4 Cumulative Impacts

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

There are no figures in this section.

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 guidance (Council on Environmental Quality 1997). The Council on Environmental Quality 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 projects in the geographic area. The Council on Environmental Quality provides guidance on cumulative impacts 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 Council on Environmental Quality 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 Council on Environmental Quality 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 No Action Alternative, Alternative 1, and Alternative 2 (the alternatives) 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 each alternative that might contribute to cumulative impacts.

[1] Council on Environmental Quality Regulations provides 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" is 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 Council on Environmental Quality guidance (Council on Environmental Quality 1997), 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 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 boundary for the cumulative impacts analysis includes, but is not limited to, the entire Mariana Islands Training and Testing (MITT) Study Area (Study Area) (Figure 2.1-1). The geographic boundaries for marine mammals and sea turtles were expanded to include activities outside the MITT Study Area that might impact migratory animals. 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 (Council on Environmental Quality 1997) and considering the specific resource in terms of its history of degradation. The Proposed Action includes ongoing and anticipated future training and testing activities. While the United States (U.S.) Department of the Navy (Navy) training and testing requirements change over time in response to world events and several other factors, the general types of activities addressed by this Environmental Impact Statement (EIS)/Overseas EIS (OEIS) are expected to continue indefinitely, and the associated impacts would occur indefinitely. Likewise, some reasonably foreseeable future actions and other environmental considerations addressed in the cumulative impacts analysis are expected to continue indefinitely (e.g., oil and gas production, maritime traffic, commercial fishing). 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 and testing 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 EIS/OEIS. The anticipated effective dates for these MMPA authorizations would be a 5-year period from May 2015 through April 2020. 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

The Affected Environment sections of Chapter 3 (Affected Environment and Environmental Consequences) describe current resource conditions and trends; these sections also discuss 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 PREFERRED ALTERNATIVE THAT MIGHT CONTRIBUTE TO CUMULATIVE IMPACTS

Direct and indirect impacts of the alternatives, 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 resource and the intensity, duration, and spatial extent of the impacts for each stressor. 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 stressor that 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 stressor that may affect and is likely to adversely affect the species was considered in the cumulative impacts analysis. Stressors 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. A determination of may affect, not likely to adversely affect indicates that the impacts would be discountable (extremely unlikely) or insignificant.

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 E, Public Participation), communications with other agencies, a review of other military activities, literature review, previous NEPA analyses for some of the other actions, 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 likely or probable (i.e., reasonably foreseeable), rather than merely possible or speculative.
- The timing and location of the other action in relationship to proposed training and testing activities.
- Whether the other action and the preferred alternative 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 environmental 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 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 each alternative were then added to the combined impacts of all other actions to describe the cumulative impacts that would result if the No Action Alternative, Alternative 1, or Alternative 2 were implemented. The cumulative impacts analysis considered additive, synergistic, and antagonistic impacts. A qualitative analysis was conducted in cases based on the available information. The analysis in Chapter 3 (Affected Environment and Environmental Consequences) indicates that the direct and indirect impacts of the No Action Alternative, Alternative 1, and Alternative 2 would be similar for many of the stressors. Therefore, much of the cumulative impacts discussion applies to all three alternatives. Specific differences between the alternatives are discussed when appropriate.

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. Descriptions of each action and environmental consideration carried forward for analysis are provided in the following sections.

4.3.2 Oil and Natural Gas Exploration, Extraction, and Production

4.3.2.1 Oil Pipeline

The Commonwealth Utilities Corporation is planning on constructing an 8-inch (20.3-centimeter) aboveground receiving pipeline that delivers fuel to the Commonwealth Utilities Corporation power plants 1 and 2 in Lower Base from the Mobile Oil Facility. This facility is located on the central western coast of Saipan. The design is complete and construction began in March 2012.

4.3.2.2 Seismic Surveys

Seismic surveys are typically accomplished by towing a sound source such as an airgun array that emits acoustic energy in timed intervals behind a research vessel. The transmitted acoustic energy is reflected and received by an array of hydrophones. This acoustic information is processed to provide information about geological structure below the seafloor. The oil and gas industry uses seismic surveys to search for new hydrocarbon deposits. In addition, academic geologists use them to study plate tectonics and other topics. The underwater sound produced by these surveys could affect marine life, including marine mammals. For example, the potential exists to expose some animals to sound levels exceeding 180 decibels (dB) referenced to (re) 1 micropascal (µPa) root mean square, which would, in turn, potentially allow temporary or permanent loss of hearing (Bureau of Ocean Energy Management 2011a). All seismic surveys conducted by U.S. vessels are subject to the MMPA authorization process administered by the NMFS, as well as the NEPA process associated with issuing MMPA authorizations. Currently, there are several MMPA authorizations for seismic surveys near the Study Area, including one for the territorial waters of the Commonwealth of the Northern Mariana Islands (CNMI).

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

#	Name of Action	Lead Agency or Proponent	Marine or Terrestrial	Timeframe	Retained for Further Analysis?
Oil and Natural Gas Exploration, Extraction, Production, and Offshore Energy Generation					
1	Oil pipeline construction	Commonwealth Utilities Corporation	Terrestrial	Present	Retained.
2	Seismic surveys	Bureau of Ocean Energy Management, oil and gas industry, National Science Foundation, and academic institutions	Marine	Past, present, and future	Retained.
3	Wave and tidal energy plants	Bureau of Ocean Energy Management	Marine	Future	Dismissed because action is speculative.
Port Improvements, Dredge Disposal, Beach Nourishment, and Mining					
4	Offshore dredge disposal program	U.S. Army Corps of Engineers, U.S. Environmental Protection Agency	Marine	Past, present, and future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
5	New Landfill Dandan	Department of Public Works	Terrestrial	Future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
6	Pagan Mining	CNMI Government Administration	Terrestrial	Past, present, and future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
7	Relocation of Landfill	Department of Public Works	Terrestrial	Present and future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
8	Deep Seabed Minerals Project	Nauru Ocean Resources	Marine	Future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
9	Commercial Port Improvements East of Hotel Wharf	Port Authority of Guam	Marine	Future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
10	Harbor Rehabilitation Project	Commonwealth Ports Authority	Marine	Present	Dismissed because action only pertains to improvements on existing structures.
Other Military Activities					
11	Army and Air Force Exchange Service on Saipan	Department of Defense	Terrestrial	Past	Retained.
12	Live Fire Training Range Complex on Guam	U.S. Navy	Terrestrial	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	Marine or Terrestrial	Timeframe	Retained for Further Analysis?
Other Military Activities (continued)					
13	Surveillance Towed Array Sensor System Low Frequency Active Sonar	U.S. Navy	Marine	Past, present, and future	Retained.
14	Facility and Infrastructure Construction throughout Guam and CNMI	Department of Defense	Terrestrial	Future	Retained.
15	Portable Joint Threat Emitter in Mariana Islands Range Complex	Department of Defense	Terrestrial	Future	Retained.
16	Wind Turbines	Naval Facilities Engineering Command	Terrestrial	Future	Dismissed because action is pending approval and funding, specific future actions are speculative.
17	Divert Activities and Exercises	U.S. Air Force	Terrestrial	Future	Retained.
Environmental Regulations and Planning					
18	Draft Safe Harbor Agreement	U.S. Fish and Wildlife Service	Marine	Past, present, and Future	Dismissed because action involves only planning and policy-related activities; specific future actions are speculative.
19	Coastal and marine spatial planning	Regional Ocean Commissions	Marine	Future	Dismissed because action involves only planning and policy-related activities (see Chapter 6, Additional Regulatory Considerations).
20	Marine Mammal Protection Act incidental take authorizations	National Marine Fisheries Service	Marine	Past, present, and future	Retained.
21	5-year review of species under the Federal Endangered Species Act	U.S. Fish and Wildlife Service	Marine and Terrestrial	Past, present, and future	Dismissed because action involves only planning and policy-related activities; specific future actions are speculative.
22	Avian and Avifauna Conservation Plans	Not applicable	Terrestrial	Past, present and future	Dismissed because action involves only planning and policy-related activities; specific future actions are speculative.

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

#	Name of Action	Lead Agency or Proponent	Marine or Terrestrial	Timeframe	Retained for Further Analysis?
Environmental Regulations and Planning (continued)					
23	Reforestation of Masso Reservoir	GovGuam and U.S. Navy	Terrestrial	Past, present, and future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
Other Environmental Considerations					
24	Commercial fishing and fishery management plans	National Marine Fisheries Service and private industry	Marine	Past, present, and future	Retained.
25	Maritime traffic	Not applicable	Marine	Past, present, and future	Retained.
26	Development of Coastal Lands	Not applicable	Marine and terrestrial	Past, present, and future	Retained.
27	Ocean noise	Not applicable	Marine	Past, present, and future	Retained.
28	Ocean pollution (including marine debris, nonpoint source pollution, and cruise ship discharges)	Not applicable	Marine	Past, present, and future	Retained.
29	Commercial and general aviation	Not applicable	Marine and Terrestrial	Past, present, and future	Retained from greenhouse gas emission analysis.
30	Transportation Improvements	Not applicable	Marine and Terrestrial	Past, present, and future	Retained.
31	Climate Change	Not applicable	Marine and Terrestrial	Past, present, and future	Retained.

