Tg N_2O.

The 6,702.3 Tg CO_2Eq generated in 2011 is a decrease from the 6,810.3 Tg CO_2Eq generated in 2010 (U.S. Environmental Protection Agency 2013). Among domestic transportation sources, light-duty vehicles (including passenger cars and light-duty trucks) represented 61 percent of CO_2 emissions, medium- and heavy-duty trucks 22 percent, commercial aircraft 7 percent, and other sources

11 percent. Across all categories of aviation, CO_2 emissions decreased by 20.8 percent (38.9 Tg) between 1990 and 2011. This includes a 59 percent (20.3 Tg) decrease in emissions from domestic military operations. To place military aircraft in context with other aircraft CO_2 emissions, in 2011 commercial aircraft generated 114.6 Tg CO_2Eq, military aircraft generated 12.2 Tg CO_2Eq, and general aviation aircraft generated 19.4 Tg CO_2Eq. Military aircraft represent roughly 8.6 percent of emissions from the overall jet fuel combustion category.

This section begins by providing the background and regulatory framework for greenhouse gases. It then provides a quantitative evaluation of changes in greenhouse gas emissions that would occur under the Proposed Action and analyzes the cumulative impacts of greenhouse gas emissions.

4.4.2.1.1 Regulatory Framework

This section addresses and summarizes documents that provide a framework for addressing the effects of climate change and greenhouse gas emissions on training activities in the TMAA Study Area.

Executive Order (EO) 13653, *Preparing the United States for the Impacts of Climate Change*, of November 2013 directs federal agencies to improve preparedness to address the impacts of climate change on human and natural resources. Federal agencies must implement coordinated planning, including cooperation with state, local, private-sector, and non-profit stakeholders to enhance the country's resilience to the effects of climate change. Federal agencies must promote partnerships and information sharing with all levels of government, engage in risk-informed decision-making and develop tools to facilitate decision-making, employ experience-based adaptive management practices, and carry out preparedness planning.

The DoD prepared a Climate Change Adaptation Roadmap in 2014 to implement the directives in EO 13653 (U.S. Department of Defense 2014). The policies and plans outlined in the Roadmap will increase the Department's resilience to the impacts of climate change, which is key to sustaining mission capabilities into the future. The Roadmap establishes three goals: (1) to identify and assess the impacts of climate change on the Department's ability to accomplish its mission, (2) to implement policies and plans to manage short- and long-term risks associated with climate change, and (3) to collaborate with internal and external stakeholders on climate change challenges. The Department identified four "lines of effort" that support these goals, one of which is training and testing, which the Roadmap describes as "critical to maintaining a capable and ready Force in the face of a rapidly changing strategic setting. Access to land, air, and sea space that replicate the operational environment for training and testing is essential to readiness."

In fulfillment of the first goal, the Roadmap identifies four main climate-related phenomena likely to impact the Department's activities: rising global temperatures, changing participation patterns, increasing frequency or intensity of extreme weather events, and sea level rise associated with storm surge. These phenomena have the potential to affect military training and testing activities by increasing the number of days activities are suspended due to adverse weather conditions, further stressing ESA-listed species and dependent ecosystems where training and testing occur, increasing health and safety risks to personnel, and increasing maintenance and repair of infrastructure and equipment used to conduct training and testing. To manage risks associated with climate change (Goal 2), the Department will continue to carry out its sustainable range program, which includes updating and revising its range complex master plans to incorporate new climate change initiatives and processes. Climate change effects will drive collaboration with stakeholders (Goal 3) and may include shared use of training and testing assets within the military and with our allies, collaboration with maritime and land

management agencies, and collaboration with the medical community to address health surveillance and disease treatment programs.

Federal agencies address emissions of greenhouse gases by reporting and meeting reductions mandated in laws, executive orders, and policies. The most recent of these is EO 13693, *Planning for Federal Sustainability in the Next Decade*, issued March 2015. EO 13693 shifts the way the government operates by establishing target greenhouse gas reduction goals for federal agencies. As outlined in the policy, goals shall be achieved by increasing efficiency, reducing energy use, and finding renewable or alternative energy solutions.

The training analyzed under the proposed action is undertaken in a manner that is influenced by the backdrop of targets for reducing greenhouse gas emissions discussed in EO 13693. Targets including Scope 1 (direct greenhouse gas emissions from sources that are owned or controlled by a federal agency), Scope 2 (direct greenhouse gas emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency), and Scope 3 (greenhouse gas emissions from sources not owned or directly controlled by a federal agency but related to agency activities such as vendor supply chains, delivery services, and employee travel and commuting) have been set for the DoD at a 40 percent reduction of greenhouse gas from the 2008 baseline by 2025.

The Navy is committed to improving energy security and environmental stewardship by reducing reliance on fossil fuels. The Navy is actively developing and participating in energy, environmental, and climate change initiatives that will increase use of alternative energy and help conserve the world's resources for future generations. The Navy Climate Change Roadmap identifies actions the Environmental Readiness Division is taking to assess, predict, and adapt to global climate change (U.S. Department of the Navy 2010). The Navy's Task Force Energy is responding to the Secretary of the Navy's energy goals through energy security initiatives that reduce the Navy's carbon footprint. The climate change roadmap (5-year roadmap) action items, objectives, and desired impacts are organized to focus on strategies, policies, and plans; operations and training; investments; strategic communications and outreach; and environmental assessment and prediction.

The DoD is taking specific actions regarding aircraft emissions. According to the U.S. Aviation Greenhouse Gas Emissions Reduction Plan (International Civil Aviation Organization 2012), DoD, including the Navy, has a number of specific military propulsion programs and initiatives underway to improve aircraft energy efficiency, which will also reduce greenhouse gases. These include:

- the Versatile Affordable Advanced Turbine Engines Program and several associated technology development sub-programs that strive to meet specific energy goals;
- the Adaptive Versatile Engine Technology Program, which is developing critical technologies to provide military turbofan engines with 25 percent improved fuel efficiency to reduce fuel burn and provide more range, persistence, speed, and payload; and
- the Adaptive Engine Technology Development Program, which seeks to accelerate technology maturation and reduce risk for transition of these technologies to a military engine in the 2020+ timeframe.