Notes: CNMI = Commonwealth of the Northern Mariana Islands, U.S. = United States

4.3.3 OTHER MILITARY ACTIONS

4.3.3.1 Army and Air Force Exchange Service on Saipan

In September 2008, the Army and Air Force Exchange Service opened a 181,000-square-foot ($ft.^2$) (16,815.4-square-meter [m^2]) Shopping Complex on Andersen Air Force Base. This facility has 81,000 $ft.^2$ (7,525.1 m^2) of retail space, which is triple the size of the old Exchange.

4.3.3.2 Live Fire Training Range Complex on Guam

In February 2012, the Navy initiated a Supplemental EIS to evaluate the environmental consequences of establishing a live-fire training range complex on Guam in support of the relocation of Marine Corps forces to Guam. Scoping meetings for the Supplemental EIS were held in March 2012. On 27 April 2012, the U.S.-Japan Security Consultative Committee issued a joint statement announcing its decision to adjust the plans outlined in the May 2006 Realignment Roadmap document. In accordance with the adjustments (the "2012 Roadmap Adjustments"), the Department of Defense adopted a new force posture in the Pacific which provided a substantially smaller Marine Corps relocation to Guam. As a result of the 2012 Roadmap Adjustments, the Navy expanded the scope of the Supplemental EIS to also evaluate the potential environmental consequences from construction and operation of a main cantonment area, including family housing, and associated infrastructure to support the relocation of a substantially reduced number of Marines than previously analyzed. The Supplemental EIS supplements the 2010 Final EIS for the Guam and CNMI Military Relocation.

4.3.3.3 Surveillance Towed Array Sensor System Low Frequency Active Sonar

In August 2012, the Navy released a Record of Decision for employing the Surveillance Towed Array Sensor System Low Frequency Active Sonar. The Navy currently plans to operate up to four Surveillance Towed Array Sensor System Low Frequency Active 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 (including the Study Area), Atlantic Ocean, Indian Ocean, and Mediterranean Sea.

4.3.3.4 Facility and Infrastructure Construction throughout Guam and the Commonwealth of the Northern Mariana Islands

Facility and Infrastructure construction throughout Guam and CNMI involves components from the U.S. Marine Corps, the Navy, and the U.S. Army. These are the main components for this Proposed Action:

- **Guam and CNMI Military Relocation.** Develop and construct facilities and infrastructure within Guam and the CNMI to meet the Marine Corps' living, training, and readiness requirements. Relocate approximately 5,000 Marines and their dependents from Okinawa to the Mariana Islands while concurrently increasing the civilian workforce. This action is analyzed in the Supplemental EIS for the Live Fire Training Range Complex on Guam discussed in Section 4.3.3.2 (Live Fire Training Range Complex on Guam).
- **CNMI Joint Military Training.** Establish ranges and training areas in the Western Pacific to meet the consolidated unfilled training requirements of the Service Components. The Notice of Intent to complete an EIS/OEIS was published in the Federal Register on 14 March 2013.
- **CVN Supplemental National Environmental Policy Act Analysis.** Construct a new deep-draft wharf with shore side infrastructure improvements creating the capability to support a transient nuclear aircraft carrier and carrier strike group in Apra Harbor, Guam.

- **X-Ray Wharf Environmental Assessment (EA).** Construction of improvements to the existing main supply wharf within Naval Base Guam to accommodate two berths for the Navy's new class of supply ships. The Final EA is anticipated in spring 2014.
- **Army.** Develop facilities and infrastructure on Guam to allow an Army Air and Missile Defense Task Force to protect Guam from potential ballistic missile attacks. Relocate approximately 600 military personnel, 900 dependents, and 100 civilian support workforces to Guam.

4.3.3.5 Portable Joint Threat Emitter in the Mariana Islands Range Complex

The Joint Threat Emitter is owned by the U.S. Navy and provides realistic threat simulations in the training environment. The primary location for the Joint Threat Emitter is planned for placement and use in Ritidian Point at Andersen Air Force Base. The Finding of No Significant Impact for the Environmental Assessment was signed on 31 July 2012.

4.3.3.6 Divert Activities and Exercises

The U.S. Air Force proposes improvements to an existing airfield on U.S. territory near the Philippine Sea in support of expanding mission requirements in the western Pacific. In addition, divert capabilities for current, emerging, and future training activities are proposed. A Draft EIS analyzing environmental impacts associated with the divert activities and exercises was published in June 2012.

4.3.4 Environmental Regulations and Planning

4.3.4.1 Coastal and Marine Spatial Planning

Dismissed because action involves only planning and policy-related activities (discussed in Chapter 6, Additional Regulatory Considerations).

4.3.4.2 Marine Mammal Protection Act Incidental Take Authorizations

The MMPA generally prohibits "take" of marine mammals in U.S. waters by any person and by U.S. citizens in international waters. The National Marine Fisheries Service can authorize "take" for specific activities.

4.3.5 Other Environmental Considerations

4.3.5.1 Commercial Fishing

Commercial fishing constitutes an important and widespread use of the ocean resources throughout the Study Area. Commercial fishing can adversely affect fish populations, other species, and habitats. Potential impacts of commercial fishing include overfishing of targeted species and bycatch, both of which negatively affect fish stocks and other marine resources. Bycatch is the capture of fish, marine mammals, sea turtles, marine birds, and other nontargeted species that occurs incidental to normal fishing operations. Use of mobile fishing gear, such as bottom trawls, disturbs the seafloor and reduces 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), and 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 mammals.

Commercial fishing can have a profound influence on individual fish populations. In a study of retrospective data, Jackson et al. (2001) analyzed paleoecological 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, Jackson et al. (2001) 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 groups of marine species, including sharks, mammals, marine birds, and sea turtles (Wallace et al. 2010).

4.3.5.2 Maritime Traffic

Portions of the Study Area are heavily traveled by commercial, recreational, and government marine vessels, with several commercial ports occurring in or near the Study Area. Section 3.12 (Socioeconomic Resources) provides additional information for marine vessel traffic in the Study Area. Primary concerns for the cumulative impacts analysis include vessels striking marine mammals and sea turtles, introduction of non-native species through ballast water, and underwater sound from ships and other vessels.

4.3.5.3 Development of Coastal Lands

Coastal development intensifies use of coastal resources, resulting in potential impacts on water quality, marine habitat, and air quality. Coastal land development in the Study Area is both intensive and extensive. Development continues to impact coastal resources through point and nonpoint source pollution, concentrated recreational use, and intensive ship traffic using major port facilities. The Study Area coastline also includes coastal tourism development (e.g., hotels, resorts, restaurants, food industry, vacation homes, second homes) and the infrastructure supporting coastal development (e.g., retail businesses, marinas, fishing tackle stores, dive shops, fishing piers, recreational boating harbors, beaches, recreational fishing facilities).

Coastal development is regulated by states and territories through the Coastal Zone Management Act and associated state and local programs. Chapter 6 (Additional Regulatory Considerations) provides additional information on coastal zone management in the Study Area.

4.3.5.4 Ocean Noise

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.

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 off the California coast. The data showed an increase in ambient noise of approximately 10 dB in the frequency ranges of 20 to 80 Hertz (Hz) and 200 to 300 Hz, and about 3 dB at 100 Hz over a 33-year period. Each 3 dB increase is noticeable to the human ear and 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). Generally the most energetic regularly operated sound

sources are seismic airgun arrays from approximately 90 vessels with typically 12 to 48 individual guns per array, firing about every 10 seconds (Hildebrand 2004).

Appendix I (Acoustic and Explosives Primer) provides additional information about sources of anthropogenic sound in the ocean and other background information about underwater noise. This section 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.

4.3.5.5 Ocean Pollution

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 ecosystems. 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 nonpoint sources (e.g., storm water runoff from watersheds), point sources (e.g., wastewater treatment plant discharges), other land-based sources (e.g., windblown debris), spills, dumping, vessels, and atmospheric deposition.

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

Polluted runoff, or non-point source pollution, is considered the major cause of impairment of ocean waters. Stormwater runoff from coastal urban areas and beaches carries waste such as plastics and Styrofoam into coastal waters. Sewer outfalls are a point source type 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 polychlorinated biphenyl (PCB) and dichlorodiphenyltrichloroethane (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 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). Harmful algal blooms are proliferations of marine and freshwater algae (including cyanobacteria and non-photosynthetic algae-like organisms) that can produce toxins, causing human illness and massive animal mortalities. They also can accumulate in sufficient numbers to alter ecosystems in detrimental ways.

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.

4.3.5.5.2 Marine Debris

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

Plastic debris is a major concern because it degrades slowly and many plastics float. The floating debris is transported by currents throughout the oceans and has been discovered accumulating in oceanic gyres (Law et al. 2010). Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants such as PCB and DDT, which accumulate up to one million times more in plastic than in ocean water (Takada 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 [kg]) of plastic debris a year (Davison and Asch 2011).

4.3.5.6 Commercial and General Aviation

Commercial and general aviation are retained for analysis and discussion due to associated emissions from aviation activities and effects on greenhouse gas. An analysis of greenhouse gas is presented in Section 4.4.3.1 (Greenhouse Gases).

4.3.5.7 Transportation Improvements

Saipan Department of Public Works Route 1 Feasibility Study will look into the prospect of passenger and vehicle ferry services between Tinian and Saipan. Service had formerly been provided between the two islands but was suspended in March 2010 due to a need for repairs. The Feasibility Study is needed to prove the economic benefits of the passenger and vehicle ferry services between the two islands and to determine any environmental impacts (Saipan Tribune 2012a).

4.3.5.8 Climate Change

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 anthropogenic warming over the last three decades has 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
- Ocean acidification

4.4 RESOURCE-SPECIFIC CUMULATIVE IMPACTS

4.4.1 RESOURCE AREAS DISMISSED FROM CURRENT IMPACTS ANALYSIS

In accordance with Council on Environmental Quality 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, sea turtles, terrestrial species and habitats, and cultural resources. While each of the following resources is discussed in the following section, detailed analysis of cumulative impacts was not necessary for the following resources as the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low. Further analysis of cumulative impacts is not warranted on the following resources:

- Sediments and water quality
- Air quality
- Marine habitats
- Marine birds
- Marine vegetation
- Marine invertebrates
- Fish
- Socioeconomic resources
- Public health and safety

4.4.2 SEDIMENTS AND WATER QUALITY

The analysis in Section 3.1 (Sediments and Water Quality) indicates that the Preferred Alternative could result in local, short- and long-term changes in sediment and water quality. However, chemical, physical, or biological changes to sediments or water quality would be below applicable standards, regulations, and guidelines and would be within existing conditions or designated uses (Section 3.1.1.2, Methods, lists applicable standards, regulations, and guidelines). The short-term impacts would arise from explosions and the byproducts of explosions and combusted propellants. It is unlikely these short-term impacts would overlap in time and space with other future actions that produce similar constituents. Therefore, the short-term impacts described in Section 3.1 (Sediments and Water Quality) are not expected to contribute to cumulative impacts.

The long-term impacts would arise from unexploded ordnance, noncombusted propellant, metals, and other materials. Long-term impacts of each alternative would be cumulative with other actions that cause increases in similar constituents. However, the incremental contribution of the No Action Alternative, Alternative 1 (Preferred Alternative), or Alternative 2 to long-term cumulative impacts would be negligible because:

- Most training and testing activities are widely dispersed in space and time;
- Most components of expended materials are inert or corrode slowly;
- Numerically, most of the metals expended are small- and medium-caliber projectiles, metals of concern comprise a small portion of the alloys used in expended materials, and metal corrosion is a slow process that allows for dilution;
- Most of the components are subject to a variety of physical, chemical, and biological processes that render them benign; and

- Potential areas of impacts would be limited to small zones immediately adjacent to the explosive, metals, or chemicals other than explosives.

Furthermore, none of the alternatives would result in long-term and widespread changes in environmental conditions, such as nutrient loading, turbidity, salinity, or pH (a measure of the degree to which a solution is either acidic [pH less than 7.0] or basic [pH greater than 7.0]). Based on the analysis presented in Section 3.1 (Sediments and Water Quality) and the reasons summarized above, the changes in sediment and water quality would be measurable, but would still be below applicable standards and guidelines; therefore, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low and further analysis of cumulative impacts is not warranted.

4.4.3 AIR QUALITY

As detailed in Section 3.2 (Air Quality), training and testing activities conducted under Alternatives 1 and 2 would result in increased criteria pollutant emissions and hazardous air pollutant emissions throughout the Study Area. Sources of the emissions would include vessels and aircraft and, to a lesser extent, munitions. Potential impacts include localized and temporarily elevated pollutant concentrations. Recovery would occur quickly as emissions disperse. The impacts of Alternatives 1 or 2 would be cumulative with other actions that involve criteria air pollutant and hazardous air pollutant emissions. However, the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be low for the following reasons:

- Most training and testing-related emissions are projected to occur at distances greater than 3 nautical miles (nm) from shore.
- Few stationary offshore air pollutant emission sources exist within the Study Area and few are expected in the foreseeable future.
- International regulations by the International Maritime Organization required commercial shipping vessels to switch to lower-sulfur fuel near U.S. and international coasts beginning in 2012 (National Oceanic and Atmospheric Administration 2011). The Department of Defense has released the *Operational Energy Strategy: Implementation Plan* which will reduce demand, diversify energy sources, and integrate energy consideration into planning (Department of Defense 2012). The U.S. Department of the Navy policy commits to a reduction of oil consumption by 50 percent by 2015; 40 percent of the Navy's total energy will come from fossil fuel alternatives and 50 percent of its onshore energy will come from renewable sources by 2020 (Environmental and Energy Study Institute 2009; Paige 2009).

Based on the analysis presented in Section 3.2 (Air Quality) and the reasons summarized above, the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be negligible. Further analysis of cumulative impacts on air quality is not warranted.

4.4.3.1 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. 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 National Oceanic and Atmospheric Administration and National Aeronautics and Space

Administration data the average surface temperature has increase by about 1.2 to 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, changes in ocean pH and salinity, changing weather patterns with increases in the severity of storms and droughts, changes to local and regional ecosystems (including the potential loss of species), shrinking glaciers and sea ice, thawing permafrost, a longer growing season, and shifts in plant and animal ranges. Climate change is likely to negatively impact the Study Area and adjacent regions.

Over the next several decades, temperatures are projected to rise. 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).

In 2009, the U.S. generated about 6,633.2 teragrams (Tg) (or million metric tons) of carbon dioxide (CO_2) equivalents (U.S. Environmental Protection Agency 2012). The 2009 inventory data (U.S. Environmental Protection Agency 2012) show that CO_2, methane (CH_4), and nitrous oxide (N_2O) contributed from fossil fuel combustion processes of mobile and stationary sources (all sectors) include approximately:

- 5,505.2 Tg of CO_2
- 686.3 Tg CH_4
- 295.6 Tg N_2O

The 6,633.2 Tg CO_2 equivalent (CO_2 Eq) generated in 2009 is a decrease from the 7,263.4 Tg CO_2 Eq generated in 2007 (U.S. Environmental Protection Agency 2011). Among domestic transportation sources, light-duty vehicles (including passenger cars and light-duty trucks) represented 64 percent of CO_2 emissions, medium- and heavy-duty trucks 20 percent, commercial aircraft 6 percent, and other sources 9 percent. Across all categories of aviation, CO_2 emissions decreased by 21.6 percent (38.7 Tg) between 1990 and 2009. This includes a 59 percent (20.3 Tg) decrease in emission from domestic military operations. To place military aircraft in context with other aircraft CO_2 emissions, in 2009, commercial aircraft generated 111.4 Tg CO_2 Eq, military aircraft generated 14.1 Tg CO_2 Eq, and general aviation aircraft generated 13.3 Tg CO_2 Eq Military aircraft represent roughly 10 percent of emissions from the overall jet fuel combustion category (U.S. Environmental Protection Agency 2012).

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.

4.4.3.1.1 Regulatory Framework

Federal agencies address emissions of greenhouse gases by reporting and meeting reductions mandated in laws, executive orders (EOs), and policies. The most recent of these are EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance* of 5 October 2009, and EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* of 26 January 2007.

Executive Order 13514 shifts the way the government operates by (1) establishing greenhouse gases as the integrating metric for tracking progress in federal sustainability, (2) requiring a deliberative planning

process, and (3) linking budget allocations and Office of Management and Budget scorecards to ensure goal achievement.

The targets for reducing greenhouse gas emissions discussed in EO 13514 for Scope 1 (direct greenhouse gas emissions from sources that are owned or controlled by a federal agency) and Scope 2 (direct greenhouse gas emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency) have been set for the Department of Defense at a 34 percent reduction of greenhouse gas from the 2008 baseline by 2020. Scope 3 targets (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) were set at a 13.5 percent reduction. EO 13514, *Strategic Sustainability Performance Plan*, submitted to the Council on Environmental Quality on 2 June 2010 contains a guide for meeting these goals.