Such technology would be applicable to a range of military aircraft (e.g., fighters, bombers).

In a complementary effort, the President directed the Navy, Department of Energy, and U.S. Department of Agriculture to invest in the construction and operation of three biofuel refineries that

will produce up to 100 million gallons of cost-competitive alternative diesel and jet fuel beginning in 2016 (International Civil Aviation Organization 2015). The Federal Aviation Administration (FAA) and the DoD are working together with industry to coordinate and fund alternative jet fuel testing activities to ensure that alternative fuels meet required specifications. The National Aeronautics and Space Administration, FAA, and the U.S. Air Force are leading efforts to understand the benefits of alternative jet fuels on emissions that impact air quality and contrail formation.

The Navy is taking other actions ashore to implement EO 13653. The Navy is implementing sustainable practices for energy efficiency, avoidance or reduction of greenhouse gas emissions, and reduction of petroleum products use. Pursuant to Chief of Naval Operations (OPNAV) Instruction 4100.5E-Shore Energy Management (June 22, 2012), it is the Navy's policy to ensure energy security and legal compliance by increasing infrastructure energy efficiency and integrating cost-effective and mission-compatible alternative energy technologies, while providing reliable energy supply ashore. Among several mandates, according to OPNAV Instruction 4100.5E, the Navy shall reduce consumption of fossil fuel, increase the use of alternative fuels by the Navy's non-tactical vehicle fleet, and reduce greenhouse gas emissions. In the most cost-effective manner, the Navy will meet the following shore energy goals:

- 50 percent ashore consumption reduction by 2020;
- 50 percent total ashore energy from alternative sources by 2020; and
- 50 percent of installations net-zero consumers by 2020.

It is through this backdrop of other DoD/Navy initiatives that influence the assets, equipment, and consumption means of fossil fuels and other materials that Navy's training actions are carried out indirectly in a manner that contributes to meeting greenhouse gas goals.

4.4.2.2 Cumulative Greenhouse Gas Impacts

Climate change is a global issue, and greenhouse gas emissions are a concern from a cumulative perspective because individual sources of greenhouse gas emissions are not large enough to have an appreciable impact on climate change. Greenhouse gas analysis considers the incremental contribution of Alternatives 1 and 2 to total estimated U.S. greenhouse emissions and their significance on climate change as compared to the No Action Alternative.

To estimate total greenhouse gas emissions, each greenhouse gas was assigned a global warming potential; that is, the ability of a gas or aerosol to trap heat in the atmosphere. The global warming potential rating system is standardized to CO_2, which has a value of one. For example, CH_4 has a global warming potential of 21, which means that it has a global warming effect 21 times greater than CO_2 on an equal-mass basis (Intergovernmental Panel on Climate Change 2007). To simplify greenhouse gas analyses, total greenhouse gas emissions from a source are often expressed as CO_2Eq. The CO_2Eq is calculated by multiplying the emissions of each greenhouse gas by its global warming potential and adding the results together to produce a single, combined emission rate representing all greenhouse gases. While CH_4 and N_2O have much higher global warming potentials than CO_2, CO_2 is emitted in much higher quantities, so it is the overwhelming contributor to CO_2Eq from both natural processes and human activities. Global warming potential-weighted emissions are presented in terms of equivalent emissions of CO_2, using units of Tg (1 million metric tons, or 1 billion kg) of carbon dioxide equivalents (Tg CO_2Eq).

In the 2011 GOA Final EIS/OEIS, greenhouse gas emissions were calculated for ships and aircraft, which contribute the majority of emissions associated with training in the Study Area. Greenhouse gas emissions from minor sources such as munitions, weapons platforms, and auxiliary equipment were considered negligible and were not calculated. Ship greenhouse gas emissions were estimated by determining annual ship fuel (typically diesel) use based on proposed activities and multiplying total annual ship fuel consumption by the corresponding emission factors for CO_2, CH_4, and N_2O. Aircraft greenhouse gas emissions were calculated by multiplying jet fuel use rates by the total operating hours, by the corresponding jet fuel emission factors for CO_2, CH_4, and N_2O, and by the total annual sorties.

All three alternatives (No Action Alternative, Alternative 1, and Alternative 2), as discussed in the 2011 GOA Final EIS/OEIS, remain the same for this Supplemental EIS/OEIS. Based on the fact that the existing conditions have not changed appreciably, and no new Navy training activities are being proposed to occur in the TMAA in this Supplemental EIS/OEIS, re-analysis of the alternatives with respect to cumulative greenhouse gas impacts is not warranted.

4.4.3 MARINE MAMMALS

4.4.3.1 Impacts of The Proposed Action That May Contribute to Cumulative Impacts

Based on the analysis presented in Section 3.8 (Marine Mammals), impacts of the Proposed Action that might contribute to cumulative impacts on marine mammals include injury (Level A harassment under the MMPA) and disturbance or behavioral modification (MMPA Level B harassment). Underwater explosions and sonar have the potential to cause injury or MMPA Level A or B harassment including Permanent Threshold Shift (PTS). Other relatively short-term activities that might inadvertently harass marine mammals meet the definition of MMPA Incidental Harassment. The remaining stressors analyzed in Section 3.8 (Marine Mammals) are not expected to result in mortality or Level A or B harassment. The incremental contribution of these remaining stressors, discussed in Section 3.8.3 (Environmental Consequences), to cumulative impacts on marine mammals, would be negligible.