Executive Order 13423 established a policy that federal agencies conduct their environmental, transportation, and energy-related activities in support of their respective missions in an environmentally economic way. It included a goal of improving energy efficiency and reducing greenhouse gas emissions of the agency through reduction of energy intensity by 3 percent annually through the end of Fiscal Year 2015, or 30 percent by the end of Fiscal Year 2015, relative to the baseline of the agency's energy use in fiscal year 2003.

The *Draft NEPA Guidance on Consideration of the Impacts of Climate Change and Greenhouse Gas Emissions* (Council on Environmental Quality 2010) states that "if a proposed action would be reasonably anticipated to cause direct emissions of 25,000 metric tons or more of carbon dioxide equivalent (CO_2 Eq) greenhouse gas emissions on an annual basis, agencies should consider this an indicator that a quantitative and qualitative assessment may be meaningful to decision makers and the public."

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 implement EO 13514 (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.

4.4.3.1.2 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. This 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 is 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 1. 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_2 Eq. The CO_2 Eq 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_2 Eq 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 Tg CO_2 Eq.

Greenhouse gas emissions were calculated for ships and aircraft (Table 4.4-1), which contribute the majority of emissions associated with training and testing in the Study Area. Greenhouse gas emissions from minor sources such as munitions, weapons platforms, and auxiliary equipment are 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.

Table 4.4-1: Greenhouse Gas Emissions from Ship and Aircraft Training and Testing Activities in the Mariana Islands Training and Testing Study Area

Alternative	Annual Emissions (Teragrams)			
	CO_2	N_2O	CH_4	CO_2 Eq
No Action Alternative	0.21	0.00	0.00	0.21
Alternative 1 (Preferred Alternative)	0.74	0.00	0.00	0.75
Increase in emissions for Alternative 1 compared to No Action Alternative	0.53	0.00	0.00	0.54
Alternative 2	0.81	0.00	0.00	0.82
Increase in emissions for Alternative 2 compared to No Action Alternative	0.60	0.00	0.00	0.61

Notes: CO_2 = carbon dioxide, N_2O = nitrous oxide, CH_4 = methane, CO_2 Eq = carbon dioxide equivalent

Ship and aircraft greenhouse gas emissions are compared to U.S. 2009 greenhouse gas emissions in Table 4.4-2; calculations are included in Appendix D (Air Quality Calculations and Record of Non-Applicability). The estimated CO_2 Eq emissions from the No Action Alternative are 0.0032 percent of the total CO_2 Eq emissions generated by the United States in 2009. The estimated CO_2 Eq emissions from Alternatives 1 and 2 would increase because of increased training and testing activities to about 0.0113 and 0.0124 percent of the total CO_2 Eq emissions, respectively, generated by the United States in 2009.

Based on the analysis presented in Section 3.2 (Air Quality) and the reasons summarized above, the changes in air quality would be measurable, but would still be below applicable standards and guidelines; therefore, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low and further analysis of cumulative impacts is not warranted.

Table 4.4-2: Comparison of Ship and Aircraft Greenhouse Gas Emissions to United States 2009 Greenhouse Gas Emissions

Alternative	Annual Greenhouse Gas Emissions (CO_2 Eq)	Percentage of U.S. 2009 Greenhouse Gas Emissions
No Action Alternative	0.22	0.0032
Alternative 1 (Preferred Alternative)	0.72	0.0113
Alternative 2	0.81	0.0124
U.S. 2009 greenhouse gas emissions	6,633.2	

Note: CO_2 Eq = carbon dioxide equivalent
Source: U.S. Environmental Protection Agency 2011

4.4.4 MARINE HABITATS

The analysis presented in Section 3.3 (Marine Habitats) indicates that marine habitats could be affected by acoustic stressors (underwater detonations) and physical disturbance or strikes (interactions with military expended materials or seafloor devices). Potential impacts include localized disturbance of the seafloor, cratering of soft bottom sediments, and structural damage to hard bottom habitats. Impacts on soft bottom habitats would be short term, and impacts on hard bottom would be long term. The impacts of each alternative would be cumulative with other actions that cause similar disturbances. The current aggregate impacts of past, present, and reasonably foreseeable future actions described in Section 4.3 (Other Actions Analyzed in the Cumulative impacts Analysis) may have a significant effect, but are not likely to adversely affect marine habitats. These aggregate impacts are considered significant because vessel strikes, dredging, and other stressors associated with other actions discussed in Section 4.3 (Other Actions Analyzed in the Cumulative impacts Analysis) and Table 4.3-1 may result in alterations of marine habitats. Alternative 1 could also result in alterations of marine habitats from underwater explosions and strikes. Although this EIS/OEIS does address some of these other actions in Section 4.3 (Other Actions Analyzed in the Cumulative impacts Analysis), many of these other actions, and their cumulative impacts on marine habitats, cannot be determined with any specificity or certainty at this time. However, it can reasonably be assumed that there may be marine habitats that could be affected by these other actions, but with no specific details regarding the individual impacts or effects. Alterations to marine habitats that might occur under Alternative 1 would be additive to those associated with these other actions. However, the relative contribution of Alternative 1 to the overall alterations of marine habitats would be low compared to the other actions for the following reasons:

- The area of hard bottom potentially impacted represents a negligible percentage (less than 1 percent as analyzed in Section 3.3, Marine Habitats) of the total hard bottom habitat in the Study Area.
- Impacts would be confined to a limited area, and recovery of soft bottom habitats would occur quickly.

Based on the analysis presented in Section 3.3 (Marine Habitats) and the reasons summarized above, the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be negligible.

4.4.5 MARINE MAMMALS

4.4.5.1 Impacts of Alternatives 1 and 2 That May Contribute to Cumulative Impacts

Based on the analysis presented in Section 3.4 (Marine Mammals), impacts of Alternatives 1 and 2 that might contribute to cumulative impacts on marine mammals include mortality, injury (Level A harassment under the MMPA), and disturbance or behavioral modification (MMPA Level B harassment).

Mortality or injury could be caused by underwater explosions or vessel strikes. Injury, in the form of permanent threshold shift (PTS), could also be caused by sonar use. Underwater explosions, swimmer defense air guns, and sonar use would result in disturbance that meets the definition of MMPA Level A and B harassment. The remaining stressors analyzed in Section 3.4 (Marine Mammals) are not expected to result in mortality or Level A or B harassment. The incremental contribution of these remaining stressors to cumulative impacts on marine mammals would be negligible. These stressors are discussed in Section 4.4.5.2 (Impacts of Other Actions) below. The impacts of Alternatives 1 and 2 considered in the cumulative impacts analysis are summarized in Chapter 3, Section 3.4 (Marine Mammals).

4.4.5.2 Impacts of Other Actions

4.4.5.2.1 Overview

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

- Mortality associated with vessel strikes, bycatch in fisheries, and entanglement in fishing and other gear
- Injury associated with 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 planning. 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, including use of explosives for oil rig removal, 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 (Section 4.4.5.2.3) and ocean noise (Section 4.4.5.2.4) subsections. Similarly, many of the actions would result in water pollution. The aggregate impacts of water pollution are addressed below in the ocean pollution section (Section 4.4.5.2.5). Bycatch is associated with commercial fishing, and the primary cause of entanglement is commercial fishing. Therefore, these stressors are discussed below in the commercial fishing section (Section 4.4.5.2.7).

4.4.5.2.2 Surveillance Towed Array Sensor System Low Frequency Active Sonar

Potential impacts on marine mammals from Surveillance Towed Array Sensor System Low Frequency Active Sonar operations include (1) nonauditory injury, (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 Surveillance Towed Array Sensor System Low Frequency Active 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 2011).

4.4.5.2.3 Maritime Traffic and Vessel Strikes

A review of the impacts of vessel strikes on marine mammals is presented in Section 3.4.4.4 (Physical Disturbance and Strike Stressors). 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).

4.4.5.2.4 Ocean Noise

As summarized by the National Academies of Science, the possibility that anthropogenic noise could harm marine mammals or significantly interfere with their normal activities is an issue of concern (National Research Council 2005). Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, and communicating with other individuals. Noise can cause behavioral disturbances, mask other sounds (including their own vocalizations), result in injury, and in some cases, even lead to death (Tyack 2009a, b; Würsig and Richardson 2008). Human-caused noises in the marine environment come from shipping, seismic and geologic exploration, military training, and other types of pulses produced by government, commercial, industry, and private sources. In addition, noise from whale-watching vessels near marine mammals has received a great deal of attention (Wartzok 2009).