4.4.3.2 Impacts of Other Actions

4.4.3.2.1 Overview

The potential impacts of other actions that are relevant to the cumulative impact analysis for marine mammals include the following:

- Mortality associated with non-Navy vessel strikes, bycatch in fisheries, and entanglement in fishing and other gear
- Injury associated with non-Navy vessel strikes, bycatch, entanglement, and underwater sound
- Disturbance, behavioral modifications, and reduced animal fitness associated with underwater noise
- Reduced animal fitness associated with water pollution

Most of the other actions and considerations retained for analysis in Table 4.3-1 would include operation of marine vessels. Exceptions include the actions listed under environmental regulations and permitting. Stressors associated with marine vessel operations that are of primary concern for the cumulative impacts analysis includes vessel strikes and underwater noise. Many of the actions would also result in underwater noise from sources other than vessels, seismic surveys, and construction activities. Rather than discussing these stressors for individual actions, their aggregate impacts are considered below as “other environmental considerations” in the maritime traffic and ocean noise subsections. Similarly, many of the actions have the potential to result in water pollution. The aggregate

impacts of water pollution are addressed in the ocean pollution section (Section 4.4.2.2.5). Bycatch is associated with commercial fishing, and the primary cause of entanglement is commercial fishing. Therefore, these stressors are discussed in the commercial fishing section (Section 4.4.2.3.1).

4.4.3.2.2 Surveillance Towed Array Sensor System Low Frequency Active Sonar

Although operation of SURTASS-LFA Sonar would not occur within or near the TMAA, marine mammals could be exposed to that sound source and migrate into the TMAA. Potential impacts on marine mammals from SURTASS-LFA Sonar operations include (1) nonauditory injury,[2] (2) permanent loss of hearing, (3) temporary loss of hearing, (4) behavioral change, and (5) masking. The potential effects from Surveillance Towed Array Sensor System Low Frequency Active Sonar operations on any stock of marine mammals from injury (nonauditory or permanent loss of hearing) are considered negligible, and the potential effects on the stock of any marine mammal from temporary loss of hearing or behavioral change (significant change in a biologically important behavior) are considered minimal. Any auditory masking in marine mammals due to low-frequency active sonar signal transmissions is not expected to be severe and would be temporary. The operation of SURTASS-LFA Sonar with monitoring and mitigation would result in no mortality. The likelihood of low-frequency active sonar transmissions causing marine mammals to strand is negligible (U.S. Department of the Navy 2012).

4.4.3.2.3 Maritime Traffic and Vessel Strikes

Vessel strikes have been and will continue to be a cause of marine mammal mortality and injury throughout the Study Area. A review of the impacts of ship strikes on marine mammals is presented in Section 3.8.2.4 (General Threats). In particular, certain large whales, such as the blue whale, are more prone to vessel strikes (Berman-Kowalewski et al. 2010; Betz et al. 2011). The most vulnerable marine mammals are thought to be those that spend extended periods at the surface or species whose unresponsiveness to vessel sound makes them more susceptible to vessel collisions (Gerstein 2002; Laist and Shaw 2006; 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. Most vessel strikes of marine mammals reported involve commercial vessels and occur over or near the continental shelf (Laist et al. 2001). The literature review by Laist et al. (2001) concluded that vessel strikes likely have a negligible impact on the status of most whale populations, but that for small populations, vessel strikes may have considerable population-level impacts. The conservation status and abundance of the species struck would determine in large part whether the injury would have population-level impacts on that species (Laist et al. 2001; Vanderlaan and Taggart 2009). There has never been a Navy vessel strike to a marine mammal in the Study Area during any previous training activities. In *Summary of Reported Whale-Vessel Collisions in Alaskan Waters* (Neilson et al. 2012), the research article reports 108 whale-vessel collisions occurred from 1978 to 2011. In 19 cases the vessel type is unknown, but of the 89 that the vessel type is known, 35 percent were private recreational, 35 percent were commercial recreational, 8 percent were cruise ships, 7 percent were commercial fishing vessels, 4 percent were USCG cutters, 3 percent were research, and 1 percent was the state ferry system.

Mysticetes

Virtually all of the rorqual whale species have been documented to have been hit by vessels. This includes blue whales (Berman-Kowalewski et al. 2010; Van Waerebeek et al. 2007; Calambokidis 2012), fin whales (as recently as November 2011 in San Diego) (Van Waerebeek et al. 2007; Douglas et al.

[2] Nonauditory injury can be defined as not relating to or functioning in hearing (Merriam-Webster 2012); this includes mortality, strike, and lung injury.

2008), sei whales (Felix and Van Waerebeek 2005; Van Waerebeek et al. 2007), minke whales (Van Waerebeek et al. 2007), and humpback whales (Lammers et al. 2003; Van Waerebeek et al. 2007; Douglas et al. 2008).

Odontocetes

Sperm whales may be exceptionally vulnerable to vessel strikes as they spend extended periods of time "rafting" at the surface in order to restore oxygen levels within their tissues after deep dives (Jaquet and Whitehead 1996; Watkins et al. 1999). There were also instances in which sperm whales approached vessels too closely and were cut by the propellers (Aguilar de Soto et al. 2006). In general, odontocetes move quickly and seem to be less vulnerable to vessel strikes than other cetaceans; however, most small whale and dolphin species have at least occasionally suffered from vessel strikes including: killer whales (Visser and Fertl 2000; Van Waerebeek et al. 2007) and short-finned pilot whales (Aguilar et al. 2000; Van Waerebeek et al. 2007).

Pinnipeds

Pinnipeds in general appear to suffer fewer impacts from ship strikes than do cetaceans. This may be due, at least in part, to the large amount of time they spend on land (especially when resting and breeding), and their high maneuverability in the water. However, California sea lions are often attracted to fishing vessels or when food is available onboard or nearby (Hanan et al. 1989), and this may make them somewhat more at risk of being hit by a vessel during these times. Ship strikes are not a major concern for pinnipeds in general (Antonelis et al. 2006; Marine Mammal Commission 2002; National Marine Fisheries Service 2007).

4.4.3.2.4 Ocean Noise

Noise is generally described as unwanted sound—sound that clutters and masks other sounds of interest (Richardson et al. 1995). Anthropogenic sources of noise that are most likely to contribute to increases in ocean noise are vessel noise from commercial shipping and general vessel traffic, oceanographic research, oil and gas exploration, underwater construction, and naval and other use of sound navigation and ranging (sonar).

Any potential for cumulative impact should be put into the context of recent changes to ambient sound levels in the world's oceans as a result of anthropogenic activities. However, there is a large and variable natural component to the ambient noise level as a result of events such as earthquakes, rainfall, waves breaking, and lightning hitting the ocean as well as biological noises such as those from snapping shrimp and the vocalizations of marine mammals.