Assessing whether a noise may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present near the noise, and the effects that sound may have on the physiology and behavior of those marine mammals. Although it is known that sound is important for marine mammal communication, navigation, and foraging (National Research Council 2003, 2005), there are many unknowns in assessing the specific effects and significance of responses by marine mammals to sound exposures such as what activity the animal is engaged in at the time of the exposure (Nowacek et al. 2007; Southall et al. 2007). Potential impacts on marine mammals from ocean noise include behavioral reactions, hearing loss in the form of temporary threshold shift (TTS) or PTS, auditory masking, injury, and mortality. Section 3.4.3.1 (Acoustic Stressors) discusses these and other possible impacts of ocean noise on marine mammals.

4.4.5.2.5 Ocean Pollution

As discussed in Sections 4.3.5.5 (Ocean Pollution) and 3.4.2.4 (General Threats), 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 3.4.2.4 (General Threats) provides an overview of these potential impacts.

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 associated with Alternatives 1 and 2. The behavioral and physiological responses of any marine mammal to a potential 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 stressors associated with Alternatives 1 and 2.

4.4.5.2.6 Climate Change

The global climate is changing and having impacts on some populations of marine mammals (Salvadeo et al. 2010; Simmonds and Eliott 2009). Climate change can affect marine mammal species directly through habitat loss (especially for species that depend on ice or terrestrial areas) and indirectly via impacts on prey, changing prey distributions and locations, and changes in water temperature. Changes in prey can impact marine mammal foraging success, which in turn affects reproductive success and survival. Climate change also may influence marine mammals through effects on human behavior, such as increased shipping and oil and gas extraction, resulting from sea ice loss (Simmons et al. 2010); see Section 3.4 (Marine Mammals) for more information on impacts on marine mammals.

4.4.5.2.7 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.

Between 1990 and 1999, the annual mean bycatch of marine mammals in U.S. fisheries was more than 6,000 animals, and most of these were killed in gill-net fisheries (Read et al. 2006). The impacts of bycatch on marine mammal populations vary based on removal rates, population size, and reproductive rates. Small populations with relatively low reproductive rates are most susceptible. Bycatch rates for about 12 percent of U.S. marine mammal stocks (almost all cetaceans) exceed their potential biological removal levels (Read 2008). The potential biological removal level is the number of animals that can be removed each year without preventing a stock from reaching or maintaining its optimal sustainable population level.

As discussed in Section 3.4.4.5 (Entanglement Stressors), 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.

4.4.5.3 Cumulative Impacts on Marine Mammals

The current aggregate impacts of past, present actions, 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 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. Alternatives 1 and 2 could also result in injury and mortality to individuals of some marine mammal species from underwater explosions, sonar, and vessel strikes. Injury and mortality that might occur under Alternatives 1 and 2 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. While quantitative estimates of marine mammal mortality from other actions are not available, bycatch for cetaceans and pinnipeds in the United States accounted for 4,146 mortalities in 1999 (Read et al. 2006).

Ocean noise associated with other actions and acoustic stressors (underwater explosions and sonar) associated with Alternatives 1 and 2 could also result in additive behavioral impacts on marine mammals. Other future actions such as construction and operation of liquefied natural gas terminals, and wave and tidal energy facilities would be expected to result in MMPA Level B harassment. However, 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. Furthermore, most of these other actions are not compatible with or could interfere with training and testing activities that involve underwater explosions and sonar use. 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 and testing.

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.

The potential also exists for the impacts of ocean pollution and acoustic stressors associated with Alternatives 1 and 2 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.

In summary, the current aggregate impacts of past and present actions and reasonably foreseeable future actions are expected to result in significant impacts on some marine mammal species in the Study Area. Therefore, cumulative impacts on marine mammals would be significant without consideration of the impacts of Alternatives 1 and 2. Alternatives 1 and 2 would contribute to and increase cumulative impacts, but the relative contribution would be low compared to other actions.

4.4.6 SEA TURTLES

4.4.6.1 Impacts of Alternatives 1 and 2 That May Contribute to Cumulative Impacts

Impacts of Alternatives 1 and 2 that might contribute to cumulative impacts on sea turtles include mortality, injury, and short-term disturbance or behavioral modification. Mortality or injury could be caused by underwater explosions or vessel strikes. Injury, in the form of PTS, could also be caused by

sonar use. Noninjurious impacts of underwater explosions and sonar use would include short-term disturbance or behavioral modification. The Navy's ESA determinations presented in Table 3.5-13 are "no effect" or "may affect, not likely to adversely affect" for the remaining stressors analyzed in Section 3.5 (Sea Turtles). The incremental contribution of these remaining stressors to cumulative impacts on sea turtles would be negligible. Therefore, these stressors are not considered further in the cumulative impacts analysis.

4.4.6.2 Impacts of Other Actions

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

- Mortality associated with vessel strikes, bycatch in fisheries, entanglement, and stressors associated with coastal development and human use of coastal environments
- Injury associated with vessel strikes, bycatch, entanglement, and underwater sound
- Disturbance, behavioral modifications, and reduced animal fitness associated with underwater noise
- Reduced animal fitness associated with ocean pollution
- Habitat loss related to coastal development

Most of the other actions and considerations retained for analysis in Section 3.5 (Sea Turtles) include operation of marine vessels. Exceptions include the actions listed under environmental regulations and planning. 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. Rather than discussing these stressors for individual actions, their aggregate impacts are considered below as "other environmental considerations" in maritime traffic (Section 4.4.6.3, Maritime Traffic and Vessel Strikes) and ocean noise (Section 4.4.6.4, Ocean Noise). Similarly, many of the actions could result in ocean pollution. The aggregate impacts of water pollution are addressed below in the ocean pollution section (Section 4.4.6.5, Ocean Pollution). Bycatch is associated with commercial fishing, and the primary cause of entanglement is commercial fishing. Therefore, these stressors are discussed below in the commercial fishing section (Section 4.4.6.6, Commercial Fishing).

4.4.6.2.1 Surveillance Towed Array Sensor System Low Frequency Active Sonar

Sea turtles could be affected if they are inside the mitigation zone (180 dB sound field) during a Surveillance Towed Array Sensor System Low Frequency Active Sonar transmission. However, because received levels from Surveillance Towed Array Sensor System Low Frequency Active Sonar operations would be below 180 dB sound pressure level within 12 nm or greater distance of any coastlines and offshore biologically important areas, effects on a sea turtle stock could occur only if a significant portion of the stock encountered the Surveillance Towed Array Sensor System Low Frequency Active Sonar vessel in the open ocean. The potential for Surveillance Towed Array Sensor System Low Frequency Active Sonar operations to expose sea turtle stocks to injurious (nonauditory or PTS) sound levels or to cause TTS or behavioral changes is considered negligible because (U.S. Department of the Navy 2011):

- Most sea turtle species inhabit the earth's oceanic temperate zones, where sound propagation is predominantly characterized by downward refraction (higher transmission loss, shorter

range), rather than ducting (lower transmission loss, longer range), which is usually found in cold-water regimes.
- Sea turtle distribution and density are generally low at ranges greater than 12 nm from the coast.
- The Surveillance Towed Array Sensor System Low Frequency Active Sonar signal has a narrow bandwidth (approximately 30 Hz).
- The ship is always moving, and the system has a low duty cycle (estimated 7.5 percent), which means sea turtles would have less opportunity to be in the mitigation zone during a transmission.
- Visual monitoring mitigation is incorporated into the Preferred Alternative.

4.4.6.3 Maritime Traffic and Vessel Strikes

Maritime traffic has increased over the past 50 years, and continued increases are expected in the future. Vessel strikes have been and will continue to be a cause of sea turtle mortality and injury throughout portions of the Study Area where sea turtles regularly occur. Because of the wide dispersal of large vessels in open ocean areas and the widespread, scattered distribution of turtles at sea, strikes during open-ocean transits are unlikely.

Some vessel strikes would cause temporary reversible impacts, such as diverting the turtle from its previous activity or causing minor injury. A National Research Council report qualitatively ranked the relative importance of various mortality factors for sea turtles. Vessel strikes were ranked 10th, behind leading factors of shrimp trawling and other fisheries (National Research Council 1990). Major strikes would cause permanent injury or death from bleeding, infection, or inability to feed. Apart from the severity of the physical strike, the likelihood and rate of a turtle's recovery from a strike may be influenced by its age, reproductive state, and general condition. Much of what is written about recovery from vessel strikes is inferred from observing individuals some time after a strike. Numerous living sea turtles bear scars that appear to have been caused by propeller cuts or collisions with vessel hulls (Hazel et al. 2007; Lutcavage et al. 1997), suggesting that not all vessel strikes are lethal. Conversely, fresh wounds on some stranded animals may strongly suggest a vessel strike as the cause of death. The actual incidence of recovery versus death is not known, given available data.

4.4.6.4 Ocean Noise

Potential impacts on sea turtles from ocean noise include behavioral reactions, hearing loss in the form of TTS or PTS, auditory masking, injury, and mortality. Section 3.5.3.1 (Acoustic Stressors) discusses these and other possible impacts of ocean noise on sea turtles.

4.4.6.5 Ocean Pollution

Marine debris can also be a problem for sea turtles through entanglement or ingestion. Sea turtles can mistake debris for prey; one study found 37 percent of dead leatherbacks to have ingested various types of plastic (Mrosovsky et al. 2009). Other marine debris, including abandoned fishing gear and cargo nets, can entangle and drown turtles in all life stages.

4.4.6.6 Commercial Fishing

Bycatch is one of the most serious threats to the recovery and conservation of sea turtle populations (National Research Council 1990; Wallace et al. 2010). Among fisheries that incidentally capture sea turtles, certain types of trawl, gillnet, and longline fisheries generally pose the greatest threat. One

comprehensive study estimated that worldwide, 447,000 turtles are killed each year from bycatch in commercial fisheries (Wallace et al. 2010).

Other fisheries that result in sea turtle bycatch in the Study Area include pelagic fisheries for swordfish, tuna, shark, and billfish; purse seine fisheries for tuna; commercial and recreational rod and reel fisheries; gillnet fisheries for shark; driftnet fisheries; and bottom longline fisheries (National Marine Fisheries Service 2009).

4.4.6.7 Coastal Development

Coastal development and increased human populations in coastal areas will continue to have impacts on sea turtles such as nesting beach habitat degradation, beach vehicular driving, beach lighting, power plant entrainment, and degradation of nearshore water quality and seagrass beds (see Section 3.5, Sea Turtles, for more information on impacts on sea turtles).

4.4.6.8 Climate Change

Climate change will have impacts on sea turtles such as rising sea level, decreasing nesting beach habitat, increasing ocean temperatures, and acidification degrading water quality and seagrass beds (see Section 3.5, Sea Turtles, for more information on impacts on sea turtles).

4.4.6.9 Cumulative Impacts on Sea Turtles

The current aggregate impacts of past, present, and reasonably foreseeable future actions are expected to result in impacts on sea turtles. These aggregate impacts include those from bycatch, vessel strikes, entanglement, and other stressors associated with other actions which are expected to result in high rates of injury and mortality that could cause population declines to ESA-listed species or inhibit species recovery. The Preferred Alternative could also result in injury and mortality to individual sea turtles from underwater explosions, sonar, and vessel strikes. Injury and mortality that might occur under Alternatives 1 and 2 would be additive to injury and mortality associated with other actions. However, the relative contribution of Alternatives 1 and 2 to the overall injury and mortality would be low compared to other actions. No sea turtle mortalities are estimated for Alternatives 1 and 2 (see Section 3.5.3.1.7.1, Model-Predicted Impacts).

Ocean noise associated with other actions and sound associated with acoustic stressors (underwater explosions and sonar) associated with Alternatives 1 and 2 could also result in additive behavioral impacts on sea turtles. Other future actions such as construction and operation of liquefied natural gas terminals, and wave and tidal energy facilities would be expected to result in similar impacts. However, it is unlikely that these actions and underwater explosions or sonar use would overlap in time and space because all of these activities are widespread and the sources are intermittent. Furthermore, most of these other actions are not compatible with or could interfere with training and testing activities that involve underwater explosions and sonar use. The Navy takes appropriate steps to avoid activities that interfere with or are not compatible with training and testing.

It is likely that distant shipping noise (which is more pervasive 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 sea turtles.

The potential also exists for the impacts of ocean pollution and acoustic stressors associated with Alternatives 1 and 2 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. However, there are no data indicating that a sea turtle affected by ocean pollution would be more susceptible to stressors associated with Alternatives 1 and 2.

In summary, the current aggregate impacts of past and present actions and reasonably foreseeable future actions are expected to result in impacts on sea turtles. Therefore, impacts on sea turtles would be significant without consideration of the impacts of Alternatives 1 and 2. Alternatives 1 and 2 would contribute to and increase cumulative impacts, but the relative contribution would be low compared to other actions.

4.4.7 MARINE BIRDS

The analysis in Section 3.6 (Marine Birds) indicates that birds could potentially be impacted by acoustic stressors (sonar and other active acoustic sources, underwater explosions, weapons firing noise, aircraft noise, vessel noise), energy stressors (electromagnetic devices), physical disturbance and strikes (aircraft, aerial targets, vessels and in-water devices, military expended materials), and ingestion (military expended materials). Potential responses would include a startle response, which includes short-term behavioral (e.g., movement) and physiological components (e.g., increased heart rate). Recovery from the impacts of most stressor exposures would occur quickly, and impacts would be localized. Some stressors, including underwater explosions, physical strikes, and ingestion of plastic military expended materials, could result in mortality. However, the number of individual birds affected is expected to be low, and no population-level impacts are expected. The impacts of Alternatives 1 and 2 would be cumulative with other actions that cause short-term behavioral and physiological impacts and mortality to birds. However, the incremental contribution of Alternatives 1 and 2 to cumulative impacts on birds would be low for the following reasons:

- Most of the proposed activities would be widely dispersed in offshore areas, where bird distribution is patchy and concentrations of individuals are often low. Therefore, the potential for interactions between birds and training and testing activities is low.
- It is unlikely that training and testing activities would influence nesting because most activities take place in water and away from nesting habitats on land. Alternatives 1 and 2 would not result in destruction or loss of nesting habitat.
- For most stressors, impacts would be short term and localized, and recovery would occur quickly.
- While a limited amount of mortality could occur, no population-level impacts would be expected.
- The Preferred Alternative is not likely to adversely affect ESA-listed bird species.

Based on the analysis in Section 3.6 (Marine Birds), and the reasons summarized above, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be negligible. Further analysis of cumulative impacts on birds is not warranted.

4.4.8 MARINE VEGETATION

The analysis presented in Section 3.7 (Marine Vegetation) indicates that marine vegetation could be affected by acoustic stressors (underwater explosions) and physical stressors (interactions with vessels and in-water devices, military expended materials, or seafloor devices). Potential impacts include localized disturbance and mortality. Recovery would occur quickly, and population-level impacts are not

anticipated. The impacts of Alternatives 1 and 2 would be cumulative with other actions that cause disturbance and mortality of marine vegetation.

The current aggregate impacts of past, present, and reasonably foreseeable future actions presented in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) may have a significant effect on marine vegetation. These aggregate impacts are considered significant because vessel strikes, increased sedimentation, and other stressors associated with other actions discussed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) and Table 4.3-1 are expected to result in injury and mortality that could inhibit species recovery. Although this EIS/OEIS does address some of these projects, developments and actions listed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis), many of these other actions and their associated cumulative impacts on marine vegetation cannot be determined with any specificity or certainty at this time. However, it can reasonably be assumed that there may be marine vegetation that could be affected by these actions, but with no specific details regarding the individual impacts or effects. Alternatives 1 and 2 could also result in injury and mortality to marine vegetation from underwater explosions and strikes. Injury and mortality that might occur under the Preferred Alternative would be additive to injury and mortality associated with other actions. However, the relative contribution of Alternatives 1 and 2 to the overall injury and mortality would be low compared to other actions for the following reasons:

- Most training and testing activities would occur in areas where seagrasses and other attached marine vegetation do not grow.
- Impacts would be localized, recovery would occur quickly, and no population-level impacts would be expected.
- Proposed training and testing activities would not result in impacts that have been historically significant to marine vegetation. For example Alternatives 1 and 2 would not increase nutrient loading, which can cause algal blooms, decrease light penetration, and impact photosynthesis of seagrasses.

Alternatives 1 and 2 would not result in long-term or widespread changes in environmental conditions such as turbidity, salinity, pH, or water temperature that could impact marine vegetation. Based on the analysis presented in Section 3.7 (Marine Vegetation) and the reasons summarized above, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be negligible. Further analysis of cumulative impacts on marine vegetation is not warranted.

4.4.9 MARINE INVERTEBRATES

The analysis presented in Section 3.8 (Marine Invertebrates) indicates that marine invertebrates could be affected by acoustic stressors (sonar and other active acoustic sources, underwater explosions, weapons firing noise, aircraft noise, vessel noise), energy stressors (electromagnetic devices), physical disturbance or strikes (vessels and in-water devices, military expended materials, seafloor devices), entanglement (fiber optic cables and guidance wires, decelerator/parachutes), and ingestion (military expended materials).