Andrew et al. (2002) compared ocean ambient sound from the 1960s to the 1990s from a receiver approximately 25 mi. (40 km) west of Point Sur, California. The data showed an increase in ambient noise of approximately 10 dB in the frequency ranges of 20–80 Hz and 200–300 Hz, and about 3 dB at 100 Hz over a 33-year period. Each 3 dB increase is noticeable to the human ear as a doubling in sound level. A possible explanation for the rise in ambient noise is the increase in shipping noise. There are approximately 11,000 supertankers worldwide, each operating 300 days per year, producing constant broadband noise at source levels of 198 dB (Hildebrand 2004).

Appendix C (Acoustic Primer) provides additional information about sources of anthropogenic sound in the ocean and other background information about underwater noise. This appendix describes the different types of effects that are possible and the potential relationships between sound stimuli and long-term consequences for individual animals and populations. A variety of impacts may result from

exposure to sound-producing activities. The severity of these impacts can vary greatly between minor impacts that have no real cost to the animal, to more severe impacts that may have lasting consequences. The major categories of potential impacts are: behavioral reactions, physiological stress, auditory fatigue, auditory masking, and direct trauma.

4.4.3.2.5 Ocean Pollution

As discussed in Section 3.8.3 (Environmental Consequences), pollutants from multiple sources are present in, and continue to be released into, the oceans. Elevated concentrations of certain compounds have been measured in tissue samples from marine mammals. Long-term exposure to pollutants poses potential risks to the health of marine mammals, although for the most part, the impacts are just starting to be understood (Reijnders et al. 2008). Section 3.8.3 (Environmental Consequences) provides an overview of these potential impacts, which include organ anomalies and impaired reproduction and immune function (Reijnders et al. 2008).

Oil spills are also a risk for marine mammals. Whales, dolphins, and pinnipeds are all air breathers and must come to the surface frequently to take a breath of air. In a large oil spill, these animals may be exposed to volatile chemicals during inhalation. Cetaceans have no fur that could be oiled and do not depend on fur for insulation. They are not susceptible to the insulation effects (hypothermia); however, haired marine mammals such as fur seals or sea otters would be at risk of insulation effects. Oil and other chemicals on skin and body may result in skin and eye irritation, burns to mucous membranes of eyes and mouth, and increased susceptibility to infection. For large whales, oil can foul the baleen they use to filter-feed, thereby potentially decreasing their ability to eat. Inhalation of volatile organics from oil or dispersants can result in respiratory irritation, inflammation, emphysema, or pneumonia. Ingestion of oil or dispersants may result in gastrointestinal inflammation, ulcers, bleeding, diarrhea, and maldigestion. Finally, absorption of inhaled and ingested chemicals may damage organs such as the liver or kidney, result in anemia and immune suppression, or lead to reproductive failure or death (National Marine Fisheries Service 2010). If the health of an individual marine mammal were compromised by long-term exposure to pollutants, it is possible that this condition could alter the animal's expected response to stressors from training activities associated with the Proposed Action. The behavioral and physiological responses of any marine mammal to a specific stressor, such as underwater sound, could be influenced by a number of other factors, including disease, dietary stress, body burden of toxic chemicals, energetic stress, percentage body fat, age, reproductive state, size, and social position. Synergistic impacts are also possible. For example, animals exposed to some chemicals may be more susceptible to noise-induced loss of hearing sensitivity (Fechter 2005). While the response of a previously stressed animal might be different than the response of an unstressed animal, there are no data available at this time to accurately predict how stress caused by various ocean pollutants would alter a marine mammal's response to a particular stressor associated with the Proposed Action.

4.4.3.3 Coastal Development

Coastal development and increased human populations in coastal areas will continue to have impacts on marine mammals such as increased tourism, non-point source pollution and runoff, power plant entrainment, and degradation of nearshore water quality and seagrass beds (see Section 3.8, Marine Mammals, for more information on impacts on marine mammals).

4.4.3.3.1 Commercial Fishing

Several commercial fisheries operate in the Study Area. Potential impacts from these activities include marine mammal injury and mortality from bycatch and entanglement. Fisheries have also resulted in

profound changes to the structure and function of marine ecosystems that adversely affect marine mammals.

Numerous ports in or near the Study Area contain both commercial and commercial passenger fishing vessel (i.e., recreational) fishing fleets that use the ocean areas within the Study Area.

Fisheries activities on a global scale remain a key threat for a number of marine mammal species; however, the best available data indicates that the majority of commercial fisheries operating within the Study Area rarely take marine mammals. In those instances where fisheries interactions rise to the level of "occasional" mortalities or serious injuries, NOAA is working to identify and reduce mortality to insignificant levels as mandated by the MMPA (78 FR 53336). In 1994, the MMPA was amended to formally address bycatch. Estimates of bycatch in the Pacific declined by a total of 96 percent from 1994 to 2006 (Geijer and Read 2013). Cetacean bycatch declined by 85 percent from 342 in 1994 to 53 in 2006, and pinniped bycatch declined from 1,332 to 53 over the same time period. However, fishery bycatch is likely the most impactful problem presently and may account for the deaths of more marine mammals than any other cause (Northridge 2008, Read 2008, Hamer et al. 2010; Geijer and Read 2013).

Entanglement in fishing gear is another major threat to marine mammals in the Study Area. In addition, 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; Pauly et al. 1998). These ecological changes may have important and likely adverse consequences for populations of marine mammals (DeMaster et al. 2001).

In summary, future commercial fishing activities in the Study Area are expected to result in significant impacts on some marine mammal species based on the relatively high injury and mortality rates associated with bycatch and entanglement. This mortality could result in or contribute to population declines for some species. Ecological changes brought about by commercial fishing are also expected to adversely impact marine mammals in the Study Area.

Entanglement of humpback whales in Alaska occur mainly in Southeast Alaska and involve crab, shrimp, unidentified pot gear, and gillnet fisheries. Humpback whales have been identified in Hawaii entangled in gear from Alaska. The number of events of identified entanglement has increased from less than 5 in 1990 to almost 15 in 2011 (Jackson et al. n.d.). The Alaska Network is permitted by NOAA Fisheries to attempt animal disentanglement. Since the Network began in 1998, there have been over 130 reports of large whale entanglements in local fishing gear, marine debris, and mooring gear (National Marine Fisheries Service n.d.).

4.4.3.4 Cumulative Impacts on Marine Mammals

The aggregate impacts of past, present, and reasonably foreseeable future actions are expected to result in significant impacts on some marine mammal species in the Study Area. The impacts are considered significant because the cumulative effects of vessel strikes, bycatch, and entanglement associated with other actions are expected to result in relatively high rates of injury and mortality that could cause population declines in some species. The Proposed Action could also result in injury or behavioral impacts to individuals of some marine mammal species from underwater explosions and sonar. Injury that might occur under the Proposed Action would be additive to injury and mortality associated with other actions. However, the relative contribution of the Proposed Action to the overall injury and mortality would be low compared to other actions. Additionally, since the analysis presented in this SEIS/OEIS demonstrates a more accurate and a significant reduction in the number of predicted

effects to marine mammals from Navy activities in the proposed action, the relative contribution of the Proposed Action to the impact to marine mammals is significantly lower than originally provided in the 2011 GOA EIS/OEIS. The Navy does not anticipate mortalities to marine mammals within the Study Area as a result of training activities under the Proposed Action. While quantitative estimates of marine mammal mortality from other actions are not available, the total bycatch estimate (lethal takes and serious injuries) for marine mammals for 39 fisheries and 54 marine mammal stocks throughout the United States was 1,887 individual animals in 2005 (National Oceanic and Atmospheric Administration 2011). Some of these mortalities likely occurred in the Study Area or affected individuals that used the Study Area seasonally.

Ocean noise associated with other actions (see Section 4.4.2.2.4, Ocean Noise), such as underwater explosions and sonar associated with the Proposed Action, could also result in additive behavioral impacts on marine mammals. However, in the Study Area, it is unlikely that these actions and underwater explosions or sonar use would overlap in time and space because these activities are dispersed and the sound sources are intermittent. The Navy takes appropriate coordination and scheduling steps (described in Section 3.12, Socioeconomic Resources) to avoid activities that interfere with or are not compatible with training.

It is likely that distant shipping noise, which is more universal and continuous, and sound associated with underwater explosions and sonar would overlap in time and space. However, there is no evidence indicating that the co-occurrence of shipping noise and sounds associated with underwater explosions and sonar use would result in harmful additive impacts on marine mammals.

As discussed in Section 4.4.2.2.5 (Ocean Pollution), the potential also exists for the impacts of ocean pollution and acoustic stressors associated with the Proposed Action to be additive or synergistic. It is possible that the response of a previously stressed animal would be more severe than the response of an unstressed animal.

4.5 SUMMARY OF CUMULATIVE IMPACTS

Marine mammals are the primary resources of concern for cumulative impacts analysis:

- Past human activities have impacted these resources to the extent that several marine mammal species occurring in the Study Area are ESA-listed.
- These resources would be impacted by multiple ongoing and future actions.
- Explosive detonations and vessel strikes under the Proposed Action have the potential to disturb, injure, or kill marine mammals.

In summary, based on the analysis presented in Section 3.8 (Marine Mammals), the current aggregate impacts of past, present, and other reasonably foreseeable future actions are not significantly different than the assessment in the 2011 GOA Final EIS/OEIS. No new information or circumstances are significant enough to warrant further cumulative impact review.

REFERENCES CITED AND CONSIDERED

Aguilar, N., Carrilllo, M., Delgado, I., Diaz, F., & Brito, A. (2000). Fast ferries impact on cetacean in Canary Islands: Collisions and displacement. *European Research on Cetaceans* 14: 164.

Aguilar de Soto, N.A., Johnson, M., Madsen, P.T., Tyack, P. L., Bocconcelli, A., & Borsani, J.F. (2006). Does Intense Ship Noise Disrupt Foraging in Deep-Diving Cuvier's Beaked Whales (*Ziphius cavirostris*)? *Marine Mammal Science*, 22(3):690-699.

Alaska Aerospace Corporation. (2013). Kodiak Launch Complex Overview.

Alaska Department of Environmental Conservation. (2012). Southeast Alaska Vessel Traffic Study.

Alaska Ocean Observing System. (2013). GulfWatch Alaska.

Allen, B.M., Brownell, R.L., & Mead, J.G. (2011). Species review of Cuvier's beaked whale, Ziphius cavirostris. Presentation to the Scientific Committee of the International Whaling Committee SC/63/SM17.

Andrew, R.K., Howe, B.M., & Mercer, J.A. (2002). Ocean ambient sound: Comparing the 1960s with the 1990s for a receiver off the California coast. *Acoustics Research Letters Online* 3(2): 65-70.

Antonelis, G. A., & Baker, J. D., et al. (2006). Hawaiian monk seal (*Monachus schauinslandi*): Status and conservation issues. *Atoll Research Bulletin* 543: 75-101.

Ashford-Hodges, N. and Simmonds, M.P. (2014). Climate change and cetaceans: an update. Presentations to the Scientific Committee of the International Whaling Commission. SC/65b/E12. 9 p.

Barco, S.G., D'Eri, L.R., Woodward, B.L., Winn, J. P., & Rotstein, D.S. (2010). Spectra fishing twine entanglement of a bottlenose dolphin: A case study and experimental modeling

Baulch, S. and Perry, C. (2012). A sea of plastic: evaluating the impacts of marine debris on cetaceans. Presentation to the Scientific Committee of the International Whaling Committee SC/64/E10. 24 p.