The current aggregate impacts of past, present, and reasonably foreseeable future actions presented in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) may have a significant effect on marine invertebrates. These aggregate impacts are considered significant because vessel strikes, dredging, and other stressors associated with other actions discussed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) and Table 4.3-1 are expected to result in injury and mortality that could cause population declines to ESA-listed species or inhibit species recovery. Although

this EIS/OEIS does address some of these other actions listed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis), many of these actions and their associated cumulative impacts on marine invertebrates cannot be determined with any specificity or certainty at this time. However, it can reasonably be assumed that there may be marine invertebrates that could be affected by these actions, but with no specific details regarding the individual impacts or effects. Alternatives 1 and 2 could also result in injury and mortality to marine invertebrates from underwater explosions, entanglement, and strikes. Injury and mortality that might occur under Alternatives 1 and 2 would be additive to injury and mortality associated with other actions. However, the relative contribution of Alternatives 1 and 2 to the overall injury and mortality would be low compared to other actions for the following reasons:

- Most potential impacts would be short-term behavioral and physiological responses.
- Any impacts from the Proposed Action resulting injury or mortality would be to a relatively small number of individuals.
- No population-level impacts are anticipated.

Based on the analysis presented in Section 3.8 (Marine Invertebrates) and the reasons summarized above, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be negligible.

4.4.10 FISH

The analysis presented in Section 3.9 (Fish) indicates that fish could be affected by acoustic stressors (sonar and other active acoustic sources, explosives, swimmer defense airguns; weapons firing, launch, and impact noise; aircraft noise; and vessel noise), energy (electromagnetic devices), physical disturbance or strikes (vessels and in-water devices, military expended materials, seafloor devices), entanglement (fiber optic cables and guidance wires, decelerator/parachutes), and ingestion (munitions, military expended materials other than munitions).

The current aggregate impacts of past, present, and reasonably foreseeable future actions presented in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) may have a significant effect on fish. These aggregate impacts are considered significant because vessel strikes, entanglement, and other stressors associated with the other actions discussed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) and Table 4.3-1 are expected to result in injury and mortality that could inhibit species recovery. Although this EIS/OEIS does address some of these other actions listed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis), many of these actions and their associated cumulative impacts on fish, cannot be determined with any specificity or certainty at this time. However, it can reasonably be assumed that there may be fish that could be affected by these other actions, but with no specific details regarding the individual impacts or effects. Alternatives 1 and 2 could also result in injury and mortality to fish from underwater explosions, entanglement, and strikes. Injury and mortality that might occur under Alternatives 1 and 2 would be additive to injury and mortality associated with other actions. However, the relative contribution of Alternatives 1 and 2 to the overall injury and mortality would be low compared to other actions for the following reasons:

- Most potential impacts would be short-term behavioral and physiological responses.
- Any impacts from the Proposed Action resulting injury or mortality would be to a relatively small number of individuals.
- No population-level impacts are anticipated.

Based on the analysis presented in Section 3.9 (Fish) and the reasons summarized above, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be negligible.

4.4.11 TERRESTRIAL SPECIES AND HABITATS

The analysis presented in Section 3.10 (Terrestrial Species and Habitats) indicates that terrestrial species could be affected by acoustic stressors (explosions, aircraft noise, and weapons firing noise), physical disturbance or strikes (aircraft, munitions strike, ground disturbance, and wildfires), and secondary stressors. Potential responses would include a startle response, which includes short-term behavioral (e.g., movement) and physiological components (e.g., increased heart rate). Recovery from the impacts of most stressor exposures would occur quickly, and impacts would be localized. Based on the type of activities in the various land training areas of the MITT Study Area, the Navy presents the following summary of effects determinations to ESA-listed species and critical habitats.

4.4.11.1 Critical Habitat

4.4.11.1.1 Critical Habitats on Guam

Critical habitat is designated on Guam for the Mariana crow, Mariana fruit bat, and Micronesian kingfisher. The critical habitat designations for these species are confined to the terrestrial portions of the Guam National Wildlife Refuge fee simple portion (Ritidian Unit). Because training does not occur within the Ritidian Unit and there is no need for training to access the portion of the road that descends down Ritidian Cliff to the Ritidian Unit, the Navy concludes that training and testing activities will not affect critical habitat designated on Guam.

4.4.11.1.2 Critical Habitats on Rota

Critical habitat is designated on Rota for the Mariana crow and Rota bridled white-eye. The Navy does not train in these areas; therefore the Proposed Action will not affect or represent an adverse modification to the designated critical habitat units on Rota and will not disturb the various primary constituent elements. The Navy concludes that the avoidance of designated critical habitat and measures designed for habitat protections described in Section 3.10.1.2 (Migratory Bird Treaty Act and 50 Code of Federal Regulations Part 21.15 Requirements) are sufficient to not affect designated critical habitat on Rota.

4.4.11.2 Summary of Endangered Species Act Effects Determinations

In 2010, the U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office issued a Biological Opinion, pursuant with Section 7 of the ESA, on proposed training and testing activities within the Mariana Islands Range Complex (MIRC), which is a portion of the MITT Study Area. The Biological Opinion concluded that training and testing activities within MIRC would have no effect on the Guam rail, short-tailed albatross, Hawaiian petrel, or Newell's shearwater. These no effect determinations were primarily based on the rare occurrence of these species within MIRC, and absence from breeding grounds and rookery sites located at Farallon de Medinilla. However, the analysis in Section 3.10 (Terrestrial Species and Habitats) notes that acoustic stressors (from explosives) and physical disturbance (from munitions strikes and wildfires) may affect, likely to adversely affect the Micronesian megapode on Farallon de Medinilla.

In summary, the current aggregate impacts of past and present actions and reasonably foreseeable future actions are not expected to result in significant impacts on terrestrial species. The only significant impacts to a terrestrial species, from training and testing activities would be on the Micronesian megapode. There are no other activities or actions, besides the training and testing activities analyzed in Section 3.10 (Terrestrial Species and Habitats) on Farallon de Medinilla that could contribute to cumulative impacts on the Micronesian megapode population.

4.4.12 CULTURAL RESOURCES

4.4.12.1 Impacts of Alternatives 1 and 2 That Might Contribute to Cumulative Impacts

As discussed in Section 3.11 (Cultural Resources), Alternatives 1 and 2 could impact submerged historic resources if certain training and testing activities are conducted where these resources occur and are not avoided. Stressors that could impact cultural resources include acoustic (underwater explosions at depth), physical disturbance (cratering from underwater detonations at depth, use of in-water devices, deposition of military expended materials, and use of ocean-bottom-deployed devices). However, the Navy routinely avoids locations of known obstructions, which includes submerged historic resources, to prevent damage to sensitive Navy equipment and vessels and to ensure the accuracy of training and testing exercises.

4.4.12.2 Impacts of Other Actions

With a few exceptions, most of the other actions retained for cumulative impacts analysis (see Table 4.3-1) would involve some form of disturbance to the ocean bottom. Exceptions include seismic surveys, environmental regulations and planning actions, ocean pollution, and most forms of ocean noise. Actions that would disturb the ocean bottom could impact submerged cultural resources if those resources are not avoided. Any physical disturbance on the ocean floor could inadvertently damage or destroy submerged historic resources if avoidance and mitigation measures are not implemented.

Other actions that result in ocean bottom disturbance require some form of federal authorization or permitting. Therefore, requirements of the National Historic Preservation Act apply to actions in territorial waters. Federal agency procedures have been implemented to identify cultural resources, avoid impacts, and mitigate impacts that cannot be avoided. For example, the Bureau of Ocean Energy Management has procedures in place to identify the probability of the presence of submerged historic resources shoreward from the 148-foot (45-meter) isobath. It also has procedures for project redesign or relocation to avoid identified resources (Minerals Management Service 2007). Nonetheless, inadvertent impacts could occur if submerged cultural resources are present. However, inadvertent impacts are greatly reduced when avoidance and mitigation measures are put in place.

4.4.12.3 Cumulative Impacts on Cultural Resources

Impacts on submerged cultural resources from other actions would typically be avoided or mitigated through implementation of federal agency programs. However, impacts could occur if avoidance or mitigation measures are not implemented or if inadvertent disturbance or destruction of resources occurs. Disturbance or destruction of submerged historic sites, including shipwrecks, would diminish the overall record for these resources and decrease the potential for meaningful research on these resources. When considered with other actions, Alternatives 1 and 2 would not contribute to cumulative impacts on submerged historic resources, if such resources are present in areas where bottom disturbing training and testing activities take place.

4.4.13 SOCIOECONOMIC RESOURCES

The analysis in Section 3.12 (Socioeconomic Resources) indicates that the impacts of Alternatives 1 and 2 on socioeconomic resources would be negligible. Alternatives 1 and 2 are not expected to contribute incrementally to cumulative socioeconomic impacts. Therefore, further analysis of cumulative impacts on socioeconomic resources is not warranted.