Baumann-Pickering, S., Simonis, A.E., Roch, M.A., McDonald, M.A., Solsona-Berga, A., Oleson, E.M., Wiggins, S.M., Brownell, R.L., Jr., & Hildebrand, J.A. (2012). "Spatio-temporal patterns of beaked whale echolocation signals in the North Pacific. 2012 Marine Mammal & Biology Program Review, Office of Naval Research. Available at: http://www.onr.navy.mil/Science-Technology/Departments/Code-32/All-Programs/Atmosphere-Research-322/~/media/Files/32/MMB-Program-Review-2012.ashx

Berman-Kowalewski, M., Gulland, F. M. D., Wilkin, S., Calambokidis, J., Mate, B., Cordaro, J., & Dover, S. (2010). Association Between Blue Whale (*Balaenoptera musculus*) Mortality and Ship Strikes Along the California Coast. *Aquatic Mammals, 36*(1), 59-66. 10.1578/am.36.1.2010.59.

Betz, S., Bohnsack, K., Callahan, A. R., Campbell, L. E., Green, S. E., & Labrum, K. M. (2011). *Reducing the Risk of Vessel Strikes to Endangered Whales in the Santa Barbara Channel: An Economic Analysis and Risk Assessment of Potential Management Scenarios.* (A group project submitted in partial satisfaction of the requirements for the degree of Master of Environmental Science and Management). Bren School of Environmental Science & Management, University of California, Santa Barbara.

Boesch, D., Anderson, D., Horner, R., Shumway, S., Tester, P., & Whitledge, T. (1997). Harmful Algal Blooms in Coastal Waters: Options for Prevention, Control and Mitigation *Special Joint Report with the National Fish and Wildlife Foundation*. (pp. 61) National Oceanic and Atmospheric Administration.

Bureau of Ocean Energy Management. (2013). Alaska G&G Permits. www.boem.gov/About-BOEM/BOEM-Regions/Alaska-Region/Resource-Evaluation/Permits/Index.aspx Website accessed December 6, 2013.

Calambokidis, J. (2012). Summary of ship-strike related research on blue whales in 2011. Manuscript on file: 9.

Cassoff, R.M., Moore, K.M., McLellan, W.A., Barco, S.G., Rotstein, D.S., & More, M.J. (2011). Lethal entanglement in baleen whales. Diseases of Aquatic Organisms 96:175-185.

Council on Environmental Quality. (1997). Considering Cumulative Effects Under the National Environmental Policy Act. (pp. 5).

Council on Environmental Quality. (2010). Draft NEPA guidance on consideration of the effects of climate change and greenhouse gas emissions.

Culik, B. (2004). Review of Small Cetaceans Distribution, Behaviour, Migration and Threats. (pp. 343) United National Environment Programme (UNEP) and the Secretariate of the Convention on the Conservation of Migratory Species of Wild Animals.

Davison, P. and Asch, R. G. (2011). Plastic ingestion by mesopelagic fishes in the North Pacific Subtropical Gyre. *Marine Ecological Progress Series, 432*, 173-180.

DeMaster, D. P., Fowler, C. W., Perry, S. L., & Richlen, M. F. (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.

Denuncio, P., Bastid, R., Dassis, M., Giardino, G., Gerpe, M., & Rodriguez, D. (2011). Plastic ingestion in Franciscana dolphins, Pontoporia blainvillei (Gervais and d'Orbigny, 1844), from Argentina. Marine Pollution Bulletin 62(8):1836-1841.

de Stephanis, R., Gimenez, J., Carpinelli, E., Gutierrez-Exposito, C., & Canadas, A. (2013). As main meal for sperm whales: Plastics debris. Marine Pollution Bulletin 69:206-214.

Douglas, A. B., Calambokidis, J., Raverty, S., Jeffries, S. J., Lambourn, D. M., & Norman, S. A. (2008). Incidence of ship strikes of large whales in Washington State. *Journal of the Marine Biological Association of the United Kingdom*, 88(6), 1121-1132.

Economic Impact of Alaska's Visitor Industry 2013-14 update. (February 2015).

Encyclopedia of Earth. (2013). Gulf of Alaska.

Fechter, L. D. (2005). Ototoxicity. *Environmental Health Perspectives, 113*(7), 443–444.

Federal Energy Regulatory Commission. (2014a). List of Permits Issued.

Federal Energy Regulatory Commission. (2014b). Listo of Permits Pending.

Felix, F. and Van Waerebeek, K. (2005). Whale mortality from ship strikes in Ecuador and West Africa. *Latin American Journal of Aquatic Mammals,* 4(1), 55-60.

Geijer, C. K. A. and Read, A. J. (2013). "Mitigation of marine mammal bycatch in U.S. fisheries since 1994." Biological Conservation 159: 54-60.

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. doi: 10.1511/2002.2.154.

Good, T.P., June, J.A., Etnier, M.A., & Broadhurst, G. (2010). Derelict fishing nets in Puget Sound and the Northwest Straits: Patterns and threats to marine fauna. Marine Pollution Bulletin 60:39-50.

Hamer, D. J., Childerhouse, S. J., & Gales, N. J. (2010). *Mitigating operational interactions between odontocetes and the longline fishing industry: A preliminary global review of the problem and of potential solutions*. Tasmania, Australia, International Whaling Commission: 30.

Hanan, D.A., Jones, L.M., & Read, R.B. (1989). California Sea Lion Interaction and Depredation Rates with the Commercial Fishing Vessel Fleet Near San Diego. California Cooperative Oceanic Fisheries Investigation Report, Vol. 30: 122-126.

Hatch, L. and Wright, A. J. (2007). A Brief Review of Anthropogenic Sound in the Oceans. International Journal of Comparative Psychology, 20, 12.

Heimbuch, H. (2013). The Arctic Sounder. *Companies await permits for Alaska Arctic seismic exploration*. June 16.

Hester, K. C., Peltzer, E. T., Kirkwood, W. J., & Brewer, P. G. (2008), Unanticipated consequences of ocean acidification: A noisier ocean at lower pH, Geophysical Research Letters, Vol. 35, L19601, doi:10.1029/2008GL034913.

Hildebrand, J. (2004). Sources of Anthropogenic Sound in the Marine Environment, *International Policy Workshop on Sound and Marine Mammals* (pp. 38). London.