4.4.14 PUBLIC HEALTH AND SAFETY

The analysis presented in Section 3.13 (Public Health and Safety) indicates that the impacts of Alternatives 1 and 2 on public health and safety would be negligible. Alternatives 1 and 2 are not expected to contribute incrementally to cumulative health and safety impacts. Therefore, further analysis of cumulative impacts on public health and safety is not warranted.

4.5 SUMMARY AND CONCLUSIONS

Marine mammals, sea turtles, and terrestrial species 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 and terrestrial species, and all sea turtles species occurring in the Study Area are ESA-listed. Several marine mammal species and stocks are also classified as strategic stocks under MMPA.
- These resources would be impacted by multiple ongoing and future actions.
- Explosive detonations and vessel strikes under the No Action Alternative, Alternative 1, and Alternative 2 have the potential to disturb, injure, or kill marine mammals and sea turtles.

The aggregate impacts of past, present, and other reasonably foreseeable future actions are expected to result in significant impacts on some marine mammal, terrestrial, and all sea turtle species in the Study Area. The No Action Alternative, Alternative 1, or Alternative 2 would contribute to cumulative impacts, but the relative contribution would be low compared to other actions. Compared to potential mortality, strandings, or injury resulting from Navy training and testing activities, marine mammal and sea turtle mortality and injury from bycatch, commercial vessel ship strikes, entanglement, ocean pollution, and other human causes are estimated to be orders of magnitude greater (hundreds of thousands of animals versus tens of animals) (Culik 2004; International Council for the Exploration of the Sea 2005; Read et al. 2006).

The analysis presented in this chapter and Chapter 3 (Affected Environment and Environmental Consequences) indicates that the incremental contribution of the No Action Alternative, Alternative 1, or Alternative 2 to cumulative impacts on sediments and water quality, air quality, marine habitats, birds, marine vegetation, marine invertebrates, fish, terrestrial species and habitats, socioeconomic resources, and public health and safety would be negligible. When considered with other actions, the No Action Alternative, Alternative 1, or Alternative 2 might contribute to cumulative impacts on submerged prehistoric and historic resources, if such resources are present in areas where bottom-disturbing training and testing activities take place. The No Action Alternative, Alternative 1, or Alternative 2 would also make an incremental contribution to greenhouse gas emissions, representing approximately 0.005 percent of U.S. 2009 greenhouse gas emissions.

This Page Intentionally Left Blank

REFERENCES

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). 10.1121/1.1461915.

Berman-Kowalewski, M., Gulland, F. M. D., Wilkin, S., Calambokidis, J., Mate, B., Cordaro, J., Dover, S. (2010). Association Between Blue Whale (<I>Balaenoptera musculus</I>) 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. F., Anderson, D. M., Horner, R. A., Shumway, S. E., Tester, P. A. & Whitledge, T. E. (1997). *Harmful algal blooms in coastal waters: Options for prevention, control, and mitigation.* (NOAA Coastal Ocean Office, Decision Analysis Series No. 10). Silver Spring, MD: NOAA Coastal Ocean Office.

Council on Environmental Quality. (1997). *Considering cumulative effects under the National Environmental Policy Act*.

Council on Environmental Quality. (2010). *Draft NEPA guidance on consideration of the effects of climate change and greenhouse gas emissions*. Prepared for heads of federal departments and agencies.

Culik, B. M. (2004). Review of small cetaceans: Distribution, behaviour, migration and threats.

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.

Department of Defense. (2012). Operational Energy Strategy: Implementation Plan. (p. 28). Washington, D.C. Prepared by Assistant Secretary of Defense for Operational Energy Plans & Programs.

Environmental and Energy Study Institute. (2009). Navy Announces Goals to Reduce Energy Demand, Increase Renewable Supply. In *Educating Congress on energy efficiency and renewable energy; advancing innovative policy solutions,*. Retrieved from http://www.eesi.org/102609_navy

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

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.

Hazel, J., Lawler, I. R., Marsh, H. & Robson, S. (2007). Vessel speed increases collision risk for the green turtle *Chelonia mydas*. *Endangered Species Research, 3*, 105–113.

Hildebrand, J. (2004). Sources of anthropogenic sound in the marine environment.

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

International Council for the Exploration of the Sea. (2005). Report of the ad-hoc group on the impacts of sonar on cetaceans and fish (AGISC).

Jackson, J. B. C., M. X. Kirby, W. H. Berger, K. A. Bjorndal, L. W. Botsford, B. J. Bourque, R. H. Bradbury, R. Cooke, J. M. Erlandson, J. A. Estes, T. P. Hughes, S. Kidwell, C. B. Lange, H. S. Lenihan, J. M. Pandolfi, C. H. Peterson, R. S. Steneck, M. J. Tegner and R. R. Warner. (2001). Historical overfishing and the recent collapse of coastal ecosystems. *Ecology Through Time, 293*.

Karl, T. R., Melillo, J. M. & Peterson, T. C. (2009). *Global climate change impacts in the United States*. New York, NY: Cambridge University Press.

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. & 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.

Law, K. L., Moret-Ferguson, S., Maximenko, N., Proskurowski, G., Peacock, E., Hafner, J. & Reddy, C. (2010). Plastic accumulation in the north Atlantic subtropical gyre. *Science, 329*.

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.

Lutcavage, M., Plotkin, P., Witherington, B. & Lutz, P. (1997). Human impacts on sea turtle survival. In P. Lutz and J. A. Musick (Eds.), *The Biology of Sea Turtles* (Vol. 1, pp. 387–409). Boca Raton, FL: CRC Press.

Minerals Management Service. (2007). Gulf of Mexico OCS oil and gas lease sales: 2007–2012. Volume I: Chapters 1–8 and appendices. MMS 2007-018.

Mrosovsky, N., Ryan, G. D. & James, M. C. (2009). Leatherback turtles: The menace of plastic. *Marine Pollution Bulletin, 58*, 287–289.

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

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

National Marine Fisheries Service. (2009). Endangered Species Act Section 7 consultation: Biological opinion for U.S. Navy activities in the Northeast, Virginia Capes, Cherry Point, and Jacksonville.

National Oceanic and Atmospheric Administration. (2011). NOAA Gulf spill restoration. Retrieved from http://www.gulfspillrestoration.noaa.gov/restoration/what-is-restoration-scoping/ as accessed on 2012, February 23.

National Research Council. (1990). Decline of the sea turtles: Causes and prevention. Washington, DC: National Academy Press.

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* (p. 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.

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.

Paige, P. (2009). SECNAV Outlines Five 'Ambitious' Energy Goals, *U.S. Navy Today*.

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.

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.

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.

Salvadeo, C. J., D. Lluch-Belda, A. Gómez-Gallardo, J. Urbán-Ramírez and C. D. MacLeod. (2010). Climate change and a poleward shift in the distribution of the Pacific white-sided dolphin in the northeastern Pacific. *Endangered Species Research* 11: 13-19.

Simmonds, M. P. & Eliott, W.J. (2009). Climate change and cetaceans: Concerns and recent developments. *Journal of the Marine Biological Association of the United Kingdom* 89(1): 203-210.

Simmons, S. E., D. E. Crocker, J. L. Hassrick, C. E. Kuhn, P. W. Robinson, Y. Tremblay and D. P. Costa (2010). Climate-scale hydrographic features related to foraging success in a capital breeder, the northern elephant seal Mirounga angustirostris. *Endangered Species Research* 10: 233-243.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, R., Greene, C., Tyack, P. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals, 33*(4), 122.

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 the Navy. (2010). Navy climate change roadmap.

U.S. Department of the Navy. (2011). Executive summary: Draft supplemental environmental impact statement/supplemental overseas environmental impact statement for surveillance towed array sensor system low frequency active (SURTASS LFA) sonar.

U.S. Environmental Protection Agency. (2009). Inventory of U.S. greenhouse gas emissions and sinks: 1990–2007.

U.S. Environmental Protection Agency. (2011). Nonpoint source pollution. Retrieved from http://www.epa.gov/reg3wapd/nps/index.htm as accessed on 2011, January 31.

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

Vanderlaan, A. S. & Taggart, C. T. (2009). Efficacy of a Voluntary Area to Be Avoided to Reduce Risk of Lethal Vessel Strikes to Endangered Whales. *Conservation Biology, 23*(6), 1467-1474. 10.1111/j.1523-1739.2009.01329x.

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.

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.

Würsig, B. & Richardson, W. J. (2008). Noise, effects of. In W. F. Perrin, B. Wursig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 765-773). San Diego, CA: Academic Press.