Hildebrand, J. A. (2005). Impacts of anthropogenic sound. Marine Mammal Research: Conservation beyond Crisis. J. E. Reynolds, The John Hopkins University Press**:** 101-124.

Intergovernmental Panel on Climate Change. (2007). Technical Summary.

Ilyina, T., Zeebe, R.E., & Brewer, P.G. (2010). Future ocean increasingly transparent to low-frequency sound owing to carbon dioxide emissions. Nature Geoscience 3:18-22.

International Civil Aviation Organization. (2012). United States Aviation Greenhouse Gas Emissions Reduction Plan (pp.16).

International Civil Aviation Organization. (2015). United States Aviation Greenhouse Gas Emissions Reduction Plan (pp.42).

International Council for the Exploration of the Sea. (2005). Ad-Hoc Group on the Impact of Sonar on Cetaceans. (pp. 50).

Jackson, K., Jensen, A.S., Lyman, E., & Savage, K. (n.d.). All Tied Up: Taking a Closer Look at Humpback Whale Entanglement in Alaska, 1990–2011.

Jackson, J. B. C., Kirby, M. X., Berger, W. H., Bjorndal, K. A., Botsford, L. W., Bourque, B. J, & Warner, R. R. (2001, July 27). Historical Overfishing and the Recent Collapse of Coastal Ecosystems. *Science, 293*. Retrieved from www.sciencemag.org.

Jacobsen, J.K., Massey, L., & Gulland, F. (2010). Fatal ingestion of floating net debris by two sperm whales (Physeter macrocephalus). Marine Pollution Bulletin 60:765-767.

Jaquet, N. and Whitehead, H. (1996). Scale-dependent correlation of sperm whale distribution with environmental features and productiviity in the South Pacific. *Marine Ecology Progress Series*, 135, 1-9.

Jauniaux, T., Haelters, J., Degracer, S., & Coignoul, F. (2013). Fatal plastic impaction in a minke whale (Balaenoptera acutorostrata). 3rd Scientific meeting of the Faculty of Veterinary Medicine, Liege, Belgium.

Keller, A. A., Fruh, E. L., Johnson, M. M., Simon, V., & McGourty, C. (2010). "Distribution and abundance of anthropogenic marine debris along the shelf and slope of the US West Coast." Mar Pollut Bull 60(5): 692-700.

Knik Arm and Toll Bridge Authority. (2013a). Record of Decision Knik Arm Crossing Project.

Knik Arm and Toll Bridge Authority. (2013b). Timeline/Schedule.

Laist, D. W., Knowlton, A. R., Mead, J., Collet, A., & Podesta, M. (2001). Collisions between ships and whales. *Marine Mammal Science, 17*(1), 35-75.

Laist, D. W. and Shaw, C. (2006). Preliminary evidence that boat speed restrictions reduce deaths of Florida manatees. *Marine Mammal Science, 22*(2), 472-479. doi: 10.1111/j.1748-7692.2006.00027.x.

Lammers, M. O., Au, W. W. L., & Herzing, D. L. (2003). The broadband social acoustic signaling behavior of spinner and spotted dolphins. *Journal of the Acoustical Society of America*, 114, 1629-1639.

Law, K. L., Moret-Ferguson, S., Maximenko, N. A., Proskurowski, G., Peacock, E. E., Hafner, J., & Reddy, C. M. (2010). Plastic accumulation in the North Atlantic subtropical gyre. [Research Support, Non-U.S. Gov't Research Support, U.S. Gov't, Non-P.H.S.]. *Science, 329*(5996), 1185-1188. 10.1126/science.1192321. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/20724586.

Le Treut, H., Somerville, R., Cubasch, U., Ding, Y., Mauritzen, C., Mokssit, A., Prather, M. (2007). Historical Overview of Climate Change Science. In: S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (Eds.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 36). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Marine Mammal Commission. (2002). Hawaiian monk seal (*Monachus schauinslandi*). Species of Special Concern, Annual Report to Congress, 2001. Bethesda, MD, *Marine Mammal Commission***:** 63-76.

Mato, Y., Isobe, T., Takada, H., Kanehiro, H., Ohtake, C., & Kaminuma, T. (2001). Plastic Resin Pellets as a Tranport Medium for Toxic Chemicals in the Marine Environment. *Environmental Science Technology, 35*, 318-324.

Merriam-Webster. (2012). Definition of NONAUDITORY. Retrieved from www.merriam-webster.com.

Mintz, J. D. and Filadelfo, R. J. (2011). Exposure of Marine Mammals to Broadband Radiated Noise. Prepared by CNA.

Myers, R. A. and Worm, B. (2003). Rapid worldwide depletion of predatory fish communities. *Nature, 423*, 280–283.

National Marine Fisheries Service. (n.d.). Large Whale Entanglements FactSheet.

National Marine Fisheries Service. (2006). Marine debris: Impacts in the Gulf of Mexico.

National Marine Fisheries Service. (2007). Alaska Groundfish Harvest Specificiations Final Environmental Impact Statement.

National Marine Fisheries Service. (2010). Impacts of oil on marine mammals and sea turtles. National Marine Fisheries Service, Silver Spring, Maryland.

National Marine Fisheries Service. (2011). Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Space Vehicle and Missile Launch Operations at Kodiak Launch Complex, Alaska.

National Marine Fisheries Service. (2013a). Yakutat Wave Energy Project.

National Marine Fisheries Service. (2013b). Alaska Predator Ecosystem Experiement 1993–2002.

National Marine Fisheries Service and Bureau of Ocean Energy Management. (2013). Effects of Oil and Gas Activities in the Arctic Ocean Supplemental Draft Environmental Impact Statement.

National Oceanic and Atmospheric Administration. (2011). Chapter 5: National Overview. U.S. National Bycatch Report. U.S Department of Commerce. National Marine Fisheries Service.

National Research Council of the National Academies. (2003). Ocean Noise and Marine Mammals. In Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals (Ed.), *Ocean Noise and Marine Mammals* (pp. 24): National Research Council of the National Academies.

National Research Council of the National Academies. (2005). Marine Mammal Populations and Ocean Noise Determining when Noise Causes Biologically Significant Effects. In National Research Council of the National Academies (Ed.). Washington DC: The National Academies Press.

Neilson, J.L., Gabriele, C.M., Jensen, A.S., Jackson, K., & Straley, J.M. (2012). Summary of Reported Whale-Vessel Collisions in Alaskan Waters. *Journal of Marine Biology*. Volume 2012. 18 pp.

Northridge, S. (2008). Fishing industry, effects of. In. Encyclopedia of Marine Mammals. W. F. Perrin, B. Wursig and J. G. M. Thewissen. San Diego, CA, Academic Press**:** 443-447.

Nowacek, D., Johnson, M., & Tyack, P. (2004). North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. *Proceedings of the Royal Society of London, 271*(B), 227-231. 10.1098/rspb.2003.2570.

Nowacek, D., Thorne, L. H., Johnston, D., & Tyack, P. (2007). Responses of cetaceans to anthropogenic noise. *Mammal Review, 37*(2), 81-115.

Pauly, D., Christensen, V., Guenette, S., Pitcher, T. J., Sumaila, U. R., Walters, C. J., & Zeller, D. (1998). Towards sustainability in world fisheries. *Nature, 418*, 689–695.

Matanuska-Susitna Borough. (2011). Port MacKenzie Master Plan Update.

Read, A. J. (2008). The looming crisis: Interactions between marine mammals and fisheries. *Journal of Mammalogy, 89*(3), 541-548.

Read, A. J., Drinker, P., & Northridge, S. (2006). Bycatch of marine mammals in U.S. and global fisheries. *Conservation Biology, 20*(1), 163–169.

Reeder, D. B. and Chiu, C. (2010). Ocean Acidification and its Impact on Ocean Noise: Phenomenology and Analysis. Journal of the Acoustical Society of America 128(3):EL137-EL143, September 2010, DOI: 10.1121/1.3431091.

Reijnders, P. J. H., Aguilar, A., & Borrell, A. (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.

Richardson, W. J., Greene, C. R., Jr., Malme, C. I., & Thomson, D. H. (1995). Marine Mammals and Noise (pp. 576). San Diego, CA: Academic Press.

Southall, B., Schusterman, R. J., Kastak, D., & Reichmuth Kastak, C. (2005). Reliability of underwater hearing thresholds in pinnipeds. *Acoustics Research Letters Online* 6(4): 243-249.

Southall B.L., Bowles A.E., Ellison W.T., Finneran J.J., Gentry R.L., Greene Jr. C.R., Kastak D., Ketten D.R., Miller J.H., Nachtigall P.E., Richardson W.J., Thomas J.A., & Tyack P.L. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals* 33:411-521.

Tyack, P. (2009a). Acoustic playback experiments to study behavioral responses of free-ranging marine animals to anthropogenic sound. *Marine Ecology Progress Series, 395*, 13. 10.3354/meps08363.

Tyack, P. (2009b). Human-generated sound and marine mammals. *Physics Today*, 39–44.

U.S. Department of Defense. (2014). 2014 Climate Change Adaptation Roadmap.

U.S. Department of Defense. (2016). DoD Directive 4715.21 Climate Change Adaptation and Resilience. Efective January 14, 2016.

U.S. Department of Homeland Security. United States Coast Guard. (2014). Draft Programmatic Environmental Assessment Arctic Operations and Training Exercises Alaska.

U.S. Department of the Navy. (2010). Navy Climate Change Roadmap Task Force Climate Change and Oceanographer of the Navy (Eds.). (pp. 28).

U.S. Department of the Navy. (2012). Final Supplemental Environmental Impact Statement/Supplemental Oversea Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active.

U.S. Department of the Navy. (2014). U.S. Arctic Roadmap 2014–2030. Navy Task Force Climate Change.

U.S. Department of the Navy. (2015). Final Environmental Assessment for Naval Special Warfare Center Detachment Kodiak, Cold Weather Maritime Training, Kodiak, Alaska.

U.S. Departments of the Army and Air Force (2013). Record of Decision for Final Environmental Impact Statement for the Modernization and Enhancement of Ranges, Airspace, and Training Areas in the Joint Pacific Alaska Range Complex.

U.S. Environmental Protection Agency. (1998). National air quality and emissions trend report, 1997: Research Triangle Park, North Carolina, EPA 454/Rñ98ñ016, p. 112ñ117.

U.S. Environmental Protection Agency. (2012). DRAFT Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010. (pp. 470).

U.S. Environmental Protection Agency. (2013). Inventory of U.S. greenhouse gas emissions and sinks: 1990–2011. EPA 430-R-13-001. 12 April.

U.S. Geological Survey. (2000). Atmospheric Deposition Program, U.S. Geological Survey Fact Sheet, 2000. 112-00: 27-36.

Van Waerebeek, K., Baker, A. N., Felix, F., Gedamke, J., Iñiguez, M., Sanino, G. P., & Wang, Y. (2007). Vessel collisions with small cetaceans worldwide and with large whales in the southern hemisphere, an initial assessment. *Latin American Journal of Aquatic Mammals*, 6(1), 43-69.

Visser, I. N. and Fertl, D. (2000). Stranding, resighting, and boat strike of a killer whale (Orcinus orca) off New Zealand. *Aquatic Mammals,* 26.3, 232-240.

Wallace, B. P., Lewison, R. L., McDonald, S. L., McDonald, R. K., Kot, C. Y., Kelez, S., & Crowder, L. B. (2010). Global patterns of marine turtle bycatch. *Conservation Letters, xx*, 1-12. doi: 10.1111/j.1755-236x.2010.00105.x.

Wartzok, D. (2009). Marine mammals and ocean noise. In J. H. Steele, K. K. Turekian and S. A. Thorpe (Eds.), *Encyclopedia of Ocean Sciences* (2nd ed., Vol. 3, pp. 628-634). Boston, MA: Academic Press.

Williams, R., Ashe, E., & O'Hara, P. D. (2011). Marine mammals and debris in coastal waters of British Columbia, Canada. Marine Pollution Bulletin 62:1303-1316.